EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

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DECLARATION

I, Jayasree, N., do hereby declare that this thesis **EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA** has not been submitted by me for the award of a Degree, Diploma, Title or Recognition before.

Calicut University,
10.09.2004.

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2004

Dr. (Mrs.) KAMALA S. PILLAI

Professor & Dean (Rtd.)
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CERTIFICATE

I, Dr. (Mrs.) Kamala S. Pillai do hereby certify that this thesis **EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA** is a record of bonafide study and research carried out by **Smt. Jayasree, N.** under my supervision and guidance. The report has not been submitted by her for the award of Degree, Diploma, Title or Recognition before.

Kamala S Pillai

Trivandrum,
.09.2004.

Dr. (Mrs.) Kamala S. Pillai
Supervising Teacher

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DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2004

CONTENTS

5

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2004

LIST OF TABLES

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2004

LIST OF FIGURES

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2004

LIST OF APPENDICES

Appendix

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
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DEPARTMENT OF EDUCATION
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2004

CHAPTER 1

INTRODUCTION

- *Need and Significance of the Study*
- *Statement of Problem*
- *Definition of key terms*
- *Variables of the study*
- *Design of the study*
- *Objectives*
- *Hypotheses*
- *Procedure*
- *Scope and Limitations*
- *Oragnisation of the Report*

Mathematics has been recognised as a living and growing intellectual pursuit throughout centuries. It has its roots in everyday activities and form the basic structure of highly advanced technological society. Therefore mathematics learning is necessary for all students; not only for those who have careers that demand advanced mathematics but also for all citizens. It is to be noted that proficiency in mathematics whether basic or advanced is not an innate characteristic: it is achieved through persistence, effort and practice on the part of learners and effective instruction on the part of teachers.

The study of mathematics has become indispensable in one's life because of its wide-ranging application in the present technological society. This society requires the use of skills such as estimating, measuring, interpreting, predicting and applying mathematics to life situations. The National Policy of Education (1986) has rightly visualised mathematics as a vehicle to train a child to think, reason, analyse, and articulate logically. Since qualitative treatment, measurement, analysis and synthesis, are being extensively used in many other academic subjects, the relevance of mathematics in child's environment and in the study of other subject areas has to be emphasized in the school curriculum. Mathematics is an important curriculum area at the school level. Everyone agrees that study of mathematics should be compulsory for all, as a part of general education at the school stage. It is also expected that all children should achieve some basic skills in mathematics at mastery level since mathematics is an important key element for students' general comprehension and analytic skills.

In the existing situation of the country, one can find that the achievement level of majority of children in mathematics is not upto the mark. Failure in mathematics is considered as one of the major factors for the overall failure rate in school, resulting in wastage and stagnation at different levels. Therefore some corrective methods are necessary for improving the quality of teaching-learning process in mathematics in schools.

Students with learning difficulties spend a substantial portion of their academic working, on mathematics learning. Major deficits in mathematical skills are apparent and persistent in them. Secondary pupils with difficulties in learning will make only a slow progress in the learning of complex concepts and skills. Teachers complain that the lack of skills in basic computation and numeration are most common even among students at higher classes. By the time students complete schooling or drop-out of schools, they might have made only the most rudimentary achievements in mathematical skills. Only a few might have acquired the levels of application and problem-solving skills necessary to function independently. It is to be noted that the progress in the learning of mathematics depends on their receiving better instruction in mathematics while they are at primary level. Many studies show that students in primary graders fail to acquire sufficient skills in fundamental operations and their applications. These persistent skill deficit, combined with limited fluency in the recall of basic mathematical facts and concepts hinder the development of higher level learning. One of the reasons for the skill deficit can be attributed to unsatisfactory and inefficient techniques of teaching and learning.

1.1 NEED AND SIGNIFICANCE

The teaching and learning of mathematics have always been a major concern in education. There is a general feeling of dissatisfaction among public and educationists about the teaching-learning strategies of mathematics currently adopted in many of the schools. Students' failure occurs mainly as a result of inadequate and inappropriate learning experiences in mathematics class. Ineffective instruction leads not only to poor performance but also to a negative estimate to self-efficiency.

In the case of primary teaching many people consider that the content is very easy to learn and anybody can teach. Mathematics is a subject, which is built on certain basic concepts. Higher concepts are impossible without the correct knowledge of the previous concept. Proper understanding of basic concepts and the ability to apply them in different situations are extremely important for the achievement in mathematics.

Teaching methods associated with outdated views of teaching and learning theories are still prevalent in many classrooms. Such practices include extensive whole-group instruction and intensive drill and practice on isolated skills for groups or individuals. These practices are not particularly effective for all primary-grade children. This challenge necessitates a pedagogical shift from transmitting a body of expected knowledge that is largely memorised to one that is largely process oriented. Helping them to develop the skills necessary to become life long learners requires a different approach to teaching and learning. Hence the major aim of teaching is to create powerful learners. Children enrolled in educational programmes, which have well-defined academic objectives will enjoy greater achievement in basic skills.

Mathematics appears to be a tough subject for many students. They often need a challenge or a boost to stimulate a real interest in it. Studies show that many students are not motivated enough by their school work and are in need of special attention to help for development of their full potential. Getting students excited about mathematics is a challenge. Some students have a natural love to work with numbers, while others struggle through every problem with aversion.

Miserable failure in schools in the final certification examination consequent to failure in mathematics is often reported, even though subjects are taught by teachers specialised themselves in mathematics. These teachers are masters of the subject but they fail to help the students to boost them and master the content. This imbalance is conspicuous in the Secondary School Leaving Certificate Examination results. The quantum of mathematics syllabus in the general curriculum has been attributed as one of the reasons for this imbalance. As a result, in the performance of mathematics there is a wide gap between the anticipated outcome and actual outcomes. There seem to be a gap between the theory and practice in teaching resulting in the discrepancies between curriculum formulated and implemented. It is reported that marks in mathematics has the lowest state average in the Secondary School Leaving Certificate Examination.

The recent findings reported in the literature by cognitive and instructional psychologists Rosenshine (1997) suggest that the role played by the individual student's information processing capabilities may be a critical factor for improving learning and retention of skills. The search for the secret of effective teaching is not a new one. The development of teaching models has successfully brought together a unique combination of theory construction and empirical testing.

Several psychologists have identified one such teaching approach that enables to improve student learning that is 'Direct Instruction Model'. Direct Instruction Model emerged as an outgrowth of attempts to synthesise principles of effective teaching into a practical pedagogical model. Pioneered by Engelmann in the 1960's Direct Instruction is a teacher-directed, school reform model, which maximises learning. This model of teaching breaks skills into teachable sub skills and then shows students how to bring these together in a larger strategy. This is a powerful research-based basal programme that not only teaches essential skills but also fosters natural fluency in mathematics, allowing smart decisions in all aspects of life. The goal of Direct Instruction is to (i) help students to attain mastery as quickly as possible and (ii) to increase student achievement.

The important objective of mathematics instruction is that, the three components of mathematics, namely basic skills, mental arithmetic and mathematical extension are to be taught to a mastery level and to be continuously revised to retain them. The suitability of Direct Instruction Model to attain the above three basic components caught the attention of the investigator as it is a systematic method of presenting the materials in small steps, pausing to check student understanding and eliciting active and successful participation from all students.

The basic theory of Direct Instruction Model of teaching and results of the research on the practical application of this model was studied carefully by the investigator to know whether this can be adopted to get better results in the mastery of basic essential concepts in mathematics in an ordinary school in Kerala. The essential features of Direct Instruction Model are detailed in Chapter II.

From the studies surveyed it was found that Direct Instruction is worth experimenting in the primary stage for mastering basic skills in a conventional educational context. Most of the studies were conducted in the western countries concentrating more on language and other skill oriented subjects including mathematics. Investigator failed to identify any study in Indian conditions. The investigator felt that the rigid classroom organisation of our schools may be disturbed only to a minimum and at the same time the attainment of instructional objectives in mathematics be maximised. The investigator is also interested in finding out not the attainment of knowledge in the content alone but how best the mastery can be attained if Direct Instruction is adopted in a conventional class.

If Direct Instruction Model is suitable for mastering tasks in one unit, it is hoped that it will be successful for other topics in the same subject and at different levels too. Considering the above factors, it seems worthwhile to examine how good Direct Instruction Model can be implemented on experimental basis in learning of basic concepts in mathematics. One of the delimitationsof Direct Instruction Model of teaching anticipated by the authors is that this method cannot be applied for all pupils for all the time and for all the educational objectives. This fact will be kept in mind during the selection of the topics for experimentation, in the selection of instructional objectives, and for drawing the sample for experimentations.

1.2 STATEMENT OF THE PROBLEM

The present study is entitled "EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA".

1.3 DEFINITION OF KEY TERMS

1.3.1 Direct Instruction Model

"Direct Instruction Model is a systematic method of presenting materials in small steps, pausing to check for student understanding and eliciting active and successful participation from all students" (Rosenshine, 1986).

1.3.2 Achievement in Select Mathematical Skills

Achievement is defined as tangible accomplishment or performance in mathematical skills. The investigator proposed to confined only to intellectual mathematical skills included in 'fractions' and 'decimals'. These intellectual skills were measured by a test comprising of fundamental operations, place value and changing from one form to another form.

1.3.3 Upper Primary Pupils

Pupils who are studying in the upper primary classes namely V, VI, and VII in the schools managed directly/aided by Director of Public Instructions' Government of Kerala.

1.4 VARIABLES OF THE STUDY

Variables included in the present study are the following.

1.4.1 Independent Variables

Two sets of variables based on methods of teaching were selected as independent variables.

1.4.1.1 Direct Instruction Model

Direct Instruction Model of teaching by Siegfried Engelmann (2001) was selected for treatment.

1.4.1.2 Objective Based Instruction

Objective Based Method of teaching adopted and followed in the upper primary schools of Kerala was considered as conventional method of teaching.

1.4.2 Dependent Variable

Achievement in Mathematical skills was considered as the dependent variable. Test to measure this variable comprise of items like Knowledge, Comprehension and Application category. Achievement in Mathematical Skills Post-Test I and Post-Test II were considered as Dependent Variables.

1.4.3 Control Variables

The control variables in the experimentation were the following.

- Previous knowledge of the subject matter
- Non-verbal Intelligence
- Numerical Ability

1.5 DESIGN

The Pre-test-Post-test Quasi-Experimental design was used for the study. Three groups were selected for treatment. Experimental Group I was taught through Direct Instruction Model, Experimental Group II was taught through Direct Instruction Model and Objective Based Instruction alternately and Control Group was taught through Objective Based Instruction only.

1.6 OBJECTIVES

The specific objectives formulated for the experimentation were given as follows:

1.6.1 To compare the mean scores of Achievement in Mathematical skills Post-Test I (tested immediately after the treatment) of Control Group and Experimental GroupI and between Control Group and Experimental Group II.

1.6.2 To compare the mean Gain scores of Achievement in Mathematical skills (Post-Test I minus Pre-Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.6.3 To compare the mean Retention scores of Achievement in Mathematical skills Post-Test II (tested two months after the treatment) of Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.6.4 To compare the mean Gain scores of Achievement in Mathematical skills (Post-Test II minus Pre-Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.6.5 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total sample, Boys and Girls.

1.6.6 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

1.6.7 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test I for Total sample, Boys and Girls.

1.6.8 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.6.9 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.6.10 To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.6.11 To study the relative effectiveness of Direct Instruction Model on Achievement in Mathematical Skills when initial difference in select variables namely 'Previous Knowledge of Subject Matter', 'Non-verbal Intelligence' and 'Numerical Ability of subjects are controlled one by one.

1.7 HYPOTHESES

To find out the relative effectiveness of Direct Instruction Model over Objective Based Instruction of Upper Primary pupils, the following hypotheses were formulated.

1.7.1 There will be significant difference in the mean scores of Achievement in Mathematical Skills Post-Test I (tested immediately after the treatment) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.7.2 There will be significant difference in the mean Gain scores of Achievement in Mathematical Skills (Post-Test I minus Pre-Test) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.7.3 There will be significant difference in the mean Retention scores of Achievement in Mathematical Skills Post -Test II (tested two months after the treatment) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.7.4 There will be significant difference in the mean Gain scores of Achievement in Mathematical Skills (Post-Test II minus Pre-Test) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

1.7.5 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total sample, Boys and Girls.

1.7.6 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total sample, Boys and Girls.

1.7.7 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test I for Total sample, Boys and Girls.

1.7.8 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.7.9 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.7.10 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test II for Total sample, Boys and Girls.

1.7.11 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II than pupil taught through Objective Based Instruction when the initial difference in Previous Knowledge of Subject Matter of subjects were controlled.

1.7.12 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II than pupils taught through Objective Based Instruction when the initial difference in Non-vertical Intelligence of subjects were controlled.

1.7.13 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II than pupils taught through Objective Based Instruction when the initial difference in Numerical Ability of subjects were controlled.

1.8 PROCEDURE

The various steps in the procedure for executing the study are summarised as given below.

1.8.1 Sample for the Study

Intact groups of students from standard VII were selected as sample and the subjects were from three different districts of Kerala. The groups were matched on the basis of Previous Knowledge of Subject Matter, Non-verbal Intelligence and Numerical Ability. Experimental Group I taught through Direct Instruction Model, Experimental Group II taught through Direct Instruction Model and Objective Based Instruction alternately and

Control Group taught through Objective Based Instruction, each consisted of sixty students.

1.8.2 Selection of the Topic for Treatment

A thorough analysis of the syllabus of mathematics at Upper Primary level was done. Investigator made discussions with experts in the field of mathematics, teachers who are handling the classes at upper primary level and students those who are studying at this level. Also the evaluation of studies conducted on achievement in mathematics, especially the studies conducted by Kouba (1988) and Bhattia (1998) as reported by Gupta (1991) enforced the investigator to select the topics 'fractions' and 'decimals' for treatment. It was also felt that these are the most difficult area among the students at any level. These are the topics which have a wide application in other subject areas and day-to-day situations. The mastery of these topics is very crucial for general comprehension and analytical thinking.

1.8.3 Instructional Materials and Tools Used for the Study

1.8.3.1 Lesson Plans Based on Direct Instruction Model

Twenty four lessons were prepared for teaching through Direct Instruction Model - fifteen were from *fractions* and nine from *decimals*. Lesson plans were prepared by adapting the lesson plan format of Direct Instruction Model proposed by Engelmann (2001).

1.8.3.2 Lesson Plans Based on Objective Based Instruction

Twenty four lesson plans were prepared for Objective Based Instruction. The objectives of both type of lesson plans (Direct Instruction Model and Objective Based Instruction) were same. Lesson plan format adopted by Department of General Education, Government of Kerala was the guidelines for preparing these lessons.

1.8.3.3 Unit Tests

Nine unit tests were prepared for experimental treatment-five from *fractions* and four from *decimals*. After Direct Instruction treatment unit tests were given to subjects.

The other tools used for the study are as follows:

1.8.3.4 Achievement Test in Mathematical skills (Pillai and Jayasree, 2001)

Achievement Test in Mathematics based on fractions and decimals were prepared and standardised by Pillai and Jayasree (2001) were used for treatment. Two parallel tests were developed, one was treated as Pre -Test and the other was used as Post-Test I and Post -Test II.

1.8.3.5 Standard Progressive Matrices Test (Raven, 1958)

1.8.3.6 Numerical Ability Test (Pillai and Jayasree, 2001)

A Numerical Ability Test was prepared and standardised by Pillai and Jayasree (2001) to measure the numerical ability of upper primary pupils of Kerala.

1.8.4 Procedure for Data Collection

Procedure adopted for collecting the required data as follows:

1.8.4.1 Administration of Pre-Test

Pre-Test was administered to Experimental GroupI, Experimental Group II and Control Group before the treatment was given.

1.8.4.2 Administration of other Tools

Data based on other Independent variables namely Non-verbal Intelligence and Numerical Ability were collected from each group using appropriate tools.

1.8.4.3 Treatment

Experimental Group I was taught through Direct Instruction Model. Experimental Group II was taught through Direct Instruction Model and Objective Based Instruction alternately and only Objective Based Instruction was given to Control Group.

1.8.4.4 Administration of Post-Test I

Immediately after the treatment, Post-Test I was administered to each group.

1.8.4.5 Administration of Post-Test II

Post-Test II was administered to every group two months after the treatment.

1.8.5 Analysis of Data

The statistical techniques used to process the collected data are the following.

1.8.5.1 Test of Significance of difference between means

1.8.5.2 Two-way ANOVA with 2 x 2 Factorial Design

1.8.5.3 Two-way ANCOVA in 2 x 2 Factorial Design.

1.9 SCOPE AND LIMITATIONS

The aim of the study was to find out the effect of Direct Instruction Model on Achievement on select Mathematical Skills of upper primary pupils. The investigator tried to find out how far the learned materials are retained in pupils after each treatment. The study also examined whether changes could occur if the effect of *Previous Knowledge in Subject Matter, Non-Verbal Intelligence and Numerical Ability* were controlled.

Precautions were made to get valid and reliable results from the experimental study. It is hoped that the learning materials prepared for this study will be beneficial to other group of students in successive years.

Even though maximum care and precautions were made, the following limitations are anticipated.

- The study was conducted in one class - Class VII, the terminal stage of upper primary level.
- The selection of topics was confined to two topics namely 'fractions' and 'decimals' only.
- Achievement Test was intended to measure three instructional objectives in cognitive domain only.
- The items in Achievement in Select Mathematical Skills were confined to objective type items only, for easy scoring and objective measurement.
- Selection of the sample schools was not state wide, but was confined to only three revenue districts of Kerala.
- Same teacher taught both the control group and experimental groups. Therefore effect of teacher variation was not studied.

1.10 ORGANISATION OF THE REPORT

Report of the present investigation was organised in the following pattern to get precision and clarity. Each chapter is explained using relevant sections and subsections.

CHAPTER 1	INTRODUCTION
	Need and Significance of the study
	Statement of Problem
	Definition of key terms
	Variables of the study
	Design of the study
	Objectives
	Hypotheses
	Procedure
	Scope and Limitations
	Organisation of the Report
CHAPTER 2	REVIEW OF RELATED LITERATURE
	Theoretical Overview
	Review of Related Studies
CHAPTER 3	METHODOLOGY
	Selection of Variables
	Objectives
	Hypotheses
	Procedure
CHAPTER 4	ANALYSIS
	Preliminary Analysis
	-Equivalence of Groups

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CHAPTER 2

REVIEW OF RELATED LITERATURE

- *Theoretical Overview*
- *Review of Related Studies*

10

REVIEW OF RELATED LITERATURE

The review of related literature is an important part of a scientific research. It has been done so as to get an awareness of the relevance and trends of the study undertaken by the investigator. Therefore an attempt was made to review literature so as to get a theoretical out line of Models of Teaching. Direct Instruction Model of teaching specifically and the studies related to Direct Instruction Model. Studies thus surveyed were categorised and presented under the following subtitles:

2.1. THEORETICAL OVERVIEW

2.2. RELATED STUDIES

2.1. THEORETICAL OVERVIEW

The methods of teaching involve three major components such as the teacher, the student, and the curriculum, which imply the existence of the strategies. The human components are the teacher and the student and the curriculum/content constitutes the material components. The skill-based components are the methods of teaching. So the success of any teaching activity depends upon the interplay among these three components of teaching. All the components together create a teaching-learning environment, which is geared to achieve educational instructional objectives. Researchers try to sort out what goes with and influences in the very complex environment of teaching and learning. The researchers are also interested in arranging these variables into models that can explain teaching more fully.

Since all the components to teaching play an equally important role in the process of teaching, researchers have done extensive studies on all the components of teaching. But researchers have shown special interest in methods of teaching. In any human activity, it is the method, which determines the achievement of objectives formulated. Similarly in the teaching process, the achievement of the instructional objectives depends on the process of teaching. Therefore, it is worthwhile to study the nature of the methods of teaching. Philosophers, psychologists, educationalists, and technologists have viewed methods of teaching in different ways in different historical era.

Although methods of teaching have passed through several developments in the history of pedagogy, teachers followed a particular way of teaching in the classroom. It is because the educational programme for teachers, prepare the teacher to follow one of a few fixed ways of teaching such as the Herbartian Method, Objective based instruction, based on modern models of teaching and the like. Attempts were made to design suitable teaching techniques based on popular educational theories. Following a few fixed ways of teaching, it has failed to achieve a variety of educational objectives, for which teaching is designed and performed. Pupils have multidimensional personalities having different learning styles. The common implications of both these facts are that the teachers should use different strategies of teaching to match the objectives of teaching, and different learning styles and personalities of students. (Passi, Singh and Sansanwal, 1990). This is due to differential content offered for the study, differential students abilities and aptitudes, and the differential classroom climate in the school. Models of Teaching emerged out of the search by Joyce and Weil (1992) to find a variety of approaches or strategies of teaching to match the various learning styles. They present a solution to the dilemma of differing learning styles.

2.1.1 MODELS OF TEACHING

During the last many decades a lot of attention has been given to improve the process of teaching, resulting in the development of a number of Models of teaching by various researchers (Decceco, 1968, Haddan 1970, Joyce & Weil, 1972, Brady, 1980). A model of teaching consists of guidelines for designing educational activities and environments. It specifies ways of teaching and learning that are intended to achieve certain specific goals. The fundamental purpose is to increase the capacity of self-education and personal acquisition of knowledge. A model of teaching is an instructional strategy to help good teachers in making their teaching more systematic and effective.

The term teaching model encompasses a broad, overall approach to instruction rather than a specific strategy. Models of teaching have some attributes that specify what the strategies and methods do not have. The attribute of a model has a coherent theoretical basis and rationale. A point of view and an orientation about what students should learn and how they learn, and recommended teaching behaviours and classroom structures for bringing about different types of learning.

Models of teaching help students to acquire information, ideas, skills, values, ways of thinking and means of expressing themselves. It is actually meant for a long-lasting outcome and increased capacities to learn easily and effectively in future. According to Joyce and Weil (1972) a teaching model is a pattern or plan, which can be used to shape curriculum or course to design instructional materials and to guide a teacher's action. A model of teaching can be used to design face-to-face teaching in classrooms or tutorial settings to shape instructional materials, including books, films, tapes, computer-mediated programmes and curriculum and long-term courses of study (Joyce, Weil & Showers, 1992). It creates the necessary environment, which facilitates the teaching-learning process. The core of the process of teaching is the arrangement of environments within which the student can interact (Dewey, 1916). Thus a model of teaching consists of guidelines for designing educational activities and environments. It specifies ways of teaching and learning that are intended to achieve certain kinds of goals (Joyce and Weil 1978).

It is a step-by-step procedure that leads to specific learning outcomes (Gunter, Estes and Schwab, 1990). Models are prescriptive teaching strategies, designed to accomplish particular instructional goals (Eggen Paul, et.al, 1979). Thus a model of teaching is designed to achieve a particular set of objectives. It is not a substitute to any teaching skill; rather it creates the conducive teaching-learning environment in which teachers teach more effectively, by making the teaching more systematic and efficient

2.1.2. CHARACTERISTICS OF MODELS OF TEACHING

The following are the Characteristics of models of teaching as listed by Joyce & Weil (1980)

(i) they are some sort of plans or guidelines or patterns or strategies of teaching

(ii) they are the systematic procedures to modify the behaviour of the learner

(iii) they specify the learning out comes or instructional objectives in terms of observable and measurable performance of students.

(iv) they specify in definite terms the environmental conditions under which a student's response should be observed

(v) they specify the criteria of acceptable performance expected from the students.

2.1.3. FUNCTIONS OF MODELS OF TEACHING

Models of teachings have three main functions in the teaching - learning or instructional process. They are the following

(i) designing of curriculum or course of study

(ii) development and selection of instructional materials.

(iii) Guiding the teacher's activities in the teaching-learning situation.

2.1.4. BASIC PROCEDURES FOR IMPLEMENTING OF A MODEL

A model can serve as an important communication device for teachers. Joyce and Wiel (1986) classified various approaches to teaching according to their instructional intents their syntaxes and the nature of their learning environments. Instructional intents are the type of learning goals the model has been designed to achieve. The use of a particular model helps the teacher to achieve some goals but not others. Joyce and Weil designed a procedure for the implementation of any instructional model. Four concepts used by them are: Syntax, Principles of Reaction, Social System and the Support System.

2.1.4.1 SYNTAX

Syntax of a model is the overall flow of a lessons activity. That is, the syntax of a model refers to the description of the model in action. That is the kinds of activities, which are sequentially organised at well-defined stages of the whole programme typically the educational environment belonging to each model. These sequences of activities are called phases. The syntax of various models differs.

2.1.4.2 PRINCIPLES OF REACTION

Principles of reaction guide the teacher's response to the learner, they tell the teacher how to regard the learner and response to what he does. In some models the teacher overtly tries to shape the behaviour of the student by rewarding certain student's activities and maintaining a neutral stand towards others.

2.1.4.3 SOCIAL SYSTEM

The social system provides a description of the student and teacher roles, and relationships and the kind of norms that are encouraged. The leadership role of the teacher varies greatly from model to model. In some models the teacher is a reflector or a facilitator of group activity; in others a counsellor and in still others, a taskmaster.

2.1.4.4 INSTRUCTIONAL AND NURTURANT EFFECT

The description of the effect of a model is categorised as direct or instructional effects and the indirect or nurturant effects. The instructional effects are those directly achieved by leading the learner in certain directions. Formulation of conceptual structures and meaningful assimilation and ideas are the important instructional effects. The nurturant effects came from experiencing the environment created by the model. Interest in enquiry, habits of precise thinking and the like are the nurturant effects.

2.1.5 CLASSIFICATION OF MODELS

During the last four decades a lot of attention has been given to improve the process of teaching, resulting in the development of a number of models of teaching. Some have been developed by educational researchers investigating how children learn and how teaching behaviour affects students learning. Others have been developed by classroom teacher experimenting with their own teaching in order to solve specific classroom problems. Still others have been invented by psychologists, industrial trainers and even by philosophers. All these models are based on empirical research, theories, hunches, postulates, hypothetical propositions and the like.

In the late 1960's, Bruce Joyce and Marsha Weil began tracing down the various teaching approaches available. They developed taxonomy to analyse the basic characteristics of a particular approach in terms of its theoretical base, its educational purpose, and the teacher and the student behaviour required to successfully execute the approach. They labelled each of these approaches ' A teaching Model'. According to them a model is an overall plan or pattern for helping students to learn specific kinds of knowledge, attitudes or skills. A teaching model has a theoretical basis or philosophy behind it and encompasses a set of specific teaching steps design to accomplish desired educational outcomes.

Each model differs in its basic rationale or philosophical base, and in the goals it has been created to achieve. Each model shares many specific procedures and strategies such as the need to motivate students and define its expectations. The monumental work by Joyce and Weil (1980) classified teaching models into four categories and labelled as "families of models". The four major families are the following

1. Information Processing Family
2. Personal Family
3. Social Family
4. Behavioural System Family

2.1.5.1 Information Processing Family Model

The major purpose of schooling is to help students acquire and process information. This purpose includes both the acquisition of new information from the various academic disciplines and the use of existing information to organise, categorise and think critically. The information-processing model of teaching has been designed to help teachers to accomplish the above-mentioned goals. This family of models aim at fostering the information processing ability in the learner. These models help the learner to seek and master information, organise it, build and test hypotheses. Joyce and Weil (1980) define information processing as the ways people handle stimuli from the environment, organise data, sense problems, generate concepts and solutions to problems, and employ verbal and nonverbal symbols. It involves intellectual skills required to analyse information, which include the ability to make observation and through the use of inference, to generalise, to predict and to explain events.

Models focusing on Information Processing come from several sources such as metacognition, learning theories, the academic disciplines, and developmental studies of human intellect. The long-term goal of all models in this family is to teach students how to think effectively. The different models mentioned by Parsi, et. al. (1990) and Joyce and Weil (1992) are presented in the following text.

Cognitive Growth Model is based on studies of students' intellectual development by Piaget, Kohlberg, Sullivan and Sigel. It is used to help adjust instruction to match the stage of maturity of an individual student and to design ways of increasing the student's rate of development. The other models in this family are Concept Attainment Model (Bruner), Inductive Thinking Model (Hilda Taba), Inquiry Training Model (Suchman), Advance Organizer Model (Ausubel) Scientific Inquiry Model (Suchman), Memory Model (Levin & Pressley)

2.1.5.2 Personal Family Models

The personal family models begin with the perspective of the individuals and allow teachers to impart self-awareness so that learners become responsible of their own growth. Teachers use the models in this family to develop student's personal characteristics - those trails that will help them lead productive lives. Skills associated with positive self-concept, self-awareness, creativity and meta cognition are the goals of this family. The major characteristics of this family of models are better-developed self-assertion and self-actualisation. Learners will increase their learning capacities and will increase academic achievement. Self-actualisation leads to lifelong learning skills that promote quality of life.

The models such as Non Directive Teaching (Roger), Awareness Training Model, Synectics Model (Gordon), The Model Classroom Meeting are included in this family.

2.1.5.3 Social Family Models

The teachers have responsibility to enhance the students' academic skills and also to help students to relate to all groups within our multi-cultural society. The social interaction model emphasise social understanding and skills and to think and inquire about important social and public issues. They range from the simple process of organising students to work together to elaborate models that teach democratic social organisation and the analysis of major social problems and critical social values.

Examples from the social family as presented by Joyce and Weil (1992) are Co-operative Learning (Salvin, David and Johnson), Role Playing Model (Fannie and Shaftel), Group Investigation Model (Dewey), Jurisprudential Model (Oliver and Shaver).

The social family models are appropriate for a broad range of learning objectives: the 'basic skills' as well as the more complex cognitive and social goals of schooling.

2.1.5.4. Behavioural System Family Models

The family was evoked from attempts to develop efficient systems for sequencing learning tasks and shaping behaviour by manipulating stimulus, response and reinforcement. The family stresses the modification of behaviour in response to tasks and feedback. These models are used in a wide variety of application to increase comfort and relaxation, decreasing phobias, changing habits and learning to control one's behaviour. They emphasize changing external behaviour of the learner and describe them in terms of visible behaviour rather than their underlying behaviour.

The models under this family include Contingency Management Model (B.F. Skinner), Self Control Model (Rimm and Masters), Mastery Learning (Bloom) and Direct Instructional Model (Engelmann).

Of the four families of models of teaching the investigator proposed to study the effectiveness of Direct Instruction Model of teaching. This model seems to be important for the investigator because much of a teacher's work in Mathematics teaching is aimed at helping students to acquire procedural knowledge and specific skills. Acquiring procedural knowledge and specific skills consists in most instances of mastering a set of specific and often sequential tasks - which is important for efficient mathematics learning.

The characteristics and the procedure of using Direct Instructional Model are explained in the following text.

2.1.6. DIRECT INSTRUCTION

Behaviour theories of teaching assume that human behaviour is shaped by contextually relevant consequences of behaviour. The discipline therefore applies principles derived from experimental analysis of behaviour to the enhancement of educational performance. The accomplishment of specific motivational, management and learning objectives are viewed in relation to their contingent consequences, antecedents and other contextual factors.

Precision in teaching emphasizes fluency building by augmenting the students' rate of response. First the students master a simple or complex fact or skill (for e.g., correctly spelling a word, applying a mathematical algorithm, giving a list of episodes proceeding a historical event). The mastery is often accomplished with the assistance of the teacher, programmed material, scripted lessons', small group, interactive instruction such as "Direct Instruction" (Becker and Carnine, 1981).

'Direct Instruction' is an instructional method that first and foremost requires that the teachers should have a command of the subject matter as close to a mastery level as possible. Whether subject matter is at elementary level, middle school level, high school level or college level, the teacher should thoroughly 'understand' the content. That means the teacher knows more than the facts, but also the structure of the content. It helps the teacher to understand each item of the content in more than one way. So that the provided information enable all students to attain the stated objectives at a level of mastery.

Direct Instruction grew out of the work of Engelmann and Carl Bereiter at the University of Oregon. Over the past 30 years, it has been developed for teaching the 'elementary' through 'secondary' language, reading, maths, higher-order thinking (reasoning), writing, science, social studies and legal concepts.

The primary goal of 'Direct Instruction Model' of teaching is to increase student achievement through carefully focused instruction. The instruction involves identifying particular skills and showing students how to apply these skills in increasing complex situations. The model aims to provide intense efficient lessons that will allow all children to master academic skills. The central element is that clear instruction eliminates misinterpretations and accelerates learning. The different meanings of Direct Instruction Model as described in International Encyclopaedia of Education are as follows.

2.1.6.1. Meaning of Direct Instruction

The general term 'Direct Instruction Model' of teaching has acquired different meanings. Each meaning is based on a particular instructional practice. A general sense of 'Direct Instructional Model' of teaching refers to instruction led by the teacher. That is the teacher-led meaning, which means, "the teacher provided direct instruction in solving the problems." The procedure that emerged from the teacher effectiveness research is referred as the teacher effective meaning. The procedure used by teachers and researchers when they teach cognitive strategies to students is the cognitive strategy meaning. The procedures associated with the DISTAR programme is referred as the DISTAR meaning and finally some authors have used the term direct instructional model of teaching to refer to the teaching behaviours that they believe, which is taken as the undesirable teaching meaning.

2.1.6.1.1 The Teacher - Led Meaning

The most general meaning of Direct Instructional model of Teaching is the teacher-led meaning. It refers to academic instructions led by the teacher, without reference to how the instruction was done.

"In Direct Instruction Model the teacher, in a face to face reasonable formal manner tells, shows models, demonstrates and teaches the skills to be learned. The key word here is the teacher who is in command of the learning situation and leads the lesson as apposed to having the lesson 'directed' by a work sheet, kit, learning centre or work book'' (Bauman, 1982).

The teacher-led meaning covers all the different meanings of Direct Instructional Model of teaching and all the other meanings are subsets of this meaning.

2.1.6.1.2 The Teacher - Effectiveness Meaning

Direct Instructional Model of teaching also known as 'Explicit Teaching', "is a systematic method for presenting materials in small steps, pausing to check for student understanding and eliciting active and successful participation from all students (Rosenshine, 1986). That is effectiveness being determined by students score on achievement tests.

Observational studies and subsequent experimental studies in mathematics and reading have yielded a wealth of information on the instructional behaviours of successful teachers (Brophy and Good, 1986)

The effective teachers use a pattern of instruction in the instructional procedure. Rosenshine and Stevens grouped the instructional procedures under six teaching 'functions' as review of previous lesson, presentation of the goals and detailed instruction, guided practice, feedback and corrections, independent practice and weekly and monthly reviews. Hunter's (1982) work is another example of teacher effectiveness meaning of Direct Instruction Model of teaching.

2.1.6.1.3 The Cognitive Strategies Meaning

The meaning of Direct Instructional Model or the new term Direct Instruction is also used for instructional procedure that teach student's cognitive strategies which enable them to become independent learners and help them to acquire higher level cognitive tasks, such as predicting, classifying, question generating and summarising. It also enables the learner to become independent learner. The predominant instructional procedure for teaching a cognitive strategy involve providing students with 'scaffolds' on which they can rely during initial learning. The scaffolds are diminished as students learn the strategy and become independent.

2.6.1.4. The DISTAR Meaning

DISTAR programme is another use of Direct Instructional Model of Teaching and to the specific instructional procedures that accompany those curriculum packages (Beeker, 1977). The acronym originally stood for Direct

Instructional System in Arithmetic and Reading. This meaning overlap with teacher - leads meaning and includes many of the instructional procedures used in the teacher effective meaning.

Engelmann develops the DISTAR Procedure in 1960s. Researchers (Gersten et. al; 1987) in the DISTAR tradition suggest Direct Instruction has 6 critical features,

- an explicit step-by-step strategies
- development of mastery in each step in the process.
- specific strategy corrections for student errors
- gradual fading from teacher directed activities towards independent work
- use of adequate and systematic practice through a range of examples of the task.
- communicative review of newly learned concepts.

2.1.6.1.5. The undesirable Teaching Meaning

Some literature used Direct Instruction Model in a pejorative, referring to different types of undesirable teaching. It is most often a statement of criticism toward various forms of teaching, which include teacher-led teaching, the teacher effectiveness pattern and DISTAR.

Examples of undesirable teaching meaning include description of Direct Instruction Model as "authoritarian" (Mckeen et.al; 1972), "regimented" (Borko and Wildman, 1986) "fact accumulation at the expense of thinking skill development" (Edwards', 1981), and "focusing upon tests" (Nicholls, 1989). Direct Instruction has also been portrayed as a 'passive' mode of teaching (Becker 1980) and in term of a metaphor of pouring information from one container (the teacher's head) to another container (the student's head) (Brown and Compione, 1990). Many classroom settings in which instruction was led by the teacher, in particular settings when the teacher lectures and the students sit passively are the undesirable teaching meaning.

These five meanings attributed to the term Direct Instruction Model of Teaching do not have distinct boundaries that can separate them. Teacher-led meaning is the broadest which covers the entire range and the other meanings are subset of it. The three instructional meanings overlap a good deal. Instructional procedures such as guided practice active student participation and fading of teacher directed activities in all three meanings, as do scaffolds such as modelling by the teacher and coaching of students. Cognitive strategy meaning was derived from research on the teaching of "less structured" task such as scientific reasoning and the teacher effectiveness meaning was derived from research on the teaching of well structured task such as arithmetic computation.

2.1.7 LEARNING PRINCIPLES UNDERLYING DIRECT INSTRUCTIONAL MODEL OF TEACHING

The naturalistic research shows that those sorts of behavioural changes called "learning" are lawful. Persons acquire skills and knowledge, and alter actions in certain ways, under certain conditions as they interact with their environment. The goal of all practice is mastery - the ability to perform a skill independently and without error.

Direct Instruction Model of Teaching draws on the work of scientific philosophers (e .g. John Stuart Mill, in a system of logic) who discovered strategies for including causal relationship and communication (instruction) (Engelmann and Carrneine, 1991). Learning occurs as individuals and groups interact with physical environments, other persons in social exchange and activities and their own stream of behaviour. The critical thing involved in interaction is that the learner becomes communicative as the result of which he builds complex skills.

- *Communicative*: As a learner becomes communicative when he acts and receives information of three kinds - signals, consequences and prompts. Each kind of information helps persons to learn more about how the world works and how to change actions in the direction of greater competence.

(i) *Signals* - Signals provide information that some thing is about to happen or that there is an opportunity to take actions.

(ii) *Consequences* - All acts have results or consequences. They provide informative feedback on the effects, and effectiveness of actions. These consequences teach what happens when the learner acts in certain ways - use this information either to continue acting the same way or to alter action. It is important at first, and especially when persons have learning difficulties; to create environments with consistent or reliable consequences (information), so students can include generalisation enabling them to predict the effects of actions and therefore guide their actions.

(iii) *Prompts*: - Prompts direct attention to signals, help craft ongoing in a more competent fashion; or help direct attention to the result of past actions. Prompts include (i) gesture, (ii) suggestions, (iii) instructions, (iv) highlighting features of the settings and (v) models.

Direct Instruction Model of teaching plays close attention to prompts, students may need. If students can overcome a difficulty by trying again, a teacher encourages this because trying again or persistence is an important aspect of behaviour. If students are not overcoming a difficulty, the teacher identifies a minimal prompt to help students to succeed. Otherwise students may make the same error again, and again and see themselves as incapable of mastering the task. Teachers in Direct Instructional Model of teaching also teach students to prompt themselves.

- *Building Complex Skills* - Teachers of Direct Instructional Model of teaching are alert to information (signals, consequences, prompts) students need to learn difficult concepts and skills. Teachers help students to assemble component skills into complex tasks and activities. Many activities are long sequences of steps. Solving a mathematical problem are sequences. Many steps must be accomplished to do the task well. Some skills are taught by working on the whole sequence at once - " a whole task presentation". Other skills and activities have so many steps that students may not learn the activity by working on the whole sequence. Therefore teachers and students work on manageable chunks. That is when students can do the first step of the problem, the teacher help them to do the first plus the second step, and so on until the students do the whole sequence; which is known as "forward chaining". The whole task (more naturalistic) method is preferred. However, if a task is too long or too complex, some students will give up and so part-to-whole methods work better.

- *Stimulus Equivalence* - Stimulus equivalence refers to emergent knowledge that is not taught directly. Instructive educators help students to develop complex concepts and skills by designing instruction based on the large literature on stimulus equivalence.

2.1.8. BASIC PROCEDURE OF IMPLEMENTING DIRECT INSTRUCTIONAL MODEL OF TEACHING

2.1.8.1. Syntax

The direct Instructional Model of teaching consists of five phases of activity: Orientation, Presentation, Structured Practice, Guided practice and Independent Practice.

Phase one is the orientation phase. The three steps in this phase are (1) teacher provides the objective of the lesson and the level of performance, (2) the teacher describe the content of the lesson and its relationship to prior knowledge and/or experience, (3) the teacher discusses the procedures of the lesson.

Phase two is the presentation phase. At this stage teacher explains the new concept or skill and provides demonstrations and examples.

The third phase is the structured practice. Here the teacher leads the students through practice examples in lockstep fashion. The guided practice in the fourth phase gives opportunity for students to practice on their own.

Independent practice is the last phase of the Direct Instruction Model of teaching. The purpose is to reinforce the new learning to ensure retention as well as to develop fluency. The teacher's role in this phase is to make sure that the student's accuracy level has remained stable and to provide corrective feedback for those who need it.

2.1.8.2 Social System

The social system of direct instruction model of teaching is highly structured. The model requires the most careful orchestration while teacher is structuring the learning environment. To be effective, the model requires attention to every detail of defining the skill or content to be taught, and nature of demonstration as well as to the practice - schedules provided for students. There are enough opportunities for teachers and students to identify goals, but the model is primarily teacher directed. This does not mean that learning environment is authoritarian or free from humour and is task oriented with high expectations for student accomplishment.

2.1.8.3 Principles of Reaction

Principles of Reaction in Direct Instructional Model of teaching are formulated in accordance with the results of previous knowledge, help students pace themselves and offer reinforcement.

2.1.8.4 Support System

The support system includes sequential learning tasks, some times as elaborate as the sets developed by the individually prescribed instruction team.

2.1.8.5 Instructional Effects

The Direct Instruction Model of teaching has been specifically designed to promote student learning of the procedural knowledge needed to perform simple and complex skills and for declarative knowledge that is well structured and can be taught in step-by-step fashion. This model stresses the importance of teaching of skills. Its design is shaped to generate and sustain motivation through pacing and reinforcement. Through success and positive feedback, it tries to enhance self-esteem.

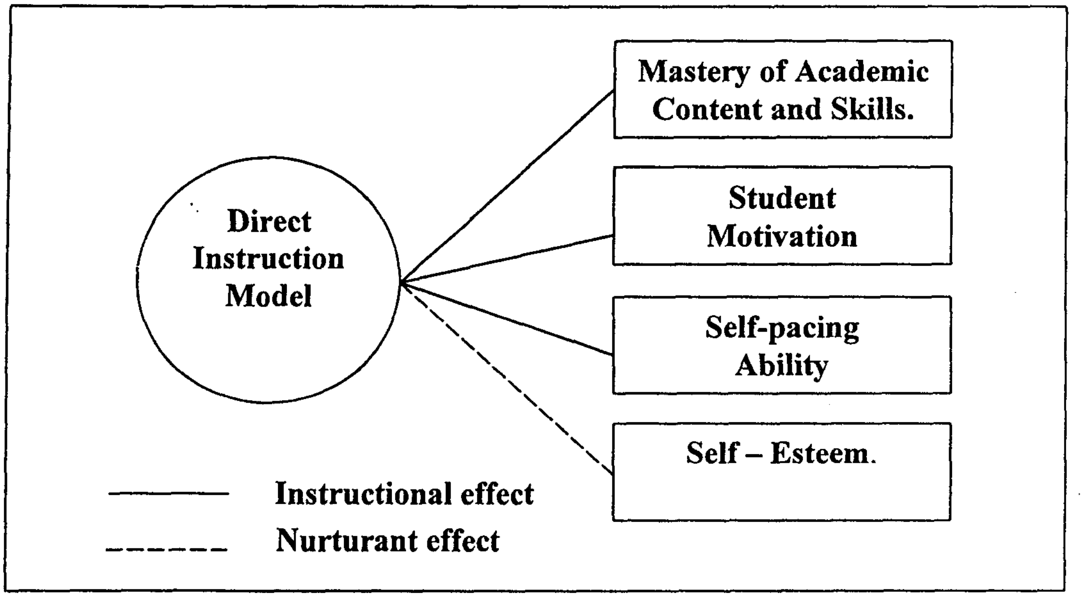

FIGURE 2-1 **Instructional and Nurturent Effects of Direct Instruction Model**

2.1.9 CERTAIN FEATURES OF DIRECT INSTRUCTION MODEL OF TEACHING

Direct Instructional Model of teaching stresses basic skills, breaking down into mini components, children master each skill before moving into the next one. Teachers trace each student's progress on daily charts. They also track behaviour, encouraging good conduct with praise. Even though there are some variations in the Direct Instruction Model proposed by different authors, there are certain common features. They are given below

2.1.9.1 Scripted Lesson Plan

Classroom scripts are all hallmark of Direct Instructional Model of teaching. All the concepts, rules and strategies that students need in any lesson is organised in a logical developmental sequence. Lessons followed by independent and small group activity to give student practice and generalise skills to new materials. Instruction gradually moves from teacher - guided to a more student - guided format, which is known as " mediated scaffolding".

Daily lessons are a sequence of short, quick paced exercises. It includes (a) review of items from previous day to ensure students are firm before adding new examples (b) work on new materials from an earlier curriculum strand (c) independent, peer or co-operative activities to practice vocabulary, solve problems or write papers, (d) review of the day's lesson.

The teacher's words and demonstrations focus precisely on the point to be made; i.e. the objectives to be achieved.

2.1.9.2 Rapid Pace

The goal of Direct Instructional Model of teaching is to move students to mastery as quickly as possible, so a large proportion of class room time is spent on fast paced teacher - directed instruction, punctuated by rhythmic choral group and individual student responses. For instructors this means a very full workday. The Direct Instruction Model of teaching programme requires teachers to ask 300 or more questions in six small group sessions each day to perform problem solving, to ensure that all students reach 100 percent mastery. This level of interaction, which produces substantial achievement gains, is made possible by the use of the heavily researched and highly refined scripts.

2.1.9.3 Achievement Grouping

Common periods for reading and mathematics are established across grades during which students are re grouped by performance level, with the idea that all students will progress at the fastest possible pace and no student will be left behind. Students who need to be re-grouped reduce these groups in size. Frequent evaluation sustains the quality of instruction and students education, it prevent the drift towards mediocrity or failure.

2.1.9.4 Meaningful Learning Experience

"Young Children especially need to be engaged in experiences that make academic content meaningful and build on prior learning" (International Reading Association and the National Association for the Education of Young Children, 1998) as reported by Kozloff and Bessellieu (2000).

All Direct Instructional Model of teaching is done in children's zone of proximal development - the area of difficulty and novelty that is within each child's reach but fosters a slight "stretch". This is ensured because: (1) the curricula in the Direct Instructional Model of teaching are in a developmental - logical progression of learning. (2) Children are always prepared (in previous lessons) for the new learning in current lessons, and (3) next lessons always teach children to use what they have recently learned. Whatever children learn is relevant to their current and future activities and they are geared to the developmental interests of children.

2.1.9.5 Higher Order Thinking

"Children need to learn not only the technical skills of reading and writing but also how to use these tools to better their thinking and reasoning" (International Reading Association and National Association for the Education of Young Children, 1998) as reported by Kozloff and Bessellieu (2000).

There is a minimum of rote learning or memorisation in Direct Instruction Model of teaching. Virtually everything else in direct Instruction is cognitive learning; of concepts, propositions and rules (classification, cause effect) and cognitive strategies (solving arithmetic problems) finally students are able for analysing complex task and reasoning processes, they do this with little teacher direction.

2.1.10. CURRICULUM DEVELOPMENT

Curriculum development involves the analysis of teacher - student communication, analysis of knowledge and the analysis of student behaviour. The curriculum developer first analyses a knowledge system (e.g. mathematics, literature) into logical classes and relationships. Next these are transformed into a precise wording of teacher presentation (instructional communications) designed to be faultless, so logically clears that students will include the proper generalization and discrimination and correctly uses the concepts, propositions and strategies. Finally, the curriculum developer specifies activities of students (e.g. answer to the questions, responses to mathematical problems) that will indicate whether students have made the proper generalisations and discriminations and correctly used concepts and strategies. Children's developmental preparation is always considered in designing Direct Instructional Model of curricula and the lessons, which are arranged into skill tracks within levels (mastery)

For successful implementation of Direct Instructional Model of teaching for various purposes American researchers have offered the necessity of reorganisation of the curricula.

This Direct Instructional model of teaching is a sophisticated way of (i) determining what students need to succeed with meaningful material (ii) arranging learning environment so students receive what they need and (iii) helping teachers and students keep track of progress and difficulties. In this way curriculum and instruction can be improved.

2.1.11 CENTRAL COMPONENTS

2.1.11.1 Curriculum and Instruction

The curriculum and methods of instruction are the most important aspects of Direct Instruction. Direct Instruction provides highly scripted and interactive lessons geared towards small homogeneously grouped students. The reading, language, arts and mathematics curricula can be used separately. Direct Instruction also covers science, social science and fact learning.

2.1.11.2 Supplies and Materials

Teachers use "Presentation books" spiral bound lesson plans that enable highly scripted, rapid paced instruction. Within these presentation books instruction for monitoring and assessing student progress, and for providing immediate feedback to students. The model offers materials designed specially for older students who have not mastered basic skills.

2.1.11.3 Scheduling and Grouping

Students are grouped homogeneously for specific subjects. As some students may be weak in one subject and strong in another, the groups may be different for different subjects. Thus, some implementations encourage each major subject to be taught at a specific time to allow for cross - grouping.

2.1.11.4 Monitoring Student Progress and Performance

A placement test is used for initial assignment of students by performance level. The pace of instruction is set according to the performance level of each group. Direct Instruction relies so heavily on grouping students by achievement levels that frequent assessment of student progress is essential. Teachers should monitor student performance every five to ten days, using such methods as calculating reading rates and error ratios. These data as well as weekly grades are used to re-group students according to their level.

2.1.11.5 Family and Community Involvement

Direct Instruction does not require family or community involvement. They recommend involving parents, by having parents use a 'Parent and Child Home Practice Guide' to work on their child's skill at home.

2.1.12 FEATURES OF DIRECT INSTRUCTION MODEL LESSONS

First, the teacher is an instructional leader. The curriculum specifies the goals, lessons and tasks, and the teacher presents these to students. As students master the material, their activities are more open ended or student guided.

Second, the teacher closely supervises and coaches students during lessons and when students are working alone or in small groups. The point is for all students to master every concept with no exception. This is possible because after many field trails teacher presentations are so logically clear that most students include the proper generalisations and discrimination. After years of research and field-testing, even error identification and corrections are formatted. Even so, to strengthen student's correct or improved actions and to correct every mistake on the spot, teachers and student engaged continuously so teachers can foster high rates of student activity; and attend, evaluate and respond to student's actions.

Third, lessons are quick paced. The developers of Direct Instructional Model of teaching learned early on that a quick pace is essential for proper learning to occur. The pace sustains attention, encourages thinking, increases the number of opportunities to participate, and reduces problematic behaviour, as students are so engrossed.

Fourth, the absolute outcome of instruction on any lesson must be mastery. Every student in the group must be able to perform the skill independently and without mistake - firm and fluent. Much researches show that mastery occurs when lessons have the following phases.

- *Attention and focus* - No programme can be successful unless every one is focused at the start of every lesson. If necessary, the teacher teaches attention and focus directly. Usually this does not take long. Lessons begin with an attention signal such as "Okay every one catches this".

- *Orientation or Preparation* - The teacher orients students to the lesson by pointing out how the lesson builds on prior work. This is written into teacher presentation scripts.

- *Models* - In the next phase, the teacher demonstrate concepts, proportions, strategies or operations addressed in that lesson. The teacher makes the concepts, rules and strategies explicit or conspicuous. The particular ways the teacher demonstrates are carefully designed; they are called "formats".

- *Lead* - Often, the next step is leading students through the operation just modelled. This step is guided practice; the teacher and students work together to find out the solution for the problem. The teacher transitions to having students respond alone when she feels the time is right. If students are not accurate, or if one student hesitates or respond incorrectly, the whole group goes through a brief correction procedure until all children are firm. The point is for students to internalise the concepts, principles and strategies previously modelled by the teacher. So they can apply them to more complex/advanced concepts in subsequent lessons. This facilitates generalization, adaptation and maintenance.

- *Test* - "Tests" occur immediately after the teacher stops demonstrating and leading. The teacher looks for accurate and quick (firm, fluent) actions from students in response to the teacher signals (e.g. questions). When students appear to be firm the teacher gives opportunities for students to more independently to use what they appear to have learned: This "test" does two things (i) It gives student a chance to practice with less scaffolding or assistance, (ii) it enables the teacher to identify precisely what each student gets and does not get, so the teacher can prepare the error correction procedures.

- *Delayed Test* - The teacher provides many opportunities later in the lesson and in subsequent lessons to give extra practice and to assess mastery. If she discovers errors of definitions, rules or strategies, these are again corrected immediately. Repeated errors of the same kind suggest that students are not prepared for the new material and or that instruction must be adapted to meet individual or group needs. (e.g. certain steps of strategy may have to be taught in smaller steps)

- *Feed Back* - The teacher corrects every error of the group and individuals. This prevents the development of gaps. Repeat the sequence (including previous error spot) to ensure that students are firm. Chronic errors suggest the need for re-teaching.

2.2. RELATED STUDIES

A review of related studies was made regarding the relative merits and limitations of Direct Instruction Model of teaching in different school subjects. These studies were found to have conducted in different samples using different research designs. It is seen that most of the studies were conducted in school subjects where intellectual skills are the main objectives. As such many of them were confined to academic subjects like mathematics and languages. Representative studies were reviewed and presented under the following sections.

2.2.1 Studies relating to Direct Instruction Model as facilitator for Achievement in Mathematics.

2.2.2 Studies Relating to Direct Instruction Model which Do Not indicate Achievement Gains in Mathematics.

2.2.3 Studies Relating Direct Instruction Model in other Academic Subjects.

2.2.4 Studies using Direct Instruction Model conducted on Special Groups.

Studies under each subsection are briefly described below:

2.2.1 Studies Relating to Direct Instruction Model as Facilitator for Achievement in Mathematics

Several Studies had conducted to find out the effect of Direct Instruction Model on Achievement in Mathematics. The following studies revealed a positive effect on achievement in mathematics.

A longitudinal evaluation on direct Instruction mathematics by Gersten and Carnine (1981) on low-income students was done. 2000 students involved in the direct instruction. Follow Through approaches evaluated, students in direct instruction model performed highest in all areas in Mathematics: (i) Computations (66% significant) (ii) Problem solving (55% significant) and (iii) Concept (37% significant). Mean Performance for 2897 students were at the fifty-fourth percentile for Total Mathematics.

Peterson and others (1981) investigated the relationships among student cognitive processes, aptitude, later achievement and attitudes, and direct instruction. Fifth and sixth – grade students (N=72) were selected as sample. Each class of twelve students were taught a two-day lesson on probability. Teaching followed direct instruction model. Tests and interviews were given at the end of the treatment. Results showed that independent of student ability, student's reports of their understanding of the lesson were significantly related to achievement. Students who reported using specific cognitive strategies did better on the achievement test than students who did not report using such strategies.

Becker and Gersten (1982) studied the later effects of direct instructions model of teaching, a follow-up of Follow through. Low income fifth and sixth grades who had completed the full three years of a first – through third-grade Direct Instructions Follow through programme were tested. Students appeared to retain the knowledge and problem –solving skills they had mastered in the primary grades.

Gersten and Carnine (1984) examined the effectiveness of direct instruction model in teaching mathematics to disadvantaged students. Results of the National Follow Through and the University of Oregon Evaluation supported the method for improving classroom practice and achievement.

Jones and Krouse (1985) conducted a study on direct instruction and to implications in verbal mathematical problem solving for elementary bearing disabled students. Feasibility of direct instruction model in special education was established. The relationship of direct instruction model to the other promising models was also analysed.

Peterson and others (1989) evaluated the generally recommended concrete-to-abstract hierarchy for presenting a new skill with three students with learning disabilities in grade 1, 2 and 4. Following collection of baseline data, place value concepts and skills were taught using a concrete, semi concrete and abstract teaching sequence in a direct instruction model. Results indicated significant gains by all three subjects, with retention demonstrated three weeks later in a different classroom setting.

The study by Glaser and others (1991) attempted to find out which scientific reasoning skills are primarily 'domain-general' and which appear to be 'domain-specific'. Twelve Universities under graduates constituted the sample. The findings suggests that the most generally useful skill for Direct Instruction may be those for evaluating the kind of problem at hand and for selecting the most appropriate process and strategies.

Ross and Nradem (1991) compared effects of 'token reinforcement', 'cognitive behaviour modification' and 'direct-instruction' on learning-disabled elementary school students' mathematical skills. Treatment was provided to 94 students for four weeks in daily one-half sessions. Significant differential gain between treatment and direct instruction groups in achievement test scores was found. Higher gain scores were associated with direct instruction model.

Harper and others (1993) examined 'Class wide student tutoring teams' and 'Direct Instruction' as a combined instructional programme to teach generalisable strategies for mathematics word problems. Fifty-two second grades students were taught a generalisable problem-solving strategy for mathematics word problems. Results were mixed but were generally supportive of the notion that 'class wide student tutoring team' and 'direct instruction' is useful assistance adjuncts to teacher-led instruction in word problem solving in mathematics.

Study conducted by Montague and others (1993) on Junior high School students (N=72) with learning disabilities received 'direct instruction' in cognitive strategies, instruction in meta-cognitive activities or both. Students improved in mathematical word problem performance and compared well with normally achieving peers.

Kitz and Nash (1995) assessed the application of effective instructional practice to the teaching of remedial algebra with dyslexic students at the University of Wisconsion. Practices involved 'direct –Instruction', 'Stranded lesson design', 'mastery learning', 'use of manipulative in problem-solving' and 'training and reading mathematical expression'. Results proved the effectiveness of the programme.

Effects of a 'Schema-based direct instruction strategy on addition and subtraction word problem - solving performance was examined by Jitendra and Hoff (1996). The sample was third and fourth grade students with learning disabilities. Results indicated that the intervention was successful in increasing the percentage of correct word problem for all students. Students interview also indicated that the strategy was beneficial.

An investigation by Woodward and others (1996) in different approaches to mathematics instruction for students with learning disabilities and at-risk for special education services. Results support the implementation of a diagnostic system designed to detect student misconception in addition and subtraction and the use of 'direct instruction' and 'diagnostic system' to supplement resource room mathematics class.

The action research project implemented and evaluated by Lane and others (1997) to improve student motivation and academic achievement. The targeted population consisted of seventh and eighth graders from a middle school in a small Midwestern community. The intervention was comprised of teaching goal-setting processes through two hours of direct instruction deeding advisor/advise for seventh graders. Results showed that lessons that included a great variety of multiple intelligences produced a higher level of intrinsic motivation among most students. The transfer of learning was most effective for short-term goals through direct instruction and enhanced students' to improve their grades.

Din (1998) investigated whether 'Direct Instruction' applied as a main instructional strategy with a focused curriculum could hold students to quickly improve their basic skills. Nineteen students 7-16 years old problem students in mathematics problem received individualised treatment for 3 weeks or twelve hours uses of pre-test, treatment, post-test as a basic design. Results showed that after treatments, the students made significant gain in their mathematic basic skills with an average gain of approximately 2.0 in Grade Equivalent Score. Findings suggest that the integrated direct instructional approach, when used appropriately, can be both effective and efficient in helping students to improve their mathematic basic skills.

Wilson (2000) investigated the effectiveness of an instructional modification (DI) on the complex problem - solving ability of students who were seriously emotionally disturbed. The experimental group was provided with direct instruction and measured the amount of learning, rate of learning and the amount of learning maintained over time. Results found significant within group differences for the experimental group on amount of learning, rate of learning and amount of learning maintained over time whether the group was experimental or control or whether the difference were within or between the groups.

The purpose of the study by Follmer (2001) was to investigate the impact of direct instruction on 'strategic reading' and 'problem solving' would have an enhancing students' mathematical thinking process when solving non-routine, text based mathematical problems. The study took place in a suburban, elementary school setting using fourth grade classes (N=48). Quasi experimental pre test/post test non equivalent peer group design was used for study.

The results indicated that the application of reading strategies and the problem-solving by the experimental group was statistically significant. Experimental and control groups show significant differences in three out of seven categories. Results also indicated that providing students with a framework for the strategic use and application of specific reading and problem-solving strategies was beneficial meta cognitively and in increasing students' level of confidence.

Study by King (2004) investigated the effect of an integrated teaching style on the mathematics performance of eight grade students in a pre-algebra class. The sample included fourty eight, eighth graders in Abias Middle School in South Georgia. Treatment completed in six weeks. The instructional method for experimental group included three integrated teaching styles: direct instruction, mastery learning and co-operative learning. Results showed that the students taught through integrated learning styles scored higher when compared to students score in control group who were taught through conventional method.

2.2.2. Studies Relating to Direct Instruction Model which Do Not indicate Achievement Gains in Mathematics

While surveying the relative effectiveness of Direct Instruction Model on students learning outcomes on Mathematics, it was noticed that in some cases no advantage in the learning outcomes was reported and in certain cases the findings were considered inconclusive. Such studies are given below.

Evertson and others (1980) examined the relationships between classroom behaviours and student outcomes in junior high mathematics and english classes. Sixty eight teachers (thirty nine english and twenty nine mathematics) were observed on two of their class sections. Results suggest that elements of both the direct instruction model and indirect influence model are supported for mathematical classes.

The purpose of the investigation by Andros and Freeman (1981) was to determine of a teachers level of implementation of the direct instruction model would vary as a function of the type feedback received in maths during initial attempts to apply the model. Twenty five elementary school teachers were taken as sample. Three treatment conditions were (i) nine worked alone while analysing tape recordings of two practice lessons; (2) nine received some feedback from the instructor during these analyses; and (iii) seven worked through the practice tapes with there colleagues. Result of ANCOVA suggested three treatment grasps did not differ in their overall level of implementation of the model. Different types of feedback did not result in different levels of implementation of the model.

Arthur (2000) examined the effects of direct and indirect delivery strategies when teaching technical problem-solving activities. Sample include thirty one technology education students enrolled the transportation technology course at North Carolinian State University. A Quasi experimental design was used for the study. Performance was measured using ranking system of performance variable score. A multivariate analysis of variance (MANOVA) was performed and no significant difference in problem-solving achievement scores and performance scores. Behaviour and attitude measures indicated a significant difference existed. Results of ANOVA showed no significant difference in achievement, performance and problem solving confidence

Studies, which show advantage over direct instruction model, are given below.

Title (1996) analysed a think-aloud protocols of a teacher who used Mathematics Assessment Questionnaire (MAQ) to explore the mathematical disposition of her students. First direct instruction model was used and then changed to an alternate self-regulatory model based on a student-centered class. Findings support the self-regulatory model.

Reinhart (2000) examined the effect of direct instruction model on in-depth problems and tasks. Results indicated that a teacher-centred, direct instruction model often did not fit well with more in depth problems and tasks. Suggests a students centred, problem-based approach, questioning strategies help students engage in learning.

Alvarado (2001) examined direct instruction teacher deviations from lesson scripts and the effects on student's academic engagement during mathematics instructions. Participants were ten male elementary students and six instructors averaged four years experience in teaching through direct instructions. Script deviations and academic engagements were measured using Eco Behavioural Assessment System Software (EBASS).

Results showed that students from minority backgrounds were academically engaged at grater frequency than non-minority students. More experienced teachers tended to remain more on script and engage students in academic responding with greater frequency.

2.2.3 Studies Relating to the effect of Direct Instruction Model on Other Academic Subject

Many studies were conducted to examine the effect of Direct Instruction Model on Achievement in English, especially on reading, acquisition of phonemic awareness and other language skills. The related studies, which show positive results, are given below.

The study conducted by Stevens and others (1991) on the impact of 'direct instruction' on reading comprehension strategies and the degree to which co-operative learning processes enhanced students' learning of strategies were studied using 486 third and fourth grades in Pennsylvania. Pre test-post test data highlight the significant impact of direct instruction and co-operative learning.

A practicum was designed by Micux (1992) to intervene and assist borderline elementary school RSP (Resource Specialist Programme) students in special education classes and/or through extra assistance within the regular classroom functioning in reading and related subject areas were placed in the RSP pull-out programme. The 11 students worked in an elementary school RSP classroom received treatment for three days a week for three months to improve their phonetic skills and other areas of language arts.

Practicum results were positive. Student's attitude about reading, school and related projects after the intervention were generally positive. Findings provide support for the use of school-based provision for borderline RSP student's early enrolment in this programme.

Casazza (1993) assessed the use of a model of direct instruction called EMQA (Explanation, Modelling, Questioning and Application) as a framework for teaching the rules of summary writing. The investigator found that teaching students to summarize using direct instruction model increases their comprehension of expository of college students.

Gettinger (1993) compared boys who received invented spelling guidance with creative writing periods and direct instruction with guided practice on spelling. Although direct instruction resulted in more targeted words spelled correctly, invented spelling resulted in more on targeted word spelled correctly, higher performance rating by children, and higher teacher rating.

Idol and Rutledge (1993) examined a rationale for integrating phonics with reading instruction for students with reading disabilities. It suggests that direct teaching of sounds be provided by constructing "sound sheets" with rows of sounds/letter combination taken directly from the text the child will read after practising the sounds.

Stephens (1993) developed a programme and implemented to improve the reading achievement of 56 learning-disabled students in grade five. Strategies for improving reading achievement include training for teachers in the use of direct instruction techniques, implementation of a direct-instruction model in the teaching of reading, use of the Corrective Reading Programme. Findings suggested direct instruction model for improving reading achievement.

Walker and others (1994) examined whether at-risk pre scholars would show gains in expressive and receptive language after using selected computer based activities in a teacher-directed, small group situation using direct-instruction techniques. Results indicated improvement in varying degrees, suggesting wider use of computer combined with direct-instruction for disadvantaged children.

Ganschow and Sparks (1995) examined the effect of direct instruction in the phonology/orthography of Spanish on the native language skills and foreign language skills and aptitude of 14 high school women at risk for foreign language problems. Pre-test post-test comparisons with students not at-risk showed that subjects made significantly greater gains on phonological/orthographic measures.

Gleason (1995) examined the effective strategies for teaching reading comprehension, written composition of narrative and expository text; and used 'direct instruction' for integrating reading and writing. The results argued for teaching, reading and writing as connected process that has similar structure. Results support the using of direct instruction to integrate reading and writing for students with learning disabilities.

Spector (1995) is of opinion that learning how to read in an alphabetic system requires children to understand the complex relationship between print and speech. Results suggest that pre-reading and beginning reading instruction should be designed to facilitate the acquisition of phonemic awareness through the application of principles of 'Direct Instruction'.

A study by Dowdell (1996) examined the effect of 'Direct Instruction' on reading achievement of sixth graders. Subjects were 72 Chicago Public school students. A sample of 30 students who performed poorly with stains of 1, 2 and 3 on the Iowa Test of Basic Skills (ITBS) were chosen to receive reading instruction through direct instruction method. Results indicated that the experimental groups gain from pre-test to post-test.

The effect of 'direct instruction' examined by Wrobel (1996) on increasing student's reading competency. The population of the two years study included 105 south - west Chicago area third-grade students from a low socio-economic background. Two random samples of 30 students were selected from the two identified population of 'Direct-Instruction' and 'Non-Direct Instruction' (traditional basal reading programme) and were classified as the experimental groups. The direct instruction group's Iowa Test of Basic Skills (ITBS) results indicated that there was a significant change in the gains of the raw score in 9 of the 10 reading achievement categories.

A study investigated by Aarnoutse (1997) the effectiveness of a listening programme using the reciprocal teaching procedure and the direct instruction model. 95, nine to eleven years old students from six special schools for children with learning disabilities were chosen as the sample for study. Results indicated that students in the experimental group showed better performance in both post-test and retention test. Results also indicated no interaction between group and listening level, and no transfer effect to general listening and reading comprehension.

Bump Sandra and other (1997) investigated a programme to improve reading and language skills. The targeted population consisted of students on 2 first grade classrooms (average class size 25) from a mid western elementary school. The review of literature combined with an analysis of the problem setting resulted in the development of a reading intervention programme of 'direct instruction'. Post intervention data indicated student's improvement in the targeted area of print awareness, phoneme awareness and phonological processing. Students increased their ability to recognize phonemes and process the use of phonemes in reading and language art activities.

Jitendra and others (1997) planed, implemented and evaluated an instructional unit that uses a 'direct instructional approach' to teach the basics of American Sign Language to elementary-age students with serious emotional or behaviour disorders. Six students were selected for the study. Results showed that direct instruction was effective for teaching Sign Language to children with behaviour disorder.

Investigation by Din (1998) whether 'direct instruction' used as a main instructional strategy, with a concentrated curriculum can help students quickly improve their basic reading skills. Subjects, 18 (age 7 to 15 years) with reading disabilities received individualised treatment for 3 weeks. Pre-test post-test design was used. Results indicated that after the treatments, the students made significant gain in their basic reading skills.

The purpose of the study by Autery (1999) was to find out the effects of direct instruction and precision teaching and the persistence rates of adult learners in the age group 18 through 24 years who are high school dropouts. The findings revealed that students taught basic educational skills with direct instruction and precision teaching methodologies significantly increased their reading comprehension and the attendance rates. Adult learners showed increased achievement and reduced attrition with these methodologies.

In a study by Hawley (2000) compared the effectiveness of a computer assisted and a teacher-directed vocabulary supplemental programme to assess the effectiveness of various methods of direct instruction. Sample consisted of eighty seven fourth grade students from Mississippi Delta school districts. Findings of the experimental study indicated that method of direct instruction made significant differences.

Dichiara (2001) compared two highly dissimilar approaches to teaching reading to students to identify as at-risk on a sample of 162, 4^{th} grade at-risk students. The first approach consisted a reading instruction using the traditional whole language basal reader as the primary means. The second approach consisted of a systematic code-emphasized, highly structured, explicit instruction with tightly contracted procedures. Pre and post-test achievement scores were examined. One school system received direct instruction (code emphasis) while others received reading instruction from traditional basal (word emphasis).

Result suggests that students identified as at-risk can benefit from a highly structured, code-emphasized instruction, and perception were evident in both student and teacher responses.

King (2001) investigated the effects of type of curriculum (Direct Instruction, Literature-Based and Authentic Reading Probes) and instructional reading level (first, second and third) on the reading progress of students with specific learning disabilities. Fifty-six elementary students participated. Significant main effects for both curriculum and instructional level and a significant interaction were found. Differences among groups in the authentic literature were not significant. The literature-based curriculum yields the lowest mean slopes across groups, despite its lack of significant difference with the direct instructions curriculum at the first grade reading level.

Owens (2001) investigated the effectiveness of the spelling mastery programme on the spelling performance of elementary students with learning disabilities. Students with learning disabilities made significant gains while using the spelling Mastery Programme by Direct Instruction. The results indicated the increasing academic responsibilities of paraprofessionals and the positive impact they can have in the direct instruction.

The study by Hagerman (2003) evaluates the effectiveness of the accelerated reading programme when used as a supplement to direct instruction. Pre-test post-test quasi experimental design was used for the study on a sample of 121 students from two suburban middle schools in Oregon. Interaction scores by group and time showed a statistically significant difference for the treatment group, suggesting accelerated reading be an effective supplement for reading practice.

Halstead (2003) conducted a study to ascertain whether a more complete set of instructional materials, containing direct instruction would be more successful at enabling students to interpret 'reflexives in a native- like manner'. The experiment was a single subject, multiple baseline procedure with cross budget replication. Results suggest direct instruction is very useful for language learners.

The purpose of the study by Johnston (2003) was to determine if direct, explicit and systematic instruction in phonological awareness increased literacy achievement scores in phonological awareness, reading and writing levels of kindergarten and first grade students. The other classes were provided with same instruction utilised in previous years. After treatment Phonological Awareness Skills Programme Test (PASPT) was administered. Significantly higher scores were associated with direct, explicit and systematic instruction.

Miller (2003) compared the Iowa Test of Basic Skills reading scores of Caucasians and Hispanics in 2nd, 3rd and 4th grades taught through direct instruction reading approach. Results show that significant differences exist favouring Caucasians and Hispanics in average total gain, average gain between 2nd and 3rd grade and the percentage of students at or above grade level at the end of three years.

A study by Mohler (2003) explored the effects of a programme of direct instruction in Phonemic awareness, multi-sensory phonics and fluency on basic reading skills on 25 low-ability, high-risk seventh grade students. Pre-test post-test assessments were done for (i) total reading score, (ii) word recognition, (iii) phonemic awareness or correct letter sequencing,

(iv) spelling or word spelled correctly and (v) oral reading. Regression analysis of individual and group performance was done Results recommended for direct instruction for reading ability.

A number of studies had been conducted to find out the effectiveness of Direct Instruction Model in Teacher Training Programmes. The studies are given below.

Murphy and others (1986) examined the basic practice model of instruction – direct instruction model, on teacher effectiveness in a coherent pattern of teaching. Results indicated an instructional improvement in using direct instruction model.

Jones and Cooper (1987) examined the effective teacher-training programme in North Carolina on reading, mathematics, and language knowledge and to learning outcomes that consist of basic skills, factual knowledge, and concept name identification. Findings indicated that direct instruction inhibits the development of critical thinking an enquiry highly valued by social studies educators. Both in social studies and in language arts, teachers must be allowed to make professional informed decisions about learning activities so that they can select appropriate conditions for types and levels of learning.

Proctor (1989) conduct a survey on students and recent graduates of a generic under-graduate special education programme based on the Direct Instruction Model as a basis for methods of instruction about their attitude towards it. Result support previous findings with in-service teachers that experience with Direct Instruction increase positive attitudes toward it.

A quasi-experimental, treatment control group investigation was designed by Veenman (1992) to test the effect of a pre-service training course on effective instruction. Two direct instructional models, one model for explicit or well-structured skills and one model for implicit skills or higher level thinking strategies. Based on trained observers pre and post training classroom observation, a significant treatment effect was found for student teachers teaching behaviours regarding effective instruction and for pupil engagement rates. The student teachers recommended instructional skill after completion of the course significantly better than prior to the course.

Lignugaris and Mechand (1993) evaluated an experimental programme in which eight special education student teachers supervised new preserves trainers in a 'Direct Instruction Practicum'. Improvements in trainer's practicum suggest the effectiveness of this peer coaching approach to supervision of field based practical.

A two-year professional development programme in Japanese Junior high School was described by Nakano and others (1993). School wide training institutes and individual practice sessions focused on behavioural methods of instruction. Observed teaching behaviours changed as a result of following the programme, and most teaches indicated the direct instruction model had major benefits, especially for slow learners.

A study conducted by Morgan and others (1994) evaluated the effect of peer coaching of five low-performing special education teacher trainers learning to deliver 'direct instruction procedures' to elementary students with mild disabilities. High performing peers videotapes and individual counselling to help trainees. Results showed increased effective teaching behaviours by the trainers.

The programme conducted by Fitzgerald and Semrau (1998) to provide efficient and effective training in a flexible, learner centred, hyper media format. The Classroom Behaviour Record (CBR) observation procedure and the instructional design of the CBR training programme, including 'direct instruction model' that it is based on hyper media design elements, knowledge skills acquisition and fluency, the generalisation and maintenance stage. The results proved the effectiveness of implementation and validation of the training.

The study by Forte (2000) examined the impact of professional development programme in the direct instruction reading programme on student achievement at an elementary school. Training was provided for 3rd, 4th and 5th grade teachers. The results of the study suggested the professional development programme did impact teacher performance and student achievement in reading.

The studies conducted to find out the effect of Direct Instruction Model in developing certain kind of Skills among pupils are presented in the following text.

Siegel and Clapp (1981) conducted a project to determine the viability, attractiveness and effectiveness of computer based instruction with 225 severely and profoundly mentally handicapped and developmentally disabled institutionalised children and adult. A direct instruction model was used for designing the computerbased lessons. The means of delivering this instruction was the *PLATO* system. Results suggested that carefully designed *PLATO* materials could provide effective and efficient instructional service.

Effectiveness of direct instruction model as an instructional method for developing computer literacy and computer programming skills was studied by Gelder and Maggs (1982) in Sydney. Fourth and fifth grade students constitute the sample. Statistical analysis of the result indicated that the most highly structured direct instruction was the most effective.

Worsham and Austin (1983) investigated the effects of language arts thinking skills programme (using of direct instruction n thinking skills) on

Scholastic Aptitude Test (SAT) performance. Highly significant differences were found between experimental group and control group for total verbal scores and reading comprehension scores.

Darch and others (1987) compared the results of direct instruction model on rural South Carolina students. Comparison of results of DI and conventional methods in reading, mathematics, language, and spelling on a sample of rural students, showed DI students outperformed local comparison students on virtually every measures.

Gersten and others (1988) evaluated long term effects of Direct Instruction follow through Model with 624 fifth and sixth graders and about 500 high school and older students who received follow through instruction. Achievement and college acceptance results consistently favoured the follow through groups over control groups with strongest effects in reading.

A direct instruction model was applied by Wesson and Keefe (1989) to the teaching of library skills to students with mild /moderate handicaps. The model involves determining students' skill levels, setting objectives, providing instructions and monitoring student progress. A term approach is recommended on direct instruction, involving the library media specialist and the special education teachers.

Weber (1990) designed lesson plans to elementary school students, the opportunity to use a highway maps to prepare for an imaginary trip to chosen destination in Illinois or surrounding state. Students who engaged in a direct instruction model that requires the use of basic skills, facts and knowledge showed positive results in their performance.

A study explored by McGoldrick (1992) the effects of direct instruction and modelling on students' ability to follow written directions. Subjects on the experimental group consisted of 62 eighth grade students enrolled in a suburban New Jerrey middle school. Results indicated that instruction in following written directions a significant gain for the experimental sample.

Davidson (1992) examined whether exposition as the dominant instructional method can be replaced by including alternative methodologies, such as 'demonstration discovery' or 'integrated curriculum methods' and 'strategies'. Changing the direct instructional models role from an instructional methodology to a planning tool allows the principal to introduce additional instructional methods based school and classroom characteristics.

Glang *et al.* (1993) reported two case studies of children, aged 6 to 8, with severe traumatic brain injuries (TBI) in which 'direct instruction programmes' were used to teach a variety of academic skills. After 12 hours instructional sessions, both students made substantial academic progress on their targeted instructional areas. The gains were seen in both discrete and more complex skills. Both students regained skills lost as a result of their injury and gained new skills.

Warger and Rutherford (1996) studied the practical way to teach social skills to all students in grade K-8, including of students with disabilities, in the classroom and cross other school settings. The instructional strategies included direct instruction, modelling, social reinforcement or feedback and self-control. Results showed the development of social skills using the collaborative approach.

The survey of related literature also revealed that certain studies do not show any special advantage of Direct Instruction Model over other methods of teaching. Studies among such category are summarised as follows.

Four classroom-based experiments in which teachers were trained to use a direct instruction model were analysed by Coladarci and Gage (1981) to compare the results of intensive and minimal training methods. Results indicated that teacher receive minimal training successfully implement it in the classroom with significant improvement in student achievement.

Baumann (1982) examined the effectiveness of direct instruction model for teaching children to comprehend main ideas of prose passages. 69 children in third, fourth grade classes were randomly assigned to an experimental group. Receiving direct instruction in main ideas, an experimental "strategy" group receiving massed basal reader instruction in main ideas, and a control group receiving vocabulary development exercises. All groups received eight, 54-minutes lessons over a period of three weeks. Post-test results revealed no significant differences between the three group's skills at comprehending main ideas.

The study by Devries (1991) examined the interaction between teachers and children in three kindergarten classrooms. Programme used in the classrooms were: a direct instruction (DI) programme, representing a cultural transmission paradigm; a constructivist programme (CON), representing the cognitive–developmental paradigm, and an eclective programme (ECL). Results indicated that the CON teachers had the most SE with children and the DI teachers the least. The DI teachers exhibited an authoritarian orientation and an academic emphasis.

Thomson (1991) examined the effects on 80 first grader's reading achievements when direct instruction phonics is incorporated as a supplement to a whole language approach. Two first grade classrooms used the Houghton Mifflies Integrated Literature Programme and two other classrooms supplemented programme with direct phonics instructions. Results indicated that the direct instruction group did significantly poorer in the school reader ness inventory.

Bay (1992) compared 'direct instruction' with 'discovery teaching' on learning disabled (N=10), behaviourally disordered (N=6) and non-handicapped (N=91) student's science achievement. No significant difference was found in the immediate post-test scores. Discovery learning students outperformed others on a retention test given two weeks later.

Smith (1992) examined the effects of direct instruction on the think-aloud protocol of ninth grade readers. Students made think-allowed protocol on two stories before and after instruction. Results showed that the instruction did not substantially affect students' interpretive operations in reading, some students were less submissive to the text.

Myles (1996) evaluated the use of 'Facilitated Communication' (FC) paired with 'direct instructional strategy' to improve the basic academic skills of 12 youths and young adults with autism. Results did not support the use of FC as an educational tool, with subjects averaging below-chance performance in FC and both control conditions.

Mosley (1997) conducted a study on the effectiveness of the direct instruction programme on reading achievement of sixth-grade students. Size of the sample was 30. Results indicated that students taught using direct instruction as opposed to students taught in the regular classroom had no statistically significant difference on reading scores.

Schweinhart and Weikart (1997) assessed the relative effects of direct instruction model and traditional nursery school preschool curriculum models. Results were found against using direct instruction in preschool programme and for using a well-defined curriculum model based on child-initiated learning activities.

Research on oral reading fluency by Komisar (1999) focused on reading with expression. The purpose of the study was to determine whether the addition of a direct instruction component to the Traditional Repeated Reading (TRR) approach would have a differential effect on oral reading expressiveness – modified repeated reading instruction (MRR) of 48 4^{th} & 5^{th} grade students with learning disabilities. Results indicated that students who received modified repeated reading instruction (MRR) become more expressive readers than traditional repeated reading (TRR).

A study conducted by Stein (1999) ascertains the effect of direct instruction on moral reasoning of high aptitude pre-adolescents as compared with average ability pre-adolescents. The study was a quasi-experimental with 2x2 factorial design. The relationship between ability level and moral reasoning were examined. 63 students took part in the study. The conclusion reached was that there was no effect on instruction in moral reasoning, between a high aptitude and average aptitude pre adolescent students in the test groups.

A Study by Dogm and Michal (2001) compared the personalised system of instruction to direct instruction in the training of direct-care staff from community residential facilities 51 direct-care staff participated in the study. Pre test-Post test experimental design was used for the study. Results showed that thee was no significant difference between the type of training received and direct care staff's ability to perform the skills.

Morris (2001) compared the effectiveness and efficiency of using a general or data-based self-evaluation tool by teachers to assess the implementation of appropriate teachers presentation behaviours when using direct instruction programme. Six teachers from rural South Georgia participated in the study.

Results indicate that using the data-based self evaluation tool was more effective and efficient than using the general self evaluation tool for the successful implementation of Direct Instruction Programme.

Jagar and others (2002) study the effects to teacher training on new instructional reading comprehension. Dutch 7th grade teachers were trained to apply either cognitive apprenticeship or direct instruction model in reading comprehension lessons. Control group teachers used the same conventional method of teaching. In both experimental conditions teachers successfully changed their behaviour, though they did not implement all characteristics of the instructional model offered in their training.

Morgenstern (2003) compared the effects of a low frequency criterion on and a high frequency Criterion on reading ability, retention, endurance, and DI Mastery check-out performance. Third grade elementary students were selected as the sample. 10-29 minutes sessions of repeated reading and paired reading with each student. The analysis of the data did not show a functional relation between frequency criteria and retention endurance, ability or the DI reading mastery check out performance.

2.2.4 Studies Using Direct Instruction Model conducted on Special Groups

The effectiveness of direct instruction model also has been experimented with select special groups such as disadvantaged, disabled, special need learners, problem learners, poverty level children (low-income children), at-risk students, behaviour disorders, low-achieving and the like. Some of these studies are given below.

Becker and Engelmann (1976) assessed the effectiveness of direct instruction model on a sample of 1200 disadvantaged primary-grade children for developing basic academic skills Wide Range Achievement Test, the

Metropolitan Achievement Test and Slosson Intelligence Test were used to measure achievement. Results indicated the effectiveness of direct instruction in building basic skills for a wide variety of disadvantaged students.

Duran (1980) examined reading curriculum for beginning Hispanic Bilingual children based on direct instruction. Results of a field test with 120 bilingual first graders indicate that the manuals direct instruction method of teaching significantly increases students' learning of vowels as compared to other bilingual methods.

Umbach and others (1987) examined differences between the reading scores of students taught by a traditional basal approach and a more structured direct instruction approach. 31, problem readers from two first grade classrooms in a low-income south-eastern rural community were selected as sample. Significantly higher achievement scores were associated with experimental group. One major factor contributing to higher scores appeared to be the direct instruction curriculum used.

Weisberg (1988) conducted a study on cognitive and academic behaviours promoted by an ongoing, long-term Direct Instruction preschool project for poverty level children (N=109). Children who received two years of training achieved at substantially higher normative levels than children trained for only one year and this advantage contained in first and second grades.

White (1988) examined the effectiveness of Direct Instruction programme with special education students in a meta-analysis comparison. Sample included 25 students. None of the studies showed results favouring comparison groups. Fifty-three percent of the outcomes significantly favoured Direct Instruction. Effects were not restricted to particular handicapping conditions, age groups, or skill areas.

Schlessman (1993) examined the impact of Follow Through, a comprehensive programme for low-income children in grade 1-3 and their parents previously enrolled in Head Start Programme. Evaluation of the Direct Instruction Model showed that parents felt that their children were receiving better academic instruction than students in any other approach.

Serafin (1993) examined the application of the Basic Direct Instruction Model (BDIM), a methodology designed to maximize student interest in instrumental and methodological courses, to graduate level educational leadership students. Sample includes 92 beginning level masters' students at a midwestern U.S University. The study concluded that; if the fundamental purpose of the course content is to introduce new concepts and acquisition of new skills, then BDIM is the most appropriate instructional strategy.

The single subject study by Lorsardo and Bricker (1994) compared the effectiveness of two intervention approaches, 'direct instruction' and 'activity based invention on acquisition and generalisation of object names by six young children who were at-risk or had developmental delays. Acquisition of object names was enhanced by use of highly structured didactic approaches to intervention (direct instruction).

Marston and others (1995) implemented research-based reading interventions (peer tutoring, reciprocal teaching, effective teaching principles, computer aided instruction, and two direct instruction models) by 37 special education resource teachers working with 176 elementary school students with mild disabilities. The computer assisted, reciprocal and direct instruction approaches resulted in higher achievement.

Harris and Graham (1996) examined the effect of abolishing direct instruction and skill-practice opportunities could have serious consequences for special-needs learners. Teachers are provided explicit and focused, even isolated instruction as needed and integrate it into the larger literary context. Findings supported the direct instruction model and skill practice opportunities.

The comparative analysis by Nelson and others (1996) examined effects of 'direct instruction', 'co-operative learning' and 'independent learning instructional practices' on the classroom behaviour of four third-graders with behaviours disorder. In the direct instruction condition, students displayed higher rates of on-task behaviour and lower rates of disruptive behaviour relative to the other learning conditions.

Swanson and Hoskyn (1998) conducted a comprehensive synthesis of experimental intervention studies that have included students with learning disabilities was based on 180 studies. Results support the pervasive influence of cognitive strategy and direct instruction model for remediating the academic difficulties of children with learning disabilities.

Swanson (1999) reviewed 180 intervention studies to identify instructional components that best predict effect size for students with learning disabilities. These included sequencing, drill-repetition, practice-feedback, and segmentation of information technology, modelling problem-solving steps, presenting cues to prompt strategy use, supplementing teacher direct instruction. A combined direct instructional model is recommended.

Bryant (2000) examined how fifteen special education junior and high school at-risk students perceived common questioning techniques used by teacher during direct instruction. The study focused on type of remembered information, distractions and the ability to participate in classroom discussion.

The results showed that students were interested in teacher questions. The findings also suggested that an inability to communicate well might be hindering their participation in classroom activities.

Grossen (2002) tested the effectiveness of direct instruction model for atrisk, low-achieving secondary students. The project began in a highly problematic California middle school and achieved record gains for all ethnic and linguistic groups and students at all levels of language arts and mathematics. The project established a professional development model that allowed for replication in other middle schools.

COMPREHENSIVE META-ANALYSIS OF EMPRICAL RESEARCH IN DIRECT INSTRUCTION MODEL: STUDIES IN U.S.A

There is ample evidence to show that Direct Instruction has a positive effect on students' achievement. Adams and Engel Mann (1996) have reported 32 of the 34 studies qualifying for inclusion in their meta-analysis demonstrate that direct instruction is effective on student achievement. (i) their review found that Direct Instruction is effective in improving over all achievement in language, reading mathematics, spelling, health and science. Several other studies confirm and reinforce these findings. Among them seven support direct instruction positive effect on reading, eleven on Mathematics, nine on language and four on affective behaviour and social skills (ii) Direct Instruction also appears to improve chances for later success. (iii) Research also suggests that students who begin with Direct Instruction with low IQs seems to progress at the same rate as students who begin with higher IQs. (iv) Two studies investigated the relation ship between the levels of implementation of Direct Instruction Supervision Code (DISC); these studies found a positive relationship between teacher rating (level of implementation in a classroom) and student performance on standardised achievement measures (e.g. the Comprehensive Test of Basic Skills Reading Assessment). The relationship varied depending on the component of the Direct Instruction approach being measured (e.g pacing format, correcting students) (v) Direct Instruction appears to improve students effective behaviour and social skills: self-esteem/concept, attitude towards self and school attribution of success or failure to self or outside, and sense of responsibility.

In 1977 an evaluation of Project Follow Through was made in U.S.A. In that achievement results of 'High Poverty Direct Instruction students were compared to students of nine other early education programme which served as control group. Direct Instruction students outer performed control group students in other educational programme in every academic measure, moving from 20th percentile to about 50th percentile. Follow up studies of students taught by Direct Instruction in the early grades also show enduring benefits. One New York comparison found that more than 63% of Direct Instruction student's graduate from college, as opposed to 38% of the control group, mean ninth-grade test scores were grade test scores were higher (ES = +0.41, reading; ES = +0.29, Mathematics), retention rates were lower (21 percent vs 0.33 percent); and there were fewer dropouts (28 percent Vs. 46 percent).

Wesley Elementary School (Houston, Texas) has one of the longest, continuous Direct Instruction implementation in the country. The student population is over 99 percent minor and 90 percent eligible for school lunch subsidies – statistics usually signal low achievement levels.

This school has ranked in the top of all schools in the state – the success has been credited to the schools adoption of 'Direct Instruction' in 1973. In 1980, students have average test scores above the 80th percentile in the reading and vocabulary.

As a part of Utahs Accelerated Student Achievement Project (ASAP) to improve poor performing Title I School in U.S.A, three elementary schools adopted, school wide 'Direct Instruction Programme' during the 1994-95 School year. The Preliminary achievement data were impressive. After two years in the programme, one school moved from last to second place (out of 24 schools) in the districts' annual Mathematics Olympics.

CONCLUSION

A survey of the literature relating to Direct Instruction Model shows that there is a rich base of empirical research incorporating Direct Instruction Model as a method of teaching, developing teacher efficiency and academic skills especially for special education students in the developed countries. An analysis of the literature reviewed reveals the following.

Direct Instruction Model is helpful in improving the achievement of the learner. Almost all the studies were conducted in America and a few studies in other developed countries. Out of the research studies many studies show positive effect of Direct Instruction Programme on the performance of subject but some studies do not show any significant gain from the programme. The investigator failed to identify any study in India or in Asia.

Out of 100 studies located, 86 of them were found to have positive effect. Twenty four studies were conducted on mathematics, among them six were found to have no significant gains on mathematics achievement – twenty six studies show positive effect on language achievement and reading, nine on teacher efficiency and eleven on developing other skills among students. From the review of related literature it is noticed that fifteen studies do not show any significant effect of direct instruction over other teaching methods on achievement. The studies also revealed that Direct Instruction Model is very much beneficial for special education leaner.

Studies reviewed mostly indicate that Direct Instruction Model is helpful in improving the academic achievement of the learner. Studies were mainly concentrated on the acceleration of achievement in Mathematics and language especially on skill oriented activities. Most of the studies wee conducted in developing countries especially on America and only one study each was from Japan, Australia and South Africa. Almost all the studies identified are experimental study using Direct Instruction Model treated singly or with other methods o teaching. Most of the Studies were concentrated on their effect on cognitive outcomes as instructional objectives.

Curriculum offered for general education in Kerala is fixed and subject oriented. Activity oriented method of instruction had been recommended but implemented only recently. But the curriculum with an overload of content has to be implemented in a rigid organisational school set-up. In the curriculum transaction a fixed duration for each subject and content area is recommended with a uniform standard of evaluation using a common textbook and learning materials. Practically teachers are not given freedom to experiment modern techniques of teaching and evaluation in the classroom with administrative support. Necessity of empirical studies on modern techniques especially methods like Direct Instruction Model of teaching and modern evaluation techniques is therefore felt imperative by the investigator. Considering the above points investigator decided to study the feasibility and effectiveness of adopting Direct Instruction Model using a select content in Mathematics.

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

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2004

CHAPTER 3

METHODOLOGY

- *Selection of Variables*
- *Objectives*
- *Hypotheses*
- *Procedure*

METHODOLOGY

The methodology followed at the various phases of the investigation is described in this chapter and presented under the following sections.

3.1 SELECTION OF THE VARIABLES

3.2 OBJECTIVES

3.3 HYPOTHESES

3.4 PROCEDURE

3.1. SELECTION OF THE VARIABLES

The review of related studies had given a clear idea of the theoretical outline of Direct Instruction Model of teaching. It helped the investigator to identify in the selection of the independent variables, the dependent variables and the variables to be controlled. Accordingly variables, which are related to achievement in mathematics, were selected and categorised for the study. A brief description of the variables selected for the study is given below.

3.1.1. Independent Variables

Two sets of variables based on methods and paradigms of teaching were selected as independent variables.

3.1.1.1 Direct Instruction Model

Direct Instruction Model belonging to Behaviour Family is a teacher directed model of teaching. According to Engelmann (1960) it increases pupils achievement through carefully focused instruction. It develops the ability to perform a skill independently without any error. According to Rosenshine (1986) 'Direct Instruction Model of teaching is a systematic method of presenting materials in small steps, pausing to check for student understanding and eliciting active and successful participation from all students'. Many studies in the western countries reveal that by using the Direct Instruction Model as an instructional strategy, slow learners and students with difficulties in learning can overcome their problem and can have high achievement in their future.

3.1.1.2. Objective Based Instruction

The second method of instruction used for the study was Objective Based Instruction. It was based on Bloom's Taxonomy modified and adopted by National Council of Educational Research and Training. It was one of the method adopted by Government of Kerala in the primary and secondary schools and was recommended by Department of Public Instruction.

3.1.2. Dependent Variables

The focus of the present study was on to explore how effective the Direct Instruction Model will be for Achievement in select Mathematical skills and retention of these over a period of time. Skills in the cognitive domain were only considered for the study. Hence skills in knowledge category, comprehension category and application category were taken. In the application category only skills in the fundamental operations were included. Thus Achievement in Mathematical Skills (Objective wise and Total score) was treated as Dependent Variable. Specific variables coming under these categories are listed below.

- Knowledge category
- Comprehension category
- Application category
- Achievement in Mathematical Skills (Total Score)

3.1.3. Control Variables

Variables controlled in the present study are the following.

(i) Previous Knowledge of the Subject Matter.

(ii) Non-Verbal Intelligence

(iii) Numerical Ability.

3.2. OBJECTIVES

The present investigation was intended to explore whether Achievement in Mathematical skills vary when Direct Instruction Model of teaching is adopted in conventional classrooms without disturbing very much the usual classroom organisational set up. The study was therefore designed as a quasi-experimental study. The design adopted was Pre-Test-Post-Test Equivalent Group design.

'Direct Instruction Model' has been selected as the Experimental Variable. The changes in Achievement in Mathematical Skills (Dependent Variable) if any, have been explored in comparison with 'Objective Based Instruction.' Other variables namely 'Previous Knowledge of the Subject Matter,' 'Non-Verbal Intelligence' and 'Numerical Ability' had been treated as Control Variables. One group was treated as Experimental Group I, taught through Direct Instruction Model only, the second group was treated as Experimental Group II, taught through Direct Instruction Model and Objective Based Instruction alternately and that third group was treated as Control Group, which was taught through Objective Based Instruction only. The objectives formulated for the present investigation are given below.

3.2.1. To Compare the mean scores of Achievement in Mathematical Skills Post test I (tested immediately after the treatment) of Control Group and Experimental Group I and between Control Group and Experimental Group II.

3.2.2. To Compare the mean Gain scores of Achievement in Mathematical Skills (Post-Test I minus Pre Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II

3.2.3. To Compare the mean Retention scores of Achievement in Mathematical Skills Post-Test II (tested two months after experimentation) of Control Group and Experimental Group I and between Control Group and Experimental Group II

3.2.4. To compare the mean Gain scores of Achievement in Mathematical skills (Post Test II minus Pre Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II

3.2.5. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

3.2.6. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

3.2.7. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-test I for Total Sample, Boys and Girls.

3.2.8. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

3.2.9. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

3.2.10. To study the main effect and interaction effect of Methods of teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

3.2.11. To study the relative effectiveness of Direct Instruction Model on Achievement in Mathematical Skills when initial difference in select variables namely 'Previous Knowledge' of Subject Matter, Non-verbal, 'Intelligence' and Numerical Ability' of the subjects are controlled one by one.

3.3. HYPOTHESES

The hypotheses formulated and tested for the study are the following.

3.3.1 There will be significant difference in the mean scores of Achievement in Mathematical Skills Post-Test I (tested immediately after treatment) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

3.3.2 There will be significant difference in the mean Gain scores of Achievement (Post-Test I minus Pre Test) between Control Group and

Experimental Groupl and between Control Group and Experimental Group II.

3.3.3 There will be significant difference in the mean Retention scores of Achievement in Mathematical Skills Post-Test II {tested two months after treatment) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

3.3.4 There will be significant difference in the mean Gain scores of Achievement in Mathematical Skills (Post Test II minus Pre Test) between Control Group and Experimental Group I and between Control Group and Experimental Group II.

3.3.5 There will be significant Main effect and Interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

3.3.6 There will be significant Main effect and Interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

3.3.7. There will be significant Main effect and Interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills in Post-Test I for Total Sample, Boys and Girls.

3.3.8 There will be significant Main effect and Interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on

Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

3.3.9 There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills in Post-Test II for Total Sample, Boys and Girls.

3.3.10 There will be significant Main effect and Interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills in Post-Test II for Total Sample, Boys and Girls.

3.3.11 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post Test I and Post Test II than pupils taught through Objective Based Instruction when the initial difference in Previous Knowledge of Subject Matter were controlled.

3.3.12 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post Test II than pupils taught through Objective Based Instruction when the initial difference in Non-Verbal Intelligence were controlled.

3.3.13 Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post Test I and Post Test II than pupils taught through Objective Based Instruction when the initial difference in Numerical Ability were Controlled.

3.4. PROCEDURE

The research design adopted for the study, procedure of selection of sample, conduct of experimentation, data collection procedure and techniques used for processing the data are described in this section.

3.4.1 The Research Design

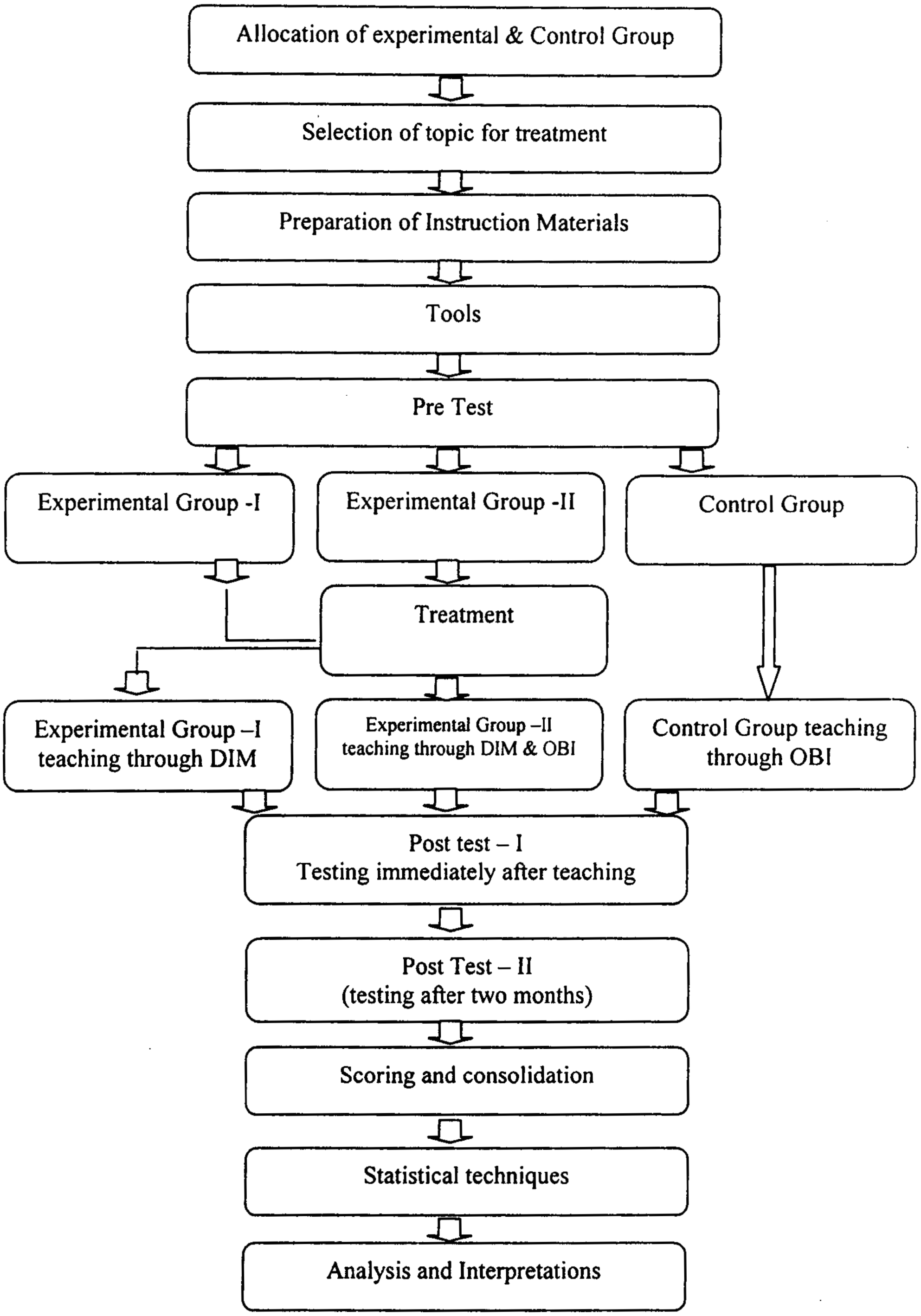
The experimental design used in this study was Pre Test – Post Test Equivalent Group Design. The graphical representation of the design is as follows.

G_1	O_1	X_1	O_2		
G_2	O_3	X_1	C	X_2	O_4
G_3	O_5	C	O_6		

O_1 O_3 O_5	- Pre-Test
O_2 O_4 O_6	- Post Test
$O_2 - O_1$	- Gain Score
$O_4 - O_3$	- Gain Score
$O_6 - O_5$	- Gain Score
G_1	- Experimental Group I
G_2	- Experimental Group II
G_3	- Control Group I
X_1 X_2	- Application of Experimental Treatment
C	- Application of Control Treatment

The design of the study is represented in the form of Flow chart and is given below.

Flow chart of the experimental design



3.4.1.1. Sample of the Study

The population of the present study covers the Upper Primary Pupils of Kerala. But the investigator decided to confine the conduct of the experiment to pupils of standard VII since they are at the terminal stage of upper primary section. Care was taken to ensure that the subjects selected were equivalent in many respects. It was decided to select coeducational schools where the medium of instruction is English for experimentation. It was also ensured that almost equal number of boys and girls were included in the sample. Instructional efficiency of the school was ascertained on the basis of the examination results of three previous consecutive years in the common Secondary School Leaving Certificate Examination (2000-2002). The statistics kept in the office of the District Educational Officer helped for this purpose. Schools with above average instructional efficiency, that is pass percentage of about fifty to fifty five for the consecutive years were included in the sample. For the smooth conduct of the experiment and for other practical reasons it was decided to select schools from urban area. Based on these criteria, schools from three revenue districts of Kerala were selected. One school from each district was selected at random for experimentation. It was also ensured that the schools are easily accessible and amenable for the investigator to conduct the experiment and are located in such a way that the subjects in the select school, where experiment was conducted do not consult each other and exchange study materials.

Assuming that each class of the select schools consists of approximately thirty pupils, two English medium class divisions from each school were selected. It was also decided to select the sample for the experiment consisting of 180 pupils of standard VII from three different schools (60 pupils were treated as Experimental Group I, 60 pupils were treated as Experimental Group II and 60 as Control Group). The actual number of sample in each group at the entry stage of the experiment is shown in the following break-up.

	Experimental Group I	Experimental Group II	Control Group	Total
Boys	30	30	30	90
Girls	30	30	30	90
Total	60	60	60	180

3.4.1.2. Allocation of Experimental Groups and Control Group

It would be difficult to carryout an experimental study on a large sample. Since the random assignment to subjects in Experimental and Control groups will not be plausible in an organised set up of the schools and to get a more natural setting for the conduct of the study it was decided to select intact class groups. Two classes were therefore considered as the unit of study. The schools were allocated as Experimental and Control groups by taking a lot. Details of the schools are given in the following break-up.

Sl. No.	Name of the School	Nature of Group
1	Devaswam Board Higher Secondary School, Kavumthakom	Experimental Group I
2	St. Teresa's Higher Secondary School, Vazhappally	Experimental Group II
3	Nair Service Society K.P. Thampan Higher Secondary School, Ottapalam	Control Group

3.4.1.3. Selection of the Topic for Treatment

The investigator carefully examined the syllabus and text books on mathematics prescribed for the upper primary schools of Kerala. It was felt that topics which require mastery of basic essential concepts that have carryover value, are worthwhile for experimentation. The investigator consulted a few subject experts of three colleges of Teacher. Education and two experts of State Council of Educational Research and Training, and a few Mathematics teachers of both primary and secondary level for this purpose. It had been pointed out that fractions, decimals and percentages are the most difficult areas faced by the learners at primary level. Moreover these topics have maximum application in day-to-day life and have linkage with other subjects. Trend reports of evaluation in mathematics also support the selection of these topics.

According to the Trend report (Ronad, 1990) acquisition of concept of fractions and decimals has been a thorny problem for learners. The National Assessment of Educational Progress confirms that fractional concepts are particularly problematic for many students. According to Kouba (1988) quoted by Gupta (1991) for third grade students about one-half of the sample could write the symbol for three-fourths. But only one in four knew the number of fourths that make a whole. About forty percent of seventh grade students could identify the point on a number line that represented a simple fraction, and a fewer than forty percent were able to identify both the largest and smallest of four fractions in a simple problem situation." The National Council for Teaching Mathematics standards focuses in the development of concepts fractions (and decimal fractions). They recommended only concrete, explanatory experiences with fractional operations. For higher grades, application of the concepts, including operations and broadening of the concepts are stressed. According to the National Council for Teaching

Mathematics reported by Riedesel (1990) the sequence for fraction instruction are:

- Concept → what is a fraction?
- Equivalence → what are the different ways of representing an amount?
- Comparison, Sequencing → How are fractions ordered?
- Operations → How are fractions combined?

Twenty five teachers teaching mathematics in MCD Model School in New Delhi were contacted by Kusum Bhatia (1998) to discuss the mathematics syllabus at primary schools. They were asked about the areas of mathematics in which students of class V face more difficulties. More than eighty five percent teachers selected decimals as one among such topics. The concept of decimal is extremely useful in day-to-day life and for transaction. This is extremely useful in learning the concept of measurement and business. Due to constrain in time, percentage was not incorporated in the experimental study. Finally the investigator made sure that the topics selected namely fractions and decimals were well amenable through Direct Instruction Model of teaching.

3.4.1.4 Preparation of Instructional Materials

The investigator prepared separate instructional materials for Experimental and Control treatment for topics selected for treatment.

A. Planning of lesson formats

The content under the selected topics *fractions* and *decimals* were categorised into subunits as given below.

Fraction:

- Concept of fraction

- Equivalent fractions
- Ordering of fractions
- Addition and subtraction of fractions
- Multiplication and Division of fractions

Decimals

- Concept of decimal
- Ordering of decimal
- Uses of decimals
- Fundamental operations with decimal

After deciding the subunits under each topic the investigator ascertained the duration required for teaching the subunits and the number of written lesson plans to be prepared for each sub unit using Direct Instruction Model and Objective Based Instruction were fixed as given below.

Sl. No.	Subunit	Number of lesson plans
1	Concept of fraction	3
2	Equivalent fractions	2
3	Ordering of fractions	2
4	Addition and Subtraction of fractions	6
5	Multiplication and Division of fractions	2
6	Concept of decimal	2
7	Ordering of decimals	1
8	Uses of decimals	1
9	Fundamental Operations with decimals	4
10	Simplification of Numerical Expression	1

It is to be noted that the instructional objectives for each subunit were same for the two methods of teaching adopted as treatment variable.

B. Lesson Plans Based on Direct Instruction Model

Four lesson plans based on Direct Instruction Model of teaching were prepared. Lesson plans suggested by Robert Slavins Direct Instruction Model (1998), Rosenshine's Direct Instruction Model (1989) Mandeline Hunter Direct Instruction Model (1999) and Engelmann's Direct Instruction Model (2001) are the most popular among the varied lesson formats of Direct Instruction Model. Among these, the format suggested by Engelmann (2001) was found to be suitable by the investigator for teaching mathematics. Other formats were also referred for preparing the lesson plans (formats).

Before preparing the lesson plans it was found necessary to select the instructional objectives to be attained, by analysing the content and also to fix the standards of performance expected to be attained by the pupils at the level of mastery. The different phases of the syntax of Direct Instruction Model prepared by Engelmann is given below.

- Attention and Focus
- Orientations
- Model
- Lead
- Test
- Delayed test and Weekly Review

Altogether twenty four lesson plans were prepared, fifteen for fractions and nine for decimals. For each sub unit a formative test was also prepared, thus finally nine formative tests – five for fractions and four for decimals were developed. Formative tests were given only for experimental treatment. No formative test was administered to control group during experimentation.

Try Out

Three lesson plans were prepared initially for the subunit fractions and two lesson plans for decimals as per Direct Instruction Model. It was decided to tryout the lesson plans to ensure the time required for the completion of teaching that sub unit covering all the phases of teaching. The difficulties faced while implementing this method in the usual classroom set-up was noted. The concerned class teacher of mathematics for that class and an expert in the field of mathematics education were also present as observes throughout the class during tries. Based on the reactions and responses by pupils and the opinion of teacher observers were noticed. The lesson formats were further scrutinised and revised by the investigator based on the suggestions of observers and reactions of pupils. Slight modifications were made on the lesson plans. These lesson plans were again scrutinised by two experts in mathematics education from the college of Teacher Education. Thus lesson plans for Direct Instruction Model were finalised. Lesson plan based on Direct Instruction Model (one each in fraction and decimal) together with the format for observation lesson during the tryout stage is presented as Appendix IA, IB and IC.

C. Lesson Plans Based on Objective Based Instruction

For Control group twenty four lessons were prepared on the basis of Instructional Objectives of Bloom's Taxonomy adopted by National Council of Educational Research and Training. For this purpose the content of fractions and decimals were thoroughly analysed on the basis of which the objectives that are to be attained in the cognitive domain. These objectives are again analysed into observable and measurable behavioural changes (specifications) that are to be taken place in the learner. These specification acts as the basis for planning lessons for control group. The terminal behaviours were then identified and written as instructional objectives. Based on the blue print of the lesson format, lessons were prepared. This format of lesson plans is being used in the schools under the general education department of Kerala State for last three decades. It is to be noted that along with this lesson format, the primary schools of Kerala have also introduced instruction under District Primary Education Programme, Minimal Level Learning, Sarva Siksha Abhayan and the like.

The format of Objective Based Instruction is given below.

Preparation

- Reviewing the previous knowledge
- Motivating the learner to learn the new ideas
- Why he/she is going to learn these ideas

Presentation

- Presenting the new materials
- Providing provisions for students for activity
- Active participation of students
- Evaluation at appropriate time

Application

- Applying the newly learned content or skill in different situations

Reviewing and Assignments

- Reviewing newly learned materials.
- Drill work and home assignments.

The sample lesson plan is given as Appendix II A and II B.

Difference between Direct Instruction Model and Objective Based Instruction are as follows:

Direct Instruction Model	*Objective Based Instruction*
Introduction Stage	
• Consists of 2 phases - Attention & Orientation	• No separate phase for introductory stage.
• Grouping of class – Pupils will be categorised in 5-6 homogeneous groups based on ability/subject competency	• No specific grouping during learning
• Motivating pupils to learn by giving the abbreviated version of specific objectives of lesson	• Motivating and sustaining interest through the situations creation to present the learning task
• Linking the days lesson with previous work	• Linking days lesson with previous work
• List the specific content and skills to be mastered	
• Agenda of the class is provided	
• Techniques of presentation such as story telling/Question-answer/narration	• Techniques such as question answer, story telling
• Time allotment is seven minutes	• Time allotment is seven minutes
Development Stage	
• This stage is also known as *Model*	
• Learning tasks are given to groups.	• Learning tasks are given to whole class
• Carefully designed *formats* were used for demonstration	• Expository techniques and illustrative talks
• Rate of learning for group as well as individual were monitored	
• Individual participation within each group is assured by the teacher and bonus points are given to group activities.	• Individual progress is not noticed. Only sample progress is assured
• Prompts are given	• Usual prompts are given
• Time allotment is about 15-20 minutes	• Time allotment is 15-20 minutes

Application Stage	
• This stage is known as 'Lead' or 'Guided Practice'.	
• Confirm that the students are firm and fluent before moving to next stage	• Class is not assessed before moving to next stage
• Individual remediation if necessary will be provided by the teacher	• If necessary general remedy will be given to whole class.
• Teacher and pupil work together during class time	• Usually teacher directs.
• Time allotment is eight minutes	• Time allotment is eight minutes
Review and Assignments	
• It is also known as 'Test' or 'Independent Practice'	• Only general overview will be done
• Worksheets are provided to each student	• Random evaluation in the class will be done.
• Mastery of each student is ensured.	• Few class assignments and home assignments are given.
• Weekly review will be done using unit tests which are followed by remediation of necessary	• Weekly review is not a must
• Students are regrouped on the basis of performance in unit test	• Unit tests are not attempted.
• Pupil progress is recorded	• Remedies are not common/compulsory
• Feedback is compulsory to ensure mastery	• Recording of individual progress is not necessary and feed- back is not given.
• In general all lessons are neither amenable through DIM of teaching nor recommended.	• All lessons are amendable through OBI.

3.4.1.5. Tools used for Measuring Control Variables

The other tools selected were to measure the control variables such as Non-Verbal Intelligence, Numerical Ability and Previous Knowledge of the Subject Matter.

A. Standard Progressive Matrices (Ravens, 1958)

Non-verbal Intelligence of the subjects were measured by administering the standard form of the Raven Progressive Matrices Test. This test is intended to estimate the subject's ability to discern and utilise a logical relationship presented by non-verbal materials. The test consists of five subtests of twelve items each. In each item a part of the geometrical design is missing. For each item the key consists of six or eight alternatives and only one belongs to the missing part. The test is a popular measure of 'g' factor of Intelligence.

Validity of the test has been studied in a variety of usual ways when Stanford-Binet test was used as the criterion, correlation varied from 0.50 to 0.86. The reliability coefficient as reported by Raven varies from 0.80 to 0.90. In a study conducted by Nair (1972) in Kerala, the reliability coefficient was found to vary from 0.70 to 0.86 by split-half method and from 0.84 to 0.91 by test-retest method.

Scoring sheet of Raven's Progressive Matrix is given as Appendix III.

B. Numerical Ability Test

A Numerical Ability Test was developed by the investigator under the guidance of her supervising teacher and consulting with some experts in mathematics. The numerical ability of an individual comes under cognitive tasks. It includes a number of stages as given below.

- Classification – the ability to sort and group objects by some similar characteristics.
- Seriation – the relationship among objects as they place them in a logical order or sequence.
- Number Concept – number concept involves more than rote counting, it concerns rational counting as well as the ability to correctly attach a numeral name to each item in a group of objects.
- Temporal concepts – the ability to place a series of events in the order of their occurrence.
- Spatial Concepts – it is concerned with relation of objects to each other in space.

The investigator includes all the above tasks except spatial concepts and the fundamental operations with whole numbers. Hence the test is able to measure the ability of individuals in handling numbers. The test consists 50 items under ten sub sections, of five items each. For each item four choices were given, indicated by A, B, C & D. Among them only one answer is correct.

In section A subjects have to identify the correct place value of the underlined digit of the given number.

Eg: 165802793

[A. lakh B. ten lakh C. crore D. ten crore]

In section B subjects choose the correct answer from the bracket.

Eg: One lakh = ------ hundreds.

[A. 1000 B. 10000 C. 100000 D. 1000000]

Section C consists of addition of numbers. By adding the numbers correctly subjects will find out the correct one from the given.

Eg. 731034 + 10991 + 327897

[A. 969922   B. 1069922   C. 1068922   D. 1069822]

Subtraction of numbers is given in section D. By subtracting the smaller one from the larger the correct answer can be identified.

Eg: 10001 - 99

[A. 9802   B. 9901   C.9902   D.8902]

In section E, items included intend to find out the correct answer subjects have to multiply the given numbers.

Eg: 325 x 15

[A. 4450   B.4875   C.5200   D. 3400]

Subjects are to find out the quotient by dividing the numbers in section F.

Eg: 1989 ÷ 9

[A. 219   B.221   C.231   D.211]

In section G subjects have to pick out the correct symbol to fill the blank in each case.

Eg: 583456 ………… 583564

[A. ≤   B. <   C. >   D =]

For each item in section H, subjects choose the correct predecessor from the bracket.

Eg: 10000

[A. 10001 B.99999 C. 999 D.9999]

Carefully studying each series subjects identity the correct missing number in section.

Eg; 3727 3728 3729 -------

[A. 3730 B. 3739 C. 3829 D.3720]

In section J subjects have to find out the correct answer to fill the blank so as to make the units correct.

Eg: 1 hetrometre = 10 .....

[A. kilometre B. decametre C. metre D.decimetre]

A draft test consisting of 100 items were prepared initially and field tested to select valid items to be included in the final test of numerical ability. Test was administered to 130 pupils of standard VII selected randomly.

Item Analysis

Item analysis of the items in the Numerical Ability Test was done using the method suggested by Ebel and Frisbic (1991). The answer sheets of 120 students were scored. For the correct answer one score was given. No score was given for incorrect answer. Fully answered 100 answer sheets were taken for item analysis. All the 100 response sheets were arranged in the descending order of total marks. From this twentyfive response sheets having highest score were taken as the upper group and the twentyfive sheets having the lowest score as the lower group. The response sheets of upper and lower groups were separated from the total group.

The difficulty index and discriminating power were computed using the formula suggested by Ebel and Frisbie (1991).

$$\text{Index of Difficulty} = \frac{U + L}{2N}$$

$$\text{Discriminating Power} = \frac{U - L}{N}$$

Where,

U = Number of correct responses in the upper group.

L = Number of correct responses in the lower group.

N = Number of subjects in any of the group.

The difficulty index and discriminating power of 100 items were computed. The Test of Numerical Ability Test, Item analysis chart, final Test of Numerical Ability and Scoring Sheet of Test of Numerical Ability are given as Appendix IV A, IV B, IV C and IV D respectively.

C. Achievement Test in Mathematical Skills

Achievement Test in Mathematical Skills developed by the investigator was used as Pre-Test. A parallel test of this test from the same blue print was prepared as Post-Test. This parallel test was used as Post-Test I and Post-Test II. Steps in the construction of the test are described in the following sections.

(i) Planning of the Test

For preparing an achievement test in fractions and decimals the investigator studied the syllabus of primary classes having these topics. The books referred for preparing the test were given below:

- Let's Learn Maths (Guptha, V.P. *et al.*, 1991).

- Teaching Elementary Mathematics (Kutz Ronald, E. 1990).
- Teaching Elementary School Mathematics (Riedesel, C, Alen, 1990).
- Teaching Arithmetic to Children (Swenson Esther, J. 1989).

It was decided to prepare test in fractions and decimals of multiple- choice items only, having 100 items which can be administered for a duration of maximum one and a half hours. The test was intended to measure abilities of cognitive domain only. The content selected were thoroughly analysed into terms, facts, concepts, principles and problem solving skills.

(ii) Preparation of the Test

Items for the Achievement in Mathematical Skills were prepared confining to the three basic objectives of cognitive domain namely Knowledge, Comprehension and Application. Items to check the mastery of concept of fractions and decimals, their ordering, uses, fundamental operations and the like were included in the test. Appropriate weightages were given to objectives. Equal weightage was given to each subunit. Only multiple choice items were included in the test. Weightage to level of difficulty was considered while the items were selected.

(iii) Preparations of Blue Print

A blue print ensuring weightage to objectives and content were prepared. The form of questions was already fixed as to include only the multiple choice items.

Weightage to objectives

Sl. No.	Objectives	Marks	Percentage
1	Knowledge	35	35
2	Comprehension	30	30
3	Application	35	35
	Total	100	100

Weightage to Content

Sl. No.	Content	Marks	Percentage
1	Concept of Fraction	10	10
2	Types and Convention of fraction	10	10
3	Equivalent and Ordering of fractions	10	10
4.	Addition and subtraction of fraction	10	10
5.	Multiplication and Division of fractions	10	10
6.	Concept of Decimals, Equivalent decimals Conversion of decimals	10	10
7.	Uses of decimals	10	10
8.	Ordering of decimals	10	10
9.	Fundamental Operations with decimals	15	15
10.	Simplification of numerical Expressions	5	5
	Total	100	100

A two-way grid specifying weightage to objective and content was prepared as a blue print for the final test and is given in Table 3.1.

TABLE 3.1
Blue Print for Achievement in Mathematical Skills

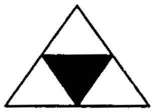
Content	Knowledge	Comprehension	Application	Total
1	10	--	--	10
2	--	7	3	10
3	5	5	-	10
4	--	5	5	10
5	--	3	7	10
6	10	--	--	10
7	5	5	--	10
8	5	5	--	10
9	--	--	15	15
10	--	--	5	5
Total	35	30	35	100

iv) Item Writing

Based on the blue print an initial pool of 150 items were prepared to be included in the draft test so as to get enough number of items of proved psychometric properties in the final test. For each item four answers were given of which only one is the correct answer and other three are distractors. Seventy five items were prepared from the topic fractions and the remaining seventy five from decimals. The items were scrutinied by experienced mathematics teachers and teacher educators. On the basis of their suggestions some items were modified. Illustration of each item under each objective is given below.

- Knowledge Category

Fraction → Write the fraction of the shaded portion in the given figure



[A. $\frac{3}{4}$ B. $\frac{2}{4}$ C. $\frac{1}{3}$ D. $\frac{4}{1}$]

Decimal → Find the correct decimal to the fraction $9\frac{1}{10}$

[A. 91.0 B. 9.01 C. 9.1 D. 0.91]

- Comprehension Category

Fraction → Find the fraction in between $\frac{5}{8}$ and $\frac{3}{4}$ having 32 as denominator.

[A. $\frac{18}{32}$ B. $\frac{22}{32}$ C. $\frac{20}{32}$ D. $\frac{42}{32}$

Decimal → 10 thousandth = 1 ---------------

A. tenth B. hundredth C. Thousandth D. one

- Application Category

Fraction → Add $5\frac{1}{4} + 4\frac{1}{5}$

[A. $9\frac{1}{9}$ B. $\frac{189}{20}$ C. $9\frac{1}{4}$ D. $9\frac{1}{5}$]

Decimal → Multiply 6.03 x 1.0

[A. 0.603 B. 6.03 C. 60.03 D. 600.3]

V. Pilot Testing

A draft test consisting of 150 items with general instruction and specific instruction for answering the questions was prepared according to the blue print. The test was administered to ten students of standard VII selected randomly. Oral instructions were also given besides the written instruction whenever necessary to clear doubts. Time taken for completion of test by each student was also noted. Scoring was done on the basis of already prepared scoring key. Observation of students taking test and analysing the problems faced by students who took the test, slight changes were made in the instructions. Thus preliminary test was prepared.

(vi) Try-out of the Draft Test

The draft test prepared consisting 150 – multiple choice items were administered to a sample of 120 students of standard VII. Before administering the test the investigator approached the administrators and pupils to make clear the purpose of the test. The test was administered under ideal conditions. The test together with response sheet was given to subjects. General guidelines were given before the test started. Specific guidelines were given at appropriate time and additional information whenever necessary.

The response sheets were collected and scored using the already prepared scoring key. One score was given for the correct answer and no score was given to wrong answers.

(vii) Item Analysis

Item analysis was undertaken using the method suggested by Ebel and Frisbie (1991). 100 response sheets were taken for item analysis. In complete sheets and manipulated sheets were discarded. For the analysis the response sheets were arranged in the descending order of total marks obtained by the subjects. The top twenty five scores were selected as upper section and those twenty five who scored the lowest marks were selected as lower section. The response for each item by the two groups was noticed. The index of difficulty and discriminating power of each item were computed using the formula suggested by Ebel and Frisbie (1991).

$$\text{Difficulty Index of item, } D_1 = \frac{U + L}{2N}$$

$$\text{Discriminating power of item, } D_1 = \frac{U - L}{N}$$

Where,

U = Number of right responses in the upper group.

L = Number of right response in the lower group.

N = Number of subjects in any of the group.

The item difficulty and discriminating power of each item was calculated.

Achievement Test in Mathematical Skills, Item Analysis, Achievement Test in Mathematical Skills Post Test I and Score Sheet are given in Appendix V A, V B, V C, V D respectively.

Difficulty index ranging between 0.30 and .80 with discriminating power above 0.30 were readily selected for the final test. However a few items with .28 and .80 were also selected to match with the blue print. Thus final test with 100 items was prepared with necessary instructions to respond. This test was then put to test for validity and reliability.

Validity

The validity of the Achievement Test in Mathematics was established in two different ways.

Subjecting the test items for experts' criticism content validity of the tes twas ensured. As per the evaluation of experts, the test content agrees with the treatment content in both the dimensions objective basedness and comprehensiveness.

Criterion validity was established by correlating the scores on Achievement Test in Mathematical Skills obtained by seventy students of Class VII in Palakkad district with their marks obtained in mathematics in the previous terminal examination. Pearson's product moment formula was used for this purpose. The correlation coefficient was found to be 0.68.

(ix) Reliability

The split half reliability was established on a sample of 70 students of VII in Palakkad District from which the test was validated. The total score for Achievement in Mathematical Skills was split into two –two sets of scores were obtained by splitting the total score into two for each student, by taking odd numbered as one set and even numbered questions a second set. The two sets of scores obtained were correlated using Pearson's product moment formula and applying the formula given below.

$$r_{tt} = \frac{2\, r_{hh}}{1 + r_{hh}}$$

r_{hh} = split half reliability.

The reliability coefficient was found to be 0.82.

The indices of validity and reliability indicated that the Achievement Test in Mathematical Skills has acceptable psychometric properties to measure the Achievement in Mathematical Skills of standard VII pupils.

(X) Preparation of Post-Test I and Post-Test II

A parallel test was prepared on the basis of the same blue print of Pre Test. This test was used as Post-Test I and retention test, that if Post Test II. The Test in Achievement in Mathematical Skills is given as Appendix VI

3.4.1.6. Data Collection Procedure

After finalising the selection of schools for the present investigation, heads of the schools were contacted through proper channel for getting permission for conducting the experiment. The investigator appraised the heads of the schools regarding the importance of the study and a schedule was fixed for experimental schools and control schools. The experimentation commenced on the month of July and completed on November, 2003.

3.4.1.6.1. Administration of Pre-Test

Prior to the introduction of treatment in the selected schools, data on Previous Knowledge of Subject Matter directly linked with the experiment, Non-Verbal Intelligence, Numerical Ability of the subjects were collected. For this purpose, Achievement Test in Mathematical Skills (Pre-Test), Raven Progressive Matrices Test and Numerical Ability Test were administered. The procedure suggested in the manuel for the administration was followed especially for Raven Progressive Matrices Test. The data thus collected ensured the entry status of the students in terms of Achievement in Mathematical Skills; Non-Verbal Intelligence and Numerical Ability.

3.4.1.6.2. Procedure of Treatment

The Experimental groups and control groups were given different treatments. The investigator has identified that each class transaction (whether it be experimental or control) lessons can be broadly categorised into four phases. They are:

(i) Introduction
(ii) Development
(iii) Application
(iv) Review and Recitation

3.4.1.6.2.1 Control Group

The treatment procedure in the control group is described below.

Students of standard VII of Nair Service Society K.P. Thampan Higher Secondary School (English medium classes) form the control group. The data collection and treatment commenced on July, 2003. Without altering the organisational set up of the classroom the investigator herself taught the lessons through Objective Based Instruction. Only conventional teaching aids were used during the treatment. Twenty four lessons were given and it took three weeks to complete it. No formative/unit test was administered during the treatment. No separate grouping of class or rearrangement of seating of students was done for control group.

(i) Introduction

For each class the first seven minutes was spent for the introduction stage. During this stage the previous lesson was reviewed and also few introductory questions relevant to that days lesson were asked to motivate the pupils' and create interest in the class. Thus a favourable situation for learning was created. The day's lesson was presented in most classes in a problematic way.

(ii) Development

The second stage was the development stage. At this phase the investigator tried to develop the new concepts, rules and the like in an expository manner. It was done mostly through pupil activity or through illustrative talk. Though there were pupil activities they were mostly teacher directed and uniform for all students. Appropriate blackboard work was given by the teacher as visual supplement or summary of the lesson. Proper generalisation and discriminations were done through several examples.

In this group pupils were mostly passive observers and there were more teacher activity. Occasionally mass answering is allowed. Pupils do not get enough opportunity to participate actively in the learning process. About fifteen minutes was spent for this stage.

(iii) Application

The third stage is application stage. Here the subjects applied the newly learned concepts or principles in new and day-to-day situations. At first it was done with the help of teachers and then subjects will be allowed to do it by themselves. For Control Group the investigator gave no attention to group work. Only common individual work either as class work or home-work. Individual mastery was ensured then and there. Only sample student mastery was noticed. No error rate measurement was done for this group and any individual remedies. General instructions were given as remedy if it was needed.

(iv) Review and Recitation

This was the last stage. About eight minutes was spent for this stage. Pupils recited silently the newly learned concepts, rules and the like. Teacher- directed evaluation was done during this stage. Class assignments and procedure for home assignments were also given.

Twenty four lessons were taken in twenty four periods. No remedial teaching was attempted during treatment. But doubts were cleared during review stage.

3.4.1.6.2.2 Experimental Group I

The procedure of treatment given to Experimental group I is described below.

(i) Grouping of Students

Before giving treatment subjects were divided into six groups on the basis of their performance in the Pre-test. Each group consisted of five pupils getting almost same score in the Pre-test, thus making the groups homogeneous.

Twenty four lesson plans based on Direct Instruction Model were already prepared for Experimental Group I. The different phases of class teaching using Direct Instruction model is detailed below.

ii) Introduction

Classes started with the first phase of Direct Instruction Model called 'Attention and Focus'. It is the anticipatory set also called as "hook" which helps to grab the students' attention, actions and statements to the objectives of the lesson. The teacher as an instructional leader began the lesson by explaining the objectives of the day's lesson for establishing a learning set. The teacher also gave an abbreviated version of the sub-objectives in a problematic manner. Attention signals suitable to each lesson such as the agenda to the class, questions to be probed, task to be performed and time schedule for each segment of the lesson were also listed. These were done to put student into a respective frame of mind, that is, to focus student attention on the lesson, to create an organizing frame work for the idea, principles or information that are to be followed and to extend the understanding and application of abstract ideas. This was done with a view to help students to master the study materials and to get their activities to be more open ended and properly guided.

In phase-2, 'Orientation', the investigator pinpointed how the lesson builds on the prior work and how it can be connected to long-range objectives and they were written as teacher presentation scripts. From the second day onwards a short review of the previous lesson was also done. Providing the rationale and overview of any lesson is important, especially for skill-oriented lessons. These were done using selected techniques such as telling a story as in the case of introducing fraction, creating a problematic situation and the like which serve (as in the use of like decimals and unlike decimals) to arouse and sustain interest in the day's lesson. About seven minutes was allotted to complete these two phases. The introduction stage of Objective Based Instruction also includes these two phases.

iii) Development of the lesson

In phase-3, 'Model' of Direct Instruction Model, the investigator demonstrated or explained or illustrated the task to be performed by the subjects. Active student participation was ensured during this period. For this purpose many paper cuttings, crayons, coloured papers, flannel board, charts and other teaching aids were used. Carefully designed demonstrations were followed. These are called 'formats'. Demonstrations were sequentially and logically arranged. Also the formats were carefully designed so as to eliminate ambiguous communication. In this phase students were kept busy as they participate in different activities. They were given different learning tasks to arrange the given materials/objects, classify or discriminate them, on the basis of which to identify new facts and concepts, develop principles and then verbalize it, symbolise it or define them and finally to develop skills in performing a particular principle depending on the demand of the day's lesson. When students were busy with the task in small groups the investigator closely supervised them and coached whenever necessary.

Investigator used prompts or cues for helping pupils for mastery. Some pupils required a more intense level of prompting inorder to accomplish a task. Prompts were given in the least instructive way, with an intention of fading them as soon as possible. One is not allowed to do the next part of a task until the prompt had been given. Gradually moving through levels of prompts students began to master each task. Pupils who were provided with support from a teacher or volunteer from the group rely on that person to give directions rather than responding to the direction. The prompts given were as follows:

- Physically assist the pupils to do the task.
- Physical assistance (if necessary) to complete the task.
- Given a gesture, or model the task, so that pupils can copy the action.
- Giving direct verbal prompt, such as :"Try to arrange it correctly."
- Giving indirect verbal prompt, such as: "what to do next?" or "How can you finish it?"

It is very important that all students are to master every concept, with no exception. To strengthen pupil's correct or improved actions and to correct every mistake on the spot, the investigator and subjects engaged and interacted continuously.

Performance of each subject in the group work was recorded. The grouping helped the investigator for easy recording. This phase is similar to the demonstration stage of Objective Based Instruction and it took about fifteen minutes to complete.

(iv) Application

The fourth phase of Direct Instruction Model – 'Lead', which is also known, as 'Guided Practice' is included in the Application category. Here an opportunity was given to each subject to demonstrate the grasp of new learning by working through a new activity or exercise selected other than the one given earlier and provided by the investigator under her direct supervision. The investigator and subjects worked together to findout the solution of the problem for those who cannot solve it independently. The investigator moved around the classroom to provide individual remediation. If students were not accurate, or if one among them hesitate to respond or respond incorrectly the whole group went through a brief correction procedure until all were firm.

(v) Review and Recitation

In phase 5 'Test' also called 'Independent Practice' occur immediately after the 'lead'. Investigator looked for accurate and quick (firm and fluent) actions from subjects in response to the investigator's signs. When subjects appeared firm, she gave opportunities for them to more independent use of concepts or principles they have learned in that class. Worksheets were already prepared for each lesson and were distributed among subjects at this stage.

The following points were attended to during the independent practice.

- Independent practice was not assigned until it is assured that all students can do it.
- Independent practice assignments were kept as short as possible.
- Clear instructions were given for doing the practice tasks.
- Once students have begun the tasks they were not interrupted.
- Periodic monitoring of independent works was made for successful completion of the task.

Error rates were recorded for each student after the session. Class will not proceed to the next lesson until the subjects were below the prefixed error rate. Whenever necessary peer tutoring was given to minimise the error rates and maximize the mastery of the learning. This phase takes about fifteen to twenty minutes to complete.

Phase-6 is the 'Delayed Test' when a large number of students make a greater number of errors, the lessons were repeated once again. When the number of students who made the error was lesser then peer tutoring was given. Additional drill work, home assignments and new work sheets were given once more. Also mastery was ensured at this stage. The last and final phase is 'Weekly Review'. Weekly review was done after every subunit. That is after two or three lessons. A 'formative test' was given at this stage, to each and every student to ensure the mastery over that particular sub-unit. The investigator did not go to the next subunit until the mastery over the present subunit was clear. If mastery was not attained any of the remedial steps such as re-teaching peer-tutoring, drill work, home assignments and the like were provided again (depending upon the situation) until mastery was ensured.

These two phases were not provided to control group and the mastery was not strictly ensured for them.

This procedure was followed for teaching the predetermined content of the topics in fractions and decimals. Altogether twentyfour lessons were taught to Experimental Group I, as per Direct Instruction Model. Nine formative tests with duration fifteen to twenty minutes were given to this group. Five formative tests were scrutinised by the subjects themselves and four were scrutinised by the investigator. Time, after the completion of formative tests was used for guided remedial. Thirty periods were required for the completion of the treatment for Experimental group I.

In Direct Instruction Model of teaching the grouping of the class was made based on the Previous Knowledge of the Subject Matter as the result of Pre-test. The pupil mastery was determined on the basis of error-rates made in the work-sheets of previous class, achievement regrouping during the progress of the lessons that is students pace of learning and nature of reinforcement and the like. This ensures the principles of reaction inherent in the Direct Instruction Model.

Support System

The sequential and logical arrangement of the learning tasks, objectives and their acceptable level of performance, their relation with previous task, meaningful learning experiences, tailored activities, scripted lesson plans, rhythmic choral and individual responses, guided practice, independent practice, motivation from teacher, knowledge of performance of each class, confidence in mastering a skill or task and the like acted as the support system of Direct Instruction Model.

Social System

Social system it can be noted that even though this model is primarily teacher directed the learning environment was not strictly authoritarian. The task orientation was with high expectations from student accomplishment. Careful orchestrations were given while structuring the environment. The investigator and subjects identified the goals of each class in a manageable chunk. The teacher provided appropriate instructions and guidance during the activities carried by the learners. These are the social system in this model.

Instructional Effect

The highly structured instructional approach accelerated the learning. Student motivation was another instructional effect by this model. The most important effect was it helped to move students to mastery as quickly as possible and developed the ability to perform a skill independently without any error. Due to the self-pacing ability developed in student increased the achievement.

3.4.1.6. 2. 3. Experimental Group II

The procedure of treatment in Experimental Group II is described below.

St. Teresa's Higher Secondary School was taken as the Experimental Group II. Twentyfour lessons were taken to Experimental Group II also alternative subunits were taught through Direct Instruction Model and Objective Based Instruction. The second, fourth, sixth and eighth units were taught through Direct Instruction Model. The first, third, fifth, seventh and ninth units were taught through objective Based Instruction. The formative tests based on second, fourth, sixth, and eighth units were given to Experimental Group II.

Four formative tests – two from fractions and two from decimals – were given to this group. Guided remedies were given after formative tests when Direct Instruction Model was followed. No mastery was ensured for the lessons taken through Objective Based Instruction. Twenty six class periods of 45 minutes each were taken for the completion of the treatment for Experimental Group II.

3.4.1.6.3. Administration of Post-Test I

To quantify the terminal characteristics of the subjects in terms of Achievement in Mathematical Skills the investigator administered a Post-Test. The Post-Test data from the subjects in Control Group, Experimental Group I and Experimental Group II were gathered the next day after the completion of the treatments.

A parallel test of Pre-Test was prepared for this purpose. The Post-Test material was prepared before administering the test, all necessary guidelines and the purpose for which it is going to administer were explained to the subjects in each group.

3.4.1.6.4. Administration of Post-Test II

Two months after the treatment the investigator administered the Post-test once again to Control Group, Experimental Group I and Experimental Group II. The aim of this test was to explore the extent of retention of Achievement in Mathematical Skills of standard VII pupils.

3.4.2. Scoring and Consolidation of Data

Scoring key was already prepared for scoring the response sheets. The investigator strictly followed the specific directions given in the manual for Raven Progressive Matrices Test; Punched scoring keys were used for Achievement Test in Mathematical Skills and Numerical Ability Test.

Incomplete score sheets and data obtained from students who had not regularly attended the experimental class sessions were not included for the analysis. Cases, which are complete in all respects, were taken into consideration. Thus data regarding final sample of 135 subjects were considered for final analysis. The break-up of the actual number of subjects falling under different category is given in Table 3.2.

TABLE 3.2

Number of Subjects Under Different Groups

Name of Group	Boys	Girls	Total
Experimental Group I	22	23	45
Experimental Group II	22	23	45
Control Group	22	23	45
Total	66	69	135

3.4.3. Procedure Used for Analysis of Data

The hypotheses of the present study were tested by employing appropriate statistical techniques. The entire statistical processing was done using computer facility.

3.4.3.1. Classificatory Techniques

Using median as cut-off point the subjects in different groups were categorised into two. Based on the scores of Pre-test subjects were categorised as Below – Average - Previous - Knowledge Group and Above – Average – Previous – Knowledge Group. In the experimentation the median of Previous – Knowledge was found to be 40.79. Subjects who scored 40 and below 40 were categorised as Below – Average – Previous – Knowledge

(BAPK) group and those who scored above 40 were considered as above Average – Previous Knowledge (AAPK) group.

The actual number of subjects falling under the two category of Previous Knowledge (BAPK and AAPK) is given in Table 3.4.

TABLE 3.3

Number of Subjects under the category of Below-Average Previous Knowledge of Subject Matter and Above-Average Previous Knowledge of Subject Matter

Nature of Group	Boys		Girls		Total	
	BAPK	AAPK	BAPK	AAPK	BAPK	AAPK
Experimental Group I	13	9	10	13	23	22
Experimental Group II	15	7	14	9	29	16
Control Group	13	9	10	13	23	22

The median of Non-Verbal Intelligence was found to be 33.93 for the total sample. Those who scored above 33 were considered as having Above Average Intelligence (AAI) and those who scored 33 and below were treated as Below Average Intelligence (BAI). The actual number of subjects falling under each category of Intelligence (BAI and AAI) is given in Table 3.4.

TABLE 3.4

Number of Subjects under the category of Below-Average Intelligence and Above- Average Intelligence

Nature of Group	Boys		Girls		Total	
	BAI	AAI	BAI	AAI	BAI	AAI
Experimental Group I	17	5	8	15	25	20
Experimental Group II	12	10	12	11	24	21
Control Group	11	11	12	11	23	22

The median of Numerical Ability Test was found to be 33.92. Those who scored 33 and below were taken as having Below – Average – Numerical – Ability (BANA) and those who scored 34 and above were treated as Above-Average-Numerical-Ability (AANA). The number of subjects falling under BANA and AANA is given in Table 3.5.

TABLE 3.5

Number of Subjects under the category of Below-Average Numerical-Ability Above- Average Numerical Ability

Nature of Group	Boys		Girls		Total	
	BANA	AANA	BANA	AANA	BANA	AANA
Experimental Group I	12	10	10	13	22	23
Experimental Group II	8	14	10	13	18	27
Control Group	10	12	16	7	26	19

3.4.3.2. Statistical Techniques Used for Analysis of Data

Statistical techniques employed in the study are given below:

A. Test of Significance of Difference between Means of Large and Small Independent Samples

To test the first four hypotheses the test of significance of difference between means of large and small independent sample was used. Experimental group I and control group and Experimental group II and Control group were compared with respect to their mean Pre-test, Post-Test-I, Post-Test II and Gain scores (Objective wise and Total Score) for Total Sample, Boys and Girls were done using this method.

The difference between means was tested using two-tailed test of significance and the results were interpreted using appropriate degrees of freedom.

B. Two-way Analysis of Variance (ANOVA) with 2 x 2 Factorial Design

To study the main effect and interaction effect of Direct Instruction Model on Achievement in Mathematical Skills of Upper Primary Pupils Two-way Analysis of Variance was employed. The two levels of methods of teaching were made by using the two levels of Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability.

Subjects of the sample belong to anyone of the following four combinations based on method of teaching and Previous Knowledge of the Subject Matter.

(i) Direct Instruction with Below-Average Previous Knowledge of Subject Matter.

(ii) Direct Instruction with Above-Average Previous Knowledge of Subject Matter.

(iii) Objective Based Instruction with Below-Average Previous Knowledge of Subject Matter.

(iv) Objective Based Instruction with Above-Average Previous Knowledge of Subject Matter.

Again the subjects were categorised into four groups based on methods of teaching and Non-Verbal Intelligence and the groups are given below.

(i) Direct Instruction Model with Below-Average-Non-Verbal Intelligence.

(ii) Direct Instruction Model with Above-Average-Non-Verbal Intelligence.

(iii) Objective Based Instruction with Below-Average-Non-Verbal Intelligence.

(iv) Objective Based Instruction with Above-Average-Non-Verbal Intelligence.

Similarly subjects were grouped into four on the basis of the method of instruction and Numerical Ability. The groups are as follows.

(i) Direct Instruction Model with Below-Average-Numerical Ability.
(ii) Direct-Instruction Model with Above-Average-Numerical-Ability.
(iii) Objective Based Instruction with Below-Average-Numerical Ability.
(iv) Objective Based Instruction with Above-Average-Numerical Ability.

Two-way ANOVA with 2 x 2 factorial design was used to study the main effect and interaction effect of the two Independent variables on Achievement in Mathematical Skills (Post-Test I and Post-Test II).

Interpretation of the analysis was done on the basis of F-values – whether F-ratio is significant or not.

C. Two-way Analysis of Covariance (ANCOVA) with 2 x 2 Factorial Design

Using the two-way factorial ANCOVA, the effectiveness of Direct Instruction Model on Achievement in Mathematical Skills over Objective Based Instruction was examined. ANCOVA was employed with three covariates, 'Previous-Knowledge of the Subject Matter' (Pre-Test Scores), 'Non-Verbal Intelligence' and 'Numerical Ability' separately. Analysis of Covariance serves the purpose of statistically removing the effects of extraneous variables from the Dependent Variable (Ferguson, 1996). In the present study it is used to remove statistically the effects of Pre-Test scores, Non-Verbal Intelligence and Numerical Ability separately.

Analysis of Covariance is a statistical technique used to control or adjusts for the effects of one or more uncontrolled variables and permit there by a valued evaluation of the outcomes of the experiment (Ferguson, 1996). This techniques is applied when there are one or more correlated variables existed with the dependent variable. This statistical technique represents an extension of Analysis of Variance to allow for the correlation between initial and final scores. Also it is possible to effect adjustments in final or terminal scores which will allow for difference in same initial variable.

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

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CHAPTER 4

ANALYSIS

- *Preliminary Analysis*
    - *Equivalence of Groups*
- *Major Analysis*
    - *Mean Difference Analysis*
    - *Analysis of Variance*
    - *Covariance Analysis*

ANALYSIS

The purpose of the study was to find out the effectiveness of Direct Instruction Model of teaching select topics in Mathematics on certain Mathematical Skills of Upper Primary Pupils. Pre-test Post-test Equivalent Experimental Group Design was used to collect the needed data. The collected data was analysed using these statistical techniques, namely, Test of Significance of Difference between Means, Analysis of Covariance and Analysis of Variance.

The analysis of data is presented under the following sections.

4.1 PRELIMINARY ANALYSIS

4.2 MAJOR ANALYSIS

4.1 PRELIMINARY ANALYSIS

As described in Chapter III (Methodology) the experiment was conducted with intact classroom groups for practical reasons. Therefore in order to ensure the equivalence of the group before the treatment, variables were introduced. The groups were matched with regard to select variables using Test of Significance of difference between Means. The variables selected for determining the equivalence of the groups were 'Previous Knowledge of the Subject Matter', Non-Verbal Intelligence' and 'Numerical Ability' of pupils. The means and standard deviation of each variable for Total sample, Boys and Girls were calculated. The result of the test of significance of difference between means for comparable groups Experimental group I and control group are summarised and presented in Table 4.1.

TABLE 4.1

Data and Resultsof the Test of Significance of Difference in the Scores of Previous Knowledge of Subject Matter, Non-verbal intelligence and Numerical Ability between Experimental Group I and Control Group (Total Sample, Boys and Girls)

Variable	Sample	Total				Boys				Girls			
		M	SD	N	t	M	SD	N	t	M	SD	N	t
Previous Knowledge of Subject Matter	Experimental Group I	41.73	7.57	45	0.34	40.36	8.17	22	1.21	43.04	6.87	23	0.70
	Control Group	42.27	7.17	45		43.09	6.28	22		41.48	7.99	23	
Non-verbal Intelligence	Experimental Group I	31.87	4.88	45	0.76	30.77	5.21	22	1.02	32.91	4.40	23	0.03
	Control Group	32.78	6.23	45		32.68	6.86	22		32.87	5.71	23	
Numerical Ability	Experimental Group I	34.49	6.96	45	0.18	33.18	7.62	22	1.02	35.74	6.18	23	1.28
	Control Group	34.27	4.15	45		34.73	4.88	22		33.83	3.35	23	

Table 4.1 reveals that the critical ratios obtained for the difference between mean scores of the variable Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability are found to be not significant even at 0.05 level (critical value being less than 1.99 for 88 df, 2.02 for 42 df and 2.02 for 44df). This result indicates that no significant difference exists in the mean Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability scores between Experimental Group I and control Group for Total Sample, Boys and Girls.

The t-test values revealed that the subjects of Experimental group I and Control group are equivalent with regard to the Previous Knowledge of subject Matter, Non-Verbal Intelligence and Numerical Ability for Total Sample, Boys and Girls.

The result of test of significance of difference between means of Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability for Experimental Group II and Control Group are summarised and presented in Table 4.2.

TABLE 4.2

Data and Results of the Test of Significance of Difference in the Scores of Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability between Experimental Group II and Control Group (Total Sample, Boys and Girls)

Variable	Sample	Total				Boys				Girls			
		M	SD	N	t	M	SD	N	t	M	SD	N	t
Previous Knowledge of Subject Matter	Experimental Group II	40.49	8.21	45	1.08	39.45	7.56	22	1.70	41.48	8.85	23	0.00
	Control Group	42.27	7.17	45		43.09	6.28	22		41.48	7.99	23	
Non-verbal Intelligence	Experimental Group II	32.82	6.46	45	0.17	31.91	6.21	22	0.38	33.70	6.75	23	0.44
	Control Group	32.78	6.23	45		32.68	6.86	22		32.87	5.71	23	
Numerical Ability	Experimental Group II	34.13	5.37	45	0.13	36.09	5.26	22	0.87	32.17	5.47	23	1.21
	Control Group	34.27	4.15	45		34.73	4.88	22		33.83	3.35	23	

From Table 4.2, the critical ratios calculated for the variables Previous-Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability of Experimental Group II and Control Group are found to be not significant even at 0.05 level (critical ratio being less than 1.99 for df 88, 2.02 for df 42 and 2.02 for df 44) for Total Sample, Boys and Girls. That is, there exist no significant difference in the mean Previous Knowledge of Subject Matter scores, Non-Verbal Intelligence scores and Numerical Ability scores between Experimental Group II and Control Group for Total Sample, Boys and Girls.

The t-test values show that the subjects of Experimental Group II and Control Group (Total Sample, Boys and Girls) are identical with regard to their Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability.

4.2 MAJOR ANALYSIS

The major analysis of the data are presented in two sections:

4.2.1 INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN MATHEMATICAL SKILLS OF EXPERIMENTAL GROUPS AND CONTROL GROUP

4.2.2 INVESTIGATION OF THE MAIN EFFECT AND INTERACTION EFFECT OF METHOD OF TEACHING AND PREVIOUS KNOWLEDGE OF SUBJECT MATTER, NON-VERBAL INTELLEGENCE AND NUMERICAL ABILITY OF THE TOTAL SAMPLE, BOYS AND GIRLS ON ACHIEVEMENT IN MATHEMATICAL SKILLS

4.2.1 INVESTIGATION OF DIFFERENCE IN MEAN SCORES OF ACHIEVEMENT IN MATHEMATICAL SKILLS OF EXPERIMENTAL GROUPS AND CONTROL GROUP

Analysis of data by comparing Achievement in Mathematical Skills between Experimental Group I and Control Group and between Experimental Group II and Control Group for Total Sample, Boys and Girls are presented in this section. To examine whether significant changes exist, if any, in the mean scores of Achievement in Mathematical Skills between Experimental Group I and Control Group and between Experimental Group II and Control Group after introducing the treatment variable. Eight comparisons were undertaken. The groups compared are given below.

4.2.1.1 Comparison of Mean Scores of Achievement in Mathematical Skills in Post-Test I of Experimental Group I and Control Group.

4.2.1.2 Comparison of Mean Scores of Achievement in Mathematical Skills in Post -Test I of Experimental Group II and Control Group.

4.2.1.3 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test I (Post-Test I – Pre-Test) of Experimental Group I and Control Group.

4.2.1.4 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test I (Post-Test I – Pre Test) of Experimental Group II and Control Group.

4.2.1.5 Comparison of Mean Retention Scores of Achievement in Mathematical Skills in Post-Test II of Experimental Group I and Control Group

4.2.1.6 Comparison of Mean Retention scores of Achievement in Mathematical Skills in Post-Test II of Experimental Group II and Control Group.

4.2.1.7 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test II (Post Test II – Pre Test) of Experimental Group I and Control Group.

4.2.1.8 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test II (Post-Test II – Pre-Test) of Experimental Group II and Control Group.

The Comparison of Mean Scores was under taken for Total Sample, Boys and Girls for Achievement in Mathematical Skills for Total Scores and Objectivewise scores. Two-tailed test of significance difference between means was used to interpret the results. Analysis and interpretation of data are presented in the following sub-sections.

4.2.1.1 Comparison of Mean Post Test I Scores of Achievement in Mathematical Skills of Experimental Group I and Control Group

The mean and standard deviation of scores on Achievement in Mathematical Skills (Objectivewise and Total Score) of Experimental Group I (taught through Direct Instruction Model) and Control Group (taught through objective Based instruction) and the t-values for Total Sample, Boys and Girls are presented in Table 4.3.

TABLE 4.3

Data and Resultsof t-test for the Mean Scores of Post Test I

(Objective wise and Total Scores between Experimental Group I and Control Group (Total Sample, Boys and Girls)

Sample	Variable	Experimental Group I			Control Group			t-value	Level of Significance
		M_1	SD_1	N_1	M_3	SD_3	N_3		
Total N=90	Knowledge Category	27.40	4.39	45	22.22	3.32	45	6.24**	0.01
	Comprehension Category	21.13	4.51	45	16.89	3.35	45	5.01**	0.01
	Application Category	20.11	6.03	45	16.56	4.67	45	3.09**	0.01
	Achievement in Mathematical Skills (Total Score)	68.64	13.62	45	55.67	9.00	45	5.27**	0.01
Boys N=44	Knowledge Category	25.64	5.15	22	22.36	2.70	22	2.58*	0.05
	Comprehension Category	18.68	4.29	22	18.18	3.55	22	0.41	NS
	Application Category	16.41	5.53	22	16.68	5.31	22	0.16	NS
	Achievement in Mathematical Skills (Total Score)	60.73	13.70	22	57.23	10.08	22	0.94	NS
Girls N=46	Knowledge Category	29.09	2.68	23	22.09	3.87	23	6.97*	0.01
	Comprehension Category	23.48	3.37	23	15.65	2.66	23	8.56**	0.01
	Application Category	23.65	4.09	23	16.43	4.09	23	5.86**	0.01
	Achievement in Mathematical Skills (Total Score)	76.22	8.31	23	54.17	7.76	23	9.09*	0.01

As per Table 4.3 the t-values obtained for the comparison of mean Achievement in Mathematical Skills in Post-Test I (Objective wise) and Total Score) for Experimental Group I and Control Group for the Total Sample and the sample of Girls were found to be significant beyond 0.01 level of appropriate degrees of freedom. The mean Achievement in Mathematical Skills in Post Test I for the sample of Boys is found to be significant only for knowledge category: significance being at 0.05 level for appropriate degrees of freedom. For comprehension category, Application category and for Total Score the t-values are found to be not significant even at 0.05 level for Boys.

The result indicate that the mean scores of Achievement in Mathematical Skills (Objectivewise and Total score) of Experimental Group I and control Group for Total Sample and for Girls in the sample are significantly different suggesting that the groups are not identical. In the case of Boys no Significant difference is found to exist in the mean Achievement in Mathematical Skills (Objectivewise and Total Score) except for Knowledge category suggesting that Boys are similar with respect to their Achievement in Mathematical Skills in Post Test I.

Though only two-tailed test of significance was attempted it can be noted that high mean Achievement in Mathematical Skills are associated with the Experimental Group I for Total Sample and for Girls both for objective wise scores and Total Score. On the contrary it is seen that mean Achievement of Boys are identical except for knowledge category.

4.2.1.2 Comparison of Mean Post-Test I scores of Achievement in Mathematical Skills of Experimental Group II and Control Group

The mean, standard deviation and t-values of Achievement in Mathematical Skills Post-Test I (Objectivewise and Total Score) of Experimental Group II (taught through Direct Instruction Model and Objective Based Instruction alternately) and Control Group (taught through Objective Based Instruction only) are presented in Table 4.4.

TABLE 4.4

Data and Results of t-test for the Mean Scores of Post Test I
(Objective wise and Total Scores between Experimental Group II and Control Group (Total Sample, Boys and Girls)

Sample	Variable	Experimental Group I			Control Group			t-value	Level of Significance
		M_2	SD_2	N_2	M_3	SD_3	N_3		
Total N=90	Knowledge Category	26.69	4.45	45	22.22	3.32	45	5.34**	0.01
	Comprehension Category	19.40	3.86	45	16.89	3.35	45	3.26**	0.01
	Application Category	17.51	6.73	45	16.56	4.67	45	0.77	N.S.
	Achievement in Mathematical Skills (Total Score)	63.60	12.79	45	55.67	9.00	45	3.37**	0.01
Boys N=44	Knowledge Category	25.91	4.47	22	22.36	2.70	22	3.11**	0.01
	Comprehension Category	18.59	6.10	22	18.18	3.55	22	0.40	NS
	Application Category	15.64	6.25	22	16.68	5.31	22	0.58	NS
	Achievement in Mathematical Skills (Total Score)	60.14	11.48	22	57.23	10.08	22	0.87	NS
Girls N=46	Knowledge Category	27.43	6.39	23	22.09	3.87	23	4.29**	0.01
	Comprehension Category	20.17	4.41	23	15.65	2.66	23	4.12**	0.01
	Application Category	19.30	6.80	23	16.43	4.09	23	1.70	NS
	Achievement in Mathematical Skills (Total Score)	66.91	13.35	23	54.17	7.76	23	3.87**	0.01

As per Table 4.4 the obtained critical ratios for Achievement in Mathematical Skills in Post-test I (Objectivewise and Total score) for Experimental Group II and Control Group for Total Sample and Girls are found to be significant at 0.01 level for appropriate degrees of freedom except for Application category. For Boys in the sample significant difference exist only for Knowledge category with the critical ratio is greater than the value accepted for 0.01 level of significance with df 42. No significant difference was found to exist for Comprehension category, Application category and for Total Score for Boys.

The result of the comparison of the mean scores of Achievement in Mathematical Skills in Post-Test I for Experimental Group II and Control Group for Total sample and Girls suggest that the groups are not similar with respect to mean Achievement in Mathematical Skills (except for Application category). But Boys in the sample are different only in Knowledge category of Achievement in Mathematical Skills.

4.2.1.3 Comparison of Gain Scores in Achievement in Mathematical Skills of Experimental Group I and Control Group

The mean Gain scores of Achievement in Mathematical Skills (Post test I minus Pre-Test) of Experimental Group I and Control Group were compared using the Test of significance of difference between means for large as well as small independent samples. Data and results are presented in Table 4.5.

TABLE 4.5

Data and Resultsof t-test for the Mean Gain Scores (Post Test I –Pre Test) Between Experimental Group I and Control Group (Total Sample, Boys and Girls)

Sample	Experimental Group I			Control Group			t-value	Level of Significance
	M_1	SD_1	N_1	M_3	SD_3	N_3		
Total	26.91	11.18	45	13.40	7.08	45	6.77**	0.01
Boys	20.36	9.17	22	14.14	7.95	22	2.35*	0.05
Girls	33.17	9.26	23	12.70	6.24	23	8.60**	0.01

The results obtained as per Table 4.5 regarding the comparison of mean Gain scores (Post-Test I minus Pre-Test) for Achievement in Mathematical Skills for Total Sample, and Girls are found greater than the value of 't' accepted for significance at 0.01 level for appropriate degrees of freedom. For Boys t-value is significant at 0.05 level. The results indicate that there exist significant differences between Experimental Group I and Control Group in mean Gain scores. The groups can therefore be considered dissimilar with regard to their mean Gain scores for Achievement in Mathematical Skills for Total Sample, Boys and Girls in the sample.

High mean Gain scores are seen associated with Experimental Group 1 suggesting the advantage of experimental Group I over Control Group for Total Sample, Boys and Girls.

4.2.1.4 Comparison of Mean Gain Scores on Achievement in Mathematical Skills of Experimental Group II and Control Group

The Means and standard deviations of the mean Gain scores (Post-Test I minus Pre-Test) for Achievement in Mathematical Skills of Experimental Group II and Control Group and their critical ratios calculated are presented in Table 4.6.

TABLE 4.6

Data and Resultsof t-test for the Mean Gain Scores (Post Test I –Pre Test between Experimental Group II and Control Group (Total Sample, Boys and Girls)

Sample	Experimental Group I			Control Group			t-value	Level of Significance
	M_2	SD_2	N_2	M_3	SD_3	N_3		
Total	23.11	10.71	45	13.40	7.08	45	5.02**	0.01
Boys	20.68	12.14	22	14.14	7.95	22	2.07*	0.05
Girls	25.43	8.78	23	12.70	6.24	23	5.55**	0.01

From Table 4.6 the t-values obtained for the comparison of mean Gain scores of Achievement in Mathematical Skills (Post-Test I–Pre-Test) between Experimental Group II and Control Group for Total Sample and Girls are found to be significant and well beyond 0.01 level and for Boys it is significant at 0.05 level. The results suggest that the mean Gain scores of Experimental Group II differ significantly from control Group in Total sample, Boys and Girls.

High Gain scores are seen associated with Experimental Group II for Total Sample, Boys and Girls indicate the advantage of Experimental Group II over Control Group.

4.2.1.5 Comparison of Mean Retention Scores of Achievement in Mathematical Skills Post-Test II of Experimental Group I and Control Group

To compare the mean retention scores of Achievement in Mathematical Skills post-Test II (Objectivewise and Total Score) of Experimental Group I and Control Group, critical ratios were computed. The data and results are presented in Table 4.7.

TABLE 4.7

Data and Result of t-test for the Mean Scores of Post Test II (Objective wise and Total Scores) Between Experimental Group and Control Group (Total Sample, Boys and Girls)

Sample	Variable	Experimental Group I			Control Group			t-value	Level of Significance
		M_1	SD_1	N_1	M_3	SD_3	N_3		
Total N=90	Knowledge Category	25.51	4.67	45	16.33	5.10	45	8.81**	0.01
	Comprehension Category	18.64	4.21	45	14.24	2.80	45	5.78**	0.01
	Application Category	17.82	5.73	45	12.93	4.08	45	4.61**	0.01
	Achievement in Mathematical Skills (Total Score)	61.98	13.29	45	43.51	8.84	45	7.67**	0.01
Boys N=44	Knowledge Category	23.55	5.59	22	19.59	3.84	22	2.67**	0.01
	Comprehension Category	16.45	4.13	22	14.59	3.08	22	1.66	NS
	Application Category	15.27	5.06	22	12.64	3.59	22	1.95	NS
	Achievement in Mathematical Skills (Total Score)	55.27	13.92	22	46.82	8.47	22	2.38*	.0.05
Girls N=46	Knowledge Category	27.39	2.50	23	13.22	4.14	23	13.74**	0.01
	Comprehension Category	20.74	3.12	23	13.91	2.52	23	7.98**	0.01
	Application Category	20.26	5.34	23	13.22	4.56	23	4.70**	0.01
	Achievement in Mathematical Skills (Total Score)	68.39	8.96	23	40.35	8.16	23	10.85**	0.01

As per Table 4.7 can be seen that the mean Retention score of Achievement in Mathematical Skills (Objective wise and Total Score) Post-Test II of Experimental Group I and Control Group for Total Sample and Girls are significantly different at 0.01 level, for Boys it was found that the mean retention scores are significantly different at Knowledge category and Total Score at 0.05 level. The results show that the Experimental Group I and Control Group are dissimilar with regard to the mean Retention scores of Achievement in Mathematical Skills for Total Sample, Girls and for Boys.

The high retention scores of Achievement in Mathematical Skills of Experimental Group I suggest the advantage of this group over Control Group.

4.2.1.6 Comparison of Mean Retention Scores of Achievement in Mathematical Skills Post-Test II of Experimental Group II and Control Group

To find out the difference in the Retention scores of Achievement in Mathematical Skills (Objectivewise and Total Score) between Experimental Group II and Control Group, test of significance of difference between means was estimated by computing t-values. The means, standard deviations and critical ratios are presented in Table 4.8.

TABLE 4.8

Data and Resultsof t-test for the Mean Scores of Post Test II (Objective wise and Total Scores) Between Experimental Group II and Control Group (Total Sample, Boys and Girls)

Sample	Variable	Experimental Group I			Control Group			t-value	Level of Significance
		M_2	SD_2	N_2	M_3	SD_3	N_3		
Total N=90	Knowledge Category	22.76	4.90	45	16.33	5.10	45	6.02**	0.01
	Comprehension Category	17.73	4.31	45	14.24	2.80	45	4.51**	0.01
	Application Category	14.87	6.24	45	12.93	2.80	45	1.72	NS
	Achievement in Mathematical Skills (Total Score)	55.36	13.57	45	43.51	8.84	45	4.85**	0.01
Boys N=44	Knowledge Category	21.73	4.39	22	19.59	3.84	22	1.68	NS
	Comprehension Category	17.73	4.39	22	14.59	3.08	22	2.68**	0.01
	Application Category	13.95	5.81	22	12.64	3.59	22	0.88	NS
	Achievement in Mathematical Skills (Total Score)	53.41	12.39	22	46.82	8.47	22	2.02*	0.05
Girls N=46	Knowledge Category	23.74	5.26	23	13.22	4.14	23	7.37**	0.01
	Comprehension Category	17.74	4.33	23	13.91	2.52	23	3.58**	0.01
	Application Category	15.74	6.64	23	13.22	4.56	23	1:47	NS
	Achievement in Mathematical Skills (Total Score)	57.22	14.64	23	40.35	8.16	23	4.72**	0.01

The mean Retention Scores (Post-Test II) obtained from Table 4.8 for Achievement in Mathematical Skills between Experimental Group II and Control Group were found to be significantly different at 0.01 level for Total Sample and Girls except for Application category. For Boys in the sample the groups were found to be significant at 0.01 level for Comprehension category and significant at 0.05 level for Total score. The Experimental Group II and Control Group are therefore be considered dissimilar with respect to the Retention score for Knowledge and Application category and Total Score for Total Sample and Girls, Comprehension category and Total score for Boys.

Wherever t-values are significant , Retention scores are seen associate with Experimental Group II suggesting the advantage of that group over Control Group.

4.2.1.7 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test II (Post-Test II – Pre-Test) of Experimental Group I and Control Group

The mean Gain scores of Achievement in Mathematical Skills of Experimental Group I and Control Group with regard to Post-Test II were compared. Test of significance of difference between means was used for comparison. The means, standard deviations and critical ratios of Experimental Group I and Control Group are presented in Table 4.9.

TABLE 4.9

Data and Resultsof t-test for the Mean Retention Scores (Post Test II –Pre Test) Between Experimental Group I and Control Group (Total Sample, Boys and Girls)

Sample	Experimental Group I			Control Group			t-value	Level of Significance
	M_1	SD_1	N_1	M_3	SD_3	N_3		
Total	20.24	1.24	45	10.55	5.24	45	10.70**	0.01
Boys	14.91	3.73	22	9.72	3.56	22	4.95**	0.01
Girls	25.35	1.13	23	8.75	5.54	23	11.99**	0.01

The mean Gain scores with regard to Post-Test II for Experimental Group I and Control Group for Total sample, Boys and Girls from Table 4.9 were found to be significantly different at 0.01 level as the obtained t-value are well beyond the t-values accepted for 0.01 level with appropriate degrees of freedom. The results thus suggest that a significant difference are associated with the mean Gain scores on Achievement in Mathematical Skills post-Test II between Experimental Group I and Control Group.

High mean gain scores are associated with experimental Group I for Total sample, Boys and Girls indicate the advantage of Experimental Group I over Control Group.

4.2.1.8 Comparison of Mean Gain Scores of Achievement in Mathematical Skills in Post-Test II (Post Test II – Pre Test) of Experimental Group II and Control Group

The mean Gain scores (Post-Test II minus Pre-Test) of the Experimental Group11 and Control Group were compared to study the difference, if any, exists using the test of significance of difference between means.

The data and results are summarised in Table 4.10.

TABLE 4.10

Data and Resultsof t-test for the Mean Retention Scores (Post Test II –Pre Test) between Experimental Group II and Control Group (Total Sample, Boys and Girls)

Sample	Experimental Group I			Control Group			t-value	Level of Significance
	M_2	SD_2	N_2	M_3	SD_3	N_3		
Total	14.87	1.24	45	11.89	5.24	45	6.96**	0.01
Boys	13.95	3.73	22	12.82	3.56	22	3.52**	0.01
Girls	15.74	1.13	23	11.14	5.54	23	6.36**	0.01

The t-values as per Table 4.10 for the comparison of mean Gain scores (Total Sample, Boys and Girls) of Experimental Group II and Control Group are found to be significant at 0.01 level as the obtained t-values are higher than the initial value set at 0.01 level with appropriate degrees of freedom. The fact that significant differences in the mean Gain scores of Achievement in Mathematical Skills between the groups suggest that they are dissimilar for Total sample, Boys and Girls.

Advantage of Experimental Group II over control Group was indicated since high means are associated with experimental Group II.

4.2.1.9. Summary and Discussion of Mean Difference Analysis

(i) Difference in mean Achievement in Mathematical Skills between Experimental Group I and Control Group was compared with regard to post-Test I scores, Retention scores and Gain-Scores in Post Test I and Post-Test II. Mean difference Analysis of Total Sample, Boys and Girls were done. The critical ratios obtained for each group at different samples were summarised and presented in Table 4.11.

TABLE 4.11

Summary of the Resultsof Mean Difference Analysis for Experimental Group I and Control Group in Achievement in Mathematical Skills

Dependent Variable	Critical Ratio				
	Sample	Knowledge Category	Comprehension Category	Application	Achievement in Mathematical Skills (Total Score)
Achievement in Mathematical Skills (Post Test I)	Total	6.24**	5.01**	3.09**	5.27**
	Boys	2.58*	0.41	0.16	0.94
	Girls	6.97**	8.56**	5.86**	9.09**
Gain Scores (Post Test I-Pre Test)	Total	--	--	--	6.77**
	Boys	--	--	--	2.35*
	Girls	--	--	--	8.60**
Achievement in Mathematical Skills (Post Test II)	Total	8.81**	5.78**	4.61**	7.67**
	Boys	2.67**	1.66	1.95	2.38*
	Girls	13.74**	7.98**	4.70**	10.85**
Gain Scores (Post Test II – Pre Test)	Total	--	--	--	10.70**
	Boys	--	--	--	4.95**
	Girls	--	--	--	11.99**

** indicates significance at 0.01 level.

* indicates significance at 0.05 level.

Critical ratios presented in Table 4.11 indicate that a significant difference in scores of Post-Test I, Post-Test II (Retention scores) and Gain scores in Post Test I and Post Test II for Total sample and Girls when Experimental Group I and Control Group were compared. For Boys significant difference was found for Knowledge category of Post-Test I and Post-Test II, Total score in Post-Test II and Gain Scores in Post- Test I and Post-Test II. On the whole Experimental Group I taught through Direct Instructions Model have advantage over Control Group in the Mean Achievement in Mathematical Skills.

ii) Difference in mean Achievement in Mathematical Skills with regard to Post- Test I scores, Post- Test II scores (Retention scores) and Gain scores in Post- Test I an Post-Test II between Experimental Group II and Control Group were compared. The critical ratios obtained for each group at different samples were summarised and presented in Table 4.12.

TABLE 4.12

Summary of the Resultsof Mean Difference Analysis for Experimental Group II and Control Group in Achievement in Mathematical Skills

Dependent Variable	Critical Ratio				
	Sample	Knowledge Category	Comprehension Category	Application	Achievement in Mathematical Skills (Total Score)
Achievement in Mathematical Skills (Post Test I)	Total	5.34**	3.26**	0.77	3.37**
	Boys	3.11**	0.40	0.58	0.87
	Girls	4.29**	4.12**	1.70	3.87**
Gain Scores (Post Test I-Pre Test)	Total	--	--	--	5.02**
	Boys	--	--	--	2.07*
	Girls	--	--	--	5.55**
Achievement in Mathematical Skills (Post Test II)	Total	6.02**	4.51**	1.72	4.85**
	Boys	1.68	2.68**	0.88	2.02*
	Girls	7.37**	3.58**	1.47	4.72**
Gain Scores (Post Test II – Pre Test)	Total	--	--	--	6.96**
	Boys	--	--	--	3.52**
	Girls	--	--	--	6.36**

** indicates significance at 0.01 level.
* indicates significance at 0.05 level.

As per Table 4.12 critical ratios indicate that a significant difference in Post- Test I, Post-Test II and Gain scores in Post-Test I and Post-Test II for Total sample and Girls except for Application category in Post-Test I and Post -Test II. In the case of Boys significant difference was found in Knowledge category of Post Test I, Gain scores in Post- Test I, Comprehension category in Post-Test II and Gain scores in Post- Test II between Experimental Group II and Control Group. In most of the cases Experimental Group taught through Direct Instruction Model and Objective Based Instruction have advantage over Control Group in mean Achievement in Mathematical Skills.

4.2. SECTION B

INVESTIGATION OF MAIN EFFECTS AND INTERACTION EFFECT OF METHODS OF TEACHING AND SELECT INDEPENDENT VARIABLES ON ACHIEVEMENT IN MATHEMATICAL SKILLS OBJECTIVE WISE AND TOTAL SCORE FOR TOTAL SAMPLE, BOYS AND GIRLS

The basic assumptions of using the ANOVA/ANCOVA such as normality, linearity and homogeneity were ensured using Statistical Package for Social Science. The analysis of the residuals was used for this purpose. The random pattern of residuals indicates that the distribution is approximately normal. The scatter plots showed that the dependent variable and covariates did not depart greatly from linearity. No missing observations were found in any cell. The analysis of residuals show that the dispersion of dependent variable within cells did not differ significantly which ensure the homogeneity of data. According to Ferguson (1981) one advantage of ANOVA/ ANCOVA is that the reasonable departure from the normality and homogeneity sometimes may occur without seriously affecting the validity of the inferences drawn from the data. However the examination of the major assumptions revealed that the basic assumptions are met to a satisfactory extend.

This part of the analysis was taken to throw light on the fifth to tenth objectives set for the study. Accordingly attempt was made to investigate whether variation in Achievement in Mathematical Skills (Objectivewise and Total score) is dependent on variation in the method of instruction namely Direct Instruction Model and Objective Based Instruction or not. Two-way analysis of variance was used to study the single effect and cross over effect of Methods of Teaching and select independent variables such as Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability of subjects. ANOVA was done separately for Total Sample, Boys and Girls.

The data was analysed using 2x2 Factorial ANOVA. The entire computations were carried out using the computer facility – Statistical Package for Social Sciences. Due to the unequal number of cases in the cells, the programme for unequal numbers was used for processing the data. Accordingly thirty six ANOVA were undertaken to study the main effect and interaction effect of Methods of Teaching and each of the three control variables on Achievement in Mathematical Skills Post-Test I – Objectivewise and Total score. Similarly thirty six ANOVA were undertaken to study the main effect and interaction effect of Methods of Teaching and each of control variables on Achievement in Mathematical Skills Post-Test II – Objectivewise and Total score.

The results of two-way ANOVA and the interpretation of the results are discussed in this section. The main effects and interaction effect on Post-Test I for Total Sample, Boys and Girls are presented first. The same pattern was used to discuss the results of two-way ANOVA for Achievement in Mathematical Skills Post-Test II.

4.2.1. Main Effect and Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample, Boys and Girls

To study the main effect and interaction effect of Methods of Teaching by Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I, twelve ANOVA was carried out in the samples separately. The sum of squares, variance estimated and the F-values were calculated for this purpose. Data and result of Two-way ANOVA are summarised and presented in Table 4.13.

TABLE 4.13
Data and Resultsof Two-way ANOVA of Achievement in Mathematical Skills Post-Test I (Objective wise and Total score) by Methods of Teaching by Previous Knowledge of Subject Matter for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter
Total (N=90)	Knowledge Category	SS	511.22	553.46	554.63
		df	1	1	1
		MS	511.22	553.46	554.36
		F	40.26**	43.58**	43.68**
	Comprehension Category	SS	407.62	348.15	408.61
		df	1	1	1
		MS	407.62	348.15	408.61
		F	35.86**	30.63**	35.95**
	Application Category	SS	693.04	747.24	568.74
		df	1	1	1
		MS	693.04	747.24	568.74
		F	23.93**	25.80**	19.64**
	Achievement in Mathematical Skills (Total Score)	SS	6685.61	5102.11	5478.35
		df	1	1	1
		MS	6685.61	5102.11	5478.35
		F	86.32**	65.88**	37.78**
Boys (N=44)	Knowledge Category	SS	407.66	206.64	253.33
		df	1	1	1
		MS	407.66	206.64	253.33
		F	41.32**	20.94**	25.67**
	Comprehension Category	SS	226.29	13.98	1114.52
		df	1	1	1
		MS	226.29	13.98	1114.52
		F	21.79**	1.34	11.03**
	Application Category	SS	184.31	24.63	92.68
		df	1	1	1
		MS	184.31	24.63	92.68
		F	6.28*	0.84	3.14
	Achievement in Mathematical Skills (Total Score)	SS	3019.27	782.37	1563.74
		df	1	1	1
		MS	3019.27	782.37	1563.74
		F	41.22**	10.68**	21.35**
Girls (N=46)	Knowledge Category	SS	86.03	429.27	342.54
		df	1	1	1
		MS	86.03	429.27	342.54
		F	6.45*	32.17**	25.66**
	Comprehension Category	SS	57.18	533.51	384.68
		df	1	1	1
		MS	57.18	533.51	384.68
		F	6.99**	65.21**	47.02**
	Application Category	SS	329.45	1052.57	603.87
		df	1	1	1
		MS	329.45	1052.57	603.87
		F	16.11**	51.45**	29.52**
	Achievement in Mathematical Skills (Total Score)	SS	2104.45	5523.95	4352.44
		df	1	1	1
		MS	2104.45	5523.95	4352.44
		F	39.73**	104.25**	82.15**

* indicate significance at 0.05 level.
** indicate significance at 0.01 level.

4.2.1.1. Main Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I

All the twelve F-ratios calculated to study the main effect of Methods of Teaching (Objectivewise and Total score) are found to be significant at 0.01 level for appropriate degrees of freedom. The values of F-ratios ranges from 6.45 to 86.32. The results suggest that methods of teaching is followed by changes in Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

4.2.1.2. Main Effect of Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I

When the results of single effect of Previous Knowledge of Subject Matter on Achievement in Mathematical Skills were studied ten out of twelve F-ratios are found to be significant. Hence it may be concluded that Previous Knowledge of Subject Matter has effect on Achievement in Mathematical Skills Post Test I.

4.2.1.3. Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I

All F-values computed to study the interaction of Methods of Teaching and Previous Knowledge of Subject Matter shows that eleven out of twelve of them are significant. The result suggests that Achievement in Mathematical Skills Post-Test I depends on the combined effect of Methods of Teaching and Previous Knowledge of Subject Matter for the sample.

4.2.1.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post-Test I between Experimental Group I and Control Group

Twelve ANOVA of Achievement in Mathematical Skills Post-Test I by Methods of Teaching by Previous Knowledge of Subject Matter was computed for Total Sample, Boys and Girls and it was done Objectivewise and for Total score.

Significant F-values were obtained in the ANOVA for Methods of Teaching. Therefore, mean scores of Achievement in Mathematical Skills Post- Test I (Objectivewise and Total score) of the two groups categorised on the basis of Methods of Teaching were compared.

Data and result of the t-values computed are summarised and presented in Table 4.14.

TABLE 4.14

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test I (Objective wise and Total score) of the Two Groups Based on Methods of Teaching for Total Sample, Boys and Girls

Sample	Dependent Variable	DIM		OBI		t-value	Level of significance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	27.40	4.39	22.22	3.32	6.24**	0.01
	Comprehension Category	21.13	4.51	16.89	3.35	5.01**	0.01
	Application Category	20.11	6.03	16.56	4.67	3.09**	0.01
	Achievement in Mathematical Skills (Total score)	68.64	13.62	55.67	9.00	5.27**	0.01
Boys N=44	Knowledge Category	25.64	5.15	22.36	2.70	9.09**	0.01
	Comprehension Category	18.68	4.29	18.18	3.55	0.41	NS
	Application Category	16.41	5.53	16.68	5.31	0.16	NS
	Achievement in Mathematical Skills (Total score)	60.73	13.70	57.23	10.08	0.94	NS
Girls N=46	Knowledge Category	29.09	2.68	22.09	3.87	6.97**	0.01
	Comprehension Category	23.48	3.37	15.65	2.67	8.56**	0.01
	Application Category	23.65	4.09	16.43	4.09	5.86**	0.01
	Achievement in Mathematical Skills (Total score)	76.22	8.31	54.17	7.76	9.09**	0.01

Table 4-14 revealed that all t-values are significant at 0.01 level for Total Sample and Girls. In the case of Boys significant difference exist only for Knowledge category. Out of twelve t-values nine of them are found to be significant.

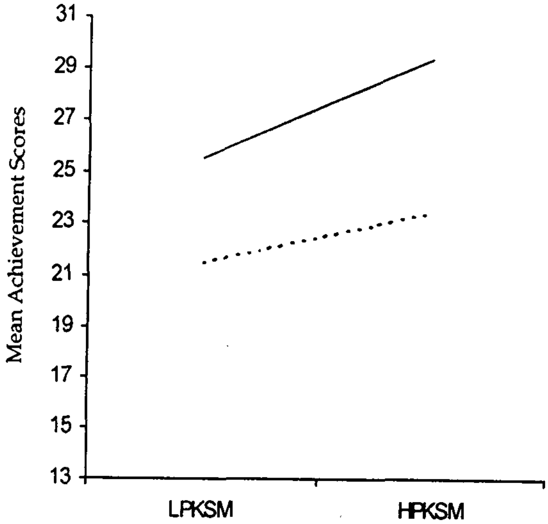
In all the cases high mean scores were found associated with Direct Instruction Model. This indicates the advantage of Direct Instruction Model over Objective Based Instruction.

4.2.1.5. Graphical Representation of the Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls

It was noticed from the twelve ANOVA computed to study the main effect and interaction effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I, all the twelve F-ratios for the interaction effect were found to be significant. Therefore an attempt was made to study the pattern of relationship of two variables for Experimental Group I and Control Group graphically.

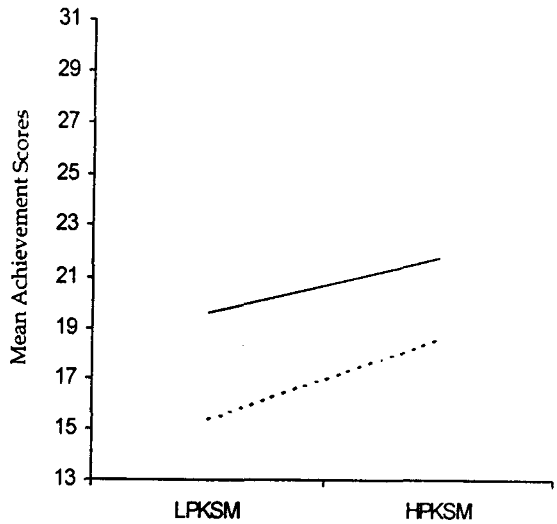
For this purpose mean scores of dependent variable Achievement in Mathematical Skills Post-Test I of the subjects were plotted on the Y-axis of the graph and the two groups categorised on the basis of Previous knowledge of Subject Matter were marked on the X-axis. Mean achievement scores of the subjects categorised on the basis of Methods of Teaching were marked separately in the graph. Pattern of relationship between two variables were examined separately for the Total Sample, Boys and Girls.

Graph representing the relationship between the Methods of Teaching and Previous Knowledge of Subject Matter for Total Sample is presented in Figure 4-1 A, B, C and D, for Boys is presented in Figure 4-2 A, B, C, D and for Girls is presented in Figure 4-3 A, B, C, D.



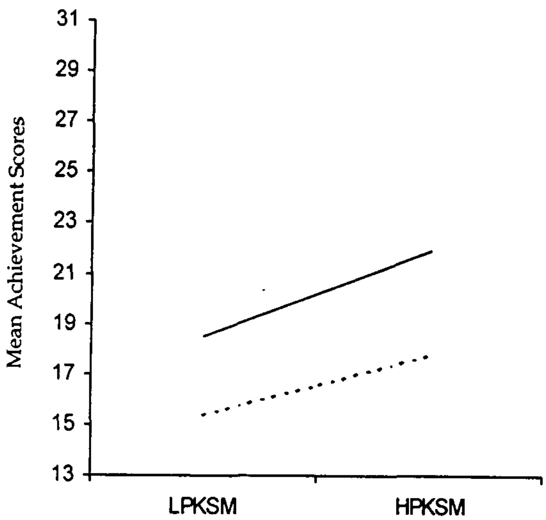
Achievement in Mathematical Skills
Knowledge Category

4 - 1 A



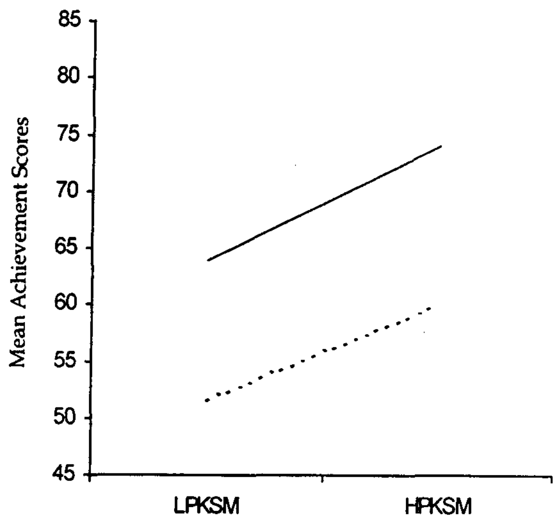
Achievement in Mathematical Skills
Comprehension Category

4 - 1 B



Achievement in Mathematical Skills
Application Category

4 - 1 C



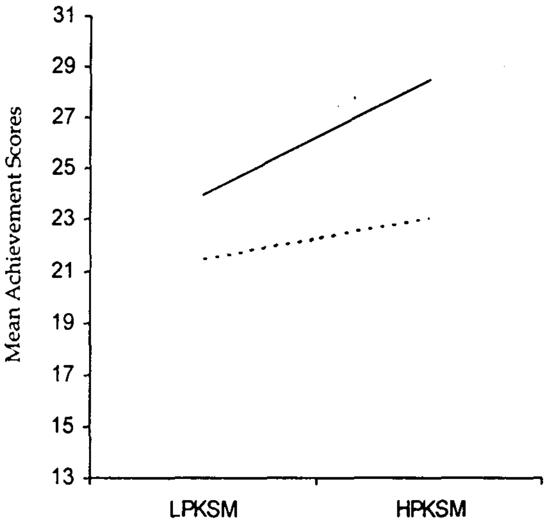
Achievement in Mathematical Skills
Total Score

4 - 1 D

LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

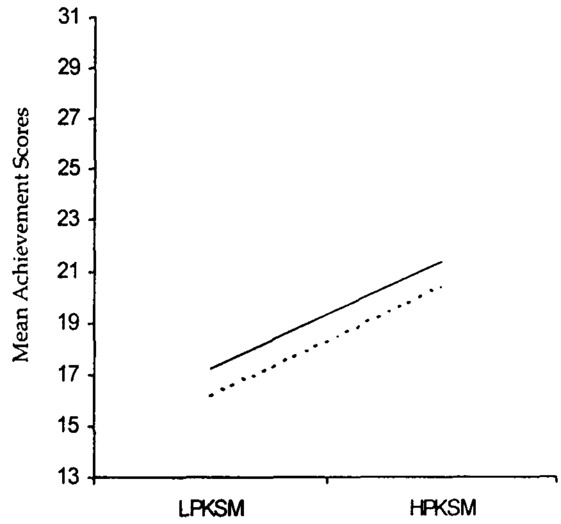
—— Experimental Group
- - - - Control Group

FIGURE 4-1. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test I for Total Sample.



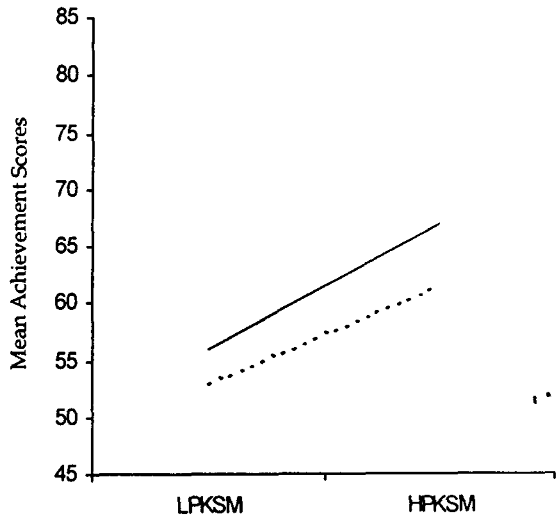
Achievement in Mathematical Skills
Knowledge Category

4 - 2 A



Achievement in Mathematical Skills
Comprehension Category

4 - 2 B



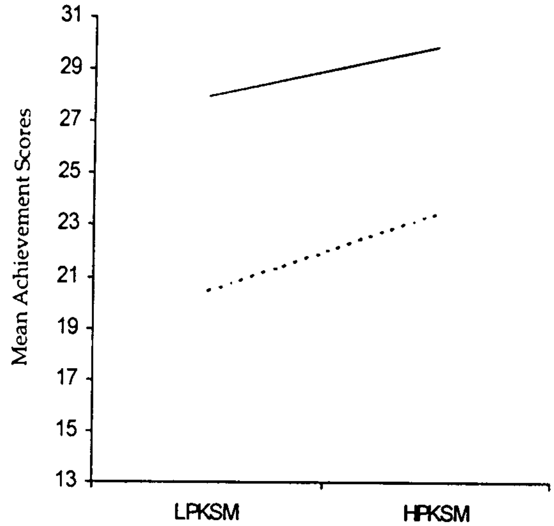
Achievement in Mathematical Skills
Total Score

4 - 2 C

LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

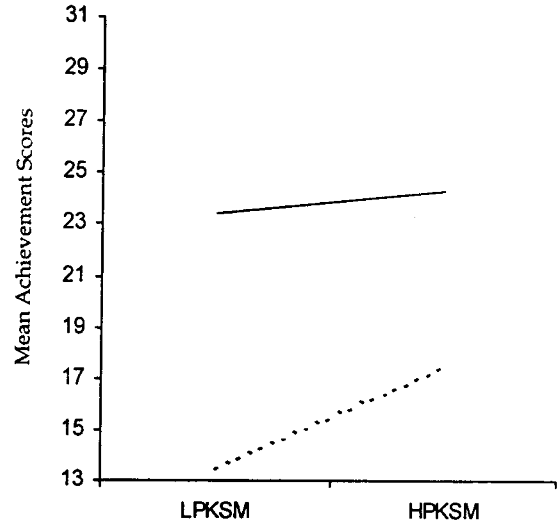
—— Experimental Group
- - - - Control Group

FIGURE 4-2. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test I for Boys.



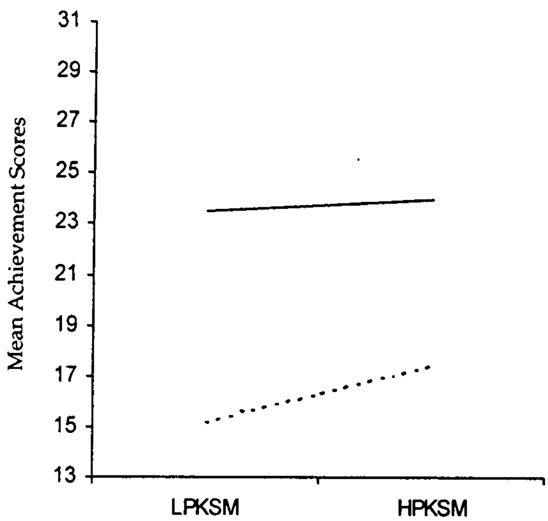
Achievement in Mathematical Skills
Knowledge Category

4 - 3 A



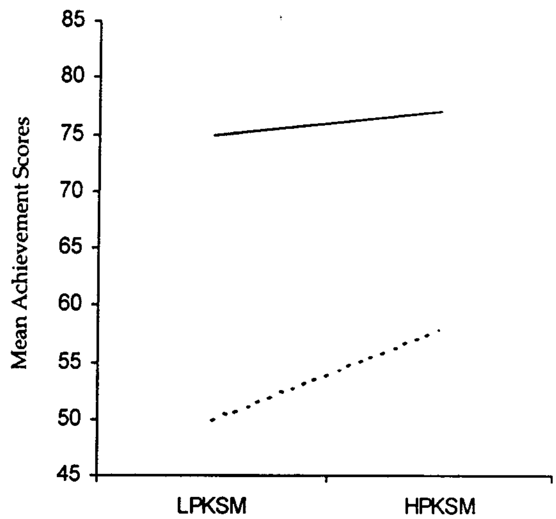
Achievement in Mathematical Skills
Comprehension Category

4 - 3 B



Achievement in Mathematical Skills
Application Category

4 - 3 C



Achievement in Mathematical Skills
Total Score

4 - 3 D

LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

—— Experimental Group
- - - - Control Group

FIGURE 4-3. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test I for Girls.

An examination of the graph reveals that the lines representing Achievement in Mathematical Skills Post-Test I of two groups are not parallel except for Comprehension category of Boys. This indicates that the interaction effect of the two variables Methods of Teaching and Previous Knowledge of Subject Matter on Post-Test I. High means are seen associated with Direct Instruction Model in the interaction can be considered to present synergistic indicating from lower to higher, higher the mean achievement scores especially for Knowledge and Application category for the Total sample. In the case of Boys also the synergistic type of interaction is found for knowledge category and Total Achievement. In the sample of Girls all the interaction effect are found to be ceiling.

4.2.2. Main Effect and Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample, Boys and Girls

The main effect and interaction effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I were analysed for Total Sample and for the sample of Boys and Girls. Altogether twelve ANOVA were computed for this purpose. The summary of Two-way factional ANOVA is presented in Table 4.15.

TABLE 4.15

Data and Resultsof Two-way ANOVA of Achievement in Mathematical Skills Post-Test I (Objective wise and Total score) by Methods of Teaching by Non Verbal Inteligence for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Non-Verbal Intelligence	Interaction Effect of Methods of Teaching and Non Verbal Intelligence
Total (N=90)	Knowledge Category	SS	358.422	3380	245
		df	1	1	1
		MS	358.422	3380	245
		F	13.40**	126.32**	9.16**
	Comprehension Category	SS	254.42	9102.22	160.56
		df	1	1	1
		MS	254.42	9102.22	160.56
		F	9.97**	356.82**	6.92*
	Application Category	SS	273.8	1061.88	176.02
		df	1	1	1
		MS	27.38	1061.68	176.02
		F	7.64**	96.15**	4.91*
	Achievement in Mathematical Skills (Total Score)	SS	3208.89	19264.36	2848.09
		df	1	1	1
		MS	329.89	1926.36	2848.09
		F	38.37**	230.31**	34.06**
Boys (N=44)	Knowledge Category	SS	2.23	1449.17	158.23
		df	1	1	1
		MS	2.23	1449.18	158.23
		F	0.77	58.37**	6.41*
	Comprehension Category	SS	19.10	4023.01	45.10
		df	1	1	1
		MS	19.10	4023.01	45.10
		F	0.84	176.70**	1.98
	Application Category	SS	31.92	5301.01	29.56
		df	1	1	1
		MS	31.92	5301.01	29.56
		F	1.01	158.21**	0.94
	Achievement in Mathematical Skills (Total Score)	SS	195.01	7961.01	627.56
		df	1	1	1
		MS	195.01	7961.01	627.56
		F	2.4	97.99**	7.73**
Girls (N=46)	Knowledge Category	SS	626.09	1954.09	92
		df	1	1	1
		MS	626.09	1954.09	92
		F	25.34**	79.09**	40.84**
	Comprehension Category	SS	706.79	5100.27	124.45
		df	1	1	1
		MS	706.79	5100.27	124.45
		F	32.34**	233.35**	5.69*
	Application Category	SS	822.01	5310.88	175.32
		df	1	1	1
		MS	822.01	5310.88	175.32
		F	25.56**	171.60**	5.67*
	Achievement in Mathematical Skills (Total Score)	SS	4300.45	11419.84	2514.79
		df	1	1	1
		MS	4300.45	11419.84	2514.79
		F	69.84**	185.46**	40.84**

* indicate significance at 0.05 level.

** indicate significance at 0.01 level.

4.2.2.1. Main Effect of Methods on Teaching on Achievement in Mathematical Skills Post Test I

As per the Table 4.15 the obtained F-values for the single effect of Methods of Teaching on Achievement in Mathematical Skills Knowledge category, Comprehension category, Application category and for Total score for Total Sample and Girls are greater than the tabled value set at 0.01 level of significance for appropriate degrees of freedom except for Boys. The result reveals that the Achievement on Mathematical Skills dependent on the Method of Teaching adopted for Total Sample and for the sample Girls and not for Boys.

4.2.2.2. Main Effect of Non-Verbal Intelligence on Achievement in Mathematical Skills Post Test I

The F-values obtained shows that the main effect of Non-Verbal Intelligence on Achievement in Mathematical Skills are significant in all twelve ANOVA computed. Significant main effect is found for Total sample Boys and for Girls in the sample. That is, Non-verbal Intelligence have significant single effect on the Achievement in Mathematical Skills for the sample Boys, Girls and Total Sample.

4.2.2.3. Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post Test I

When results of study of joint effect of Methods of Teaching and Non-Verbal Intelligence were examined, ten out of twelve F-ratios were found to be significant. This result suggests that Methods of Teaching and Non-Verbal Intelligence have combined effect on Achievement in Mathematical Skills Post Test I.

4.2.2.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post-Test I between Experimental Group I and Control Group

Wherever significant F-values were obtained for the single effect of Methods of Teaching on Achievement in Mathematical Skills Post Test I (Objectivewise and Total score) between Experimental Group I and Control Group were compared using test of significance difference by computing t-values.

Data and results of t-test are presented in Table 4.16.

TABLE 4.16

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test I (Objective wise and Total score) of the Two Groups Based on Methods of Teaching for Total Sample, Boys and Girls

Sample	Dependent Variable	DIM		OBI		t-value	Level of signi-ficance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	27.40	3.78	22.22	3.32	6.24**	0.00
	Comprehension Category	21.13	4.51	16.89	3.35	5.01**	0.00
	Application Category	20.11	6.03	16.56	4.67	3.09**	0.00
	Achievement in Mathematical Skills (Total score)	68.64	13.62	55.67	9.00	5.27**	0.00
Girls N=46	Knowledge Category	29.09	2.68	22.09	3.87	6.97**	0.01
	Comprehension Category	23.48	3.37	15.65	2.66	8.56**	0.01
	Application Category	23.05	4.09	16.43	4.09	5.86**	0.01
	Achievement in Mathematical Skills (Total score)	76.22	8.31	54.17	7.76	9.09**	0.01

Table 4-16 shows that t-values obtained for comparison of mean scores of Post-Test I (Objectivewise and Total score) are found greater than the tabled value for significance at 0.01 level for appropriate degrees of freedom for Total Sample and Girls. But for boys there exists a significant difference at 0.05 level for Knowledge category only.

Teaching through Direct Instruction Model can be considered to have advantage over Objective Based Instruction in the case of Total Sample and Girls in the sample since high means are seen associated with Experimental Group I.

4.2.2.5. Graphical Representation of the Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls

Twelve ANOVA computed to examine the main effect and interaction effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I revealed that ten out of twelve F-ratios for the interaction effect of the variables were significant. Therefore an attempt was made to study the interaction graphically. Two categories of Non-Verbal Intelligence were marked on the X-axis and the mean Achievement in Mathematical Skills Post-Test I was marked along the Y-axis. The interaction effect was examined separately for Total Sample, Boys and Girls.

Graphical representation of the relationship between Methods of Teaching and Non-Verbal Intelligence of Total Sample is presented in Figures 4-4 A, B, C and D; for Boys is presented in Figure 4-5 A and Band for Girls is presented in Figure 4-6 A, B, C and D.

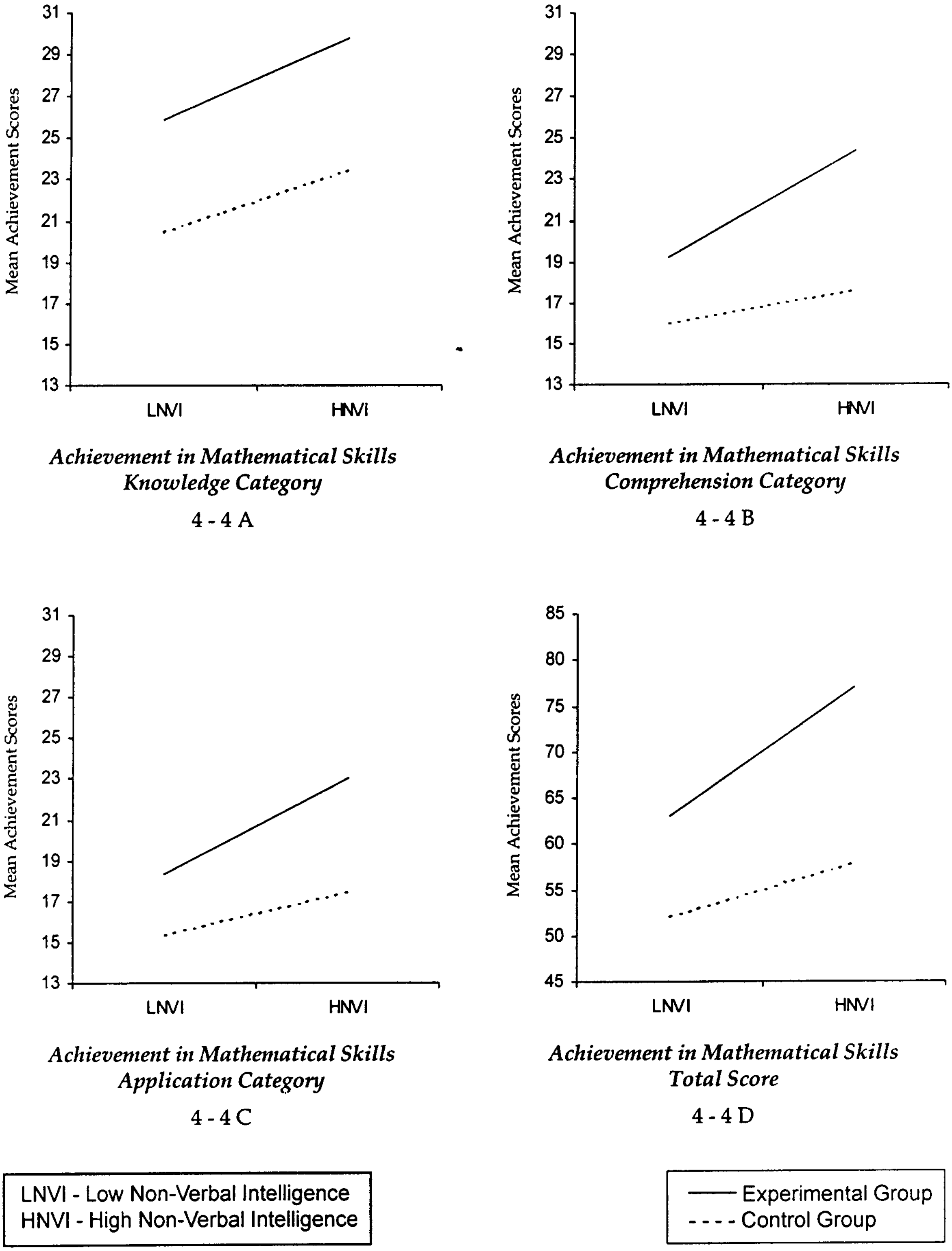
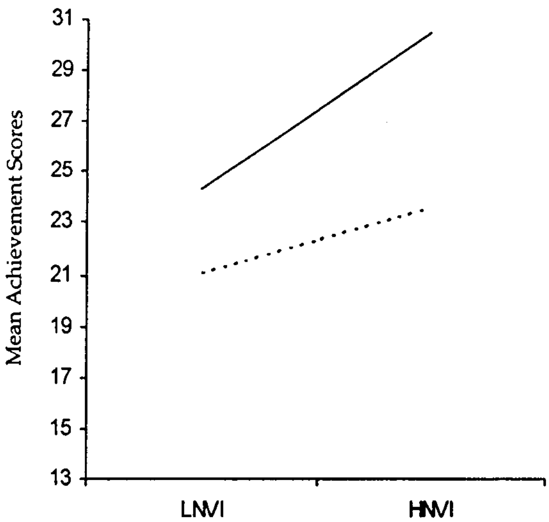
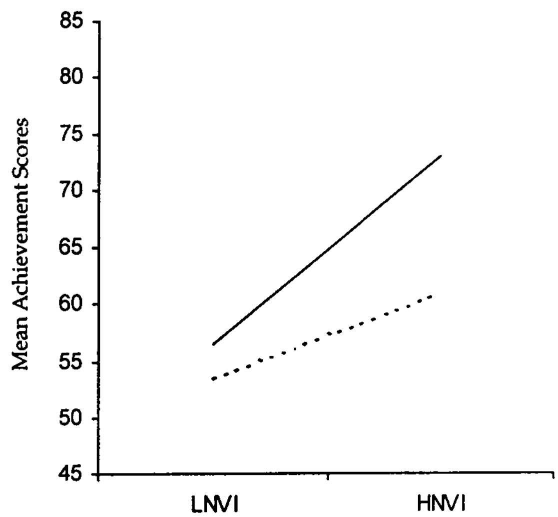


FIGURE 4-4. Interaction Effect (Methods of Teaching and Non-Verbal Intelligence) on Achievement in Mathematical Skills Post Test I for Total Sample.



Achievement in Mathematical Skills
Knowledge Category
4 - 5 A

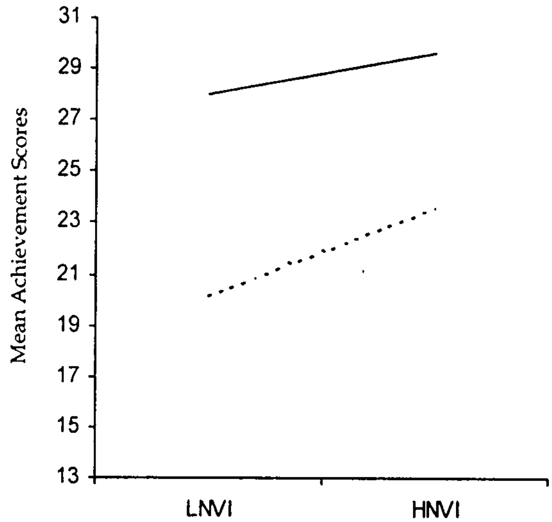


Achievement in Mathematical Skills
Total Score
4 - 5 B

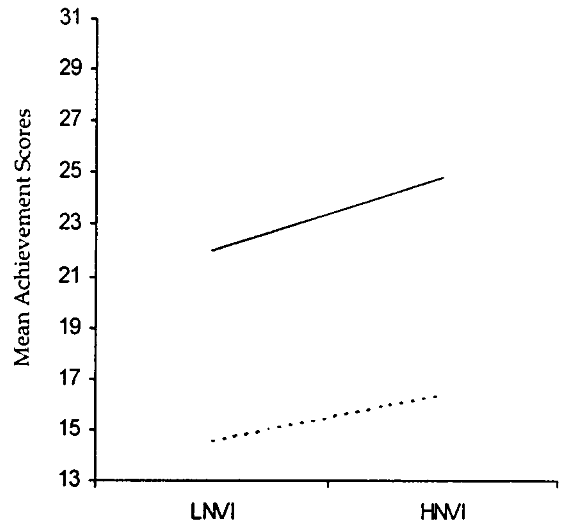
LNVI - Low Non-Verbal Intelligence
HNVI - High Non-Verbal Intelligence

—— Experimental Group
- - - - Control Group

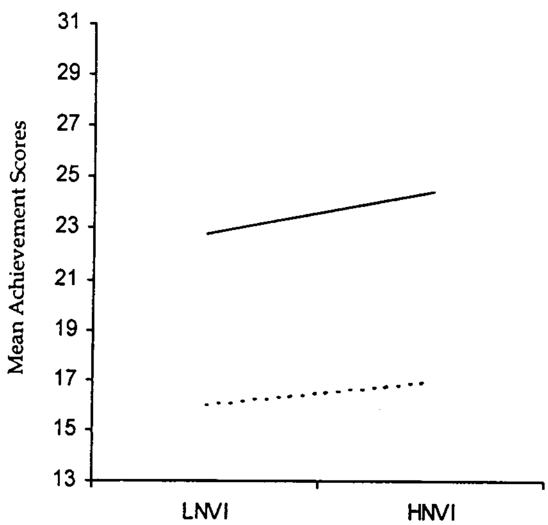
FIGURE 4-5. Interaction Effect (Methods of Teaching and Non-verbal Intelligence) on Achievement in Mathematical Skills Post Test I for Boys.



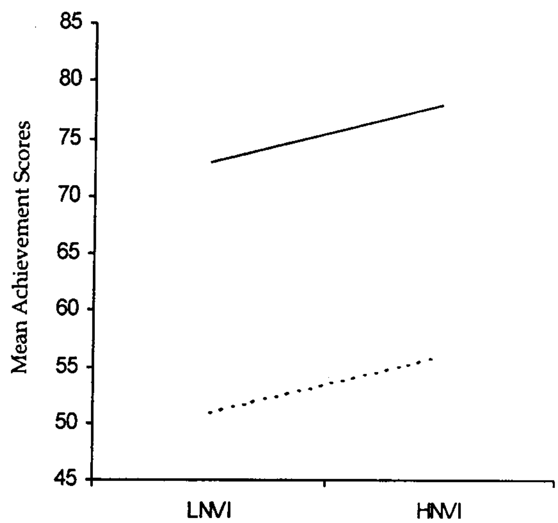
Achievement in Mathematical Skills
Knowledge Category
4 - 6 A



Achievement in Mathematical Skills
Comprehension Category
4 - 6 B



Achievement in Mathematical Skills
Application Category
4 - 6 C



Achievement in Mathematical Skills
Total Score
4 - 6 D

LNVI - Low Non-Verbal Intelligence
HNVI - High Non-Verbal Intelligence

—— Experimental Group
- - - - Control Group

FIGURE 4-6. Interaction Effect (Methods of Teaching and Non-verbal Intelligence) on Achievement in Mathematical Skills Post Test I for Girls.

From the graph it is noticed that the lines representing the two groups are non-parallel. The line representing Direct Instruction Model is always above the line representing Objective Based Instruction and the difference between low Non-Verbal Intelligence and high Non-Verbal Intelligence groups were seems to be wider representing the interaction as synergistic type for Total Sample, Boys and Girls. For the Knowledge category of Girls interaction is ceiling type.

4.2.3. Main Effect and Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample, Boys and Girls

Twelve ANOVA for Achievement in Mathematical Skills Post-Test I by Methods of Teaching by Numerical Ability were computed for Total Sample, Boys and Girls and this was done both for Objectivewise scores and Total score.

The sum of squares, variance and F-values were calculated to examine the main effect and interaction effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post-Test I. The data and results of Two-way ANOVA are summarised and presented in the following Table 4.17.

TABLE 4.17

Data and Resultsof Two-way ANOVA of Achievement in Mathematical Skills Post-Test I (Objective wise and Total score) by Methods of Teaching by Numerical Ability for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter
Total (N=90)	Knowledge Category	SS	646.01	3406.05	84.05
		df	1	1	1
		MS	646.01	3406.05	84.05
		F	21.93**	115.64**	2.85
	Comprehension Category	SS	503.34	9144.94	38.27
		df	1	1	1
		MS	503.34	9144.94	38.27
		F	17.85**	324.21**	1.36
	Application Category	SS	530.45	765.81	46.01
		df	1	1	1
		MS	530.45	765.81	46.01
		F	13.77**	176.62**	1.19
	Achievement in Mathematical Skills (Total Score)	SS	3985.61	9119.34	2198.01
		df	1	1	1
		MS	3985.61	9119.34	2198.01
		F	46.17**	122.40**	25.46**
Boys (N=44)	Knowledge Category	SS	40.91	6273.28	64.27
		df	1	1	1
		MS	40.91	6273.28	64.27
		F	1.22	155.84**	3.01
	Comprehension Category	SS	0.28	1966.55	58.91
		df	1	1	1
		MS	0.28	1966.55	58.91
		F	0.01	58.85**	1.76
	Application Category	SS	0.56	4875.28	3.28
		df	1	1	1
		MS	0.56	4875.28	3.28
		F	0.91	155.84**	0.11
	Achievement in Mathematical Skills (Total Score)	SS	356.01	6860.28	405.92
		df	1	1	1
		MS	356.0	6860.28	405.92
		F	3.96*	75.83**	4.51*
Girls (N=46)	Knowledge Category	SS	858.27	1464.01	28.271
		df	1	1	28.27
		MS	858.27	1464.01	0.28
		F	36.34**	62.03**	
	Comprehension Category	SS	952.35	4285.78	47.35
		df	1	1	1
		MS	952.35	4285.78	47.35
		F	45.90**	206.61**	0.13
	Application Category	SS	1085.39	4480.04	80.39
		df	1	1	1
		MS	1085.39	4480.04	80.39
		F	36.37**	150.14**	0.10
	Achievement in Mathematical Skills (Total Score)	SS	4879.34	8725.26	2104.35
		df	1	1	1
		MS	4879.34	8725.26	2104.35
		F	80.70**	120.45**	34.80**

* indicate significance at 0.05 level.

** indicate significance at 0.01 level.

4.2.3.1. Main Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I

Results in Table 4.17 indicate highly significant F-ratios (nine out of twelve) are obtained for the single effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample and Girls. The results show that differences in Method of Teaching is influencing the differences in Achievement in Mathematical Skills for Girls and Total Sample. For Boys, F-ratios are not found significant even at 0.05 level.

4.2.3.2. Main Effect of Numerical Ability on Achievement in Mathematical Skills Post-Test I

When the results of single effect of Numerical Ability on Achievement was studied it was noticed that all the twelve ANOVA are found to be significant at 0.01 level for appropriate degrees of freedom. This indicates that as the scores on Numerical Ability changes there is changes in Achievement in Mathematical Skills.

4.2.3.3. Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post- Test I

F-values obtained for interaction of the two variables shows that nine out of twelve ANOVA are not significant. Hence combined effect of Methods of Teaching and Numerical Ability cannot consider to be having joint effect on Achievement in Mathematical Skills Post-Test I.

4.2.3.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post-Test I between Experimental Group I and Control Group

As post- hoc comparison, where F-values were found significant, test of significance difference between mean Achievement in Mathematical Skills Post-Test I of Experimental Group 1 and Control Group was estimated to find out the advantageous group. Altogether nine t-values were computed.

Data and results of the mean comparison is presented in Table 4.18.

TABLE 4.18

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test I (Objective wise and Total score) of the Two Groups Based on Methods of Teaching for Total Sample, Boys and Girls

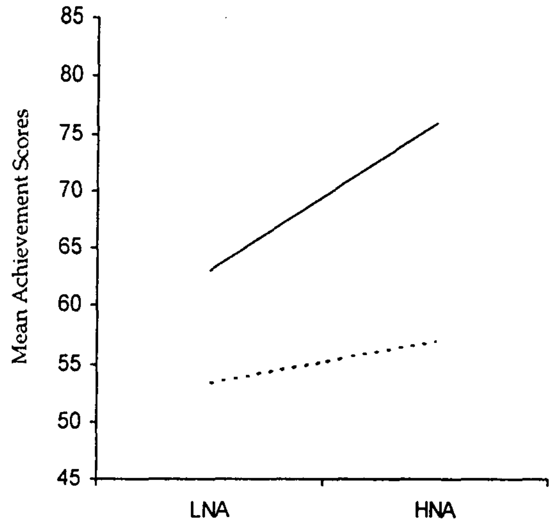
Sample	Dependent Variable	DIM		OBI		t-value	Level of significance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	27.40	4.39	22.22	3.32	6.24**	0.01
	Comprehension Category	21.13	4.51	16.89	3.35	5.01**	0.01
	Application Category	20.11	6.03	16.56	4.67	3.09**	0.01
	Achievement in Mathematical Skills (Total score)	68.64	13.62	55.67	9.00	5.27**	0.01
Girls N=46	Knowledge Category	29.09	2.68	22.09	3.87	6.97**	0.01
	Comprehension Category	23.48	3.37	15.65	2.66	8.56*	0.01
	Application Category	23.65	4.09	16.43	4.09	5.86**	0.01
	Achievement in Mathematical Skills (Total score)	.22	8.31	54.17	7.76	9.09**	0.01

t-values obtained from Table 4.18 shows that there exists significant difference between Experimental Group I and Control Group in mean Achievement in Mathematical Skills at 0.01level for Total Sample and Girls. In the case of Boys no significant difference in mean is found to exist in Total score even though F-ratio is significant.

The results suggest that significant differences in mean Achievement in Mathematical Skills exist between Experimental Group I and Control Group and that high mean scores are associated with Experimental Group I indicating the advantage of Direct Instruction Model over Objective Based Instruction.

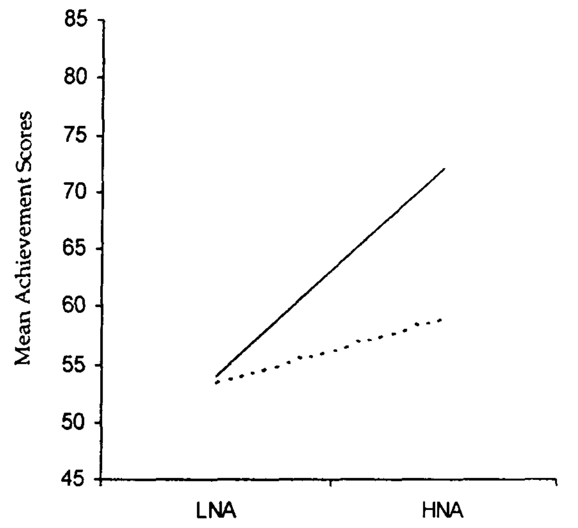
4.2.3.5. Graphical Representation of the Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post- Test I for Total Sample, Boys and Girls

Three out of twelve F-ratios obtained for the interaction effect of Achievement in Mathematical Skills Post-Test I by Methods of Teaching by Numerical Ability were found to be significant for Total Sample, Boys and Girls. Graphical representation of the interactions are presented in Figure 4-7 A, B and C.



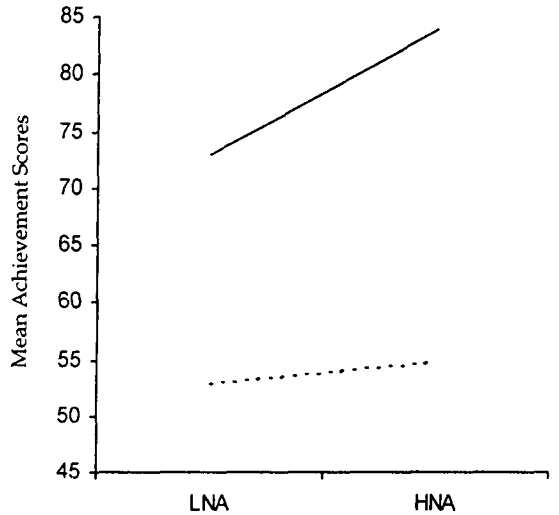
Interaction Effect for Total Sample

4 - 7 A



Interaction Effect for Boys

4 - 7 B



Interaction Effect for Girls

4 - 7 C

LNA - Low Numerical Ability
HNA - High Numerical Ability

—— Experimental Group
- - - - Control Group

FIGURE 4-7. Interaction Effect (Methods of Teaching and Numerical Ability) on Achievement in Mathematical Skills Post Test I for Total Sample, Boys and Girls.

An examination of the graph reveals that the separation of lines depicting mean achievement of Experimental Group I and Control Group are not only parallel but the means of experimental group are always consistently above the line depicting the Control Group. It is also noticed that the differences for the total achievement become wider from low numerical ability to high numerical ability group. Hence synergistic interaction is seen here also.

Summary of Two-way ANOVA on Achievement in Mathematical Skills Post -Test I

To check whether Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) depends on Methods of Teaching, Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability, thirty six ANOVA were undertaken. The F-values obtained were consolidated and presented in Tale 4.19.

TABLE 4-19

Summary of F-values of the Main Effect and Interaction Effects of Methods of Teaching, Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability on Achievement in Mathematical Skills Post Test I (Objective wise and Total Score) for Total sample, Boys and Girls

Sample	Dependent Variable	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter	Main Effect of Methods of Teaching	Main Effect of Non-Verbal Intelligence	Interaction Effect of Methods of Teaching and Non-Verbal Intelligence	Main Effect of Methods of Teaching	Main Effect of Numerical Ability	Interaction Effect of Methods of Teaching and Numerical Ability
Total	Knowledge Category	40.26**	43.58**	43.68**	13.40**	126.32**	9.16**	21.93**	115.64**	2.85
	Comprehension Category	35.86**	30.63**	35.93**	9.97**	356.82**	6.92*	17.85**	324.21**	1.36
	Application Category	23.93**	25.80**	19.64**	7.64**	96.15**	4.91*	13.77**	176.62**	1.19
	Total Score	86.32**	65.88**	37.78**	38.37**	230.31**	34.06**	46.17**	122.40**	25.46**
Boys	Knowledge Category	41.32**	20.94**	25.67**	0.77	58.37**	6.41*	1.22	155.84**	3.01
	Comprehension Category	21.79**	1.34	11.03**	0.84	176.70**	1.98	0.01	58.85**	1.76
	Application Category	6.28*	0.84	3.14	1.01	158.21**	0.94	0.91	155.84**	0.11
	Total Score	41.22**	10.68**	21.35**	2.40	97.99**	7.73**	3.96	75.83**	4.51*
Girls	Knowledge Category	6.45*	32.17**	25.66**	25.34**	79.09**	40.84**	36.34**	62.03**	0.28
	Comprehension Category	6.99**	65.21**	47.02**	32.34**	233.35**	5.69*	45.90**	206.61**	0.13
	Application Category	16.11**	51.45**	29.52**	25.56**	171.60**	5.67*	36.37**	150.14**	0.10
	Total Score	39.73**	104.25**	82.15**	69.84**	185.46**	40.84**	80.70**	120.45**	34.80**

** indicates the level of significance at 0.01 level.

* indicates the level of significance at 0.05 level.

4.2.4. Main Effect and Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score) for Total Sample, Boys and Girls

Twelve ANOVA for Achievement in Mathematical Skills Post-Test II (Retention score) by Methods of Teaching by Previous Knowledge of Subject Matter was estimated for Total score and Objectivewise scores for Total sample, Boys and Girls. The sum of squares, variance estimated and the F-values were estimated to find out the main effect and interaction effect. Data and results of two-way ANOVA are summarised and presented in Table 4.20.

TABLE 4.20

Data and Results of Two-way ANOVA of Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) by Methods of Teaching by Previous Knowledge of Subject Matter for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter
Total (N=90)	Knowledge Category	SS	511.23	553.46	554.63
		df	1	1	1
		MS	511.23	553.46	554.63
		F	40.26**	43.58**	43.68**
	Comprehension Category	SS	354.64	407.62	348.15
		df	1	1	1
		MS	354.64	407.62	348.15
		F	40.15**	35.87**	30.64**
	Application Category	SS	693.04	747.25	568.74
		df	1	1	1
		MS	693.04	747.25	568.74
		F	23.93**	25.81**	19.64**
	Achievement in Mathematical Skills (Total Score)	SS	6685.61	5102.11	5478.35
		df	1	1	1
		MS	6685.61	5102.11	5478.35
		F	86.33**	65.88**	70.74**
Boys (N=44)	Knowledge Category	SS	393.87	301.85	282.95
		df	1	1	1
		MS	393.87	301.85	282.95
		F	28.29**	21.67**	20.32**
	Comprehension Category	SS	160.55	62.20	99.38
		df	1	1	1
		MS	160.55	62.20	99.38
		F	16.61**	6.44*	10.28**
	Application Category	SS	228.63	190.04	152.54
		df	1	1	1
		MS	228.63	190.04	152.54
		F	16.14**	13.42**	10.77**
	Achievement in Mathematical Skills (Total Score)	SS	3530.69	2085.70	2145.90
		df	1	1	1
		MS	3530.69	2085.70	2145.90
		F	71.19**	42.06**	43.27**
Girls (N=46)	Knowledge Category	SS	646.43	1027.15	870.97
		df	1	1	1
		MS	646.43	1027.15	870.97
		F	57.50**	91.37**	77.48**
	Comprehension Category	SS	354.47	376.06	395.03
		df	1	1	1
		MS	354.47	376.06	395.03
		F	40.15**	42.59**	44.74**
	Application Category	SS	843.98	911.79	693.33
		df	1	1	1
		MS	843.98	911.79	693.33
		F	55.03**	59.45**	45.21**
	Achievement in Mathematical Skills (Total Score)	SS	7277.71	7073.22	6604.12
		df	1	1	1
		MS	7277.71	7032.22	6604.12
		F	145.61**	141.52**	133.34**

* indicate significance at 0.05 level.

** indicate significance at 0.01 level.

4.2.4.1. Main Effect of Methods of Teaching on Achievement in Mathematical Skills Post Test II

The results of the single effect of Methods of Teaching on Retention scores shows that all the obtained twelve F-values exceed the critical limit set for significance at 0.01 level for appropriate degrees of freedom. That Method of Teaching has significant single effect on Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) for Total Sample, Boys and Girls.

4.2.4.2. Main Effect of Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II

When the result of single effect of Previous Knowledge of Subject Matter on Retention scores was studied all the twelve F-values are found to be significant. The result suggests that Previous Knowledge of Subject Matter have single effect on Achievement in Mathematical Skills Post Test II for Total Sample, Boys and for Girls.

4.2.4.3. Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II

The results obtained for the interaction show that all F-values are significant at 0.01 level suggesting that Achievement in Mathematical Skills Post Test II depends on the joint effect of Methods of Teaching and Previous Knowledge of Subject Matter.

4.2.4.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post-Test II Between Experimental Group I and Control Group

Since significant F-values were obtained for the main effect of the Methods of Teaching on Retention, post-hoc comparison of the mean Retention score was attempted further. Test of significance difference between mean Achievement Scores (Retention) of Experimental Group I and Control Group were computed.

The summary and results of the t-values obtained are presented in Table 4.21.

TABLE 4.21

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test II (Objective wise and Total score) of the Two Groups of Sample Based on Methods of Teaching for Total Sample, Boys and Girls

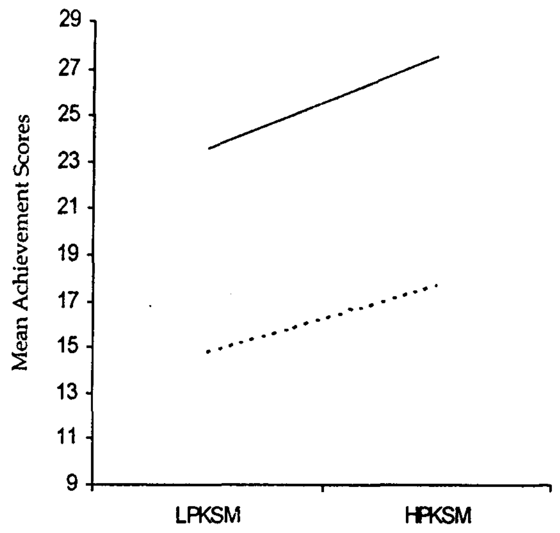
Sample	Dependent Variable	DIM		OBI		t-value	Level of significance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	25.51	4.67	16.33	5.10	8.81**	0.01
	Comprehension Category	18.64	4.21	14.24	2.80	5.78**	0.01
	Application Category	17.82	5.73	12.93	4.08	3.05**	0.01
	Achievement in Mathematical Skills (Total score)	61.98	13.29	43.51	8.84	7.67**	0.01
Boys N=44	Knowledge Category	23.55	5.59	19.59	3.84	2.67**	0.05
	Comprehension Category	16.45	4.13	14.59	3.08	1.66	NS
	Application Category	15.27	5.06	12.64	3.59	1.95	NS
	Achievement in Mathematical Skills (Total score)	55.27	13.92	46.82	8.47	2.38*	0.05
Girls N=46	Knowledge Category	27.39	2.50	13.22	4.14	13.74**	0.01
	Comprehension Category	20.74	3.12	13.91	2.52	7.98**	0.01
	Application Category	20.26	5.34	13.22	4.56	4.70**	0.01
	Achievement in Mathematical Skills (Total score)	68.39	8.96	40.35	8.16	10.85**	0.01

Table 4.21 shows that t-values obtained for comparison of mean scores of Post-Test II (Objectivewise and Total score) are found greater than the tabled value except for Comprehension and Application category in the case of Boys. Ten out of twelve t-values are found to be significant.

Since high means are associated with Experimental Group I, group taught through Direct Instruction Model of teaching can be considered to have advantage over group taught through Objective Based Instruction.

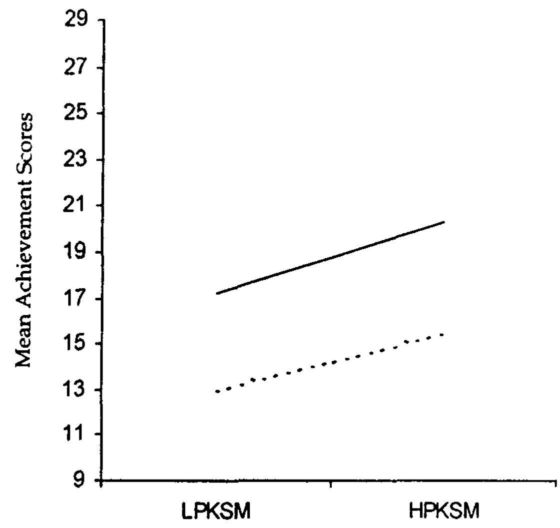
4.2.4.5. Graphical Representation of Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post- Test II for Total Sample, Boys and Girls.

When the interaction effect of Previous Knowledge of Subject Matter by Methods of Teaching by Subject Matter on Retention scores, all F-values are found to be significant. The interaction is graphically represented in Figure 4-8 A, B, C and D for Total sample, Figure 4-9 A, B, C and D for Boys and Figure 4-10 A, B, C and D for Girls.



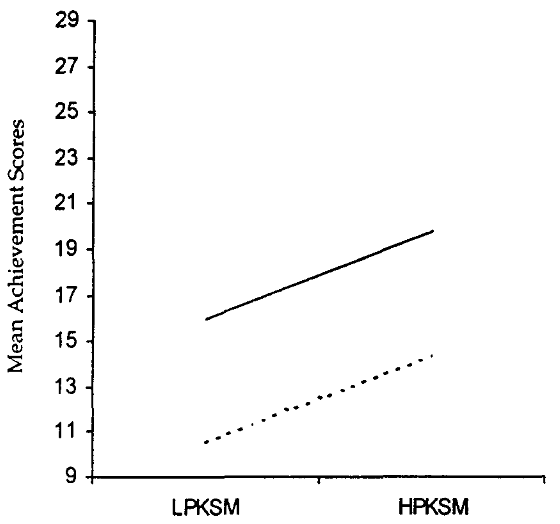
Achievement in Mathematical Skills
Knowledge Category

4 - 8 A



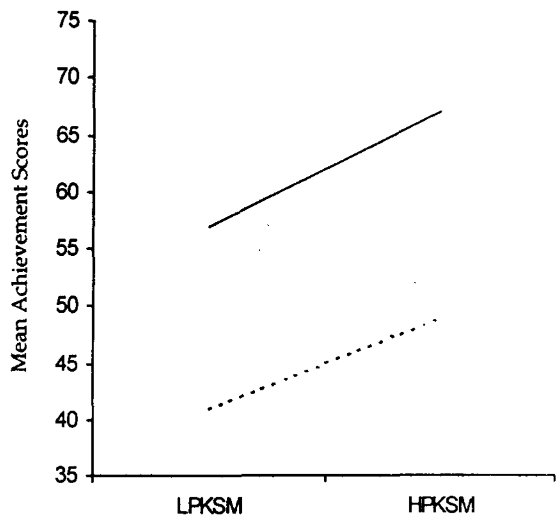
Achievement in Mathematical Skills
Comprehension Category

4 - 8 B



Achievement in Mathematical Skills
Application Category

4 - 8 C



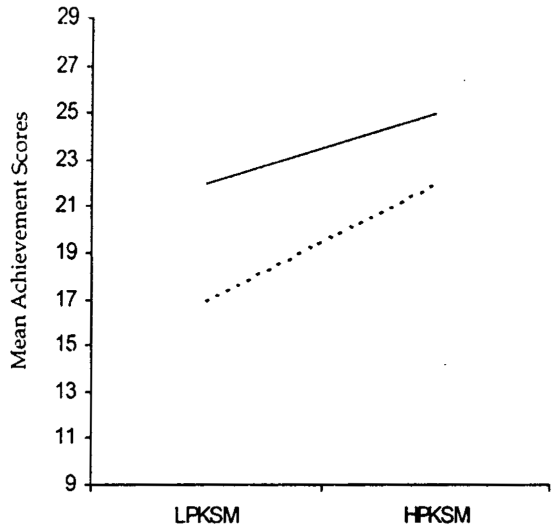
Achievement in Mathematical Skills
Total Score

4 - 8 D

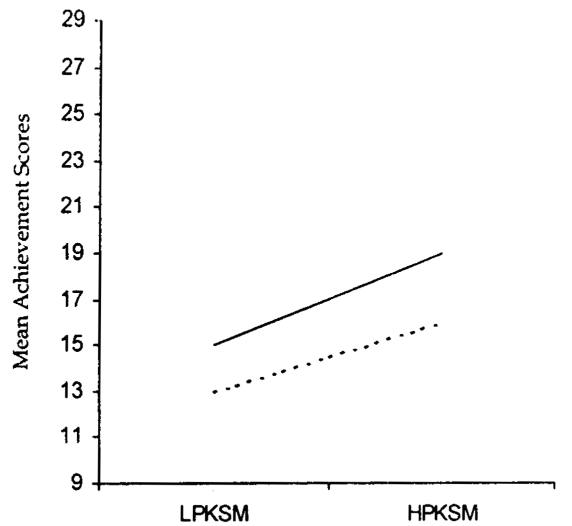
LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

—— Experimental Group
- - - - Control Group

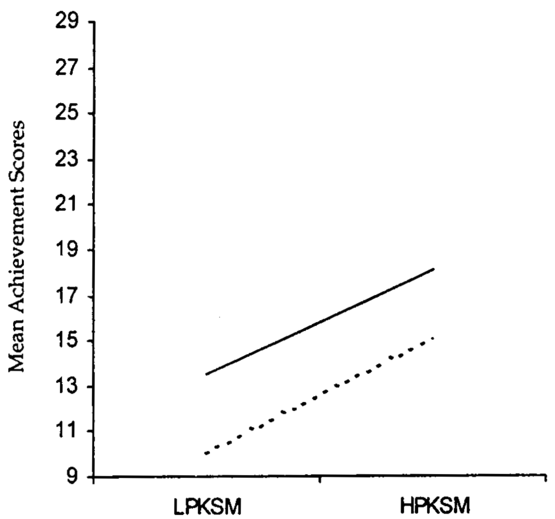
FIGURE 4-8. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test II for Total Sample.



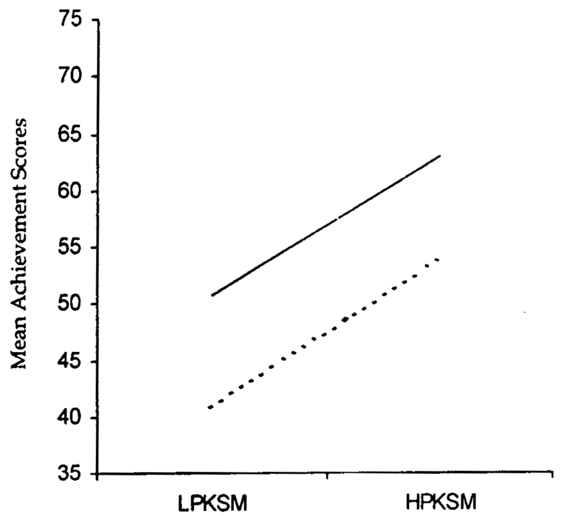
Achievement in Mathematical Skills
Knowledge Category
4 - 9 A



Achievement in Mathematical Skills
Comprehension Category
4 - 9 B



Achievement in Mathematical Skills
Application Category
4 - 9 C

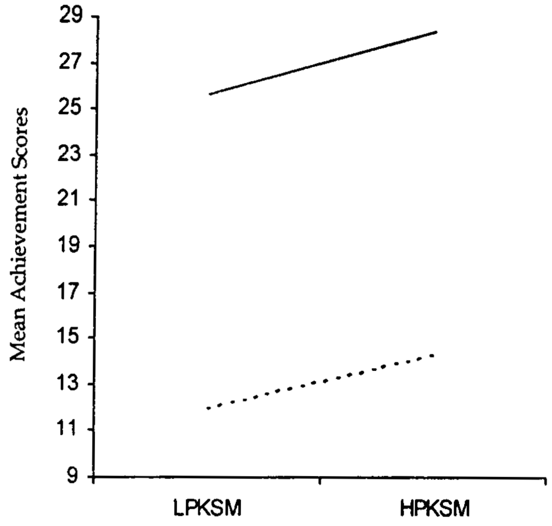


Achievement in Mathematical Skills
Total Score
4 - 9 D

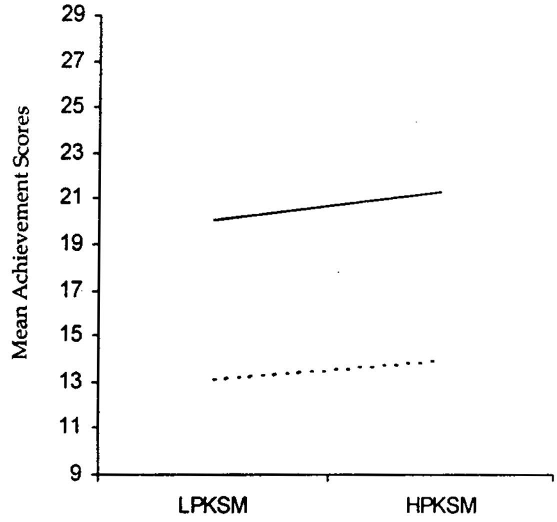
LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

—— Experimental Group
- - - - Control Group

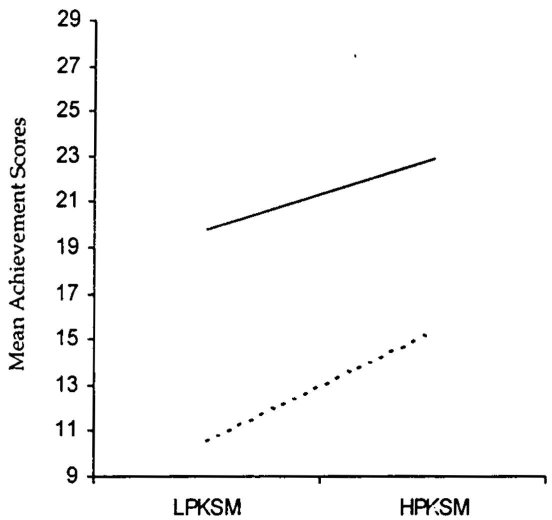
FIGURE 4-9. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test II for Boys.



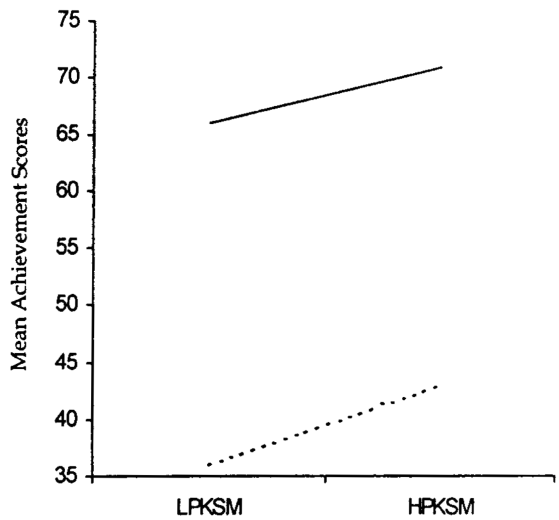
Achievement in Mathematical Skills
Knowledge Category
4 - 10 A



Achievement in Mathematical Skills
Comprehension Category
4 - 10 B



Achievement in Mathematical Skills
Application Category
4 - 10 C



Achievement in Mathematical Skills
Total Score
4 - 10 D

LPKSM - Low Previous Knowledge of Subject Matter
HPKSM - High Previous Knowledge of Subject Matter

—— Experimental Group
- - - - Control Group

FIGURE 4-10. Interaction Effect (Methods of Teaching and Previous Knowledge of Subject Matter) on Achievement in Mathematical Skills Post Test II for Girls.

An examination of the graphs reveals that the lines representing Retention scores of the two groups (group taught through Direct Instruction Model and group taught through Objective Based Instruction) are not parallel in most of the cases, indicating the interaction effect of the two variables. High means are seen associated with group taught through Direct Instruction Model. The interaction can be considered to be synergistic type.

4.2.5. Main Effect and Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score) for Total Sample, Boys and Girls

Twelve ANOVA on Achievement in Mathematical Skills Post Test II by Methods of Teaching by Non Verbal Intelligence were computed for Total Sample, Boys and Girls and also for both Objectivewise score and Total score.

Data and results of Two-way ANOVA for Achievement in Retention scores are summarised and presented in Table 4.22.

TABLE 4.22

Data and Resultsof Two-way ANOVA of Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) by Methods of Teaching by Non Verbal Intelligence for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter
Total (N=90)	Knowledge Category	SS	627.20	5667.22	473.69
		df	1	1	1
		MS	627.20	5667.22	473.69
		F	23.40**	211.42**	17.67**
	Comprehension Category	SS	268.89	1270.80	172.09
		df	1	1	1
		MS	268.89	1270.80	172.09
		F	11.23**	530.22**	7.18*
	Application Category	SS	328.05	1438.67	220.01
		df	1	1	1
		MS	328.05	1438.67	220.01
		F	10.95**	80.98**	7.35**
	Achievement in Mathematical Skills (Total Score)	SS	3208.89	19261.36	2848.09
		df	1	1	1
		MS	3208.89	19261.36	2848.09
		F	38.37**	230.31**	34.06**
Boys (N=44)	Knowledge Category	SS	13.92	2373.28	219.56
		df	1	1	1
		MS	13.92	2373.28	219.56
		F	0.53	89.59**	8.29**
	Comprehension Category	SS	1.38	5940.10	98.28
		df	1	1	1
		MS	1.38	5940.10	98.28
		F	0.06	274.58**	4.54*
	Application Category	SS	0.41	7128.00	137.5
		df	1	1	1
		MS	0.41	7128.00	137.5
		F	0.02	289.63**	5.58*
	Achievement in Mathematical Skills (Total Score)	SS	195.01	7961.01	627.56
		df	1	1	1
		MS	195.01	7961.01	627.56
		F	2.40	97.99**	7.73**
Girls (N=46)	Knowledge Category	SS	984.79	3324.01	2514.79
		df	1	1	1
		MS	984.79	324.01	2514.79
		F	44.22**	149.27**	40.84**
	Comprehension Category	SS	580.01	6766.53	254.45
		df	1	1	1
		MS	580.01	6766.53	254.45
		F	27.31**	318.65**	11.43**
	Application Category	SS	610.53	7255.32	74.68
		df	1	1	1
		MS	610.53	7255.32	74.88
		F	20.66**	245.55**	3.26*
	Achievement in Mathematical Skills (Total Score)	SS	4300.45	8419.84	2514.79
		df	1	1	1
		MS	4300.45	8419.84	2514.79
		F	69.84**	185.46**	40.84**

* indicate significance at 0.05 level.

** indicate significance at 0.01 level.

4.2.5.1. Main Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II

The main effect of Methods of Teaching on Achievement on Mathematical Skills Post- Test II is found to be significant at 0.01 level for appropriate degrees of freedom for Total Sample and Girls. No significant main effect of Methods of Teaching on Retention was noticed for Boys in the sample. The results suggest that Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score) depend on Methods of Teaching is true for the Total Sample and Girls. In the case of Boys Achievement does not change with changes in Methods of Teaching.

4.5.5.2. Main Effect of Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II

As per Table 4.22 the main effect of Non-Verbal Intelligence on Retention of Achievement in Mathematical Skills are found to be significant at 0.01 level for Total Sample, Boys and Girls. The results show that the changes in Non-Verbal Intelligence cause changes in Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls in the sample.

4.2.5.3. Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II

All obtained F-values as per Table 4.22 are found to be significant. Hence it can be concluded that Achievement in Mathematical Skills Post-Test II depends on the combined effect of Methods of Teaching and Non-verbal Intelligence.

4.2.5.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post-Test II between Experimental Group I and Control Group

Mean scores of Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score) between Experimental Group I and Control Group were compared using the test of significance of difference between means, as the F-ratios were found to be significant for Total Sample and Girls.

The relevant details are summarised and presented in Table 4.23.

TABLE 4.23

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test II (Objective wise and Total score) of the Two Groups of Sample Based on Methods of Teaching for Total Sample, Boys and Girls

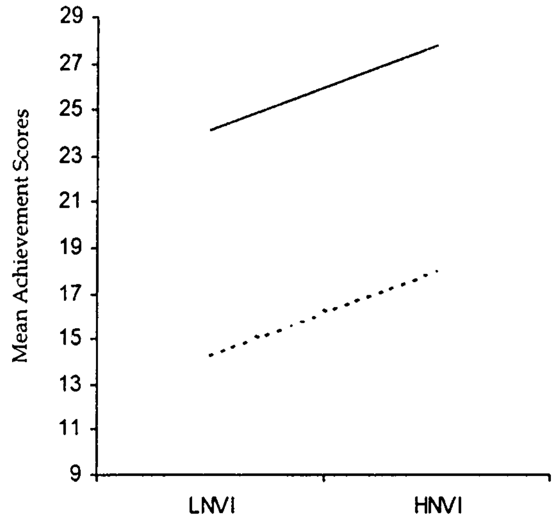
Sample	Dependent Variable	DIM		OBI		t-value	Level of signi-ficance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	25.51	4.67	16.33	5.10	8.81**	0.01
	Comprehension Category	18.64	4.21	14.24	2.80	5.78**	0.01
	Application Category	17.82	5.73	12.93	4.08	4.61**	0.01
	Achievement in Mathematical Skills (Total score)	61.98	13.29	43.51	8.84	7.67**	0.01
Girls N=46	Knowledge Category	27.39	2.50	13.22	4.14	13.74**	0.01
	Comprehension Category	20.74	3.12	13.91	2.52	7.98**	0.01
	Application Category	20.26	5.34	13.22	4.56	4.70**	0.01
	Achievement in Mathematical Skills (Total score)	68.39	8.96	40.35	8.16	10.85**	0.01

The obtained t-values from Table 4.23 show that there exist significant difference in mean Achievement in Mathematical Skills Post-Test II between the groups taught through Direct Instruction Model and Objective Based Instruction. The values range from 4.61 to 13.74 and are significant well beyond 0.01 level. The results suggest that there exist significant difference between the two groups with regard to mean Achievement in Retention test. Since high means are associated with Experimental Group I, taught through Direct Instruction Model, this group can be considered to have advantage over the group, which received Objective Based Instruction.

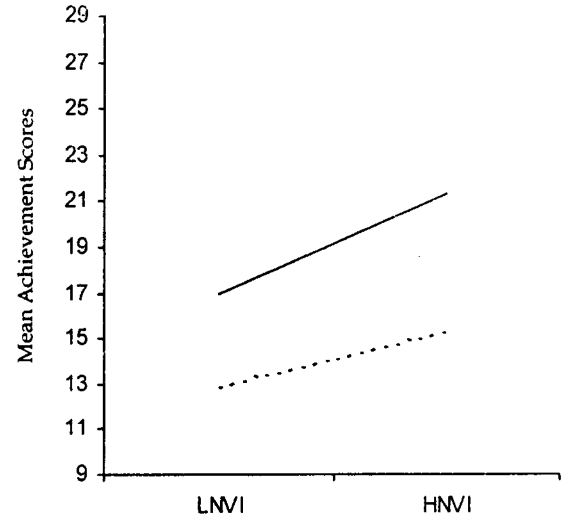
4.2.5.5. Graphical Representation of Interaction Effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls

All the F-values obtained for the interaction effect of Methods of Teaching and Non-Verbal Intelligence was found to be significant. Therefore an attempt was made to study the pattern of relationship of two variables for Experimental Group I and Control Group.

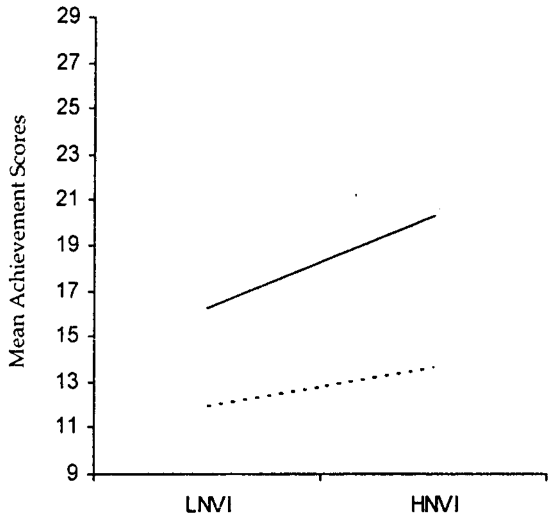
Graph representing the relationship between Methods of Teaching and Non-Verbal Intelligence on Retention score for Total Sample is presented in Figure 4-11 A, B, C and D for Boys in Figure 4-12 A, B, C and D and for Girls in Figure 4-13 A, B, C and D.



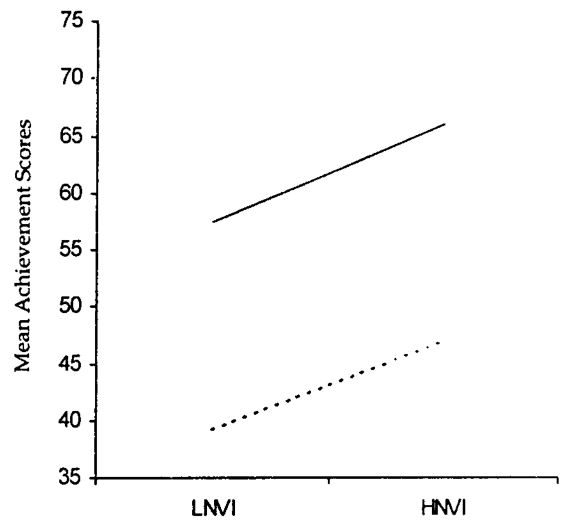
Achievement in Mathematical Skills
Knowledge Category
4 - 11 A



Achievement in Mathematical Skills
Comprehension Category
4 - 11 B



Achievement in Mathematical Skills
Application Category
4 - 11 C

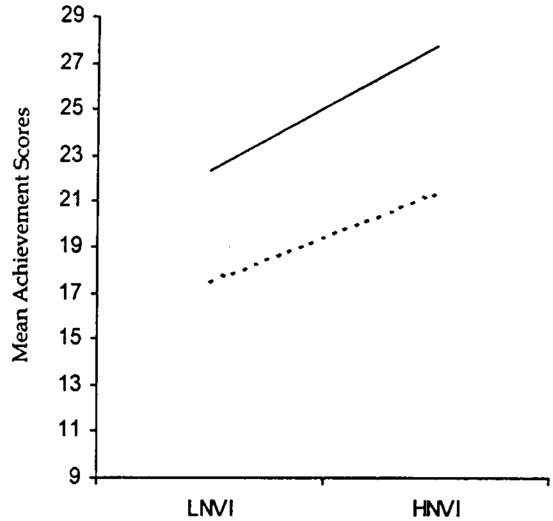


Achievement in Mathematical Skills
Total Score
4 - 11 D

LNVI - Low Non-Verbal Intelligence
HNVI - High Non-Verbal Intelligence

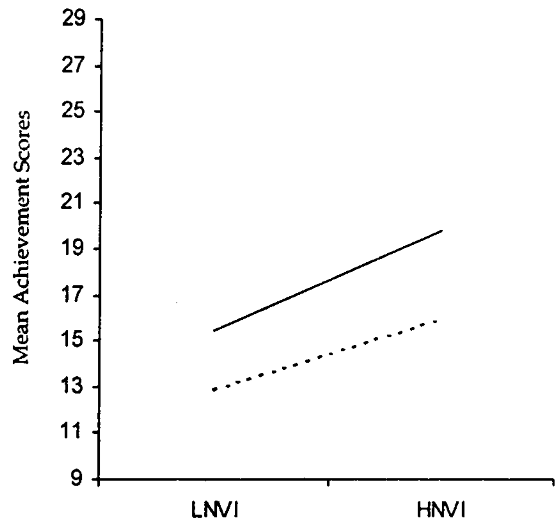
—— Experimental Group
- - - - Control Group

FIGURE 4-11. Interaction Effect (Methods of Teaching and Non-verbal Intelligence) on Achievement in Mathematical Skills Post Test II for Total Sample.



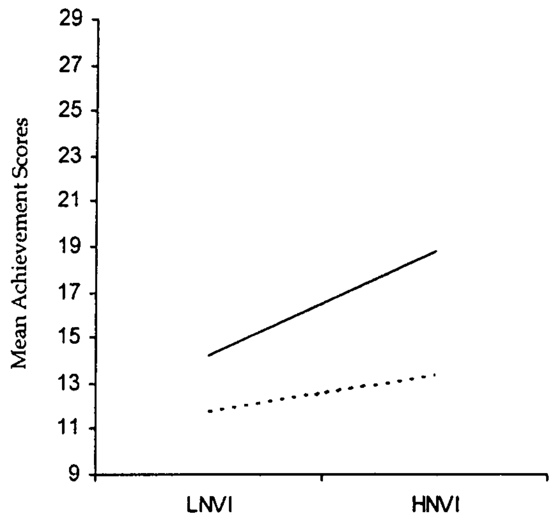
Achievement in Mathematical Skills
Knowledge Category

4 - 12 A



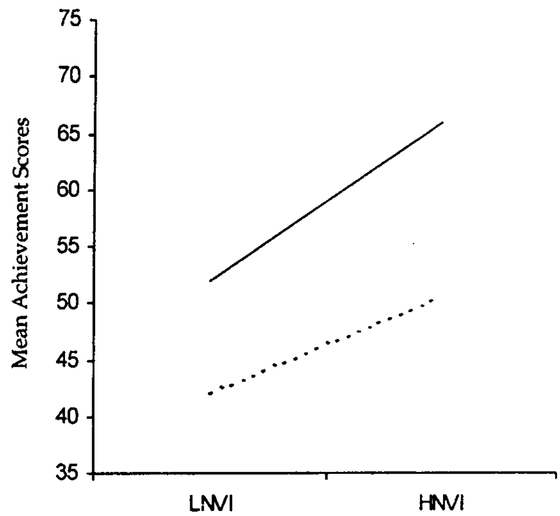
Achievement in Mathematical Skills
Comprehension Category

4 - 12 B



Achievement in Mathematical Skills
Application Category

4 - 12 C



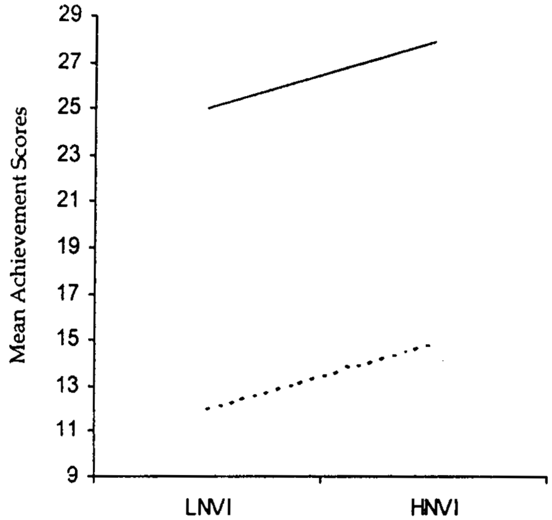
Achievement in Mathematical Skills
Total Score

4 - 12 D

LNVI - Low Non-Verbal Intelligence
HNVI - High Non-Verbal Intelligence

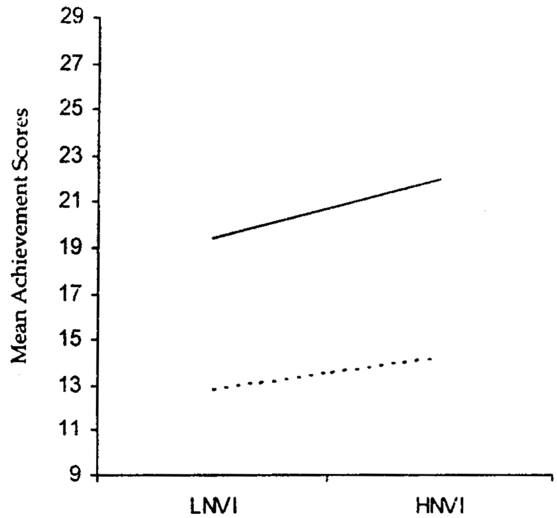
—— Experimental Group
- - - - Control Group

FIGURE 4-12. Interaction Effect (Methods of Teaching and Non-verbal Intelligence) on Achievement in Mathematical Skills Post Test II for Boys.



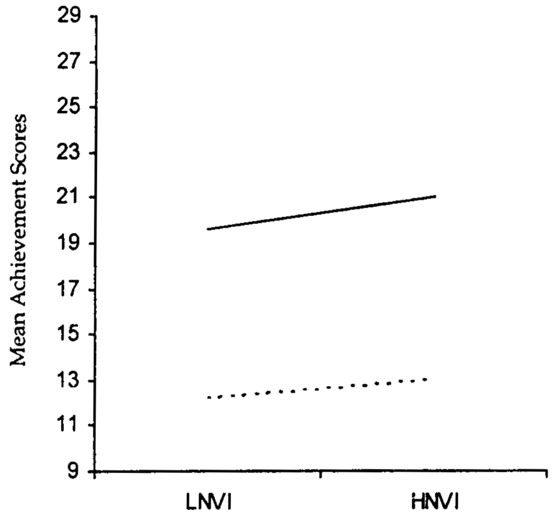
Achievement in Mathematical Skills
Knowledge Category

4 - 13 A



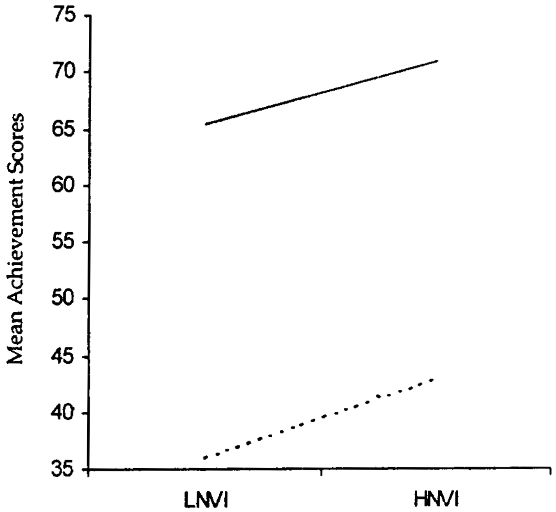
Achievement in Mathematical Skills
Comprehension Category

4 - 13 B



Achievement in Mathematical Skills
Application Category

4 - 13 C



Achievement in Mathematical Skills
Total Score

4 - 13 D

LNVI - Low Non-Verbal Intelligence
HNVI - High Non-Verbal Intelligence

—— Experimental Group
- - - - Control Group

FIGURE 4-13. Interaction Effect (Methods of Teaching and Non-verbal Intelligence) on Achievement in Mathematical Skills Post Test II for Girls.

The graph of interaction revealed that all the lines are not parallel. The line representing Direct Instruction Model always shows superiority over Objective Based Instruction line in all cases. The differences between groups became wider from low intelligence to high intelligence group. Almost all interactions were of synergistic type.

4.2.6. Main Effect and Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post Test II (Objectivewise and Total score) for Total Sample, Boys and Girls

The main effect and interaction effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post-Test II were studied for Total Sample, Boys and Girls. Twelve ANOVA were calculated objectivewise and for Total score.

The summary of Two-way ANOVA is presented in Table 4.24.

TABLE 4.24

Data and Resultsof Two-way ANOVA of Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) by Methods of Teaching by Numerical Ability for Total Sample, Boys and Girls

Sample	Dependent Variable	Source of Variation	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter
Total (N=90)	Knowledge Category	SS	644.01	3406.05	84.05
		df	1	1	1
		MS	644.01	3406.05	84.05
		F	21.93**	115.64**	2.85
	Comprehension Category	SS	503.34	9144.94	38.27
		df	1	1	1
		MS	503.34	9144.94	38.27
		F	17.85**	324.21**	1.36
	Application Category	SS	530.45	10656.81	46.01
		df	1	1	1
		MS	530.45	10656.81	46.01
		F	13.77**	276.61**	1.19
	Achievement in Mathematical Skills (Total Score)	SS	3985.61	12190.05	2198.01
		df	1	1	1
		MS	3985.61	12190.05	2198.01
		F	46.17**	222.39**	25.46**
Boys (N=44)	Knowledge Category	SS	40.91	1966.55	58.91
		df	1	1	1
		MS	40.91	1966.55	58.91
		F	1.22	58.85**	1.76
	Comprehension Category	SS	0.28	4875.28	3.28
		df	1	1	1
		MS	0.28	4875.28	3.28
		F	0.01	154.73**	0.11
	Application Category	SS	0.56	6273.28	0.28
		df	1	1	1
		MS	0.56	6273.28	0.28
		F	0.01	155.84**	0.01
	Achievement in Mathematical Skills (Total Score)	SS	356.01	6860.56	405.92
		df	1	1	1
		MS	356.01	6860.56	405.92
		F	3.96	76.24**	4.51*
Girls (N=46)	Knowledge Category	SS	858.27	1464.01	28.27
		df	1	1	1
		MS	858.27	1464.01	28.27
		F	36.37**	62.04**	1.20
	Comprehension Category	SS	952.35	4286.72	47.35
		df	1	1	1
		MS	952.35	4286.72	47.35
		F	45.90**	206.61**	2.28
	Application Category	SS	1085.39	4480.04	80.39
		df	1	1	1
		MS	1085.39	4480.04	80.39
		F	36.37**	150.14**	2.69
	Achievement in Mathematical Skills (Total Score)	SS	4879.35	12725.26	2104.35
		df	1	1	1
		MS	4879.35	12725.26	2104.35
		F	80.70**	210.45**	34.80**

* indicate significance at 0.05 level.

** indicate significance at 0.01 level.

4.2.6.1. Main Effect of Methods of Teaching on Achievement in Mathematical Skills Post Test II

The main effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II exceeds the critical limit set at 0.01 level ($P < 6.81$ and $P < 6.76$) for appropriate degrees of freedom for Total sample and Girls. That is Retention scores changes with changes in the method of teaching for Girls and Total sample. F-value for the single effect of Achievement in Mathematical Skills by Methods of Teaching is seen not significant for Boys in the sample.

4.2.6.2. Main Effect of Numerical Ability on Achievement in Mathematical Skills Post Test II

The results of ANOVA from Table 4.24 shows that all F-ratio where significant at 0.01 level. The single effect of Numerical Ability on Retention score is found to be significant for all samples. That is changes in Achievement in Mathematical Skills Post-Test II depend on changes on Numerical Ability.

4.2.6.3. Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post Test II

When interaction effect of Methods of Teaching by Numerical Ability was examined it was found that only three out of twelve F-values were significant. Therefore Achievement in Mathematical Skills Post-Test II cannot be considered to be due to the combined effect of Methods of Teaching and Numerical Ability.

4.2.6.4. Comparison of Mean Scores of Achievement in Mathematical Skills Post Test II Between Experimental Group I and Control Group

Mean Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) of the two groups who received two different methods of teaching were compared wherever F-ratios in the ANOVA are found to be significant. For the comparison t-ratios were calculated. The relevant details of the comparison are presented in Table 4.25.

TABLE 4.25

Data and Results of Test of Significant Difference Between Means of Achievement in Mathematical Skills Post Test II (Objective wise and Total score) of the Two Groups of Sample Based on Methods of Teaching for Total Sample, Boys and Girls

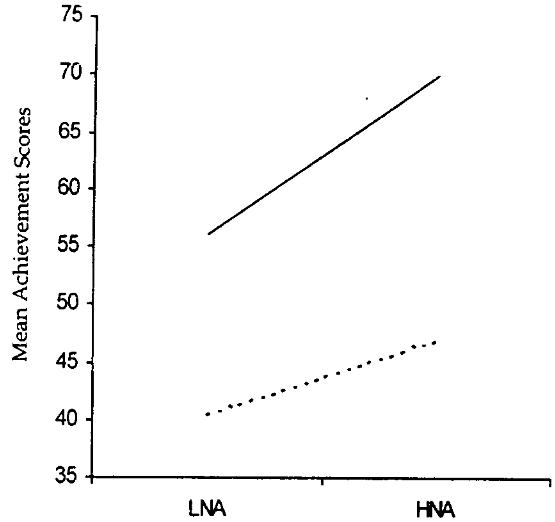
Sample	Dependent Variable	DIM		OBI		t-value	Level of signi-ficance
		Mean	SD	Mean	SD		
Total N=90	Knowledge Category	25.51	4.67	16.33	5.10	8.81**	0.01
	Comprehension Category	18.64	4.21	14.24	2.80	5.78**	0.01
	Application Category	17.82	5.73	12.93	4.08	4.61**	0.01
	Achievement in Mathematical Skills (Total score)	61.98	13.29	43.51	8.84	7.67**	0.01
Girls N=46	Knowledge Category	27.39	2.50	13.22	4.14	13.74**	0.01
	Comprehension Category	20.74	3.12	13.91	2.52	7.98**	0.01
	Application Category	20.26	5.34	13.22	4.56	4.70**	0.01
	Achievement in Mathematical Skills (Total score)	68.39	8.96	40.35	8.16	10.85**	0.01

The results as per Table 4.25 reveals that all the four t-values obtained for the comparison of means of Total sample and all the four t-values for the girls in the sample are significant beyond0.01 level. The t-values were found to range from 4.61 to 10.85.

4.2.6.5. Graphical Representation of the Interaction Effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills Post- Test II

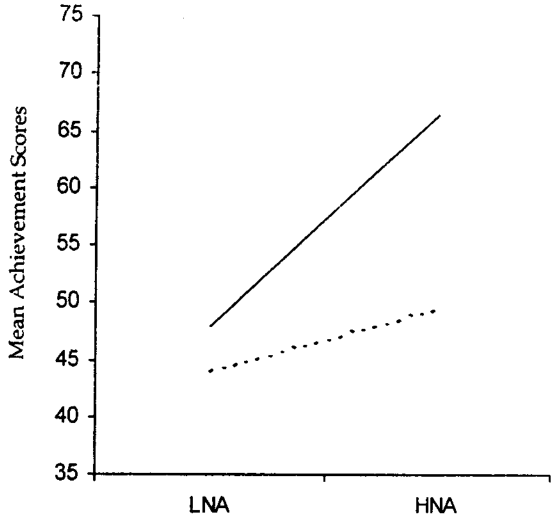
The twelve ANOVA were computed to study the main effect and interaction effect of Methods of Teaching and Numerical Ability on Achievement in Mathematical Skills. Only three out of twelve F-ratios were found to be significant. Significant F ratios were obtained for Total score for Total Sample, Boys and Girls.

Graphical representation of the interaction effect on Total score for Total Sample, Boys and Girls are presented in Figure 4-15 A, B and C respectively.



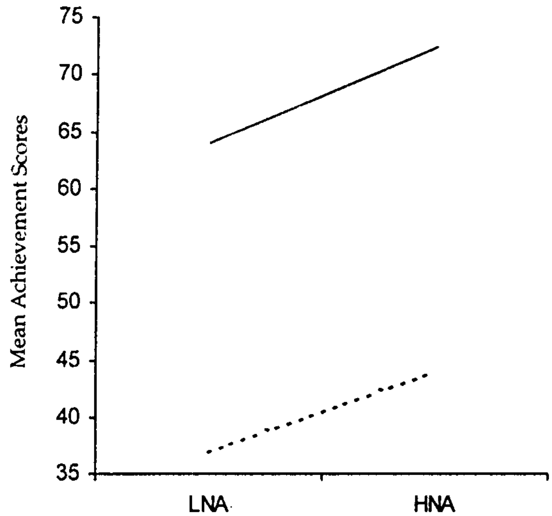
Interaction Effect for
Total Sample

4 - 14 A



Interaction Effect for
Boys

4 - 14 B



Interaction Effect for
Girls

4 - 14 C

LNA - Low Numerical Ability
HNA - High Numerical Ability

—— Experimental Group
- - - - Control Group

FIGURE 4-14. Interaction Effect (Methods of Teaching and Numerical Ability) on Achievement in Mathematical Skills Post Test II for Total Sample, Boys and Girls.

From the graph it is noticed that the line representing mean Achievement in Mathematical Skills Post-Test II of Experimental Group I and Control Group are not parallel and the line representing Direct Instruction Model lies always above the line representing Objective Based Instruction. Synergistic type of interaction is noticed since differences became wider from low numerical ability to high numerical ability.

Summary of Two-way ANOVA on Achievement in Mathematical Skills Post- Test II

To study the main effect and interaction effect of Methods of Teaching, Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability on Achievement in Mathematical Skills Post Test II, thirty six ANOVA were undertaken. The F-values obtained for the ANOVA are presented in Table 4.26.

TABLE 4.26

Summary of F-values of the Main Effect and Interaction Effects of Methods of Teaching in combination with Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability (one by one) on Achievement in Mathematical Skills Post Test II (Objective wise and Total Score) for Total sample, Boys and Girls

Sample	Dependent Variable	Main Effect of Methods of Teaching	Main Effect of Previous Knowledge of Subject Matter	Interaction Effect of Methods of Teaching and Previous Knowledge of Subject Matter	Main Effect of Methods of Teaching	Main Effect of Non-Verbal Intelligence	Interaction Effect of Methods of Teaching and Non-Verbal Intelligence	Main Effect of Methods of Teaching	Main Effect of Numerical Ability	Interaction Effect of Methods of Teaching and Numerical Ability
Total	Knowledge Category	40.26**	43.58**	43.68**	23.40**	211.42**	17.67**	21.93**	115.64**	2.85
	Comprehension Category	40.15**	35.87**	30.64**	11.23**	530.22**	7.18*	17.85**	324.21**	1.36
	Application Category	23.93**	25.81**	19.64**	10.95**	80.98**	7.35**	13.77**	276.61**	1.19
	Total Score	86.33**	65.88**	70.74**	38.37**	230.31**	34.06**	46.17**	222.39**	25.46**
Boys	Knowledge Category	28.29**	21.67**	20.32**	0.53	89.59**	8.29**	1.22	58.85**	1.76
	Comprehension Category	16.61**	6.44*	10.28**	0.06	274.58**	4.54*	0.01	154.73**	0.11
	Application Category	16.14**	13.42**	10.77**	0.02	289.63**	5.58*	0.01	155.84**	0.01
	Total Score	71.19**	42.06**	43.27**	2.40	97.99**	7.73**	3.96	76.24**	4.51*
Girls	Knowledge Category	57.50**	91.37**	77.48**	44.22**	149.27**	40.84*	36.37**	62.04**	1.20
	Comprehension Category	40.15**	42.59**	44.74**	27.31**	318.64**	11.43*	45.90**	206.61**	2.28
	Application Category	55.03**	59.45**	45.21**	20.66**	245.55**	3.26	36.37	150.14**	2.69
	Total Score	145.61**	141.52**	133.34**	69.84**	185.46**	40.84**	80.70**	210.45**	34.80**

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

4.2.7. Discussion of Two-way ANOVA

Fifty four ANOVA were undertaken to examine whether Achievement in Mathematical Skills are depended on changes in Methods of Teaching, Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability. The significance of main effect of each variable and interaction effect of Method of Teaching with each independent variable on Achievement in Mathematical Skills Post Test I and Post Test II are consolidated and presented in Table 4.27 and Table 4.28 respectively.

TABLE 4.27

Summary of the Significance of F-values Obtained for Main Effect and Interaction Effect of Methods of Teaching, Previous Knowledge of Study Materials, Non-Verbal Intelligence and Numerical Ability on Achievement in Mathematical Skills Post Test I for Total Sample, Boys and Girls

Sample	Source of Variation	Dependent Variable			
		KC	CC	AC	Total Score
Total	Methods of teaching	HS	HS	HS	HS
	Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching	HS	HS	HS	HS
	Non Verbal Intelligence	HS	HS	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	S	S	HS
	Methods of teaching	HS	HS	HS	HS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	HS
Boys	Methods of teaching	HS	HS	HS	HS
	Previous Knowledge of Study Materials	HS	NS	NS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	NS	HS
	Methods of Teaching	NS	NS	NS	NS
	Non Verbal Intelligence	HS	HS	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	NS	NS	HS
	Methods of teaching	NS	NS	NS	NS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	S
Girls	Methods of teaching	S	S	HS	HS
	Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching	HS	HS	HS	HS
	Non Verbal Intelligence	HS	S	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	HS	S	HS
	Methods of teaching	HS	HS	HS	HS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	HS

HS denotes significance at 0.01 level; S denotes significance at 0.05 level; NS denotes not significant.

TABLE 4.28

Summary of the Significance of F-values Obtained for Main Effect and Interaction Effect of Methods of Teaching, Previous Knowledge of Study Materials, Non-Verbal Intelligence and Numerical Ability on Achievement in Mathematical Skills Post Test II for Total Sample, Boys and Girls

Sample	Source of Variation	Dependent Variable			
		KC	CC	AC	Total Score
Total	Methods of teaching	HS	HS	HS	HS
	Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching	HS	HS	HS	HS
	Non Verbal Intelligence	HS	HS	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	S	HS	HS
	Methods of teaching	HS	HS	HS	HS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	HS
Boys	Methods of teaching	HS	HS	HS	HS
	Previous Knowledge of Study Materials	HS	S	HS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching	NS	NS	NS	NS
	Non Verbal Intelligence	HS	HS	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	S	S	HS
	Methods of teaching	NS	NS	NS	NS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	S
Girls	Methods of teaching	S	HS	HS	HS
	Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching x Previous Knowledge of Study Materials	HS	HS	HS	HS
	Methods of Teaching	HS	HS	HS	HS
	Non Verbal Intelligence	HS	HS	HS	HS
	Methods of Teaching x Non Verbal Intelligence	HS	HS	S	HS
	Methods of teaching	HS	HS	HS	HS
	Numerical Ability	HS	HS	HS	HS
	Methods of Teaching x Numerical Ability	NS	NS	NS	HS

HS denotes significance at 0.01 level; S denotes significance at 0.05 level; NS denotes not significant.

Summary of test of significance difference between means

Wherever F-values are found to be significant, comparison of the mean scores of Achievement in Mathematical Skills Post Test I (Objectivewise and Total Score) revealed that nine out of twelve t-values were found to be significant. High means are associated with group taught through Direct Instruction Model.

Wherever F-values are found to be significant, comparison of the mean scores of Achievement in Mathematical Skills Post Test II (Objectivewise and Total Score) revealed that ten out of twelve t-values were found to be significant. High means are associated with group taught through Direct Instruction Model.

The scrutiny of the results of ANOVA conducted on Post-Test I and Post-Test II revealed the following:

- Method of Teaching has significant effect on Post-Test I and Post-Test II in fifty eight out of seventy two ANOVA undertaken. Hence Achievement in Mathematical Skills Post Test I and Post Test II can be considered to be depended on the type of Method of Teaching.
- In ten out of twenty four ANOVA, significant main effect of Previous Knowledge of Subject Matter on Achievement in Mathematical Skills in Post-Test I and Post-Test II was found to exist. That is achievement may be attributed to variation in the levels of Previous Knowledge of Subject Matter.
- All the F-values were found to be highly significant for the main effect of Non-Verbal Intelligence on Achievement in Post-Test I and Post Test II. Achievement in Mathematical Skills and its retention is highly influenced by the Non-Verbal Intelligence.

- Highly significant F-ratios were noticed for the main effect of Numerical Ability on Post-Test I and Post-Test II. Hence it may be concluded that the variation in Achievement in Mathematical Skills Post-Test I and Post-Test II is attributed to variation in the levels of Numerical Ability.

- All F-values for the interaction effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I and Post-Test II was found significant. Therefore it may be inferred that Post-Test I and Post-Test II is attributed to the combined effect of Methods of Teaching and Previous Knowledge of Subject Matter.

- In twenty one out of twenty four ANOVA, significant interaction of Methods of Teaching and Non-Verbal Intelligence were found to exist. Therefore it may infer that Achievement in Mathematical Skills Post-Test I and Post-Test II is attributable to the combined effect of Methods of Teaching and Non-Verbal Intelligence.

- Interaction effect of Methods of Teaching and Numerical Ability on Post-Test I and Post-Test II was found only in four out of twelve ANOVA. The combined effect of Methods of Teaching and Numerical Ability is not influencing the Achievement in Mathematical Skills and its Retention.

4.3. ANALYSIS OF COVARIANCE FOR ACHIEVEMENT IN MATHEMATICAL SKILLS POST-TEST I AND POST-TEST II (OBJECTIVEWISE AND TOTAL SCORE) FOR TOTAL SAMPLE

Analysis of covariance was undertaken to study differences, if any exists, in Achievement in Mathematical Skills Post-Test I and Post-Test II when initial differences in select variables such as Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability were controlled. For using Two-way factorial design the two Methods of Teaching selected are Direct Instruction Model and Objective Based Instruction. The independent variables were categorised into two levels as – Previous Knowledge of Subject Matter (Below – Average Previous Knowledge of Subject Matter and Above – Average Previous Knowledge of Subject Matter), Non-Verbal Intelligence (Below – Average Intelligence and Above – Average Intelligence), Numerical Ability (Below – Average Numerical Ability and Above – Average Numerical Ability).

4.3.1. Analysis of Covariance for Achievement in Mathematical Skills Post-Test I (Objectivewise and Total Score) By Previous Knowledge of Subject Matter for Total Sample

To examine whether significant changes exist in the mean scores of Achievement in Mathematical Skills Post-Test I when Previous Knowledge of Subject Matter was taken as covariate, two-way factorial ANCOVA was employed first. The analysis was undertaken for Objectivewise scores and scores for Total Sample only.

Summary of the results of ANCOVA is presented in Table 4.29.

TABLE 4.29

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Post Test I (Objective wise and Total Score) – Pre Test Scores as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Previous Knowledge of Subject Matter	Methods of Teaching x Previous Knowledge of Subject Matter	Residual
Knowledge category	SS Df MS F	553.46 1 553.46 43.59**	511.23 1 511.23 40.26**	544.36 544.36 48.87**	63737.77 87 77.45
Comprehension category	SS Df MS F	348.16 1 348.16 30.64**	407.62 1 407.62 35.87**	255.16 1 255.16 22.45**	988.74 87 11.37
Application category	SS Df MS F	747.25 1 745.25 25.80**	693.04 1 693.04 23.93**	1558.75 1 1558.75 53.83**	2519.40 87 28.96
Achievement in Mathematical Skills Post Test I (Total Score)	SS Df MS F	5102.12 1 5102.12 65.88**	6685.61 1 6685.61 86.33**	1199.95 1 1199.95 15.49**	6737.77 87 77.45

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

As per Table 4.29 the obtained F-value for the effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I for Knowledge category, Comprehension category, Application category and Total score are 43.59, 30.64, 25.50 and 65.88 respectively. All F-values are well beyond the tabled value 6.96 for df 1,87 at 0.01 level of significance. This indicates that single effect on methods of teaching on Achievement in Mathematical skills is significant even when the influence of the covariate Previous Knowledge of Subject Matter is removed by simple linear regression.

The results therefore suggest that the variation in the means of Achievement in Mathematical Skills Post-Test I (Objectivewise and Total Score) cannot be attributed to the influence of the covariate-Previous Knowledge of Subject Matter. Hence it can be concluded that the differences in the mean Achievement in Mathematical Skills Post-Test I may not be due to the effect of Previous Knowledge of Subject Matter but may be due to the treatment variable – Methods of Teaching.

Post-hoc Comparison of Adjusted Mean Between Experimental Group I and Control Group

To findout, of the two groups which received two different treatments, that is, Experimental Group I taught through Direct Instruction Model or Control group taught through Objective Based Instruction which one differ in the adjusted means of Achievement in Mathematical Skills Post-Test I, test of significance of difference between adjusted means was applied.

The data and results of the post-hoc comparison of the adjusted means of Achievement in Mathematical Skills Post Test I is presented in Table 4.30.

TABLE 4.30

Data and Results of Test of Significant difference Between Adjusted Means of Achievement in Mathematical Skills Post-Test I (Objective wise and Total Score) for Total Sample – Previous knowledge of Subject Matter as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	27.16	4.79	45	22.00	3.71	45	5.71**
Comprehension category	21.16	4.53	45	16.88	3.35	45	5.08**
Application category	20.11	6.03	45	15.67	6.05	45	3.49**
Achievement in Mathematical Skills Post Test I (Total Score)	68.60	13.80	45	54.82	10.70	45	5.29**

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

All the four obtained t-values as per Table 4.30 regarding the test of significance difference in the adjusted means of Achievement in Mathematical Skills Post-Test I (Objective wise and Total score) between Experimental group I and Control group (four comparisons) are found to be significant beyond 0.01 level.

It is to be noted that in all the four comparisons, high means are associated with Experimental Group I taught through Direct Instruction Model suggesting the advantage of Direct Instruction Model over Objective Based Instruction.

4.3.2. Analysis of Covariance for Achievement in Mathematical Skills Post Test I (Objective wise and Total Score) By Non-Verbal Intelligence for Total Sample

Relative effectiveness of Direct Instruction Model and Objective Based Instruction was studied using Two-way ANCOVA where Non-Verbal Intelligence was treated as covariate. Samples were categorised into two groups – Experimental group and Control group, based on the treatment (methods of instruction) given to them.

Summary of Two-way ANCOVA is presented in Table 4.31.

TABLE 4.31

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Skills Test I (Objective wise and Total Score) – Non-Verbal Intelligence as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Non-Verbal Intelligence	Methods of Teaching X Non-Verbal Intelligence	Residual
Knowledge category	SS Df MS F	379.04 1 379.04 31.81**	579.21 1 579.21 48.61**	219.01 1 219.01 18.38**	1036.71 87 11.92
Comprehension category	SS Df MS F	256.74 1 256.74 22.78**	415.72 1 415.72 36.88**	152.86 1 152.86 13.56**	980.64 87 11.27
Application category	SS Df MS F	200.54 1 200.54 8.67**	1199.24 1 1199.24 51.82**	243.90 1 243.90 10.54**	2013.21 87 23.14
Achievement in Mathematical Skills Post Test I (Total Score)	SS Df MS F	2414.13 1 2414.13 29.66**	6343.03 1 6343.03 77.94**	1856.98 1 1856.98 22.82**	7080.315 87 81.38

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

The F-values obtained from Table 4.31 are 31.81 (Knowledge category), 22.78 (Comprehension category) 8.67 (Application category) and 29.66 (Total score). The values are found highly significant beyond 0.01 level for appropriate degrees of freedom. The results indicate that significant single effect of Methods of Teaching on Post-Test I exist when the effect of Non-Verbal Intelligence is statistically controlled.

The results therefore suggest that the variation in the means in Post-Test I may be due to the influence of the treatments given to the groups – Experimental Group and Control Group.

Post-hoc comparison of Adjusted Mean Between Experimental Group and Control Group

Test of significance difference between means was applied to examine which of the groups – Experimental or Control group differ in the adjusted means in Post-Test I.

The results of post-hoc test of significance difference between adjusted mean of Achievement in Mathematical Skills Post-Test I is given in Table 4.32.

TABLE 4.32

Data and Results of Test of Significance difference Between Adjusted Means of Achievement in Mathematical Skills Post-Test I (Objective wise and Total Score) for Total Sample – Non Verbal Intelligence as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	27.63	5.16	45	23.47	2.92	45	3.31**
Comprehension category	20.64	3.32	45	16.73	4.13	45	3.47**
Application category	20.41	4.62	45	15.35	5.6	45	3.27**
Achievement in Mathematical Skills Post Test I (Total Score)	69.04	13.42	45	55.52	9.66	45	3.86**

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

As per Table 4.32 the t-values obtained are 3.31 (Knowledge category), 3.47 (Comprehension category), 3.27 (Application category) and 3.86 (Total Score). All values were found to be greater than the t-value required for significance at 0.01 level. Hence the two groups can be considered to be significantly different with respect to their mean achievement after receiving the treatment.

Experimental Group I taught through Direct Instruction Model shows advantage over Control Group taught through Objective Based Instruction as the means of the experimental Group I is found higher than the means of control groups.

4.3.3. Analysis of Covariance for Achievement in Mathematical Skills in Post Test I (Objective wise and Total score) By Numerical Ability for Total Sample

Two-way factorial ANCOVA was utilized to examine the effective of Direct Instruction Model and Objective Based Instruction on Achievement in Mathematical Skills in Post Test I when Numerical Ability of subjects was taken as covariate. The analysis was done for Total Sample for Knowledge, Comprehension, and Application Category and for Total score.

Summary of Two-way ANCOVA used for the study is given in Table 4.33.

TABLT 4.33

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Skills Post Test I (Objective wise and Total Score) Numerical Ability as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Numerical Ability	Methods of Teaching X Numerical Ability	Residual
Knowledge category	SS Df MS F	563.29 1 563.29 31.43**	282.37 1 282.37 18.34**	34.76 1 34.76 2.27	1333.54 87 15.33 1
Comprehension category	SS Df MS F	384.35 1 384.35 28.40**	218.75 1 218.75 16.16**	25.25 1 25.25 1.87	1177.61 87 13.54
Application category	SS Df MS F	415.47 1 415.47 12.27**	266.86 1 266.86 7.88**	28.98 1 28.98 0.86	2945.581 87 33.86
Achievement in Mathematical Skills Post Test I (Total Score)	SS Df MS F	4004.73 1 4004.73 31.43**	2337.24 1 1337.24 18.34**	266.38 1 266.38 2.09	11086.14 87 127.43

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

The F-ratios obtained as per Table 4.33 are 31.43, 28.40, 12.27 and 31.43 for Knowledge, Comprehension and Application category and for Total score respectively. All values are highly significant at 0.01 level (6.96, df, 1,87). The results indicate that the single effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I is significant even when the influence of Numerical Ability of the subjects are statistically controlled though a linear adjustment was made by simple regression. Therefore differences in mean achievement can be attributed to the differences in the method of instruction.

Post-hoc Comparison of Adjusted Mean between Experimental Group I and Control Group

To examine which group causes the variation on Achievement in Mathematical Skills Post-Test I, after the treatment has completed, test of significance of difference between adjusted mean was employed.

The result of t-test is given in Table 4.34.

TABLE 4.34

Data and Results of Test of Significant difference Between Adjusted Means Of Achievement in Mathematical Skills Post-Test I (Objective wise and Total Score) for Total Sample – Numerical Ability as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	27.64	5.15	45	23.48	2.92	45	3.30**
Comprehension category	20.62	4.63	45	16.92	2.56	45	3.25**
Application category	20.00	5.90	45	15.92	4.78	45	2.53**
Achievement in Mathematical Skills Post Test I (Total Score)	68.09	15.22	45	56.91	7.90	45	3.02**

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

The 't-values' obtained as a result of the comparison between Experimental Group I and Control Group are 3.30, 3.25, 2.53, 3.02 for Knowledge category, Comprehension category, Application category and Total score respectively. All the obtained values are found to be significant.

It can also be seen that high adjusted means are associated with the Experimental group taught through Direct Instruction Model which indicate the advantage of this group over Control Group through Objective Based Instruction.

4.3.4. Analysis of Covariance for Retention on Achievement in Mathematical Skills Post-Test II (Objectivewise and Total Score) By Previous Knowledge of Subject Matter for Total Sample

To examine the effectiveness of Methods of Teaching for retention of Achievement in Mathematical Skills Post Test II, two-way factorial ANCOVA was utilised. Summary of the analysis is presented in Table 4.35.

TABLE 4.35

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Skills Post Test II (Objective wise and Total Score) Previous Knowledge of Subject Matter as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Previous Knowledge of Subject Matter	Methods of Teaching X Previous Knowledge of Subject Matter	Residual
Knowledge category	SS Df MS F	1027.15 1 127.15 91.37**	233.99 1 233.99 20.81**	480.80 1 480.80 42.77**	978.02 87 11.24
Comprehension category	SS Df MS F	376.06 1 376.06 42.59**	354.47 1 354.47 40.15**	59.54 1 59.54 6.74*	768.16 87 8.83
Application category	SS Df MS F	911.79 1 911.79 55.03**	843.99 1 843.99 59.45**	0.00 1 0.00 0.00	1334.24 87 15.34
Achievement in Mathematical Skills Post Test I (Total Score)	SS Df MS F	7073.22 1 7073.22 141.52**	7277.77 1 7277.71 145.61**	0.00 1 0.00 0.00	4348.30 87 49.98

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

As per Table 4.35 the obtained F-values for the effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II are 91.37, 42.57, 55.03 and 141.52 for Knowledge category, Comprehension category, Application category and Total score respectively F-values are found to be well beyond the tabled value (6.96, df, 1.87) at 0.01 level of significance.

These results suggest that the single effect of Methods of Teaching and the Retention of Achievement in Mathematical skills is significant even–when the influence of Previous Knowledge of Subject Matter was statistically controlled. Therefore the variation in mean achievement in Post-Test II can be attributed to the variation in Methods of Teaching selected for experimentation. Hence comparison of adjusted means was taken up further.

Post-hoc comparison of Adjusted Means Between Experimental Group I and Control Group

To find out which of the two groups – Experimental Group I and Control Group cause variation in the mean scores, test of significant difference between adjusted means was applied.

The data and results of the comparison of the adjusted means of Achievement in Mathematical Skills Post-test II is presented in Table 4.36.

TABLE 4.36

Data and Results of Test of Significant difference Between Adjusted Means Of Achievement in Mathematical Skills Post-Test II (Objective wise and Total Score) for Total Sample – Previous Knowledge of Subject Matter as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	25.51	4.67	45	18.53	3.88	45	7.70**
Comprehension category	18.64	4.21	45	14.24	2.79	45	5.84**
Application category	17.82	5.73	45	12.91	4.07	45	4.68**
Achievement in Mathematical Skills Post Test I (Total Score)	62.13	13.47	45	45.73	9.10	45	6.77**

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

The results as per Table 4.36 reveal that all the t-values obtained are significant at 0.01 level as the values are found to exceed 2.58. There exists a difference between Experimental Group I and Control Group in the adjusted means of achievement. High means are seen associated with the Experimental Group I taught through Direct Instruction Model showing advantage over Objective Based Instruction.

4.2.5 Analysis of Covariance for Retention on Achievement in Mathematical Skills Post-Test II (Objective wise and Total Score) By Non-Verbal Intelligence for Total Sample

Summary of the data and results of two-way factorial ANCOVA of retention of Achievement in Mathematical Skills – Post-Test II by Method of Teaching by Non-Verbal Intelligence are presented in Table 4.37.

TABLE 4.37

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Skills Post Test II (Objective wise and Total Score) Numerical Intelligence as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Numerical Intelligence	Methods of Teaching X Numerical Intelligence	Residual
Knowledge category	SS	773.72	615.68	321.79	1008.76
	Df	1	1	1	87
	MS	773.72	615.68	321.79	11.59
	F	66.73**	53.10**	27.75**	
Comprehension category	SS	287.53	350.99	148.08	771.63
	Df	1	1	1	87
	MS	287.53	350.99	148.08	8.87
	F	32.42**	39.57**	16.70**	
Application category	SS	343.04	531.56	199.64	1646.67
	Df	1	1	1	87
	MS	343.04	531.56	199.64	18.93
	F	18.12**	28.08**	10.55**	
Achievement in Mathematical Skills Post Test I (Total Score)	SS	4040.28	4612.66	2011.32	7013.34
	Df	1	1	1	87
	MS	4040.28	4612.66	2011.32	80.61
	F	50.12**	57.22**	24.95**	

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

As per Table 4.37 the F-values obtained for the effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II are 66.73, 32.42, 18.12 and 50.12 for Knowledge, Comprehension, Application category and for Total score. F-values are well beyond the tabled value at 0.01 level of significance. This indicates that the single effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II is significant even when the influence of the covariate Non-Verbal Intelligence is removed by single linear regression.

The results suggest that the variation in Retention scores cannot be attributed to the influence of the covariate and it may due to the treatment variable – Methods of Teaching.

Post-hoc Comparison of Adjusted Means Between Experimental Group I and Control Group

To find out which Group – Experimental Group I or Control Group differ in the adjusted means in retention scores, test of significance of difference between adjusted means was applied.

Data and result of the post-hoc comparison of Retention scores is presented in Table 4.38.

TABLE 4.38

Data and Results of Test of Significant difference Between Adjusted Means Of Achievement in Mathematical Skills Post-Test I (Objective wise and Total Score) for Total Sample – Non-verbal Intelligence as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	25.49	4.56	45	16.31	5.23	45	8.88**
Comprehension category	18.62	4.20	45	14.26	2.79	45	5.84**
Application category	17.82	5.07	45	12.91	4.07	45	4.68**
Achievement in Mathematical Skills Post Test I (Total Score)	62.13	13.46	45	44.70	9.10	45	6.77**

** indicates the level of significance at 0.01 level.

* indicates the level of significance at 0.05 level.

As per Table 4.38, all the four t-values obtained regarding the test of significance of difference in adjusted means of Achievement in Mathematical Skills Post Test II (Objectivewise and Total Score) between Experimental Group I and Control Group are found to be significant beyond 0.01 level.

It is to be noted that in all the four comparisons, high means are associated with Experimental Group I taught through Direct Instruction Model suggesting the advantage of Direct Instruction Model over Objective Based Instruction.

4.3.6. Analysis of Covariance for Retention in Achievement in Mathematical Skills Post-Test II (Objective wise and Total Score) By Numerical Ability for Total Sample

Summary of the data and result of two-way factorial ANCOVA of retention in Achievement in Mathematical Skills in Post-Test II by Method of Teaching by Numerical Ability are presented in Table 4.39.

TABLE 4.39

Summary of Two-way Factorial ANCOVA for Achievement in Mathematical Skills Post Test II (Objective wise and Total Score) Numerical Ability as Covariate for Total Sample

Dependent Variables	Source of Variation	Methods of Teaching	Numerical Ability	Methods of Teaching X Numerical Ability	Residual
Knowledge category	SS Df MS F	1051.87 1 1051.87 65.81**	233.99 1 233.99 14.64**	43.64 1 43.64 2.73	1390.46 87 15.98
Comprehension category	SS Df MS F	409.76 1 409.76 39.26**	214.64 1 214.64 20.57**	25.84 1 25.84 2.48	907.98 87 10.44
Application category	SS Df MS F	343.04 1 343.04 22.58**	531.56 1 531.56 8.49**	199.64 1 199.64 1.21	1984.59 87 22.81
Achievement in Mathematical Skills Post Test I (Total Score)	SS Df MS F	5745.55 1 5745.55 52.67**	2135.38 1 2135.38 19.57**	306.05 1 306.05 2.81	9490.62 87 109.09

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

F-values obtained as per Table 4.39 are Knowledge category (65.81), Comprehension category (39.26), Application category (22.58) and Total Score (52.67). The values are found significant beyond 0.01 level for appropriate degrees of freedom. The results indicate that significant single effect of Methods of Teaching on Post-Test II exist even when the effect of Numerical Ability is statistically controlled. The result therefore suggests that the variation in means retention scores may be due to the influence of treatments given to the Experimental Group I and Control Group.

Post-hoc Comparison of Adjusted Means Between Experimental Group I and Control Group

Test of significance of difference was applied to examine which of the two groups differ in the adjusted means of Achievement in Mathematical Skills Post Test II.

The results of post-hoc comparison of adjusted mean in Achievement in Mathematical Skills Post-Test II using t-test is given in Table 4.40.

TABLE 4.40

Data and Results of Test of Significant difference Between Adjusted Means of Achievement in Mathematical Skills Post-Test I (Objective wise and Total Score) for Total Sample – Numerical Ability as Covariate

Dependent Variable	Experimental Group I			Control Group			t-value
	M_1	SD_1	N_1	M_2	SD_2	N_2	
Knowledge category	24.47	4.66	45	16.59	4.83	45	7.88**
Comprehension category	18.59	4.21	45	14.18	2.79	45	5.84**
Application category	17.79	5.73	45	12.91	4.07	45	4.68**
Achievement in Mathematical Skills Post Test I (Total Score)	62.13	13.46	45	45.73	9.10	45	6.76**

** indicates the level of significance at 0.01 level.
* indicates the level of significance at 0.05 level.

Table 4.40 shows that the obtained t-values for the comparison of Experimental Group I and Control Group for mean achievement in Knowledge category, Comprehension category, Application category and Total score are 7.88, 5.84, 4.68 and 6.76 respectively. All values exceed the t-value required for significance at 0.01 level.

It can be noticed that high adjusted means are associated with Experimental Group I which received Direct Instruction teaching. This result suggests the advantage of Direct Instruction Model over Objective Based Instruction.

4.3.7 Summary and Discussion of Two-way Factorial ANCOVA

To examine the effect of Direct Instruction Model on Achievement in Mathematical Skills Post-Test I and its Retention score, if any exist, when initial differences in select variables were controlled, fourty eight ANCOVA were undertaken. The study was undertaken for Total Sample only. The variables controlled were Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability of subjects one by one.

The result of F-values obtained in ANCOVA for Post-Test I and Post-Test II were summarised and presented in Table 4.41.

TABLE 4.41

Summary of 2x2 Factorial ANCOVA for Post-Test I and Post-Test II for Total Sample

Dependent variable		F-values for Methods of Teaching		
		COVARIATES		
		Previous Knowledge of Subject Matter	Non-Verbal Intelligence	Numerical Ability
Achievement in Mathematical Skills Post Test I	Knowledge Category	43.59**	31.81**	31.43**
	Comprehension Category	30.64**	22.78**	28.40**
	Application Category	25.80**	8.67**	12.27**
	Achievement Skills (Total Score)	65.88**	29.66**	31.43**
Achievement in Mathematical Skills Post Test II	Knowledge Category	91.37**	66.73**	65.81**
	Comprehension Category	42.59**	32.42**	39.26**
	Application Category	55.03**	18.12**	22.58**
	Achievement Skills (Total Score)	141.52**	50.12**	52.67**

* indicates the level of significance at 0.05 level.
** indicates the level of significance at 0.01 level.

An examination of the results of Table 4.41 shows that all F-values obtained in the ANCOVA are found to be significant. This indicates that the single effect of Methods of Teaching on Achievement in Mathematical Skill Post-Test I and Post-Test II is significant even when the influence of the covariates such as Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability are removed one by one by simple linear regression.

The results therefore suggest that the variation in the mean Achievement in Mathematical Skills Post-Test I and Post-Test II (Objective wise and Total score) cannot be attributed to the influence of the covariates. Hence it can be concluded that the differences in the mean achievement may be due to the effect of Methods of Teaching given to different groups.

Since all obtained F-values in twentyfour ANCOVA were found to be significant post-hoc comparison of adjusted means were attempted for this purpose. Test of significance of difference between means of Achievement Test in Mathematical Skills Post-Test I and Post-Test II were carriedout. The summary and results of Post-hoc comparison of Experimental Group I and Control Group with regard to mean achievement are given in Table 4.42.

TABLE 4.42

Summary of Post-hoc Comparison of Test of Significance of Difference Between Adjusted Means of Achievement in Mathematical Skills Post-Test I and Post-Test II

Dependent variable		t-values for Methods of Teaching		
		COVARIATES		
		Previous Knowledge of Subject Matter	Non-Verbal Intelligence	Numerical Ability
Achievement in Mathematical Skills Post Test I	Knowledge Category	5.71**	3.31**	3.30**
	Comprehension Category	5.08**	3.47**	3.25**
	Application Category	3.49**	3.27**	2.53**
	Achievement Skills (Total Score))	5.29**	3.86**	3.02**
Achievement in Mathematical Skills Post Test II	Knowledge Category	7.70**	8.88**	7.88**
	Comprehension Category	5.84**	5.84**	5.84**
	Application Category	4.68**	4.68**	4.68**
	Achievement Skills (Total Score)	6.77**	6.77**	6.76**

* indicates the level of significance at 0.05 level.

** indicates the level of significance at 0.01 level.

The t-value obtained from Table 4.42 is found to be significant in all the twenty four cases. It was also noticed that in all twenty four cases high means are associated with Experimental Group I (group which is taught through Direct Instruction Model), which suggests the advantage of Direct Instruction Model ~~are~~ Objective Based Instruction in teaching the topics selected for study.

4.5.4. Conclusion and Interpretation

Summary of the results of the mean difference analysis of Achievement in Mathematical Skills Post-Test I (test conducted immediately after introducing the treatment variable Direct Instruction Model to Experimental Group I, Direct Instruction Model and Objective Based Instruction to Experimental Group II and Objective based Instruction to Control Group) revealed that between Experimental Group I and Control Group nine out of twelve t-values were significant and between Experimental Group II and Control Group revealed that seven out of twelve t-values were significant similarly in Post-Test II (test conducted two months after treatment) the results revealed that between Experimental Group I and Control Group ten out of twelve t-values were significant and between Experimental Group II and Control Group eight out of twelve t-values were found significant. When mean Gain Scores (Post-Test I minus Pre-Test) and (Post-Test II minus Pre-Test) of Experimental Group I and Control Group and between Experimental Group II and Control Group were compared, results revealed all the t-values were significant.

In all the cases high means are associated with experimental groups taught through Direct Instruction Model. The results suggest that pupils taught through Direct Instruction Model have higher mean Achievement in Mathematical Skills in Total as well as component scores, than Control Group taught through objective Based Instruction especially for Girls in the sample and Total sample. It is to be noticed that significant differences were noticed in the case of Boys for higher objectives.

The above findings are in consistency with many studies conducted in developed countries (Becker and Gersten, 1982; Peterson and others, 1989; Ross and Nradem, 1991; Din, 1998).

When the main effect and interaction effect of Methods of Teaching and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I and Post-Test II was examined (twenty four ANOVA were undertaken for this purpose). The main effect of Methods of Teaching was found to be significant since all F-values are significant. The results suggest that variation in Achievement in Mathematical Skills (Objective wise and Total Score) can be attributed to the variation in Methods of Teaching. Whenever significant F-ratios were obtained, test of significance difference in mean Achievement in Mathematical Skills between Experimental Group I and Control Group were employed. Results showed that all the obtained t-values were significant and high achievement means are associated with the group taught through Direct Instruction Model.

When interaction effect of Methods of Teaching and Previous Knowledge of Subject Matter was studied, the results revealed that variation in Achievement in Mathematical Skills depend on the combined effect of the two variables, since all the twenty four F-ratios were significant. The nature of interaction was studied graphically. The graphs show that higher the scores in Previous knowledge of Subject Matter, higher the obtained mean scores in Achievement in Mathematical Skills (Synergestic interaction). The same result was obtained for Retention (Post-Test II) scores also. The results therefore suggest that the Methods of Teaching has differential effect on Achievement in Mathematical Skills for subjects with different scores in Previous Knowledge of Subject Matter. It is to be noted that the main objective of introductory phase of Direct Instruction Model is 'Orientation.' In this phase the teacher has to ascertain that the students have the pre requisite knowledge and/or skills for receiving the current lesson. In the Slavin's Model of Direct Instruction this is considered to be one of the most important components of the overview or Orientation phase of the lesson before presenting the day's lesson. It is the duty of the teacher to bring to the forefront of cognitive structure, those information and skills which are directly linked to the day's lesson.

Similarly Non-Verbal Intelligence and Numerical Ability when combined with Methods of Teaching were examined for its effect on Achievement in Mathematical Skills in Post-Test I and Post-Test II. Results revealed that main effect of Methods of Teaching were found to be significant for eight out of twelve ANOVA in Post-Test I an d eight out of twelve ANOVA in Post-Test II. Mean difference in Mathematical Skills was found to be in favour of Experimental Group I taught through Direct Instruction Model. Engelmann (1996) summarising the research on Direct Instruction from studies conducted over twenty five years observed that students' reading and mathematical scores improve considerably when taught through Direct Instruction Model with students grouped on the basis of IQ scores. All groups were made substantial achievement above expectations.

In Engelmann's (1996) opinion the in-depth analysis of the results show that unlike the common comment that Direct Instruction is only for special education students, all students made progress. The graphical representation for the interaction effect of Non-Verbal Intelligence and Methods of Teaching and Numerical Ability and Methods of Teaching and Numerical Ability and Methods of Teaching on Achievement in Mathematical Skills in the experimental study reveals a synergestic interaction. High mean achievement in all the cases were in favour of

Experimental Group I, taught through Direct Instruction Model and students with high score on Non-Verbal Intelligence and Numerical Ability but significant gains were also noticed for low intelligence and low numerical ability group.

When the effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I and Post-Test II with the effect of Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability were statistically controlled one by one, the results revealed that all F-values for Methods of Teaching were found to be significant. Comparison of adjusted means of Achievement in Mathematical Skills was found to be significantly higher for Experimental Group I taught through Direct Instruction Model and Experimental Group II taught through Direct Instruction Model and Objective Based Instruction alternately.

The findings of the present study revealed that Direct Instruction Model is effective in the teaching of decimals and fractions for Achievement in Mathematical skills of upper primary pupils. It is also to be specifically noted that Direct Instruction makes only limited organisational demands on the schools co-operated with the study. The time on task was approximately six class periods more than what is required for conventional method of teaching. The additional time taken ensure for better mastery of the basic essential concepts. It is hoped that the additional time taken at this juncture can be compensated in the later classes for learning more complex concepts.

EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

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CHAPTER 5

SUMMARY FINDINGS AND SUGGESTIONS

- *Study in Retrospect*
- *Major Findings*
- *Tenability of Hypothesis*
- *Suggestions for Improving*
- *Educational Practice*
- *Suggestions for Further Research*

SUMMARY, FINDINGS AND SUGGESTIONS

This chapter deals with the study in retrospect, major findings, tenability of hypotheses, suggestions for improving educational practice and suggestion for further research.

5.1. STUDY IN RETROSPECT

The different aspects in the various stages of the present study are presented in the following subsections.

5.1.1 Restatement of the problem

The present study was an attempt to examine whether Achievement in Mathematical Skills vary when Direct Instruction Model of teaching adopted in a regular classroom without disturbing much the organisational set up of the school. Hence the present study was executed in the context of a conventional classroom where select topics in Mathematics were taught through Direct Instruction Model and compared with a class taught through Objective Based Instruction used by teachers in conventional classes.

The problem under investigation was hence titled as "EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA".

5.1.2 Variables of the Study

The design of the present experimental study was Pre-Test-Post-Test Equivalent Group Design. The variables selected for the investigation of the problem under Experimental design are the following

5.1.2.1 Independent variables

Two sets of variables based on methods of instruction were selected as independent variables

5.1.2.1.1 Direct Instruction Model

Direct Instruction Model of Teaching by Engelmann (2001) was selected for treatment.

5.1.2.1.2 Objective Based Instruction

Objective Based Instruction which is popularly adopted in the upper primary schools of Kerala till recently was considered as the conventional method of teaching.

5.1.2.2. Dependent Variable

Achievement in Mathematical Skills and its retention were considered as the dependent variable.

5.1.2.3 Control Variables

The control variables in the experimentation were the following

- Previous Knowledge of Subject Matter
- Non-Verbal Intelligence
- Numerical Ability

5.1.3. Objectives of the study

The present study was designed with the following objectives.

5.1.3.1. To Compare the mean scores of Achievement in Mathematical Skills Post test I (tested immediately after the treatment) of

Control Group and Experimental Group I and between Control Group and Experimental Group II.

5.1.3.2. To Compare the mean Gain scores of Achievement in Mathematical Skills (Post-Test I minus Pre Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II

5.1.3.3. To Compare the mean Retention scores of Achievement in Mathematical Skills Post-Test II (tested two months after experimentation) of Control Group and Experimental Group I and between Control Group and Experimental Group II

5.1.3.4. To compare the mean Gain scores of Achievement in Mathematical skills (Post Test II minus Pre Test) of Control Group and Experimental Group I and between Control Group and Experimental Group II

5.1.3.5. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

5.1.3.6. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls.

5.1.3.7. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based

Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-test I for Total Sample, Boys and Girls.

5.1.3.8. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

5.1.3.9. To study the main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

5.1.3.10. To study the main effect and interaction effect of Methods of teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls.

5.1.3.11. To study the relative effectiveness of Direct Instruction Model on Achievement in Mathematical Skills when initial difference in select variables namely 'Previous Knowledge' of Subject Matter, Non-verbal, 'Intelligence' and Numerical Ability' of the subjects are controlled one by one.

5.1.4 Procedure

Summary of the procedure adopted for executing the study is given below.

5.1.4.1 Design of the study

Pre-Test-Post-Test Equivalent Group Design was used for the experimentation. The graphical representation of the study is given as follows

G_1	O_1	x	O_2		
G_2	O_3	x	C	O_4	
G_3	O_5	C	O_6		
O_1	O_2	O_5		-	Pre-Test
O_2	O_4	O_6		-	Post-Test
O_2 - O1				-	Gain scores
$O_4 - O_3$				-	Gain scores
$O_0 - O_5$				-	Gain scores
X		-	Application of Experimental Treatment		
C		-	Application of control Treatment		
G_1		-	Experimental Group I		
G_2		-	Experimental Group II		
G_3		-	Control Group		

5.1.4.2 Sample for the study

Samples comprised of intact groups of standard VII pupils of upper primary classes. Two classes each from three different schools were selected as Experimental Group I, Experimental Group II and Control Group. The Experimentation was conducted on a sample of 180 pupils, each group comprised of 60 students: thirty students in each class.

5.1.4.3 Selection of Topics for Treatment

The topics which were amenable for the treatment using Direct Instruction Model and Objective Based Instruction were selected. From the analysis of the syllabus of mathematics at upper primary classes the investigator selected 'fractions' and 'decimals' for the treatment.

5.1.4.4. Instructional Materials and Tools for the study

Instructional materials and tools used for the present investigations were as follows.

- **Lessons Plans Based on Direct Instruction Model**

Twenty four lesson plans were prepared for Direct Instruction Model based on 'fractions' and 'decimals'. For this purpose lesson plans based on Engelmann's Direct Insertion Model were adopted and used for experimental treatment. The different phases of the syntax of the lesson are Attention and Focus, Orientations, Model, Lead, Test, Delayed Test andWweekly review.

- **Lesson Plans Based on Objective Based Instructions**

Separate lesson plans were prepared for the same topics - fractions and decimals, based on Objective Based Instruction , adapted by National Council of Educational Research and Training. These lesson plans were used for teaching the Control Group.

- **Unit Tests**

Nine unit tests were prepared by the investigator for experimental groups. These were administered at appropriate intervals during the Direct Instruction treatment.

- **Achievement Test in Mathematical Skills**

A test consisting of hundred multiple choice items - fifty from fractions and fifty from decimals was used as Pre-Test. A parallel test of this was used as Post-Test I and Post-Test II. The test was developed by Pillai and Jayasree (2001).

Other tools used for the study were

- Standard Progressive Matrices Test (Raven, 1958)
- Numerical Ability Test

Numerical Ability Test was developed by Pillai and Jayasree (2001) which consists of ten sections each contain five items.

5.1.4.5 Procedure Adopted for Data Collection

The procedure adopted for collecting necessary data were as follows

i) Administration of Pre-Test

Before the treatment was given Pre-Test was administered to Experimental Group I, Experimental Group II and Control Group.

ii) Administration of other Tools

Intelligence and Numerical Ability of the subjects were collected before the treatment using the appropriate tools mentioned under 5.1.4.4.

iii) Treatments

After selection of the topics for treatment instructional materials and tools were prepared. Experimental Group I, was taught through Direct Instructions Model and Experimental Group II was treated through Objective Based Instruction and Direct Instruction Model alternately. Control Group was taught through Objective Based Instruction only. Formative tests were given to the experimental groups at the appropriate time fixed earlier.

iv) Administration of Post-Test I

Post-Test I was given to three groups immediately after the treatment.

v) Administration of Post-Test II

Post- Test II was administered to Experimental Group I, Experimental Group II and Control Group two months after the treatment.

5.1.4.6 Analysis of Data

The Statistical processing of the data was done using computer facilities as Statistical Package for Social Science. The techniques used for analysing the data are the following.

- Test of Significance of difference between means
- Two-way ANOVA with 2x2 factorial design
- Two-way ANCOVA with 2x2 factorial design.

For the analysis each group was divided into two levels.

5.2 MAJOR FINDINGS OF THE STUDY

The major findings of the investigation are presented in the following sections.

5.2.1 RESULTS OF MEAN DIFFERENCE ANALYSIS OF ACHIEVEMENT IN MATHEMATICAL SKILLS AFTER TREATMENT

Result of mean difference analysis of Achievement in Mathematical Skills in Post-Test I and Post-Test II between Experimental Group I and Control Group and between Experimental Group II and Control Group are given below:

5.2.1.1 Difference in the Mean Scores of Achievement in Mathematical Skills Post-Test I of Experimental Group I and Control Group

Significant difference in the mean Achievement in Mathematical Skill Post-Test 1 scores (Objectivewise and Total score) between Experimental Group I and Control Group was found for the Total Sample and for Girls at 0.01 level. In the case of Boys no significant difference was found in the mean Post-Test I scores except for Knowledge category at 0.01 level.

The obtained t-values are given below:

Dependent Variable	t-values		
	Total Sample	Boys	Girls
Knowledge category	6.24	2.58	6.97
Comprehension category	5.01	0.41	8.56
Application category	3.09	0.16	5.86
Achievement in Mathematical Skills (Total Score)	5.27	0.94	9.09

5.2.1.2 Difference in the Mean Scores of Achievement in Mathematical Skills Post-Test I of Experimental Group II and Control Group

Significant difference in the mean Achievement in Mathematical Skills Post-Test I scores (Objectivewise and Total score) between Experimental Group II and Control Group was found for Total sample and Girls at 0.01 level except for Application category. In the case of Boys Knowledge category was found to be significant at 0.01 level and all others were not significant.

The t-values obtained are presented as follows:

Dependent Variable	t-values		
	Total Sample	Boys	Girls
Knowledge category	5.34	3.11	4.29
Comprehension category	3.26	0.40	4.12
Application category	0.77	0.58	1.70
Achievement in Mathematical Skills (Total Score)	3.37	0.87	3.87

5.2.1.3 Difference in the Mean Gain Scores of Achievement in Mathematical Skills (Post-Test I minus Pre-Test) of Experimental Group I and Control Group

Significant difference was found in mean Gain scores (Total score of Achievement in Mathematical Skills) between Experimental Group I and Control Group at 0.01 level for Total Sample (CR= 6.77) and Girls (CR=8.60) and at 0.05 level for Boys (CR= 2.35).

5.2.1.4 Difference in the Mean Gain Scores of Achievement in Mathematical Skills (Post-TestI minus Pre-Test) of Experimental Group II and Control Group

Significant difference was found in the mean Gain scores (Total score) between Experimental Group II and Control Group for Total Sample (CR= 5.02), Boys (CR=2.07) and Girls (CR=5.55).

5.2.1.5 Difference in the Mean Scores of Achievement in Mathematical Skills Post-Test II of Experimental Group I and Control Group

The t-values obtained for the comparison of Experimental Group I and Control Group for mean Post-Test II score (Objective wise and Total score) for Total sample and Girls were found to be significant beyond 0.01 level.

For the subsample Boys, the mean scores were found to be significant for Knowledge category and Total Score in Achievement in Mathematical Skills. The t-values obtained are as follows.

Dependent Variable	t-values		
	Total Sample	Boys	Girls
Knowledge category	8.81	2.67	13.74
Comprehension category	5.78	1.66	7.98
Application category	4.61	1.95	4.70
Achievement in Mathematical Skills (Total Score)	7.67	2.38	10.85

5.2.1.6 Difference in Mean Scores of Achievement in Mathematical Skills Post-Test II of Experimental Group II and Control Group

Significant difference in the mean Post-Test II scores (Objective wise and Total score) between Experimental Group II and Control Group were found for Total Sample and Girls at 0.01 level except for Application category. Significant difference were found in Comprehension category and Total score for Boys. The critical values are presented as follows:

Dependent Variable	t-values		
	Total Sample	Boys	Girls
Knowledge category	6.02	1.68	7.37
Comprehension category	4.51	2.68	3.58
Application category	1.72	0.88	1.47
Achievement in Mathematical Skills (Total Score)	4.85	2.02	4.72

5.2.1.7 Difference in the Mean Gain Scores of Achievement in Mathematical Skills (Post-Test II minus Pre-Test) of Experimental Group I and Control Group

Significant difference was found in mean Gain scores (Total score on Achievement in Mathematical Skills) between Experimental Group I and Control Group at 0.01 level for Total Sample (CR = 10.70), Boys (CR=4.95) and Girls (CR=11.99).

5.2.1.8 Difference in the Mean Gain Scores on Achievement in Mathematical Skills (Post-Test II minus Pre-Test) of Experimental Group II and Control Group

The mean Gain scores (Total Achievement) was found to be significantly different at 0.01 level between Experimental Group II and Control Group for Total Sample (CR=6.96), Boys (CR=3.52), and Girls (CR=6.36).

5.2.2 RESULTS OF MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND INDEPENDENT VARIABLES ON ACHIEVEMENT IN MATHEMATICAL SKILLS

Thirty six ANOVA were undertaken to study the main effect and interaction effect of Methods of Teaching and Previous-Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability (one by one) on Achievement in Mathematical Skills Post-Test I. Similarly thirty six ANOVA were carried out on Achievement in Mathematical Skills Post-Test II. The results obtained are as follows.

5.2.2.1 Main Effect and Interaction Effect of Methods of Teaching by Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I

The main effect and interaction effect of Methods of Teaching by Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I (Objective wise and Total score) for Total sample, Boys and Girls were studied using twelve ANOVA. The results are summarised and given below.

Sample	Dependent variable	Methods of Teaching	Previous Knowledge of Subject Matter	Methods of Teaching x Previous Knowledge of Subject Matter
Total	Knowledge Category	40.26	43.58	43.68
	Comprehension Category	35.86	30.63	35.93
	Application Category	23.93	25.80	19.64
	Achievement Skills Post-Test I (Total Score)	86.32	65.88	37.78
Boys	Knowledge Category	41.32	20.94	25.67
	Comprehension Category	21.79	1.34	11.03
	Application Category	6.28	0.84	3.14
	Achievement Skills Post-Test I (Total Score)	41.22	10.68	21.35
Girls	Knowledge Category	6.45	32.17	25.66
	Comprehension Category	6.99	65.21	47.02
	Application Category	16.11	51.45	29.52
	Achievement Skills Post-Test I (Total Score)	39.73	104.25	82.15

All F-ratios obtained for main effect of Methods of Teaching, ten out of twelve F-ratios for the main effect of Previous Knowledge of Subject Matter and the interaction effect of Method of Teaching and Previous Knowledge of Subject Matter were found to be significant for Achievement in Mathematical Skills Post-Test I.

5.2.2.2 Main effect and Interaction effect of Methods of Teaching by Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I

Twelve ANOVA were computed to study the main effect and interaction effect of Methods of Teaching by Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample, Boys and Girls. All the F-values are summarised and presented below.

Sample	Dependent variable	Methods of Teaching	Non-Verbal Intelligence	Methods of Teaching x Non-Verbal Intelligence
Total	Knowledge Category	13.40	126.32	9.16
	Comprehension Category	9.97	356.82	6.92
	Application Category	7.64	96.15	4.91
	Achievement Skills Post-Test I (Total Score)	38.37	230.31	34.06
Boys	Knowledge Category	0.77	58.37	6.41
	Comprehension Category	0.84	176.70	1.98
	Application Category	1.01	158.21	0.94
	Achievement Skills Post-Test I (Total Score)	2.40	97.99	7.73
Girls	Knowledge Category	25.34	79.09	40.84
	Comprehension Category	32.34	233.35	5.69
	Application Category	25.56	171.60	5.67
	Achievement Skills Post-Test I (Total Score)	69.84	185.46	40.84

The main effect of Methods of Teaching was found to be significant in eight out of twelve ANOVA. Highly significant F-values are found for Non-Verbal Intelligence at 0.01 level. Ten out of twelve ANOVA were found to be significant for the interaction effect of Methods of Teaching by Non-Verbal Intelligence.

5.2.2.3 Main Effect and Interaction Effect of Methods of Teaching by Numerical Ability on Achievement in Mathematical Skills Post-Test I

The main effect and interaction effect of Methods of Teaching by Numerical Ability on Post-Test I (Objective wise and Total score) for Total Sample, Boys and Girls were studied in twelve ANOVA. The obtained F-values are presented below.

Sample	Dependent variable	Methods of Teaching	Numerical Ability	Methods of Teaching x Numerical Ability
Total	Knowledge Category	21.93	115.64	2.85
	Comprehension Category	17.85	324.21	1.36
	Application Category	13.77	176.62	1.19
	Achievement Skills Post-Test I (Total Score)	46.17	122.40	25.46
Boys	Knowledge Category	1.22	155.84	4.51
	Comprehension Category	0.01	58.85	1.76
	Application Category	0.91	155.84	0.11
	Achievement Skills Post-Test I (Total Score)	3.96	75.83	4.51
Girls	Knowledge Category	36.34	62.03	0.28
	Comprehension Category	45.90	206.61	0.13
	Application Category	36.37	150.14	0.10
	Achievement Skills Post-Test I (Total Score)	80.70	120.45	34.80

Nine out of twelve F-values were found to be significant for main effect of Methods of Teaching. Highly significant F-values are associated with Numerical Ability. Only three F-values were significant for the interaction effect of Methods of Teaching by Numerical Ability on Post-Test I.

5.2.2.4 Main Effect and Interaction Effect of Methods of Teaching by Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II

The obtained F-values for the main effect and interaction effect of Methods of Teaching by Previous Knowledge Subject Matter on Achievement in Mathematical Skills Post-Test II (Objective wise and Total score) for Total sample, Boys and Girls are given below.

Sample	Dependent variable	Methods of Teaching	Previous Knowledge of Subject Matter	Methods of Teaching x Previous Knowledge of Subject Matter
Total	Knowledge Category	40.26	43.58	43.68
	Comprehension Category	40.15	35.87	30.64
	Application Category	23.93	25.81	19.64
	Achievement Skills Post-Test I (Total Score)	86.33	65.88	70.74
Boys	Knowledge Category	28.29	21.67	20.32
	Comprehension Category	16.61	6.44	10.28
	Application Category	16.14	13.42	10.77
	Achievement Skills Post-Test I (Total Score)	71.19	42.06	43.27
Girls	Knowledge Category	57.50	91.37	77.48
	Comprehension Category	40.15	42.59	44.74
	Application Category	55.03	59.45	45.21
	Achievement Skills Post-Test I (Total Score)	145.61	141.52	133.34

All the F-ratios obtained for main effect of Methods of Teaching, main effect of Previous Knowledge of Subject Matter and combination effect of Methods of Teaching by Previous Knowledge of Subject Matter were found to be highly significant.

5.2.2.5 Main effect and Interaction effect of Methods of Teaching by Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II

The results obtained for the main effect and interaction effect of Methods of Teaching by Non-Verbal Intelligence on Retention scores (Objectivewise and Total score) for Total Sample Boys and Girls are presented below.

Sample	Dependent variable	Methods of Teaching	Non-Verbal Intelligence	Methods of Teaching x Non-Verbal Intelligence
Total	Knowledge Category	23.40	211.42	17.67
	Comprehension Category	11.23	530.22	7.18
	Application Category	10.95	80.98	7.35
	Achievement Skills Post-Test I (Total Score)	38.37	230.31	34.06
Boys	Knowledge Category	0.53	89.59	8.29
	Comprehension Category	0.06	274.58	4.54
	Application Category	0.02	289.63	5.58
	Achievement Skills Post-Test I (Total Score)	2.40	97.99	7.73
Girls	Knowledge Category	44.22	149.27	40.84
	Comprehension Category	27.31	318.65	11.43
	Application Category	20.66	245.55	3.26
	Achievement Skills Post-Test I (Total Score)	69.84	185.46	40.84

Eight out of twelve F-values were found to be significant at 0.01 level for the main effect of Methods of Teaching. All F-ratios were found highly significant for the main effect of Non-Verbal Intelligence. For the interaction effect of Methods of Teaching by Non-Verbal Intelligence, all F-Values are significant.

5.2.2.6 Main effect and Interaction effect of Methods of Teaching by Numerical Ability on Achievement in Mathematical Skills Post-Test II

The results obtained for the study of main effects and interaction effect of Methods of Teaching by Numerical Ability on Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score) are summarised and presented below.

Sample	Dependent variable	Methods of Teaching	Numerical Ability	Methods of Teaching x Numerical Ability
Total	Knowledge Category	21.93	115.64	2.85
	Comprehension Category	17.85	324.21	1.36
	Application Category	13.77	276.61	1.19
	Achievement Skills Post-Test I (Total Score)	46.17	222.39	25.46
Boys	Knowledge Category	1.22	58.85	1.76
	Comprehension Category	0.01	154.73	0.11
	Application Category	0.01	155.84	0.01
	Achievement Skills Post-Test I (Total Score)	3.96	76.24	4.51
Girls	Knowledge Category	36.37	62.04	1.20
	Comprehension Category	45.90	206.61	2.28
	Application Category	36.37	150.14	2.69
	Achievement Skills Post-Test I (Total Score)	80.70	210.45	34.80

The F-values obtained show that nine out of twelve ANOVA were significant for the main effect of Methods of Teaching. All F-values are significant at 0.01 level for the main effect of Numerical Ability. The F-values obtained for the interaction effect of Methods of Teaching by Numerical Ability, only three out of twelve were significant. All the other values fail to reach the level accepted for 0.05 level of significance.

5.2.3 RESULTS OF ANALYSIS OF COVARIANCE (TOTAL SAMPLE)

Altogether twenty four Analysis of Covariance effect of Methods of Teaching on Achievement in Mathematical Skills Post-TestI/Post-Test II were estimated by controlling Previous Knowledge of Subject Matter, Non-Verbal Intelligence and Numerical Ability (one by one) statistically and the results are summarised in the following sections.

5.2.3.1 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I with Previous Knowledge of Subject Matter as Covariate

When Previous Knowledge of Subject Matter was taken as covariate, the analysis revealed that all F-values are significant beyond 0.01 level. The F-values obtained are 43.59, 30.64, 25.80 and 65.88 for Knowledge category, Comprehension category, Application category and for Total score respectively.

In the post-hoc comparison of test of significance difference between adjusted mean of Post-Test I between Experimental Group I and Control Group was carried out. All t-values were found significant beyond 0.01 level. (t-values for Knowledge category 5.71, Comprehension category 5. 08, Application category 3.49, and Total score 5.29). High means are associated with Experimental Group I taught through Direct Instruction Model.

5.2.3.2 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I with Non-Verbal Intelligence as Covariate

Results of the covariance analysis with Non-Verbal Intelligence as covariate shows that all F-values for Methods of Teaching are significant at 0.01 level. The F-values obtained for Knowledge category is 31.81, Comprehension category is 22.78, Application category is 8.67 and for Total score is 29.66.

The post-hoc comparison of adjusted mean Achievement in Mathematical Skills between Experimental Group I and Control Group (Objectivewise and Total score) was found beyond 0.01 level for df-1, 87. The obtained t-values were 3.31, 3.47, 3.27 and 3.86 for each category and Total score. High means associated with Experimental Group I indicated the advantage of Direct Instruction Model over Objective Based Instruction.

5.2.3.3 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I with Numerical Ability as Covariate

Significant F-values are found for Methods of Teaching on Achievement in Mathematical Skills Post-Test I Objectivewise and Total score at 0.01 level when Numerical Ability of subjects was treated as covariate. F-values obtained for Post-Test I are Knowledge category (31.43), Comprehension category (28.40), Application category (12.27) and Total score (31.43).

All t-values obtained in the Post-hoc comparison were found significant showing that there exist significant difference between Experimental Group I and Control Group. The t-values obtained are 3.30 for Knowledge category, 3.25 for Comprehension category, 2.53 for Application category and 3.02 for Total score. In all cases Experimental Group I taught through Direct Instruction Model has advantage over Control Group taught through Objective Based Instruction, as high means are associated with Experimental Group I.

5.2.3.4 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II with Previous Knowledge of Subject Matter as Covariate

Results of analysis of covariance with Previous Knowledge of Subject Matter as covariate revealed significant F-values ($P<0.01$) for Methods of Teaching on Achievement in Mathematical Skills Post-Test II. F-values for Retention are Knowledge category 91.37, Comprehension category 42.57, Application category 55.03 and Total score 141.52.

In the Post-hoc comparison of adjusted mean (Objectivewise and Total score) between Experimental Group and Control Group, significant difference was found beyond 0.01 level. The obtained t-values are 7.70, 5.84, 4.68 and 6.77 for Knowledge category, Comprehension category, Application category and for Total score respectively. High means associated with Experimental Group I indicated the advantage of Direct Instruction Model over Objective Based Instruction.

5.2.3.5 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II with Non-Verbal Intelligence as Covariate

When Non-Verbal Intelligence was taken as covariate, the analysis revealed that all F-values are well beyond the significance at 0.01 level. The F-values obtained are Knowledge category 66.73, Comprehension category 32.42, Application category 18.12, and Total score 50.12.

Results of Post-hoc test revealed that statistically significant difference in adjusted mean between Experimental Group I and Control Group were found at 0.01 level. In all cases Experimental Group I taught through Direct

Instruction Model was found to have advantage over the Control Group taught through Objective Based Instruction. The t-values obtained for Post-Test II are Knowledge category 8.88, Comprehension category 5.84, Application category 4.68, and Total score 6.77.

5.2.3.6 Effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II with Numerical Ability as Covariate

In the co-variance analysis with Numerical Ability as covariate, significant F-values were obtained for Methods of Teaching on Achievement in Mathematical Skills Post-Test II (Objectivewise and Total score). The values of F obtained are 65.81 for Knowledge category, 39.26 for Comprehension category, 22.58 for Application category and 52.67 for Total score in Post-Test II.

Results of Post-hoc comparison with adjusted mean revealed that statistically significant mean difference exists between Experimental Group I and Control Group ($P<0.01$). The t-values are Knowledge category 7.88, Comprehension category 5.84, Application category 4.68, and Total score 6.76. In all comparison, high means are associated with Experimental Group I showing the advantage of Direct Instruction Model over Objective Based Instruction.

5.3. TENABILITY OF HYPOTHESES

The tenability of hypotheses of the present study was examined on the basis of the findings after analysis.

5.3.1 First hypothesis states that *"There will be significant difference in the mean scores of Achievement in Mathematical Skills in Post-Test I (tested immediately after treatment) between Control Group and*

Experimental Group I and between Control Group and Experimental Group II"

Twelve comparisons of mean Achievement in Mathematical Skills on Post I (three Objectivewise scores and Total score in Total Sample, Boys and Girls) between Experimental Group I and Control Group and twelve comparison between Experimental Group II and Control Group were attempted. In the first set of comparisons nine out of twelve and in the second set of comparisons seven out of twelve were found to be significant. Hence first hypothesis is substantiated to a greater extent.

5.3.2 The second hypothesis states that *"There will be significant difference in the mean Gain scores of Achievement in Mathematical Skills (Post-Test I minus Pre-Test) between Control Group and Experimental Group I and between Control Group and Experimental Group II"*

Six mean Gain scores (Post-Test I score minus Pre-Test score) on Achievement in Mathematical Skills (Total score) was computed and compared between Experimental Group I and Control Group and between Experimental Group II and Control Group for Total Sample, Boys and Girls. All t-values were found to be significant. The second hypothesis was therefore, substantiated fully.

5.3.3 The third hypothesis states that *"There will be significant difference in the mean Achievement in Mathematical Skills in Post-Test II (tesedt two months after treatment) between Control Group and Experimental Group I and between Control Group and Experimental Group II"*

Twelve comparisons of mean Achievement in Mathematical Skills in Post-Test II (Objectivewise and Total score) between Experimental Group I and Control Group and another twelve comparisons between Experimental Group II and Control Group were done. Out of twenty four comparisons seventeen were found to be significant. Therefore the third hypothesis is substantiated to a greater extent.

5.3.4 The fourth hypothesis states that *"There will be significant difference in the mean Gain scores of Achievement in Mathematical Skills (Post-Test II - Pre-Test) between Control Group and Experimental Group I and between Control Group and Experimental Group II"*

Significant difference beyond 0.01 level in the mean Gain scores on Achievement in Mathematical Skills (Post-Test II-Pre-Test) for Total score between the Experimental Groups and Control Group was noticed for Total Sample, Boys and Girls. Hence fourth hypothesis is fully substantiated.

5.3.5 The fifth hypothesis states that *"There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls"*

Significant main effect of Methods of Teaching on Achievement in Mathematical Skill Post-Test I was found to exist (Objectivewise and Total score) for Total Sample, Boys and Girls.

Previous Knowledge of Subject Matter was found to have main effect on Post-Test I for Total Sample and Girls and for Knowledge category and Total score in the case of Boys.

Significant interaction of Methods of Teaching and Previous Knowledge of Subject Matter was found to exist except for Application category of Boys. Hence the hypothesis is substantiated to a great extent.

5.3.6 The Sixth hypothesis states that *"There will be significant difference in the main effect and interaction effect of Methods of Teaching (Direct*

Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls"

Methods of Teaching were found to have significant main effect on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) for Total Sample and Girls.

All the F-ratios for the single effect of Non-Verbal Intelligence were found to be significant for Total Sample, Boys and Girls.

Ten out of twelve F-values were found to be significant for the combined effect of Methods of Teaching by Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test I. Therefore, this hypothesis is substantiated to a good extent.

5.3.7 The seventh hypothesis states that *"There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test I for Total Sample, Boys and Girls"*

Significant main effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test I (Objectivewise and Total score) was found to exist for the Total Sample, and Girls. For Boys significant effect was found only for Knowledge category.

The single effect of Numerical Ability on Post-Test I found to exist (Objectivewise and Total score) for all samples.

Interaction effect of Methods of Teaching by Numerical Ability on Post-Test I was found to exists only in four out of twelve F-values. This hypothesis is substantiated to a greater extent.

5.3.8 The eighth hypothesis states that *"There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Previous Knowledge of Subject Matter on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls"*

Significant main effect of Methods of Teaching on Post-Test II was found to exist since all F-values are significant (Objectivewise and Total score) for Total Sample, Boys and Girls.

Main effect of Previous Knowledge of Subject Matter on Retention scores (Objectivewise and Total score) was found to be significant in all cases.

All interaction effect of Methods of Teaching and Previous Knowledge of Subject Matter were found to be significant for Total Sample, Boys and Girls. Hence the hypothesis is fully substantiated.

5.3.9 The ninth hypothesis states that, *"There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls"*

Significant single effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II was found to exist for Total Sample, Boys and Girls.

Main effect of Non-Verbal Intelligence on Retention scores was found to be significant in all cases objectivewise and for total score.

The interaction effect of Methods of Teaching and Non-Verbal Intelligence on Achievement in Mathematical Skills Post-Test II was found to be significant for Total Sample, Boys and Girls. Therefore the hypothesis is substantiated to a great extent.

5.3.10 The tenth hypothesis states that *"There will be significant main effect and interaction effect of Methods of Teaching (Direct Instruction Model and Objective Based Instruction) and Numerical Ability on Achievement in Mathematical Skills Post-Test II for Total Sample, Boys and Girls"*

Single effect of Methods of Teaching on Achievement in Mathematical Skills Post-Test II was found to be significant (Objectivewise and Total score) for Total Sample and Girls. All F-values for the main effect of Numerical Ability was found to be significant in all cases.

Interaction effect was found to exist only for Total scores in Total Sample, Boys and Girls. The hypothesis is substantiated to a greater extent.

5.3.11 The eleventh hypothesis states that *"Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II than pupils taught through Objective Based Instruction when the initial difference in Previous Knowledge of Subject Matter were controlled"*

To test this hypothesis, eight ANCOVA followed by Post-hoc test of significance between adjusted mean was estimated for Total Sample. Significant difference in Achievement in Mathematical Skills Post-Test I and Post-Test II (Objectivewise and Total score) between Experimental Group I and Control Group was found in all cases of ANCOVA and t-test. In all cases significant difference in favour of Experimental Group I taught through Direct Instruction Model was noticed. Hence the hypothesis was fully substantiated.

5.3.12 The twelfth hypothesis states that *"Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II than pupils taught through Objective Based Instruction when the initial difference in Non Verbal Intelligence were controlled"*

Eight ANCOVA followed by t-test between Experimental Group I and Control Group was undertaken to test this hypothesis. Significant difference in the mean Achievement in Mathematical Skills Post-Test I and Post-Test II were found Objectivewise and Total score for the Total Sample. Since high means are associated with Experimental Group I taught through Direct Instruction Model, its advantage over Objective Based Instruction, indicates in all the cases. Therefore the twelveth hypothesis was fully substantiated.

5.3.13. The thirteenth hypothesis states that *"Pupils taught through Direct Instruction Model will have high mean Achievement in Mathematical Skills in Post-Test I and Post-Test II when the initial difference in Numerical Ability were controlled"*

To test this hypothesis, ANCOVA followed by t-test in adjusted mean between Experimental Group I and Control Group was undertaken. Significant difference between the groups in Post-Test I and Post-Test II (Objectivewise and Total score) were found in all the adjusted mean achievement in Mathematical Skills. Significant difference in favour of Experimental Group I taught through Direct Instructions Model was noticed in all the cases. The thirteenth hypothesis was therefore fully substantiated.

5.4. SUGGESTIONS FOR IMPROVING EDUCATIONAL PRACTICE

Based on the findings of the present investigation, the following suggestions are putforth for improving the existing educational practice in schools.

1. From the present study, it is noticed that Direct Instruction Model is effective in the teaching of the select topics 'decimals' and 'fractions' for Achievement in Select Mathematical Skills of standard VII pupils. It is to be specially noted that Direct Instruction Model which focuses on concepts and procedures and not merely on rote learning of content is feasible in a conventional class with a rigid organisational set up. A limitation which can be pointed out is that about fifteen to twenty per cent of additional class periods are required for the completion of the topic. But the additional time-on-task ensures more active participation of pupils in learning and better content mastery of the essential concepts which especially have a carry over value.

2. During the experiment using Direct Instruction Model it was observed that students enjoy mathematics lessons and they do not have unfounded fear of mathematics as the teacher could demonstrate to them that they can also succeed. For pupils who were weak and diffident for overt expression at the beginning of the lesson and those who were not used to learning in small groups, the use of appropriate prompts by the teacher helped for mastery learning.

3. One of the techniques of presentation of days' lesson is grouping and regrouping of pupils who are of similar skills and content mastery. This technique helped for more individualisation because fast learners can advance through the programme while less advanced pupils received the extra practice they need. In the existing educational system, the individual differences are not practically attended to by the teachers. DIM has built-in-system of teaching procedure for attending to individual differences. This technique can be followed by all teachers in the conventional class teaching.

4. Teachers in Direct Instruction Model have the full responsibility of leading the classroom instruction, monitoring the outcomes of specific learning tasks, requiring ample evidence from pupils of their mastery of learning and providing feedback to pupils concerning their errors, reteaching, regrouping and the like. The preparation of lesson formats, worksheets, recording of observation of student learning, selection and preparation of concrete prompts etc. consume a considerable amount of time of the teacher preparation of teaching. This may require special training for teachers not only for preparation of lesson scripts etc. but also for effective classroom transaction. But once a lesson package is prepared, this can be used for in similar classes in the successive years also; with modification whenever it is found necessary. Like minded mathematics teachers can pool their expertise and extra time for preparing lesson scripts, work sheets, and the like in the Direct Instructional Model format for the benefit of successful implementation of specific topics in the mathematics syllabus.

5. One of the limitations of Direct Instruction Model is that this model cannot be used for all subject areas and for all the students. This method can be adopted to teach skill developing content areas especially for the benefit of under-achievers, disadvantaged pupils and pupils with specific disability in mathematics.

6. Since Direct Instruction Model is a teacher directed approach of teaching, at the same time a cognitive strategy of teaching, it can be adopted for teaching of students of all abilities from both rural and urban areas, of schools of different organisational set up and of different size of classes.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

The findings of the present study can be extended for further research on the lines mentioned below.

5.5.1. Effect of Direct Instruction Model on Affective domain can be examined along with cognitive domain.

5.5.2. Effect of Direct Instruction Model on Problem-solving Skills and Computational Skills among Upper Primary school students can be examined.

5.5.3. The replication of the study on other areas in mathematics such as proportions and ratios can be attempted.

5.5.4. Effect of Direct Instruction Model on other skill areas especially for language skills can be conducted.

5.5.5. Effect of Direct Instruction Model on Achievement in Mathematical Skills by considering Examination Anxiety, Learning Style and Interest as Control Variables can be studied.

5.5.6. Relative effectiveness of Direct Instruction Model among english/malayalam medium, rural/urban, private/government population can be conducted.

5.5.7. Effect of Direct Instruction Model using varied lesson formats on academic skills can be studied.

5.5.8. The study can be replicated on students with learning disabilities, special needs, social disadvantage and of different classroom learning environment.

5.5.9. Effect of Direct Instruction Model on Achievement in Mathematical Skills among secondary school pupils can also be conducted.

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EFFECT OF DIRECT INSTRUCTION MODEL ON ACHIEVEMENT IN SELECT MATHEMATICAL SKILLS OF UPPER PRIMARY PUPILS OF KERALA

JAYASREE. N.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
in Education

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

2004

APPENDICES

17

APPENDIX – IA

DEPARTMENT OF EDUCATION

CALICUT UNIVERSITY

LESSON PLAN BASED ON DIRECT INSTRUCTION MODEL –II

PLANNING PHASE.

CONTENT TO BE TAUGHT: Concept of the fractions 1/4 and 3/4.

OBJECTIVES **A. Content Objectives**

1. Given, a rectangular shaped paper cutting, student will be able to recognise that the four divided parts are equal and the four equal parts make a whole.

2. Given, two set of situations such as objects, paper cuttings and the like students will be able to distinguish the fraction one by four and three by four.

3. Given, different paper cuttings, students will be able to recognise that for getting a quarter the whole is divided into four equal parts.

4. Given, an object divided into four equal parts and out of this, one part is taken into account, student will be able to generalise that the considered part is one-fourth of the whole.

5. Given, any situation student will be able to translate the verbal statement one-fourth symbolically as 1/4.

6. Given, any situation student will be able to explain the concept of 1/4 of an object.

7. Given, an object divided into four equal parts and out of this three of them are taken into consideration student will be able to generalise that the considered parts are three-fourth of the whole.

8. Given, verbally the idea of three-fourth, student will be able to symbolise three-fourth as 3/4.

9. Given, any situation, student will be able to explain the concept of 3/4 of an object.

10. Given, a whole is divided into four equal parts and consider 1/4 and 3/4 student will be able to discrimate them.

11. Given, a random collection of objects, student will be able to select appropriate method for dividing the collection into four equal parts.

12. Given, a random collection of objects, student will be able to identify the number of objects in ¼ of the collection and 3/4 of the collection.

13. Given, any situation, student will be able to picturise 1/4 and 3/4 of an object.

14. Given, any situation, student will be able to graphically represent 1/4 and 3/4 of a collection of objects.

B. Process Objectives

1. Student will observe, notice and answer to questions.

2. Student will give examples, practice the concept/rule.

3. Student will actively participate in the group activities.

4. Student will ensure the mastery over the learned concept/rule.

5. Student himself/herself will assume more responsibility as the lessons progress.

PREREQUISITE KNOWLEDGE

1. Concept of equal parts of a whole

2. Concept of numerator and denominator.

3. Concept of 1/2.

CONDUCTING THE LESSON

Phase-1. Attention and Focus.

Tr: "Good morning every one".

"How are you today? Are you ready for the new lesson"?

St: "Yes madam".

Tr: "Excellent! So to day we can study about the fractions three by four and one by four of an object and a collection".

"Raju, did you heard about it?"

St: "Yes, in my house, usually I heard about these terms".

Tr: "Tomy, did you know the concept of 1/4 and 3/4".

St: "No miss".

Tr: "So today we are going to learn about the fractions $\frac{1}{4}$ and $\frac{3}{4}$. Then you can use these concepts whenever it is necessary. You can identify the these concept among many, graphically represent it".

St: "Will you give work sheet at the end of the class"?

Tr: "Surely. So that I can ensure whether you are masters over the concepts 1/4 and 3/4. Are you ready?"

St: "Yes miss!" said the students all together.

Phase – 2. Orientations

Tr: "Meena, can you remember what we learn yesterday"?

St: 'Yes, about the fraction $\frac{1}{2}$".

Tr: "Renjith, can you explain the concept 1/2.

Student explaining it.

Tr: "Which is the numerator of this fraction? Can anybody explain what do you mean by the numerator of a fraction"?

Tr: "Which is the denominator of the fraction 1/2? Rema, could you please explain the denominator of a fraction"?

Tr: "Ramu, what do you mean by 1/2 of a collection? What is the peculiarity of each part, when a collection is divided into two equal parts?"

Tr: "Salim, how will you find out the number of objects in $\frac{1}{2}$ of a collection?"

Tr: "There is a cake on the table. You can see it. I am going to cut it into a number of equal portions. Meera, now I am going to give you one piece. Do you want to know what fraction of the cake is given to you and what fraction remains with me?"

"Can anyone answer my questions?" "How will you find this"?

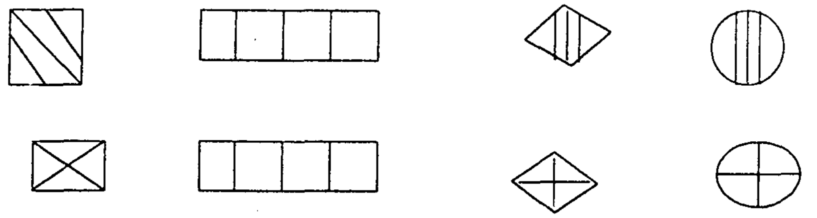
Phase – 3. Model

Teacher placed a flannel board on the table.

Tr: "Observe the two sets of figures placed on the flannel board".

Set -I

Set-II



Students observe the figures.

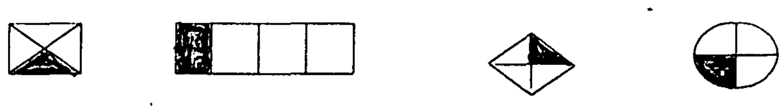
Tr: "What is the main difference between the pairs of figures in the two sets? Can you identify it, Maya?"

(A clue is given by the teacher, if necessary – shape/number of divisions)

St: "In Set II, all figures are divided into four equal parts. But in Set I even though there are four parts; they are not equal".

Cut-outs of these figures with equal shape and size are given to each group.

Tr: "Shade one part of the divisions out of four equal parts".



Tr: "Can you express this shaded portion as a fraction"?

St: "Yes, the object is divided into four equal parts. So the shaded portion can be expressed as a fraction".

Tr: "Then, what will be its denominator? Why?"

St: "Since there are four equal parts, the denominator of the fraction will be 4".

Tr: "How many of the portions are shaded"?

St: "Only one portion is shaded".

Tr: "What does this number indicates for the fractions"?

St" "This number will be indicated as the numerator of the fraction".

Tr: "Can you say what is the fraction of the shaded portion?"

St: "There are four equal parts and only one part is shaded. Therefore the fraction of the shaded portion is ¼".

Tr: "Then what will be the fraction of the unshaded portion?"

St: "3/4".

Tr: "How does the numerator become 3?"

St: "Out of 4 equal parts, 3 of them are not shaded".

Tr: "How does the denominator become 4?"

St: "The object is divided into four equal parts. Hence the denominator becomes 4".

Teacher gives paper cuttings with different regular shapes to each group.

Tr: "Cut the paper cutting and give me 1/4 of it".

Students doing it correctly.

Tr: "I have eight apples with me. I gave 1/4 of the apples to Rema. Can anybody could find out the number of apples that had given to Rema?"

Tr: "How many apples remain with me?"

Tr: "Can you indicate the fraction of the apples that remains with me"?

Tr: "How can you find out this?"

On the flannel board teacher fixes the picture of 8 balls.

O O O O

O O O O

Tr: "This is a collection of 8 balls. Can you divide this collection into 4 equal parts". Try it by drawing the figure in you notebook. Using trail and error method, students divide the collection into 4 equal parts in different ways.

O O	O O		
O O	O O		

O	O	O	O
O	O	O	O

Tr: "What is the number of balls in each collection"?

St: "There are two balls in each collection"

Tr: "Consider two balls among the eight balls, how can you indicate balls fractionally?"

St: "Out of the 8 balls, two were considered. 8 balls are divided into 4 equal parts and in each part there are two balls. So these two balls can represent a fraction".

Tr: "What is that fraction"?

St: "1/4"

Tr: Then, what will be ¼ of 8 balls"?

St: "2".

Tr: "What will be 3/4 of 8 balls"?

St: "6".

Tr: "Can you answer how many apples I had given to Rema?"

St: "Two".

Tr: "How many apples remain with me?"

St: "Six".

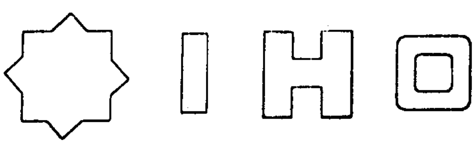
Tr: "Now can you answer how many apples are given to Rema? and how many apples remains with me?"

St: "Rema got two apples and six apples remain with you.

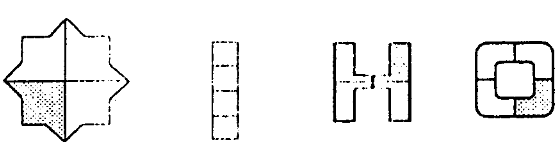
Phase – 4 Lead

Tr: "Let us practice whatever we have learned".

Paper cuttings of different shape and size and crayons are distributed among the learners.

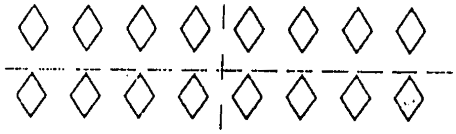


Tr: Fold the given paper cuttings in to 4 equal parts. shade $\frac{1}{4}$ of the paper cuttings using pencil.



Tr: Draw 12 objects in your note book and divide it in to 4 equal parts.

Tr: Draw 16 diamonds in your notebook. Divide it into 4 equal parts.



St: Do when the collection is divided in to 4 equal parts, each part constitute 4 diamonds.

Tr: Count the number of objects in $\frac{1}{4}$ of the collection?

St: $\frac{1}{4}$ of the collection have 4 diamonds.

Tr: Count the number objects in $\frac{3}{4}$ of the collection.

St: $\frac{3}{4}$ of the collection have 12 diamonds.

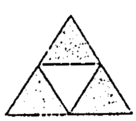
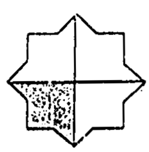
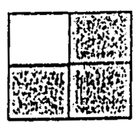
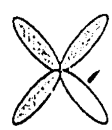
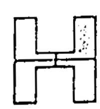
Phase – 5 Test

Tr: "Now I am going to give you work sheets. You have to answer all the questions. Do not discuss each other.

WORKSHEET NO:2

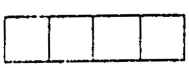
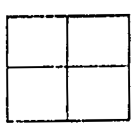
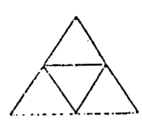
Answer all the questions

I Write down the fraction for the shaded part.

....

II. Shade the object to indicate the fraction given below for each question

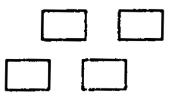
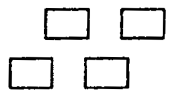
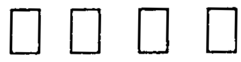
  

$\frac{1}{4}$ $\frac{3}{4}$ $\frac{1}{4}$

III. Write down the fraction of the shaded objects in the given collection

IV. Shade the objects of the given collection to indicate the fraction given below in each case.

$\frac{1}{4}$ $\frac{3}{4}$ $\frac{1}{4}$

V. Count the number of objects in $\frac{\text{'1'}}{4}$ and $\frac{\text{'3'}}{4}$ of the given collections.

1. 0 0 0 0
   0 0 0 0 Number of Objects in $\frac{1}{4}$ of the collection =.........
   0 0 0 0
   0 0 0 0 No. of Objects in $\frac{3}{4}$ of the collection = ...

2. a a a a a Number of Objects in $\frac{1}{4}$ of the collection =.............
   a a a a a
   a a a a a Number of objects in $\frac{3}{4}$ of the collection =.................
   a a a a a

3.  Number of objects in $\frac{1}{4}$ of the collction = ...
   Number of objects in $\frac{3}{4}$ of the collection = ...

4. 0 0 0 0 Number of objects in $\frac{1}{4}$ of the collection = ...
   0 0 0 0 Number of the objects in $\frac{3}{4}$ of the collection = ...
   0 0 0 0
   0 0 0 0
   0 0 0 0

Phase- 6 Feed back.

Feed back will be given according to results of the evaluation of the work sheets of each indicidual.

APPENDIX I B

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON PLAN BASED ON DIRECT INSTRUCTION MODEL – XVII

PLANNING PHASE

CONTENT TO BE TAUGHT →

Types of Decimals – Like decimals and unlike decimals.

How to convert unlike decimals into like decimals.

OBJECTIVES

A. Content Objectives

1. Given any decimal, student will be able to identify the number of decimal places in each decimal number.
2. Given any situation, student will be able to define like decimals and unlike decimals.
3. Given any situation, student will be able to give examples for like and unlike decimals.
4. Given any decimal, student will discriminate like decimals and unlike decimals.
5. Given any situation, student will generalise a rule for converting like decimals into unlike decimals.
6. Given any unlike decimal, student will convert it into like decimal.

B. Process Objectives

1. Student will observe, notice, discriminate and answer to questions.
2. Student will give examples and practice the rule learned.
3. Student will actively participate in the group activity.
4. Student will ensure the mastery over the learned concept and rule.
5. Student himself/herself will assume more responsibility as the lesson progress.

Phase-3 Model

Tr: "We have already learned about like fractions and unlike fractions. Similarly we have like decimals and unlike decimals".

Teacher writesthree groups of decimals on the Black Board.

I 0.3, 1.7, 2.9, 25.8, 100.4

II 0.05, 6.28, 17.11, 211.43

III 0.312, 2.201, 14.006, 370.064

Tr: "Consider group I. In each case how many decimal places are there"?

St: "Only one decimal place".

Tr: "Take the decimals in group II. How many decimal places are there?"

St: "In group II each decimal have two decimal places".

Tr: "What is the peculiarity of group III"?

St: "Group III consists of decimals with three decimal places".

Tr: "Decimals having same number of decimal places are called like decimals".

Tr: Can you give examples for like decimals".

Students are giving examples correctly.

Tr: "What will be unlike decimals?"

St: "Decimals having different number of decimal places are called unlike decimals".

Tr: "Can you give examples for unlike decimals".

Students are giving the examples correctly.

Tr: "Consider the decimal 0.5 and 0.63 which type of decimals are they?"

St: "Unlike decimals".

Tr: "Can you suggest any method to convert these unlike decimals into like decimals?"

St: "If both of them have two decimal places they will become like decimals".

Tr: "How can you make 0.5 to a decimal having two decimal places?"

St: "If we take an equivalent decimal of 0.5 with two decimal places we can solve it".

Tr: "Which is the equivalent decimal of 0.5 having two decimal places?"

St: "0.50".

Tr: "Now, 0.50 and 0.63 are like decimals".

Tr: "Can you make a rule for converting unlike decimals into like decimals?"

St: "Notice the number of decimal places in the given decimals. Identify the decimal number having largest number of decimal places. Then convert the other decimals into equivalent decimals with the same number of decimal places as the decimal with the largest number of decimal places have".

Tr: "OK, Now every body knows how to convert unlike decimals in to like decimals".

Phase – 4 Lead

Tr: "Are you ready to practice in the group what we have just learned".

St: "We are ready".

Teacher gives some unlike decimals to each group.

Tr: "Explain in each problem how will you convert each unlike decimal to like decimal?"

Students explain the rule and giving correct answer. If anybody is wrong feedback will be given.

Phase – 5 Test

Tr: "I think it is the time to do some problems individually. So I am going to give you worksheets.

WORKSHEET - 17

I. **Which of the following pairs of decimals consists of like decimals. Put a 'tickmark' /) against like decimals.**

(i) 79.9 , 7.99 = ...

(ii) 1.52, 0.152 =..........

(iii)9.13, 6.27 = ...

(iv)3.9 , 13.7 = ...

(v) 3.003 , 3.030 = ...

II. **Convert each of the following groups of unlike decimals into groups of like decimals.**

(i) 7.8 , 8.71 = ...

(ii) 17.1 , 27.6, 3.28 = ...

(iii)24.93 , 2.493, 249.3 = ...

(iv)2.718, 13.29, 650.014= ....

(v) 200.01, 13.4, 9.00 = ...

III. **Write two equivalent decimals for each of the given decimal**

(i) 8.03 = ...

(ii) 2.1 = ...

(iii) 27.4 = ...

(iv) 309.16 = ...

(v) 57.24 = ...

APPENDIX - I C

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

OBSERVATION PROFORMA

Name of the Teacher :

Designation :

Name of the Institution :

Experience in Teaching :

Sl. No.	Skills/Competency	Level of Effectiveness		
		High	Medium	Low
1	Planning of Lesson			
2	Clarity of Structuring			
3	Establishment of the rapport with pupils			
4	Introduction of topic			
5	Establishment of set			
6	Demonstration by teacher			
7	Activities selected			
8	Selection and use of instructional materials			
9	Students activity			
10	Sequence of activities			
11	Accountability of teacher			

12	Encouraging learners			
13	Questioning skill			
14	Reinforcement/Prompts			
15	Supervision by teacher			
16	Check for learning understanding			
17	Monitoring learner activity			
18	Manage of class room time to focus on learning			

19. Overall - Explain your overall judgement of the teacher's effectiveness

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20. Suggestion for Improvement

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DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

38

LESSON PLAN BASED ON OBJECTIVE BASED INSTRUCTION

Name of the teacher :	Standard		
Name of the School :		Division	
Subject :	Mathematics	Strength	
Unit :	Fractions	Date	
Lesson Unit :	Concept of 1/4 and 3/4	Duration	

CONTENT ANALYSIS

Terms : On eby fourth, three by fourth.

Fact : In the case $^1/_4$, only one part is considered out of four equal parts.
In $^1/_4$, 1 is the numerator and 4 is denominator.
In $^3/_4$, only 3 parts are taken from 4 equal parts.
In $^3/_4$, 3 is the numerator and 4 is the denominator.

Concept : $^1/_4$ indicates that a whole is divided in to four equal parts and out of these four parts only one is taken.
$^3/_4$ indicates that a whole is divided in to four equal parts and out of these four parts 3 of them are taken.

Symbols : one by four → $^1/_4$ there by four → $^3/_4$,

INSTRUCCCTIONAL OBJECTIVES.

The pupil

(i) acquires knowledge aboout the above terms, facts etc.
(ii) develops proper understanding of the concepts.
(iii) develops the ability to apply the above concepts in relevant situations.
(iv) develops skill in using the concepts $^1/_4$ and $^3/_4$.

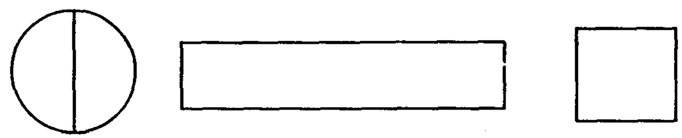
PREVIOUS KNOWLEDGE.

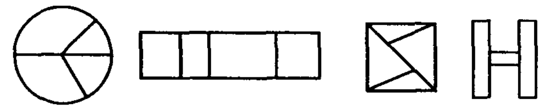
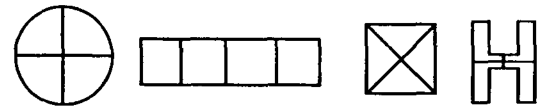
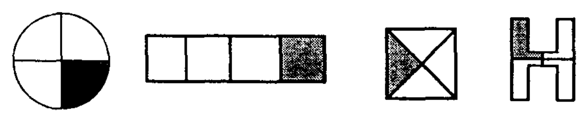
The concepts of $^1/_2$ of an object.

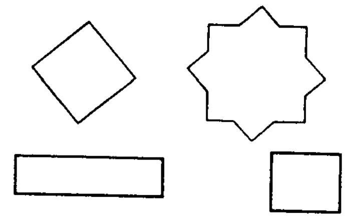
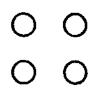
The concept of $^1/_2$ of a collection.

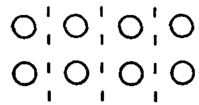
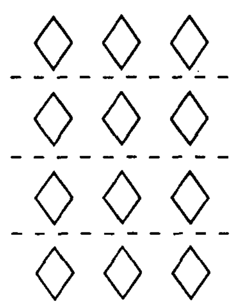
LEARNING AIDS

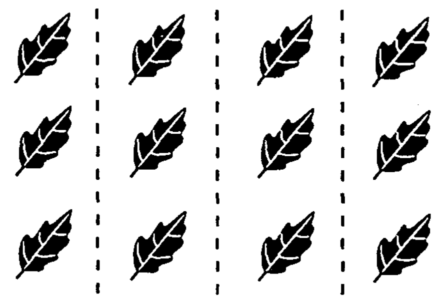
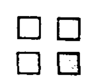
Paper cuttings, Collection of objects

Content	*Specification*	*Learning Experiences*	*Evaluation.*
Preparation The concept of $^1/_2$	recalls	How will you represent one-half fractionally? What do you mean by $^1/_2$? What does I indicates? What does 2 indicates? Shade $^1/_2$ of the gives figures.	
$^1/_2$ of an object	recognises		
$^1/_2$ of a collection	recognises	Using dotted lines divide the collections in to $^1/_2$ and findout. the number of objects in $^1/_2$ of the collection 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
Number of objects in $^1/_2$ of a collection	recalls.	How will you identify the number of objects in $^1/_2$ of a given collection?	

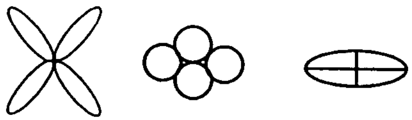
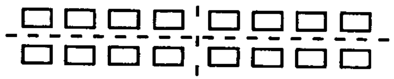
Content	*Specification*	*Learning Experiences*	*Evaluation.*
<u>Presentations:</u>		What is the main difference between the two sets given below.	
	Compares	Set-I 	
		Set-II 	
Division of four equal equal parts	discriminates	In Set -II all the figures are divided in to 4 equal parts and in Set-I these are not equally divided eventhough there are divided four parts.	
	seen relation ship among data	Also in set-II these four equal parts together make a whole.	
	analyses	Consider one part among these. Shade it. How can we express thiis part as afraction?	
			
	recalls	The whole thing is divided in to How many parts?	
	recognises	Are all these equal parts?	
		How many parts are taken for consideratiion?	
	recognises recalls	What does this member indicates for the fraction?	
	recognises	How many equal parts are these ?	
	recalls	What does this member indicate for the fraction?	

Content	*Specification*	*Learning Experiences*	*Evaluation.*
	seen relationship among data	Now what is the fraction indiicating the shaded portions? $^{1}/_{4}$ which reads as one-by-four.	
$^{1}/_{4}$ means out of 4 equal parts one is taken.	generalises	$^{1}/_{4}$ of an object means out of four equal parts only one is considerd.	
	establishes the result	When a whole is divided in to 4 equal parts, then each part is called $^{1}/_{4}$ of the object.	What do you mean by $^{1}/_{4}$ of an object.Find out $^{1}/_{4}$ of the given objects and shade it 
$^{1}/_{4}$ of a collection		Consider the given collection of balls. Divide the collection into 4 equal parts and find the number of objects in each collection.	
	notices	 Here 4 balls make a whole	
	identifies	Consider one ball. How can you indicate this ball? $^{1}/_{4}$ → out of 4 balls, one ball is considered	

Content	*Specification*	*Learning Experiences*	*Evaluation.*
$^1/_4$ of 4 is 1	concludes	$^1/_4$ of a collection of 4 balls is 1	what will be $^1/_4$ of a collection of 4 objects
	identifies	Consider 8 balls  8 balls are divided into 4 equal parts using 3 dotted lines. $^1/_4$ of the collection consist 2 balls	
$^1/_4$ of 8 is 2	generalises	That is $^1/_4$ of a collection of 8 balls is 2	What will be $^1/_4$ a collection of 8 objects
Using dotted lines divide the collection into 4 equal parts; count the number of objects in each sub collection	establishes a general rule	How will you find out $^1/_4$ of a collection ? The collection will be divided into 4 equal parts using dotted lines. Counting the number of obejcts in a particular subccllection we can find $^1/_4$ of that collection	How will you findout $^1/_4$ of a collection?
<u>Application</u> Applyging the concept of $^1/_4$ of a collection	selects appropriate method	Divide the given 12 diammonds into 4 equal parts and findout how many diammands make one fourth of the collection. 	

Content	*Specification*	*Learning Experiences*	*Evaluation.*
		Using 3 dotted lines the collection is divided into 4 equal parts. Each part consists of 3 diammonds	
32	identifies	$\therefore$ $^1/_4$ of a collection of 12 diammonds consists 3 diammonds	
		Find out the number of leaves in $^1/_4$ of the collection of 12 leaves	
	selects appropriate method		
		Using three dotted lines the collection of leaves are divided into 4 equal parts. Each $^1/_4$ of the collection has 3 leaves	
<u>Presentation</u> concent g $^3/_4$		Take the first paper folding again in which $^1/_4$ is shaded. In each case $^1/_4$ of the shape is shaded consider the unshaded portions	
	analysis identifies	what fraction willit represent? Why? The unshaded portions will represent $^3/_4$ of the whole	
When on object is divided into 4 equal parts and 3 of them were considered the for wil be $^3/_4$	illustrates	The whole is divided into 4 equal parts. So the denominator will be 4. Out of this 4 parts 3 of them are unshaded. So 3 indicates the numerator	
		In the case of 4 equal squares  one square is haded. ie. $^1/_4$ of the collection is shaded. What fraction will be unshaded squares represent?	

78

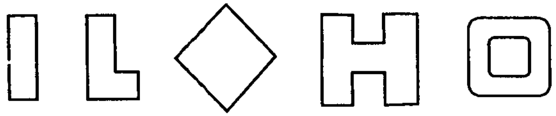
Content	*Specification*	*Learning Experiences*	*Evaluation.*
<u>Application</u> Concept of $^3/_4$ an object and collection	explains idenfies	Out of 4 equal squares 3 of them were unshaded so the fraction will be $^3/_4$ Shade $^3/_4$ of the figures  Divide the given collection into 4 equal parts and indicate the number of objects in each $^3/_4$ part  Each collection has 4 objects $\therefore$ $^3/_4$ of the collection is 12	What do you mean by $^3/_4$ of a collection? How will you count the the number of objects in $^3/_4$ of a collection.

<u>Review</u>

1. Explain the concept of $^1/_4$
2. Explain the concept of $^3/_4$
3. Distinguish $^1/_4$ and $^3/_4$
4. How will you findout the number of objects in $^1/_4$ of a collection of objects?
5. How will you findout the number of objects in $^3/_4$ of a collection of objects?

Assignments

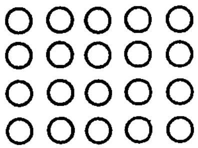
Draw the given figures in your note book

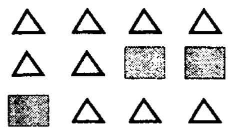
1. 

31

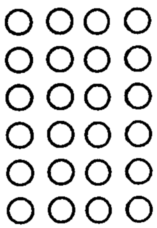
Shade $^3/_4$ of the figures

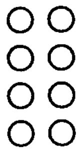
2. Count the number of objects in $^1/_4$ of the given collections

(a) 

(b) 

3. Count the number of objects in $^3/_4$ of the given collection

(a) 

(b) 

APPENDIX – II B

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON PLAN BASED ON OBJECTIVE BASED INSTRUCTION

Name of the teacher :		Standard	:
Name of the school :		Division	:
Subject :	Mathematics	Date	:
Unit :	Decimals	Duration	:
Lesson Unit :	Types of decimals	Strength	:

CONTENT ANALYSIS

Terms – Decimal places, like decimals, unlike decimals.

Definition

Decimal places – The places of the digits in the decimal part of the decimal number are called decimal places.

Like decimals – Decimals having the same number of decimal places are called like decimals.

Unlike decimals – Decimals having different decimal places are called unlike decimals.

Fact – All equivalent decimals are unlike but unlike decimals may or may not be equivalent.

Principle → Conversion of unlike decimals into like decimals.

⇒ First identify the number of decimal places in the decimal number with the largest number of decimal places. Change the other decimals into their equivalent decimals having the largest number of decimal places.

INSTRUCTIONAL OBJECTIVES

The pupil (i) acquires knowledge of the above facts.

(ii) develops proper understanding of the principle

(iii) develops ability in converting unlike decimals into like decimals.

PREVIOUS KNOWLEDGE

41 (I) concept of place values of digits.

(ii) concept of equivalent fractions.

CONTENT	Specification	Learning Experiences	Evaluation
Introduction	recalls	Write the decimal of the fraction 3/100	
	recalls	Give the number name of the decimal 4.02	
	simplifies	Convert the decimal 0.9 into a fraction of the lowest form.	
	simplifies	Convert the decimal 210.5 into a fraction and write it as a mixed numeral.	
	recalls	Define like fractions and unlike fractions. Give examples	

42

Development		One day Raman called his children and told them he decided to divide his property among them. He decided to divide his property in three portions as follows 33.888 percent, 33.09 percent and 33.022 percent. First he called his eldest son and asked him which of the share did he prefer. The elder son wanted the biggest share. But he was very poor in understanding decimal numbers. He was confused of the numbers that was told by his father. How can we help the elder son As we have like fractions and unlike fractions, we have like decimals and unlike decimals. Consider the following groups of decimals. I $\rightarrow$ 0.3, 1.7, 2.9, 21.6,37.6 II $\rightarrow$ 0.05, 6.08, 7.13, 211.13 III$\rightarrow$ 0.123, 1.012, 4.111, 41.003, 119.064	
The places of digit on the decimal part of a decimal number are called decimal places	recognises	In group I how many digits are there in the decimal places? Here each decimal has only one decimal place. In group I how many digits are there in the decimal places?	

	recognises	In group II each decimal has two decimal places.	
		In group III how many digits are there in the decimal places?	
	recognises	In group III each decimal has three decimal places.	
Dec. having same number of decimal places are like decimals	generalises	Decimals having same number of decimal places are called like decimals	What are like decimals Give egs
		What will be unlike decimals?	
Dec. having different number of decimals places are called unlike decimals	suggests	Decimals having different number of decimal places are called unlike decimals.	What are unlike decimals. Give egs.
Presentation	identifies	Consider the decimals 0.5 and 0.61 which type of decimals are these	
		They are unlike decimals, 0.5 has only one decimal place and 0.61 has two decimal places.	
	Analyses	Can you convert these unlike decimals into like decimals?	
		For this 0.5 has to converted into a decimal having two decimal places and its value should not be changed.	
		Say a decimal equivalent to 0.5 and has two decimal places.	
	recalls	0.5 and 0.50 are equivalent decimals.	

		In the pair of decimals 0.5, 0.61, we change 0.5 in to 0.50 $\Rightarrow$ 0.50, 0.61	
		Now what is the number of decimal places in the decimal 0.50	
	recognises	There are two decimal places.	
		What is the number of decimal places in the decimal 0.61	
		There are two decimal places.	
	generalises	Hence 0.50 and 0.61 are like decimals.	How will you convert two unlike decimals into like decimal
		How will you convert unlike decimals into like decimals?	
For converting unlike decimals to like decimal first identify the decimal having largest decimal places and change others decimals having the same decimal places	establishes a principle	(i) Identify the number of decimal places, in the decimal with the largest number of decimal places. (ii) Change other decimals into their equivalent decimals which have the same number of decimal places as the decimal with the largest number of decimal places.	How will you convert unlike decimals into like decimals.
Application		Put a tick mark (√) against the like decimals.	
Concept of like and unlike fraction		(a) 3.9, 13.7 (b) 9.13, 6.72 (c) 3.003, 3.03 (d) 100.71, 97.283	
	recalls	What are like decimals and unlike decimals?	

45

		Consider 3.9, 13.7. What is the number of decimals places n each case.	
	recognises	Only one place.	
		So what type of decimals are there?	
	identifies	Since the decimal part has only on decimal place. Hence they are the decimals.	
		Are 6.91 and 9.13 like decimals?	
	verifies	Since there are two decimal places, they are like decimals.	
	verifies	3.003 and 3.30 $\Rightarrow$ In the first there are 3 decimal places and in the second there are only two. Hence they are not like decimals. They are unlike decimals.	
	verifies	Similarly 100.71 has 2 decimal place and 97.283 has 3 decimal place. So they are unlike decimals	

Assignments

46

I **Which of the following pairs of decimals consists of like decimals. Put a ‘tickmark’ /) against like decimals.**

(i) 79.9 , 7.99

(ii) 1.52, 0.152

(iii)9.13, 6.27

(iv)3.9 , 13.7

(v) 3.003 , 3.030

II. **Convert each of the following groups of unlike decimals into groups of like decimals.**

(i) 7.8 , 8.71

(ii) 17.1 , 27.6, 3.28

(iii)24.93 , 2.493, 249.3

(iv)2.718, 13.29, 650.014

(v) 200.01, 13.4, 9.00

III. **Write two equivalent decimals for each of the given decimal**

(i) 8.03

(ii) 2.1

(iii) 27.4

(iv)309.16

(v) 57.24

APPENDIX - III

STANDARD
PROGRESSIVE MATRICES
SETS A, B, C, D, & E

Name ______________________ Ref. No. ____________

Place ______________________ Date ____________

Age ______________________ Birthday ____________

Test begun ______________ Test ended ____________

A			B			C			D			E		
1			1			1			1			1		
2			2			2			2			2		
3			3			3			3			3		
4			4			4			4			4		
5			5			5			5			5		
6			6			6			6			6		
7			7			7			7			7		
8			8			8			8			8		
9			9			9			9			9		
10			0			10			10			10		
11			11			11			11			11		
12			12			12			12			12		

Time	Total	Grade

Tested by ______________________

APPENDIX V - A

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

TEST OF NUMERICAL ABILITY

This is a test intended to know your ability in the fundamental operations with numbers and your understanding of number concepts and relationships. For each question, 4 choices are given, indicated by A, B, C and D only one answer will be correct. Findout the answer for each question and put the mark 'X' on the appropriate letter against each question in the answer sheet. Separate answer sheet will be provided for answering. Do not make any mark on the question paper. If you want to change your answer put a $\square$ (a small square) on 'X' and then put another 'X' against the correct answer.

Model

Simplify 2 + 4 + 3

A 6 B 7 C 9 D5

The correct answer is '9' indicated by the letter C. Hence put the mark 'X' on C.

In this test there are 10 sections. In each section the operations with numbers are different. Carefully read the questions and answer all the given questions in each section.

SECTION A

(In this section ten questions are given. In each case findout the place value of the underlined digit of the numeral).

1. 76$\underline{2}$3

   [A. ones   B. tens   C. hundreds   D. thousands]

2. 8$\underline{4}$09

   [A. ones   B. tens   C. hundreds   D. thousands]

3. 400$\underline{3}$

   [A. ones   B. tens   C. hundreds   D. thousands]

4. 7$\underline{6}$120

   [A. ones   B. tens   C. hundreds   D. thousands]

5. $\underline{2}$769

   [A. tens   B. hundreds   C. thousands   D. ten thousands]

6. $\underline{8}$7961

   [A. tens   B. hundreds   C. thousands   D. ten thousands]

7. 1$\underline{2}$3640

   [A. hundreds   B. thousands   C. ten thousands   D. lakhs]

8. $\underline{3}$56721

   [A. hundreds   B. thousands   C. ten thousands   D. lakhs]

9. 1$\underline{6}$5802793

   [A. lakhs   B. ten lakhs   C. crores   D. ten crores]

10. 2$\underline{4}$018697

    [A. lakhs   B. ten lakhs   C. crores   D. ten crores]

29

SECTION B

(10 questions are given in this section. For each question findout the correct numerical from the bracket.)

1. Four hundred fifty two

   [A. 4052 B. 452 C. 42 D. 425]

2. Three thousand seventy four

   [A. 3074 B. 374 C. 30074 D. 30704]

3. Nine thousand nine hundred

   [A. 0990 B. 9090 C. 990 D. 9900]

4. Three thousand one hundred seven

   [A. 300107 B. 30107 C. 3107 D. 31007]

5. Ten thousand one

   [A 10100 B 10010 C 1001 D 10001]

6. Eleven thousand nine hundred ninenty nine

   [A. 11999 B. 1199 C. 11099 D. 110099]

7. One lakh

   [A. 1000 B. 10000 C. 100000 D. 1000000]

8. Forty thousand two hundred five

   [A. 400205 B. 40205 C. 402005 D. 4025]

9. Nine hundred thousand

   [A. 9000000 B. 900000 C. 90000 D. 9000]

10. One lakh ten thousand one

    [A. 101001 B. 100101 C. 110001 D. 11001]

50

SECTION C

(Simplify the 10 questions given in this section using the fundamental operation addition, choose the correct answer from the bracket).

1. 6 + 3 + 5

   [A. 12 B. 13 C. 14 D. 15]

2. 24 + 13

   [A. 47 B. 37 C. 57 D. 36]

3. 86 + 48

   [A. 124 B. 135 C. 144 D. 134]

4. 368 + 243

   [A. 511 B. 611 C. 621 D. 612]

5. 3552 + 4037

   [A. 6589 B. 7689 C. 7589 D. 7579]

6. 12531 + 3407

   [A. 15938 B. 16938 C. 15838 D. 15948]

7. 1432 + 809 + 189

   [A. 2330 B. 2428 C. 1430 D. 2430]

8. 10001 + 9999

   [A. 19991 B. 199991 C. 2000 D. 20000]

9. 243563 + 124138

   [A. 266701 B. 367701 C. 267601 D. 267791]

10. 731034 + 10991 + 327897

    [A. 969922 B. 1069922 C. 1068922 D. 1069822]

5

SECTION D

(Simplify the given ten questions and pickout the correct answer from the bracket).

1. 11 – 6

   [A. 6 B. 4 C. 7 D. 5]

2. 84 – 12

   [A. 62 B. 72 C. 82 D. 71]

3. 91 – 36

   [A. 55 B. 65 C. 45 D. 56]

4. 247 – 52

   [A. 195 B. 196 C. 194 D. 186]

5. 9367 – 7347

   [A. 1020 B. 2010 C. 2020 D. 2030]

6. 76532 – 20496

   [A. 56035 B. 56036 C. 56046 D. 55036]

7. 3000 – 40

   [A. 2960 B. 2860 C. 2950 D. 2940]

8. 37100 – 765

   [A. 3635 B. 35335 C. 36345 D. 36335]

9. 10001 – 99

   [A. 9802 B. 9901 C. 9902 D. 8902]

10. 287321 – 163804

    [A. 123507 B. 123517 C. 123417 D. 123527]

SECTION E

(10 questions are given in this section. Choose the correct answer from the four given choices by finding the product of the given numbers).

1. $287 \times 1 =$

   [A. 287　　B. 286　　C. 288　　D. 0]

2. $3493 \times 0 =$

   [A. 3493　　B. 3494　　C. 3492　　D. 0]

3. $47 \times 10 =$

   [A. 47　　B. 57　　C. 470　　D. 0]

4. $173 \times 100 =$

   [A. 273　　B. 17300　　C. 1730　　D. 173]

5. $12 \times 4 =$

   [A. 24　　B. 16　　C. 58　　D. 48]

6. $15 \times 40 =$

   [A. 600　　B. 60　　C. 6000　　D. 55]

7. $234 \times 3 =$

   [A. 468　　B. 234　　C. 702　　D. 237]

8. $325 \times 15 =$

   [A. 4550　　B. 4875　　C. 5200　　D. 340]

9. $74 \times 42 =$

   [A. 2108　　B. 3108　　C. 3008　　D. 3118]

10. $437 \times 111 =$

    [A. 49507　　B. 48407　　C. 48507　　D. 48307]

SECTION F

(Divided the following numbers and findout the quotient in each case from the four given choices)

1. $0 \div 87 =$

   [A. 1   B. 0   C. 87   D. 78]

2. $27 \div 1 =$

   [A. 27   B. 28   C. 26   D. 1]

3. $382 \div 382 =$

   [A. 0   B. 1   C. 382   D. 381]

4. $373 \div 10 =$

   [A. 3730   B. 373   C. 37   D. 3]

5. $4175 \div 100 =$

   [A. 4175   B. 417   C. 41   D. 4]

6. $56 \div 7 =$

   [A. 49   B. 63   C. 7   D. 8]

7. $72 \div 12 =$

   [A. 84   B. 4   C. 5   D. 6]

8. $1650 \div 50 =$

   [A. 33   B. 30   C. 40   D. 32]

9. $1989 \div 9 =$

   [A. 219   B. 221   C. 231   D. 211]

10. $5157 \div 27 =$

    [A. 291   B. 192   C. 191   D. 181]

SECTION G

(Identify the correct symbol from the bracket to fill the blank in each case. 10 questions are given)

1. 9 4

   [A. < B. > C. = D. ≤]

2. 46 64

   [A. < B. > C. = D. ≥]

3. 76 67

   [A. = B. < C. > D. ≤]

4. 106 160

   [A. > B. ≥ C. = D. <]

5. 286 268

   [A. > B. = C. < D. ≤]

6. 1090 1009

   [A. = B. > C. < D. ≤]

7. 7654 7560

   [A. = B. > C. < D. ≥]

8. 78031 30470

   [A. > B. < C. = D. ≤]

9. 23179 23179

   [A. > B. < C. ≠ D. =]

10. 583456 583564

    [A. ≤ B. < C. > D. =]

SECTION H

(For questions 1 to 5 choose the correct successor of each number from the given options).

1. 36

   [A. 0   B. 1   C. 36   D. 37]

2. 100

   [A. 101   B. 100   C. 1   D. 99]

3. 2174

   [A. 2274   B. 2184   C. 2176   D. 2175]

4. 7089

   [A. 7088   B. 7090   C. 7091   D. 7089]

5. 9999

   [A. 1000   B. 10000   C. 99999   D. 9998]

(Four questions 6 to 10 choose the correct predecessor of each from the bracket)

6. 2

   [A. 0   B. 1   C. 2   D. 3]

7. 10

   [A. 9   B. 10   C. 11   D. 0]

8. 481

   [A. 491   B. 482   C. 480   D. 479]

9. 2670

   [A. 2671   B. 2670   C. 2669   D. 2660]

10. 10000

    [A. 10001   B. 99999   C. 999   D. 9999]

SECTION I

(10 number series are given in this section. Carefully study each series and findout the missing number).

1. 78 76 74 .....

   [A. 70 B. 72 C. 73 D. 75]

2. 25 50 75 .....

   [A. 0 B. 1 C. 100 D. 90]

3. 25 50 75 .....

   [A. 0 B. 1 C. 100 D. 80]

4. 12 24 36 .....

   [A. 46 B. 42 C. 38 D. 48]

5. 64 16 4 .....

   [A. 0 B. 1 C. 2 D. 8]

6. 3727 3728 3729 .....

   [A. 3730 B. 3739 C. 3829 D. 3720]

7. 3156 3166 3176 .....

   [A. 3276 B. 3286 C. 3186 D. 3177]

8. 3712 3812 3912 .....

   [A. 3922 B. 3913 C. 4912 D. 4012]

9. 2007 3007 4007 .....

   [A. 4006 B. 4008 C. 4017 D. 5007]

10. 48156 58156 68156 .....

    [A. 78156 B. 69156 C. 68256 D. 68166]

SECTION J

(In this section there are ten questions. For each question pickout the correct measure for the given unit)

1. 1 metre = ... centimeters

   [A. 1 B. 10 C. 100 D. 1000]

2. 1 kilogram = ... grams

   [A. 1 B. 10 C. 100 D. 1000]

3. .... litres = 1 kilo litre

   [A. 1000 B. 100 C. 10 D. 1]

4. 1 kilogram = ... hectogram

   [A. 1000 B. 100 C. 10 D. 1]

5. 1 kilometre = ... decagram

   [A. 1000 B. 100 C. 10 D. 1]

6. 1 hectormetre = 10 ....

   [A. kilometre B. decametre C. metre D. decimetre]

7. 1 litre = 10 ....

   [A. millilitre B. centilitre C. decilitre D. dekalitre]

8. 1 dekagram = ... centigram

   [A. 1 B. 10 C. 100 D. 1000]

9. 1000 litres = 1 ....

   [A. kilolitre B. hectolitre C. dekalitre D. litre]

10. .... hectometre = 1 kilometre

    [A. 10 B. 100 C. 1000 D. 10000]

APPENDIX - IV B

RESULTS OF ITEM ANALYSIS OF TEST OF NUMERICAL ABILITY

SECTION - A

Sl. No	U	L	$D_I = \frac{U+L}{2N}$	$D_p \frac{U-L}{N}$	Item omitted/ selected
1	25	21	.92	.16	O
2	24	20	.88	.16	O
3	23	15	.76	.32	S
4	24	18	.84	.24	O
5	24	15	.78	.36	S
6	25	20	.90	.20	O
7	23	15	.76	.32	S
8	24	14	.76	.40	S
9	22	12	.68	.40	S
10	21	15	.72	.24	O

SECTION-B					
Sl. No	U	L	$D_I = \frac{U+L}{2N}$	$D_p \frac{U-L}{N}$	Item omitted/ selected
1	25	20	.90	.20	O
2	25	21	.92	.16	O
3	25	22	.94	.12	O
4	24	21	.90	.12	O
5	24	19	.86	.20	O
6	23	15	.76	.32	S
7	24	16	.80	.32	S
8	25	15	.80	.40	S
9	23	15	.76	.32	S
10	22	4	.52	.72	S

SECTION – C

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$D_P = \frac{U-L}{N}$	Item Omitted/selected
1	25	20	.90	.20	O
2	25	22	.94	.12	O
3	24	17	.82	.28	O
4	25	19	.88	.24	O
5	23	15	.76	.32	O
6	25	15	.80	.40	O
7	24	16	.80	.32	S
8	22	14	.72	.32	S
9	23	10	.66	.52	S
10	21	8	.58	.52	S

SECTION – D

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	25	20	.90	.20	O
2	25	22	.94	.12	O
3	24	17	.82	.28	O
4	25	19	.88	.24	O
5	23	15	.76	.32	S
6	25	22	.94	.12	O
7	24	16	.80	.32	S
8	22	14	.72	.32	S
9	23	10	.66	.52	S
10	21	8	.58	.52	S

SECTION – E

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	25	23	.96	.08	O
2	25	15	.80	.40	S
3	24	20	.88	.16	O
4	24	19	.86	.20	O
5	25	19	.88	.24	O
6	23	15	.76	.32	S
7	25	12	.74	.52	S
8	24	7	.62	.68	S
9	22	11	.66	.44	S
10	22	5	.54	.68	S

SECTION – F

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	23	11	.68	.48	S
2	24	22	.92	.08	O
3	25	19	.88	.24	O
4	22	14	.72	.32	S
5	20	13	.66	.28	O
6	21	14	.70	.28	O
7	25	9	.68	.64	S
8	22	9	.62	.52	S
9	24	5	.58	.76	S
10	17	10	.54	.28	O

SECTION – G

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	25	23	.96	.08	O
2	25	21	.92	.16	O
3	25	15	.80	.40	S
4	25	14	.78	.44	S
5	24	18	.84	.24	O
6	23	20	.86	.12	O
7	23	15	.76	.32	S
8	22	14	.72	.32	S
9	25	20	.90	.20	O
10	20	12	.64	.32	S

SECTION – H

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	25	20	.90	.20	O
2	25	21	.92	.16	O
3	25	18	.86	.28	O
4	25	16	.82	.36	O
5	23	15	.76	.32	O
6	25	17	.84	.32	S
7	25	16	.82	.36	S
8	23	9	.64	.56	S
9	24	10	.68	.56	S
10	22	7	.58	.60	S

SECTION – I

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	24	8	.64	.64	S
2	23	15	.76	.32	S
3	18	11	.58	.28	O
4	20	17	.74	.12	O
5	17	10	.54	.28	O
6	23	11	.68	.48	S
7	22	16	.76	.24	O
8	22	14	.72	.32	O
9	24	10	.68	.56	S
10	23	8	.62	.60	S

SECTION – J

Sl. No.	U	L	$D_I = \frac{U+L}{2N}$	$.D_p = \frac{U-L}{N}$	Item omitted/ selected
1	23	9	.64	.56	S
2	25	10	.70	.60	S
3	20	4	.48	.64	S
4	10	5	.30	.20	O
5	12	5	.34	.28	O
6	13	4	.34	.36	S
7	12	8	.40	.16	O
8	9	6	.30	.12	0
9	16	3	.38	.52	S
10	11	4	.30	.28	O

APPENDIX V - A

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

TEST OF NUMERICAL ABILITY

This is a test intended to know your ability in the fundamental operations with numbers and your understanding of number concepts and relationships. For each question, 4 choices are given, indicated by A, B, C and D only one answer will be correct. Findout the answer for each question and put the mark 'X' on the appropriate letter against each question in the answer sheet. Separate answer sheet will be provided for answering. Do not make any mark on the question paper. If you want to change your answer put a □ (a small square) on 'X' and then put another 'X' against the correct answer.

Model

Simplify 2 + 4 + 3

A 6 B 7 C 9 D5

The correct answer is '9' indicated by the letter C. Hence put the mark 'X' on C.

In this test there are 10 sections. In each section the operations with numbers are different. Carefully read the questions and answer all the given questions in each section.

SECTION - A

(In this section five questions are given. In each case find out the place value of the underlined digit)

1. $\underline{8}7961$

   [A tens B hundreds C thousands D ten thousands]

2. $1\underline{2}3640$

   [A hundreds B thousands C ten thousands D lakhs]

3. $\underline{3}56721$

   [A hundreds B thousands C ten thousands D lakhs]

4. $1\underline{6}5802793$

   [A lakhs B ten lakhs C crores D ten crores]

5. $2\underline{4}018697$

   [A lakhs B ten lakhs C crores D ten crores]

SECTION B.

(Find out the correct numerical form from the bracket)

1. Nine thousand nine hundred

   [A 0990 B 10010 C 9009 D 9900

2. Ten thousand one

   [A 10100 B 10010 C 1001 D 10001

3. one lakh

   [A 1000 B 10000 C 100000 D 1000000]

4. Forty thousand two hundred and five.

   [A 400205 B 40205 C 40205 D 4025]

5. Nine hundred thousand

   [A 9000000 B 900000 C 90000 D 9000]

SECTION C

(Simplify the given questions using the fundamental operation addition, and choose the correct answer from the bracket)

1. 12531 + 3407

   [A 15938 B 16938 C 15838 D 15948]

2. 1432 + 809 + 189

   [A. 2330 B 2428 C 1430 D 2430]

3. 10001 + 9999

   [A 19991 B 199991 C 2000 D 20000]

4. 243563 + 124138

   [A 266701 B 367701 C 267601 D 267791]

5. 731034 + 10991 + 327897

   [A 969922 B 1069922 C 1068922 D 1069822]

SECTION D

(Simplify the given five questions and pick out the correct answer from bracket)

1. 9367 – 7347

   [A 1020 B 2010 C 2020 D 2030]

2. 3000 - 40

   [A 2960 B 2860 C 2950 D 2940]

3. 37100 - 765

   [A 3635 B 35335 C 36345 D 36335]

4 10001 - 99

   [A 9802 B 9901 C 9902 D 8902]

5 287321 - 163804

   [A 123507 B 123517 C 123417 D 123527]

SECTION E

(Choose the correct answer from the four given choices by finding the product of the given numbers)

1. 3493 x 0

   [A 3493 B 3494 C 3495 D 0]

2. 234 x 3

   [A 468 B 234 C 702 D 237]

3. 825 x 15

   [A 4550 B 4875 C 5200 D 340]

4. 74 x 42

   [A 2108 B 3108 C 3008 D 3118]

5. 437 x 111

   [A 49507 B 48407 C 48507 D 48307]

SECTION F

(Divide the following numbers and find out the quotient in each case)

1. 0 ÷ 87

   [A 1 B 0 C 8 D 7]

2. 373 ÷ 10

   [A 3730 B 373 C 37 D 3]

3. 72 ÷ 12

   [A 84 B 4 C 5 D 6]

4. 1650 ÷ 50

   [A 33 B 30 C 40 D 32]

5. 1989 ÷ 9

   [A 219 B 221 C 231 D 211]

SECTION G

(Identify the correct symbol from the bracket to fill the blank in each case)

1. 76 67

   [A = B < C > D ≤]

2. 106 160

   [A > B ≥ C = D]

3 7654 7560

   [A = B > C < D ≥]

4 78031.....30470

   [A > B < C = D ≤]

5 583456.........583564

   [A ≤ B < C > D =]

SECTION H

(For each five question choose the correct predecessor from the bracket)

1. 2

   [A 0 B 1 C 2 D 3]

2. 10

   [A 9 B 10 C 11 D 0]

3. 481

   [A 491 B 482 C 480 D 479]

4. 2670

   [A 2671 B 2670 C 2669 D 2660]

5. 10000

   [A 10001 B 99999 C 999 D 9999

SECTION I

(Carefully study each series and find out the missing number)

1. 78 76 74 ....

   [A 70 B 72 C 73 D 75]

2. 25 50 75 ...

   [A 0 B 1 C 100 D 90]

3. 3727 3728 3729 ....

   [A 3730 B 3739 C 3829 D 3720]

4. 2007 3007 4007 ....

   [A 4006 B 4008 C 4017 D 5007]

5. 48156 58156 68156 ....

   [A 78156 B 69156 C 68256 D 68166]

SECTION J

(Five questions are given, pick out the correct answer to fill the blanks)

1. 1 metere = ...centimeters

   [A 1 B 10 C 100 D 1000]

2. 1 Kilogram = ...grams

   [A 1 B 10 C 100 D 1000]

3. ....liter = 1 kilolitre.

   [A 1000 B 100 C 10 D 1]

4. 1 hectometre = 10............

   [A kilolitre B decametre C metre D decimetre]

5. 1000 litre = 1........

   [A kilolitre B hectoliter C deckalitre D litre] bn

APPENDIX - V A

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

TEST OF ACHIEVEMENT IN MATHEMATICS FOR UPPER PRIMARY PUPILS.

Dr. Kamala. S. Pillai.
Professor of Education (Retired)

Jayasree N.
Research Scholar

INSTRUCTIONS Time: 2 hour

This is a test in fractions and decimals. Answer all the questions. Do not write anything in the question paper. Write your answers in the answer sheet provided . The serial number of the questions are given in the answer sheet. For each question it is written A,B,C and D in the answer sheet. Find out the correct answer for each questions and put a mark 'X' aganist the correct letter A,B,C or D in the response sheet. If you want to change your answers , put a (a small square) on your 'X' and then put another 'X' aganist the correct answer.

Model.

Four fractions are given below. Find out the highest fraction among them.

$\frac{4}{7}$ $\frac{4}{10}$ $\frac{4}{8}$ $\frac{4}{9}$

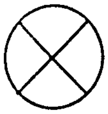
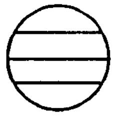
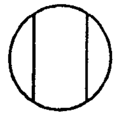
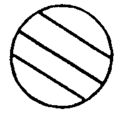
$\left\{ A\ \frac{4}{7} \quad B\ \frac{4}{8} \quad C\ \frac{4}{9} \quad D\ \frac{4}{10} \right\}$

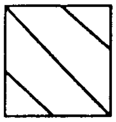
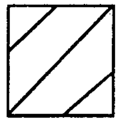
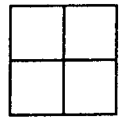
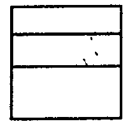
Mark your answer like this

Q. No: ~~A~~ B C D

The correct answer is $\frac{4}{7}$ indicated by the letter A. Put the mark 'X' ons A.Similarly answer all the questions.

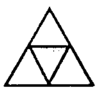
For figures are given under each question in 1 to 3. In each which one among the given figures is equally divided.

1. A  B  C  D 

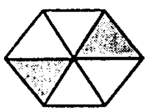
2. A  B  C  D 

3. A  B  C  D 

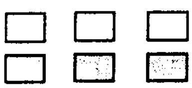
Write the fraction of the shaded portions or object in the given figures in questions 4,5 and 6. In each question 4 fractions are given, only one is correct.

4. 

{A $\frac{3}{4}$ B $\frac{1}{4}$ C $\frac{1}{3}$ D $\frac{4}{1}$}

5. 

{A $\frac{4}{6}$ B $\frac{6}{2}$ C $\frac{2}{6}$ D $\frac{6}{4}$}

6. 

{A $\frac{3}{6}$ B $\frac{2}{6}$ C $\frac{4}{6}$ D $\frac{1}{6}$}

Four fractions are given in questions 7 and 8 find out the correct fraction.

7. Numerator is 3 and denominator is 7

{A $\frac{7}{3}$ B $\frac{3}{7}$ C 3.7 D 7.3}

8. Two -fifth, the correct fraction is

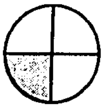
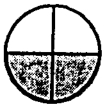
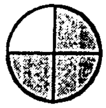
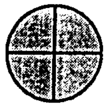
{A 2.5 B $\frac{5}{2}$ C 5.2 D $\frac{2}{5}$}

In questions 9,10,11 and 12 find out the correct figure indicating the given fraction

9. $\frac{1}{2}$

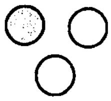
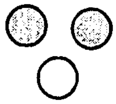
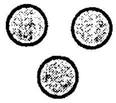
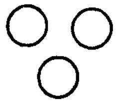
{A  B  C  D }

10. 4

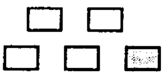
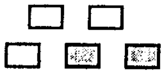
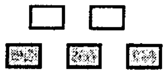
{A  B  C  D  }

7\

11. $\frac{2}{3}$

{A  B  C  D  }

12. $\frac{3}{5}$

{A  B  C  D  }

Choose the correct example from the bracket for the questions 13 to 18.

13. Like fractions

{A $\frac{2}{7}$ $\frac{4}{7}$ B $\frac{2}{7}$ $\frac{7}{4}$ C $\frac{7}{2}$ $\frac{4}{7}$ D $\frac{7}{2}$ $\frac{7}{4}$ }

14. Unlike fractions

{A $\frac{2}{7}$ $\frac{4}{7}$ B $\frac{2}{7}$ $\frac{4}{4}$ C $\frac{2}{2}$ $\frac{4}{2}$ D $\frac{7}{2}$ $\frac{7}{4}$ }

15. Proper fraction

{A $\frac{4}{5}$ B $\frac{5}{4}$ C $\frac{4}{4}$ D $\frac{5}{5}$ }

16. Improper fraction.

{A $\frac{4}{5}$ B $\frac{5}{4}$ C $\frac{4}{4}$ D $\frac{5}{5}$ }

17. Mixed fraction

{A $\frac{6}{6}$ B $\frac{6}{7}$ C $\frac{7}{6}$ D $1\frac{1}{6}$ }

18. Unit fraction

{A $\frac{6}{6}$ B $\frac{6}{7}$ C $\frac{7}{6}$ D $1\frac{1}{6}$ }

19. Which is the correct fraction of $\frac{20}{3}$ if it is converted in to a mixed fraction.

{A $2\frac{3}{6}$ B $3\frac{2}{6}$ C $6\frac{2}{3}$ D $6\frac{3}{2}$ }

20. Which is the correct fraction among the given fractions if $7\frac{1}{3}$ is converted in to im proper fraction

{A $\frac{3}{22}$ B $\frac{11}{3}$ C $\frac{21}{3}$ D $\frac{22}{3}$ }

Four fractions are given in questions 21 and 22. Find out the smallest fractions among the given.

21. $\frac{3}{5}$ $\frac{1}{5}$ $\frac{4}{5}$ $\frac{2}{5}$

{A $\frac{1}{5}$ B $\frac{2}{5}$ C $\frac{3}{5}$ D $\frac{4}{5}$ }

22. $\frac{6}{4}$ $\frac{6}{3}$ $\frac{6}{5}$ $\frac{6}{2}$

{A $\frac{6}{2}$ B $\frac{6}{3}$ C $\frac{6}{4}$ D $\frac{6}{5}$ }

For the questions 23 and 24 find out the highest fraction from the given four fractions.

23. $\frac{2}{4}$ $\frac{1}{4}$ $\frac{3}{4}$ $\frac{4}{4}$

{A $\frac{1}{4}$ B $\frac{2}{4}$ C $\frac{3}{4}$ D $\frac{4}{4}$ }

24. $\frac{7}{4}$ $\frac{7}{3}$ $\frac{7}{1}$ $\frac{7}{2}$

{A $\frac{7}{1}$ B $\frac{7}{2}$ C $\frac{7}{3}$ D $\frac{7}{4}$ }

For questions 25 to 27, indentify the correct fraction

25. If $\square\square$=1 , then what is $\square$?

{A $\frac{2}{1}$ B $\frac{1}{2}$ C 2 D 1 }

26. If $\begin{array}{|c|c|}\hline & \\ \hline & \\ \hline \end{array}$ = 1, then what is $\square\square\square$

{A 3 B $\frac{4}{3}$ C $\frac{3}{4}$ D $\frac{1}{3}$ }

27. If $\square\square\square\square\square\square\square\square\square$ =1, then what is $\square\square\square$?

{A 3 B $\frac{9}{3}$ C $\frac{3}{9}$ D $\frac{1}{3}$ }

28. Choose the correct symbol to match the blank

$\frac{6}{9}$ .... $\frac{4}{9}$

{A > B< C = D none of these}

29. Find the number of objects in $\frac{1}{4}$ part of the given collection

△ △ △ △
△ △ △ △
△ △ △ △

{A 12 B 6 C 4 D 3}

30. Which of the given fraction is equal to 2 1/3

$\left\{ A\ \frac{5}{3} \quad B\ \frac{7}{3} \quad C\ \frac{2}{3} \quad D\ \frac{6}{3} \right\}$

From questions 31 to 34 choose the correct fraction from the bracket to fill the blank.

31. $\frac{3}{7} = \frac{9}{\square}$

{A 7 B 14 C 21 D 3}

32. $2\frac{1}{4} = \frac{18}{\square}$

{A 7 B 8 C 9 D 10}

33. $\frac{4}{3} = \frac{\square}{15}$

{A = 5 B 15 C 10 D 20}

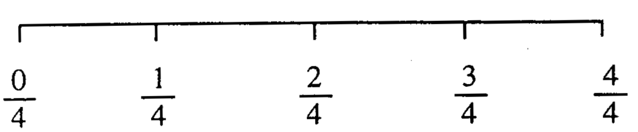
34. $\frac{9}{2} = \square\frac{1}{2}$

{A 4 B 3 C 2 D 5}

35. Which of the given fraction is equal to $\frac{'2'}{3}$

$\left\{ A\ \frac{2}{3} \quad B\ \frac{4}{9} \quad C\ \frac{20}{30} \quad D\ \frac{6}{6} \right\}$

36. Which is the equalent fraction of $\frac{1}{2}$ from the given number line.



$\left\{ A\ \frac{1}{4} \quad B\ \frac{2}{4} \quad C\ \frac{3}{4} \quad D\ \frac{4}{4} \right\}$

78

37. If the fractions $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{4}$ $\frac{2}{6}$ are arranged in the ascending order.

{A $\frac{2}{7}$ $\frac{2}{6}$ $\frac{2}{5}$ $\frac{2}{4}$

B $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{6}$ $\frac{2}{4}$

C $\frac{2}{4}$ $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{6}$

D $\frac{2}{4}$ $\frac{2}{5}$ $\frac{2}{6}$ $\frac{2}{7}$}

38. If the fractions $\frac{7}{10}$ $\frac{9}{10}$ $\frac{6}{10}$ $\frac{8}{10}$ are arranged in the descending order

{A $\frac{7}{10}$ $\frac{9}{10}$ $\frac{8}{10}$ $\frac{6}{10}$

B $\frac{6}{10}$ $\frac{7}{10}$ $\frac{8}{10}$ $\frac{9}{10}$

C $\frac{9}{10}$ $\frac{8}{10}$ $\frac{7}{10}$ $\frac{6}{10}$

D $\frac{8}{10}$ $\frac{6}{10}$ $\frac{7}{10}$ $\frac{9}{10}$}

39. Questions 39 to 41 choose the correct number from the bracket to make the fractions equal.

$6\frac{\square}{5} = 7$

{A 4 B 5 C 6 D 7}

40. $11 = 10\frac{\square}{6}$

{A 3 B 4 C 5 D 6}

41. $15\frac{5}{10} = 14\frac{\square}{10}$

{A 5 B 1 C 10 D 15}

42. Find the fraction in between $\frac{5}{8}$ and $\frac{3}{4}$ having 32 as denominator.

{A $\frac{18}{32}$ B $\frac{22}{32}$ C $\frac{20}{32}$ D $\frac{26}{32}$ }

Which whole number for make the statement true for questions 43 and 44.

43. $\frac{\square}{9} = \frac{4}{\square}$

{A 36 B 16 C 81 D 6}

44. $\frac{2}{\square} = \frac{\square}{8}$

{A 4 B 10 C 16 D 64}

From questions 44 to 48 fill in the blanks by choosing the correct number from the bracket.

45. $\frac{5}{9} + \frac{\square}{9} = \frac{8}{9}$

{A 9 B 8 C 5 D 3}

46. $\frac{11}{15} - \frac{7}{5} = \frac{\square}{15}$

{A 3 B 4 C 7 D 11}

47. $\frac{1}{7} + \frac{2}{7} + \frac{\square}{7} = \frac{6}{7}$

{A 1 B2 C 3 D6}

48. $\frac{\square}{4} - \frac{1}{4} = \frac{2}{4}$

{ A 3 B 2 C 1 D 4}

49. Is the value of $\frac{2}{5} + \frac{2}{5} + \frac{2}{3}$ equal to $3 \times \frac{2}{5}$

{A true B false C none of these D all the above}

50. Which is the lowest form of the fraction 4/16

{A $\frac{4}{8}$ B $\frac{2}{4}$ C $\frac{2}{8}$ D $\frac{1}{4}$ }

Simplify the questions 51 to 62

51. $5\frac{1}{4} + 4\frac{1}{5}$

{A $9\frac{1}{9}$ B $\frac{189}{20}$ C $9\frac{1}{4}$ D $9\frac{1}{5}$ }

52. $2\frac{2}{3} + 3\frac{1}{2}$

{ A $\frac{37}{2}$ B $\frac{3}{5}$ C $\frac{37}{6}$ D $5\frac{3}{3}$ }

53. $\frac{5}{8} - \frac{1}{4}$

{ A $\frac{3}{4}$ B $\frac{4}{4}$ C $\frac{8}{3}$ D $\frac{3}{8}$ }

54. $3\frac{1}{2} - 2\frac{1}{3}$

{ A $\frac{1}{2}$ B $\frac{7}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$ }

55. $4\frac{1}{5} - 3\frac{1}{3}$

{ A $\frac{13}{15}$ B $\frac{7}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$ }

56. $4\frac{1}{2} \times 5$

{ A $20\frac{1}{2}$ B $4\frac{5}{2}$ C $4\frac{1}{10}$ D $22\frac{1}{2}$ }

57. $\frac{2}{5} \div \frac{4}{15}$

{ A $\frac{8}{5}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D $\frac{8}{15}$ }

58. $4\frac{1}{2} \times 2\frac{2}{9}$

{ A $8\frac{2}{18}$ B 10 C $4\frac{1}{18}$ D $8\frac{1}{18}$ }

59. $\frac{1}{7} \times \frac{28}{3}$

{ A $\frac{28}{7}$ B $\frac{28}{3}$ C $\frac{28}{10}$ D $\frac{4}{3}$ }

60. $\frac{3}{5} \div 3$

{ A $\frac{1}{5}$ B $\frac{9}{5}$ C $\frac{3}{15}$ D $\frac{5}{3}$ }

61. $10\frac{1}{2} \div 3\frac{1}{2}$

{ A 3 B $30\frac{1}{2}$ C $30\frac{1}{4}$ D $\frac{10}{3}$ }

62. $5\frac{1}{3} \div \frac{1}{3}$

$\{$A $\frac{16}{9}$ B $\frac{1}{5}$ C 5 D 16$\}$

In questions 63 to 68 some statements are given choose the correct answer from the bracket.

63. When are multiply the numerator and denominator with same number are will get an equivalent fraction

A always false B always true

C sometimes false D some times true

64. The product of the fractional number and the multiplicative inverse of the fractional number will be one

A always true C may be true

B sometimes true D none of thes

65. A number has only one multiplicative inverse.

A false B true

C sometimes false D sometimes true

66. If the cross product of two fractional number are equal then the fractions are equivalent fractions.

A always true B sometimes true

C always false D sometimes false

67. Fractions with different denominators are called like fractions

A sometimes true B sometimes false

C always true D always false}

68. One is the only number whose multiplicative inverseis not a fractional number

A Both true and false B false

C true D none of these

69. Paul had a rope of 3 1/2 m length and Rahim 3 1/4 m length. whose rope is longer.

A Rahim B Paul

C Equal D none of these

70. Which are the fractions whose sum is 1 and difference is ——

$\{$A $1, \frac{1}{2}$ B $\frac{1}{4}$ $\frac{3}{4}$ C $\frac{2}{3}$ $\frac{1}{2}$ D $\frac{1}{2}$ $\frac{1}{4}$ $\}$

71. Which mixed numeral with only odd digits, so that the mixed numeral represents an even whole number.

$\{$A $1\frac{9}{3}$ B $1\frac{3}{9}$ C $3\frac{1}{9}$ D $9\frac{1}{3}$ $\}$

In questions 72 to 74 , number series are given. Find out the correct number to fill the blank.

78

72. $\frac{3}{6}$. 1 1 $\frac{3}{6}$ ....

{A 3 B 2 C 4 D 2 $\frac{3}{6}$ }

73. 1 $\frac{1}{2}$ 3 4 $\frac{1}{2}$ ....

{A 9 B 8 C 6 D 12 $\frac{1}{2}$ }

74. 4 2 1 ....

{A 2.1 B 1.2 C $\frac{2}{1}$ D $\frac{1}{2}$ }

75. Study the pattern of the fractions given below :

$$\frac{1}{2} = \frac{1}{2}$$

$$\frac{1}{2} + \frac{1}{4} = \frac{3}{4}$$

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{7}{8}$$

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = \frac{15}{16}$$

Applying the pattern, find out the answer for the given question.

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} = \text{..................}$$

{A $\frac{31}{32}$ B $\frac{31}{24}$ C $\frac{22}{24}$ D $\frac{22}{32}$ }

Find out the decimal for the given in questions 76 to 80

76. $\frac{7}{100}$

{ A .07 B .007 C .7 D 7.0}

77. 9 $\frac{1}{10}$

{ A 91.0 B 9.01 C 9.1 D .91}

78. 8 tens + 4 ones + 6 tenths

{A 84.06 B .846 C 8.46 D 84.6}

79. 6 tens + 9 thousandths

{A 60.09 B 60.009 C 60.9 D 60.090}

80. If $\square\square\square\square\square\square\square\square\square\square$ =1 then what is $\square\square$?

{A 0.002 B 2.0 C 0.2 D 0.02}

81. $\square\square\square\square\square$ = 1, what is $\square\square\square$?

{A 0.6 B 0.3 C 3.5 D 5.3}

For questions 82 and 83 find the correct fraction.

82. 0.50

$\left\{ A\ \frac{50}{10} \quad B\ \frac{5}{10} \quad C\ \frac{5}{100} \quad D\ \frac{50}{1000} \right\}$

83. 7.04

$\left\{ A\ \frac{704}{1000} \quad B\ \frac{74}{1000} \quad C\ 7\frac{4}{10} \quad D\ 7\frac{4}{100} \right\}$

Find out place valueof the digit underlined in the given decimals for questions 84 and 85.

84. 28.<u>6</u>4

{A thousandth B hundredth C ones D thenth}

85. 8.00<u>9</u>

{A tenth B hundredth C thousandth D hundred}

Find an equivalent decimal for the given decimaly

86. 0.6

{A 0.06 B 0.60 C 6.06 D 6.60}

like

Find out the decimal for the given decimal

87. 1.72

{A 17.2 B .172 C 3.45 D 8.9}

Questions 88 to 94 fill in the blanks

88. 0.13 = 0.013, It is ....

{A always false B always true C sometimes true D may be true}

89. 0.9 = 0.900 It is ....

{A always false B sometimes false C sometimes true D always true}

90. 3.620 kg = ...

{A 3620 gm B 3 gm 620 kg C 3kg 620kg D 3gm 620gm}

91. 21.03 = ...

{A 21 m 3 cm B 2103 mm C 21mm 3cm D 21.03 mm}

92. Rs 10.75 = ...

{A 10.75 paisee B 1075 rupees C 107500 paisee D 1075 paisee

93. 23.50 lt. = ...

{ A 2350 ml. B 2350 lt C .2350 lt D 235000 lt

94. 7.705 km

{A 7705 km B 7.705 m C 7705 m D 77.05 m}

Questions 95 to 99 , write the given in appropriate units

95. 50.400 km

{A 50400 km B 50.4 km C 50km 4m D 50km 400m}

96. 7.3 cm

{A 73cm B .73cm C 73mm D 7cm 3mm}

97. 74.050kg

{A 74kg 05gm B 74kg 50gm C 74kg 5gm D 74kg 500 gm}

98. 8.360 lt

{A 8l 36 ml B 8360 l C 8 l 036 ml D 8 l 360 ml}

99. 3.47 m

{ A 3m 47cm B 347 m C 3cm 47m D 3m 047 cm}

Questions 100 to 102 , fill in the blanks.

100. 10 thousandth = 1 ....

{ A thenth B hundredth C thousandth D one}

101. 10 hundreth = 1..........

{ A ten B one C tenth D hundredth}

102. .... tenth = 1 one

{ A 0 B 1 C 10 D 100}

In questions 103 to 110 fill the blanks using appropriate symbol.

103. 0.875........0.857

{ A > B = C < D none of these}

104. 65.087.........65.0870

{A > B < C # D =}

105. 12.125 .... 12.215

{A > B < C = D none of these}

106. 18.7 .... 18.699

{A = B < C > D none of these}

107. 14.7............ 14.81

{ A > B < C = D none of these}

108. $\frac{3}{10}$ 0.3

{A >   B <   C ≠   D =}

109. $\frac{1}{10}$ 0.3

{ A <   B >   C =   D none of these}

110. 0.6 .... $\frac{4}{100}$

{A =   B <   C >   D none of these}

Choose the correct answer from the bracket for questions 111 to 115

111. The place value of a digit becomes one- tenth as the digit moves from left to right by one place.

{A always false   B always true   C sometimes false   D sometimes true}

112. A decimal number has two parts- a whole number part and a decimal part.

{ A always true   B always false   C sometimes true   D sometimes false}

113. Decimals having same number of decimal place are called like decimals

{ A Sometimes true   B sometimes false   C always true   D always false}

114. Unlike decimals may or may not be equivalent decimals.

{A false   B true   C sometimes false   D none of these}

115. Adding zeros after the extreme right digit of a decimal number part changes its value.

{ A true   B sometimes true   C may be true   D false}

116. Which is an unlike decimal for the given decimal 15.01

{A 15.001   B 1.501   C 15.10   D 10.15}

For questions 117 and 118 arrange the decimal in the asending oeder

117. 98.11, 65.45, 101.61, 6.05

{ A 101.61, 98.11, 65.45, 6.05

B 6.05, 65.45, 98.11, 101.61

C 101.61, 65.45, 98.11, 6.05

D 6.05, 98.11, 65.45, 101.61, }

118. 2.8, 2.47, 2.01, 2

{ A 2, 2.01, 2.47, 2.8

B 2.01, 2, 2.47, 2.8

C 2.8, 2.47, 2, 2.01

D 2.8, 2.47, 2.01, 2 }

119. Arrange the decimals in the descending order

25.251, 25.521, 25.125, 25.215

{ A 25.125, 25.215, 25.521, 25.521

B 25.125, 25.521, 25.215, 25.521

C 25.521, 25.251, 25.215, 25.125

D 25. 521, 25.215, 25.251, 25.125 }

Simplify questions 120 to 137

120. 0.1 + 0.9

{A 0.10 B 1.1 C 10 D 1}

121. 0.4 + 0.73

{ A 2.113 B 3.13 C 2.77 D 2.33}

122. 17.13 + 13.07

{A 30 . 137 B 20.20 C 30.20 D 30.110}

123. 10.23 + 3.01 + 2.1

{ A 15.34 B 15.1124 C 15.43 D 16}

124. 8.6 - 4.3

{ A 4.3 B 3.4 C 4.2 D 3.2}

125. 7.87- 5. 09

{ A 1.87 B 1.88 C 1.78 D 2.78}

126. 5.07 - 4.2

{ A 0.78 B 0.87 C 1.87 D 1.05}

127. 24.59 × 10

{ A 2.459 B 24.59 C 245. 9 D 2459}

128. 8.30 × 2

{ A 1.660 B 16.06 C 1.66 D 16.6}

129. 6.03 × 100

{ A 6030 B 603 C 60.3 D 6.03}

130. 0.2 × 0.3

{ A 0.06 B 0.6 C 0.006 D 6}

131. 0.07 × 0.8

{ A 0.56 B 0.0056 C 5.6 D 0.056}

132. 2.4 ÷ 6

{ A 40 B 4 C 0.4 D 0.04}

133. 8.64 ÷ .02

{ A 4320 B 432 C 43.2 D 4.32}

134. $0.5 \div 0.25$

{ A 20 B 0.2 C 0.02 D 2}

135. $0.8 \div 4$

{ A 0.2 B 0.02 C 2 D 20}

136. $36 \div 0.6$

{ A 60 B 6 C 600 D 0.6}

137. $0.12 \div 3$

{ A 40 B 4 C 0.4 D 0.04}

138. $25 \div 0.05$

{ A 5000 B 500 C 50 D 5}

139. Which of the following gives 36 as the quotient

{ A $0.216 \div 0.006$

B $0.216 \div 0.06$

C $0.216 \div 0.6$

D $0.216 \div 6$}

140 Which of the following gives 15 as the quotient

{ A $13.5 \div 9$

B $13.5 \div 0.9$

C $13.5 \div 0.09$

D $13.5 \div 0.009$}

Given $286 \times 11 = 3146$ and $286 \div 11 = 26$

Find the value of each for questions 141 to 146

141. 2.86×0.11

{A 0.3146 B 3.146 C 31.46 D 0.03146}

142. 286×0.11

{ A 3146 B 314.6 C 3.146 D 31.46}

143. 28.6×1.1

{ A 3.146 B 314.6 C 31.46 D 0.3146}

144. $28.6 \div 0.11$

{ A 0.26 B 260 C 26 D 2.6}

145. $2.86 \div 1.1$

{ A 0.26 B 2.6 C 26 D 260}

146. $2.86 \div 11$

{ 0.26 B 2.6 C 26 D 260}

Questions 147 to 150 , simplify.

147. $12 - 8 \div 4 \times 2$

{ A 2 B 11 C 4 D 8}

148. $12 - 9 \div 3 + 4 \times 2$

{ A $\frac{3}{11}$ B 7 C 1 D 10}

149. $\frac{1}{2} + \frac{3}{10} \div \frac{3}{5} - \frac{1}{3} \times \frac{5}{2}$

{ A $\frac{5}{2}$ B $\frac{1}{6}$ C $\frac{5}{3}$ D $\frac{1}{2}$}

150. $2.2 \div 0.2 \times 2.0 + 2$

{ A 24 B 1.05 C 26 D 2.75}

NUMERICAL ABILITY TEST
SCORE SHEET

Name.....................................School.....................................

Std: & Division ....Boy/Girl.....................................

SECTION A					SECTION B				
1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D

SECTION C					SECTION D				
1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D

SECTION E					SECTION F				
1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D

SECTION G					SECTION H				
1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D

SECTION I					SECTION J				
1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D

APPENDIX – V B

DEPARTMENT OF EDUCATION

CALICUT UNIVERSITY

RESULT OF ITEM ANALYSIS OF ACHIEVEMENT IN MATHEMATICAL SKILLS

Sl.No.	U	L	$D_i = \frac{U+L}{2N}$	$D_p = \frac{U-L}{N}$	Item Omitted/ Selected
1	21	16	.74	.20	O
2	23	19	.84	.16	O
3	23	17	.80	.24	O
4	22	12	.68	.40	S
5	21	12	.66	.36	S
6	25	14	.78	.44	S
7	25	15	.80	.40	S
8	24	12	.72	.48	S
9	20	8	.56	.48	S
10	24	15	.78	.36	S
11	25	14	.78	.44	S
12	25	15	.80	.40	S
13	23	8	.62	.60	S
14	24	9	.66	.60	S
15	19	9	.56	.40	S
16	22	10	.64	.48	S
17	25	11	.72	.56	S
18	22	20	.84	.08	S
19	21	6	.54	.60	S
20	24	10	.68	.56	S
21	15	7	.44	.32	S
22	10	8	.36	.08	S
23	18	11	.58	.28	S
24	16	5	.42	44	S

25	19	12	.62	.28	S
26	17	2	.38	.60	S
27	12	3	.30	.36	S
28	21	13	.68	.32	S
29	17	4	.42	.52	S
30	23	14	.74	.36	S
31	22	13	.70	.36	S
32	21	9	.60	.48	S
33	24	14	.76	.40	S
34	22	8	.60	.56	S
35	22	14	.72	.32	S
36	22	18	.80	.16	O
37	15	6	.42	.36	S
38	15	7	.44	.32	S
39	17	5	.54	.48	O
40	19	12	.62	.28	O
41	7	4	.22	.12	O
42	15	5	.40	.40	S
43	20	13	.66	.28	O
44	16	10	.52	.24	O
45	25	15	.80	.40	S
46	25	13	.76	.48	S
47	23	12	.70	.44	O
48	20	12	.64	.32	S
49	14	6	.40	.32	S
50	23	10	.66	.72	S
51	15	6	.42	.36	S
52	18	4	.44	.56	S
53	14	6	.40	.32	S
54	21	9	.60	.48	S
55	22	8	.60	.56	S
56	16	8	.48	.32	S
57	18	6	.48	.48	S

58	15	5	.40	.40	S
59	20	12	.64	.32	S
60	20	7	.54	.52	S
61	21	9	.60	.48	S
62	18	7	.50	.44	S
63	15	6	.42	.36	S
64	14	6	.40	.32	S
65	19	11	.60	.32	S
66	11	3	.28	.28	O
67	22	14	.72	.32	S
68	19	4	.46	.60	S
69	25	14	.78	.44	O
70	14	7	.42	.20	O
71	15	8	.46	.28	O
72	16	10	.52	.24	O
73	14	7	.42	.28	O
74	18	12	.60	.24	O
75	2	3	.10	-.02	O
76	19	9	.56	.40	S
77	17	6	.46	.44	S
78	15	5	.40	.40	S
79	20	4	.48	.64	S
80	15	8	.46	.28	O
81	4	3	.14	.04	O
82	14	6	.40	.32	S
83	12	4	.32	.32	S
84	22	10	.64	.48	S
85	11	3	.28	.32	S
86	14	6	.40	.32	S
87	14	5	.38	.36	S
88	13	10	.46	.12	O
89	2	8	.20	-.24	O
90	15	6	.42	.36	S

91	13	5	.36	.32	S
92	18	10	.56	.32	S
93	19	9	.58	.40	S
94	17	9	.52	.32	S
95	16	7	.46	.36	S
96	13	5	.36	.32	S
97	14	6	.40	.32	S
98	13	5	.56	.32	S
99	19	7	.52	.48	S
100	10	6	.32	.16	O
101	11	5	.32	.24	O
102	11	3	.28	.32	O
103	15	6	.42	.36	S
104	17	8	.50	.36	S
105	19	8	.54	.44	S
106	15	6	.42	.36	S
107	17	9	.52	.32	S
108	22	8	.60	.56	S
109	13	5	.36	.32	S
110	15	6	.42	.36	S
111	11	3	.28	.32	O
112	13	6	.38	.28	O
113	17	13	.60	.20	O
114	12	9	.42	.12	O
115	15	8	.46	.28	O
116	16	9	.50	.28	O
117	19	10	.58	.36	S
118	13	6	.38	.28	O
119	16	6	.44	.40	S
120	14	6	.40	.32	S
121	12	4	.32	.32	S
122	18	7	.50	.44	S
123	20	11	.62	.36	S

124	20	11	.62	.36	S
125	18	10	.56	.32	S
126	14	6	.40	.32	S
127	13	5	.36	.32	S
128	11	3	.28	.32	S
129	14	8	.44	.32	S
130	16	8	.48	.32	S
131	16	8	.48	.44	S
132	17	7	.48	.32	S
133	13	5	.36	.32	S
134	13	5	.56	.32	S
135	5	4	.36	.04	S
136	5	6	.22	-.04	O
137	12	6	.36	.24	O
138	7	5	.24	.08	O
139	9	2	.22	.28	O
140	7	5	.24	.08	O
141	10	4	.28	.24	O
142	11	5	.32	.24	O
143	12	6	.36	.24	O
144	10	6	.32	.20	O
145	6	4	.20	.08	O
146	11	4	.30	.28	O
147	14	4	.36	.40	S
148	17	6	.46	.44	S
149	13	5	.36	.32	S
150	12	2	.28	.40	S

APPENDIX V - C

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

TEST OF ACHIEVEMENT IN MATHEMATICS FOR UPPER PRIMARY PUPILS.

Dr. Kamala. S. Pillai.
Professor of Education (Retired)

Jayasree N.
Research Scholar

INSTRUCTIONS Time: 2 hour

This is a test in fractions and decimals. Answer all the questions. Do not write anything in the question paper. Write your answers in the answer sheet provided . The serial number of the questions are given in the answer sheet. For each question it is written A,B,C and D in the answer sheet. Find out the correct answer for each questions and put a mark 'X' aganist the correct letter A,B,C or D in the response sheet. If you want to change your answers , put a (a small square) on your 'X' and then put another 'X' aganist the correct answer.

Model.

Four fractions are given below. Find out the highest fraction among them.

$\frac{4}{7}$ $\frac{4}{10}$ $\frac{4}{8}$ $\frac{4}{9}$

$\left\{ A\ \frac{4}{7} \quad B\ \frac{4}{8} \quad C\ \frac{4}{9} \quad D\ \frac{4}{10} \right\}$

Mark your answer like this

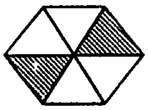
Q. No: $\overset{\times}{A}$ B C D

The correct answer is $\frac{4}{7}$ indicated by the letter A. Put the mark 'X' ons A.Similarly answer all the questions.

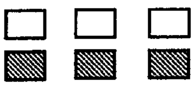
Write the fraction of the shaded portions or objects in the given figures in questions 1,2 & 3. In each question 4 fractions are given, only one is correct.

1. 

$\left\{ A\ \frac{3}{4} \qquad B\ \frac{1}{4} \qquad C\ \frac{1}{3} \qquad D\ \frac{4}{1} \right\}$

2. 

$\left\{ A\ \frac{4}{6} \qquad B\ \frac{6}{2} \qquad C\ \frac{2}{6} \qquad D\ \frac{6}{4} \right\}$

3. 

$\left\{ A\ \frac{3}{6} \qquad B\ \frac{2}{6} \qquad C\ \frac{4}{6} \qquad D\ \frac{1}{6} \right\}$

Four fractions are given in questions 4 and 5 find out the correct fraction.

4. Numerator is 3 and denominator is 7

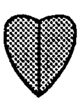
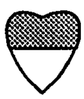
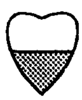
$\left\{ A\ \frac{7}{3} \qquad B\ \frac{3}{7} \qquad C\ 3.7 \qquad D\ 7.3 \right\}$

5. Two -fifth, the correct fraction is

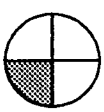
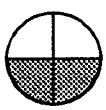
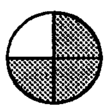
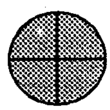
$\left\{ A\ 2.5 \qquad B\ \frac{5}{2} \qquad C\ 5.2 \qquad D\ \frac{2}{5} \right\}$

In questions 6,7,8 and 9 find out the correct figure indicating the given fraction

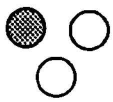
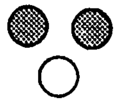
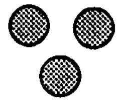
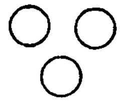
6. $\frac{2}{2}$

{ A  B  C  D  }

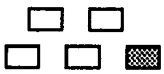
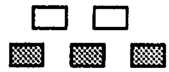
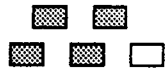
7. $\frac{3}{4}$

{ A  B  C  D  }

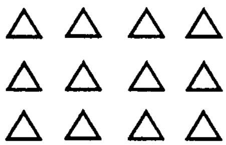
8. $\frac{2}{3}$

{A  B  C  D  }

9. $\frac{3}{5}$

{A  B  C  D  }

10. Find the number of objects in $\frac{1}{4}$ part of the given collection



{A 12   B 6   C 4   D 3}

Choose the correct example from the bracket for the questions 11 to 15.

11. Like fractions

{A $\frac{2}{7}$ $\frac{4}{7}$ B $\frac{2}{7}$ $\frac{7}{4}$ C $\frac{7}{2}$ $\frac{4}{7}$ D $\frac{7}{2}$ $\frac{7}{4}$}

12. Unlike fractions

{A $\frac{2}{7}$ $\frac{4}{7}$ B $\frac{2}{4}$ $\frac{4}{4}$ C $\frac{2}{2}$ $\frac{4}{2}$ D $\frac{7}{2}$ $\frac{7}{4}$}

13. Proper fraction

{A $\frac{4}{5}$ B $\frac{5}{4}$ C $\frac{4}{4}$ D $\frac{5}{5}$}

14. Improper fraction.

{A $\frac{4}{5}$ B $\frac{5}{4}$ C $\frac{4}{4}$ D $\frac{5}{5}$}

15. Mixed fraction

{A $\frac{6}{6}$ B $\frac{6}{7}$ C $\frac{7}{6}$ D $1\frac{1}{6}$}

16. Which is the correct fraction of $\frac{20}{3}$ if it is converted in to a mixed fraction.

{A $2\frac{3}{6}$ B $3\frac{2}{6}$ C $6\frac{2}{3}$ D $6\frac{3}{2}$}

17. Which is the correct fraction if $7\frac{1}{3}$ is converted in to im proper fraction

$\left\{ A\ \frac{3}{22} \right.$ B $\frac{11}{3}$ C $\frac{21}{3}$ D $\left. \frac{22}{3} \right\}$

Four fractions are given find out the smallest fractions among the them.

18. $\frac{3}{5}$ $\frac{1}{5}$ $\frac{4}{5}$ $\frac{2}{5}$

$\left\{ A\ \frac{1}{5} \right.$ B $\frac{2}{5}$ C $\frac{3}{5}$ D $\left. \frac{4}{5} \right\}$

19. $\frac{7}{4}$ $\frac{7}{3}$ $\frac{7}{1}$ $\frac{7}{2}$

$\left\{ A\ \frac{7}{1} \right.$ B $\frac{7}{2}$ C $\frac{7}{3}$ D $\left. \frac{7}{4} \right\}$

20. Find the fraction in between $\frac{5}{8}$ and $\frac{3}{4}$ having 32 as denominator.

$\left\{ A\ \frac{18}{32} \right.$ B $\frac{22}{32}$ C $\frac{20}{32}$ D $\left. \frac{22}{32} \right\}$

21. Choose the correct symbol to match the blank

$\frac{6}{9}$ .... $\frac{4}{9}$

{A > B< C = D none of these}

Questions 22 to 25 choose the correct number from the bracket to fill the blank

22. $\frac{3}{7} = \frac{9}{\square}$

{A 7 B 14 C 21 D 3}

23. $2\frac{1}{4} = \frac{18}{\square}$

{A 7 B 8 C 9 D 10}

24. $\frac{4}{3} = \frac{\square}{15}$

{A = 5 B 15 C 10 D 20}

25. $\frac{9}{2} = \square\frac{1}{2}$

{A 4 B 3 C 2 D 5}

१०४

26. Which of the given fraction is equal to $\frac{'2'}{3}$

{A $\frac{3}{2}$ B $\frac{4}{9}$ C $\frac{20}{30}$ D $\frac{6}{6}$}

27. If the fractions $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{4}$ $\frac{2}{6}$ are arranged in the ascending order,

{A $\frac{2}{7}$ $\frac{2}{6}$ $\frac{2}{5}$ $\frac{2}{4}$

B $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{6}$ $\frac{2}{4}$

C $\frac{2}{4}$ $\frac{2}{7}$ $\frac{2}{5}$ $\frac{2}{6}$

D $\frac{2}{4}$ $\frac{2}{5}$ $\frac{2}{6}$ $\frac{2}{7}$}

28. If the fractions $\frac{7}{10}$ $\frac{9}{10}$ $\frac{6}{10}$ $\frac{8}{10}$ are arranged in the descending order

{A $\frac{7}{10}$ $\frac{9}{10}$ $\frac{8}{10}$ $\frac{6}{10}$

B $\frac{6}{10}$ $\frac{7}{10}$ $\frac{8}{10}$ $\frac{9}{10}$

C $\frac{9}{10}$ $\frac{8}{10}$ $\frac{7}{10}$ $\frac{6}{10}$

D $\frac{8}{10}$ $\frac{6}{10}$ $\frac{7}{10}$ $\frac{9}{10}$}

29. Which is the lowest form of the fraction $\frac{4}{16}$

{A $\frac{4}{8}$ B $\frac{2}{4}$ C $\frac{2}{8}$ D $\frac{1}{4}$}

Which whole number for make the statement true for questions 30 and 33.

30. $\frac{5}{9} + \frac{\square}{9} = \frac{8}{9}$

{A 9 B 8 C 5 D 3}

15

31. $\frac{11}{15} - \frac{7}{15} = \frac{\square}{15}$

{A 3   B 4   C 7   D 11}

32. $\frac{5}{10} + \frac{3}{10} + \frac{2}{10} = \_\_\_\_$

{A 1   B2   C 3   D6}

33. $\frac{\square}{4} - \frac{1}{4} = \frac{2}{4}$

{ A 3   B 2   C 1   D 4}

34. Is the value of $\frac{2}{5} + \frac{2}{5} + \frac{2}{5}$ equal to $3 \times \frac{2}{5}$

{A true   B false   C none of these   D all the above}

Simplify the questions 35 to 46.

35. $5\frac{1}{4} + 4\frac{1}{5}$

{A $9\frac{1}{9}$ B $\frac{189}{20}$ C $9\frac{1}{4}$ D $9\frac{1}{5}$}

36. $2\frac{2}{3} + 3\frac{1}{2}$

{A $\frac{37}{2}$ B $\frac{3}{5}$ C $\frac{37}{6}$ D $5\frac{3}{3}$}

37. $\frac{5}{8} - \frac{1}{4}$

{A $\frac{3}{4}$ B $\frac{4}{4}$ C $\frac{8}{3}$ D $\frac{3}{8}$}

38. $3\frac{1}{2} - 2\frac{1}{3}$

{A $\frac{1}{2}$ B $\frac{7}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$}

39. $4\frac{1}{5} - 3\frac{1}{3}$

{A $\frac{13}{15}$ B $\frac{7}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$}

40. $4\frac{1}{2} \times 5$

{A $20\frac{1}{2}$ B $4\frac{5}{2}$ C $4\frac{1}{10}$ D $22\frac{1}{2}$}

41. $\frac{2}{5} \div \frac{4}{15}$

{A $\frac{8}{5}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D $\frac{8}{15}$}

42. $4\frac{1}{2} \times 2\frac{2}{9}$

{A $8\frac{2}{18}$ B 10 C $4\frac{1}{18}$ D $8\frac{1}{18}$}

43. $\frac{1}{7} \times \frac{28}{3}$

{A $\frac{28}{7}$ B $\frac{28}{3}$ C $\frac{28}{10}$ D $\frac{4}{3}$}

44. $\frac{3}{5} \div 3$

{A $\frac{1}{5}$ B $\frac{9}{5}$ C $\frac{3}{15}$ D $\frac{5}{3}$}

45. $10\frac{1}{2} \div 3\frac{1}{5}$

{A 3 B $30\frac{1}{2}$ C $30\frac{1}{4}$ D $\frac{10}{3}$}

46. $5\frac{1}{3} \div \frac{1}{3}$

{A $\frac{16}{9}$ B $\frac{1}{5}$ C 5 D 16}

In questions 47 to 50 some statements are given Choose the correct answer from the bracket.

47. When we multiply the numerator and denominator with same number we will get an equivalent fraction

A always false B always true

C sometimes false D some times true

48. The product of the fractional number and the multiplicative inverse of the fractional number will be one

A always true C may be true

B sometimes true D none of these

49. A number has only one multiplicative inverse.

A false B true C sometimes false D sometimes true

50. One is the only number whose multiplicative inverse is not a fractional number

A Both true and false B false C true D none of these

Find out the decimal for the given in questions 51 to 54

51. $\frac{7}{100}$

{ A .07 B .007 C .7 D 7.0}

52. $9\frac{1}{10}$

{ A 91.0 B 9.01 C 9.1 D .91}

53. 8 tens + 4 ones + 6 tenths

{A 84.06 B .846 C 8.46 D 84.6}

54. 6 tens + 9 thousandths

{A 60.09 B 60.009 C 60.9 D 60.090}

For questions 55 and 56 find the correct fraction.

55. 0.50

$\left\{ A\ \frac{50}{10} \quad B\ \frac{5}{10} \quad C\ \frac{5}{100} \quad D\ \frac{50}{1000} \right\}$

56. 7.04

$\left\{ A\ \frac{704}{1000} \quad B\ \frac{74}{1000} \quad C\ 7\frac{4}{10} \quad D\ 7\frac{4}{100} \right\}$

Find out place valueof the digit underlined in the given decimals for questions 57 and 58.

57. $28.\underline{6}4$

{A thousandth B hundredth C ones D thenth}

58. $8.00\underline{9}$

{A tenth B hundredth C thousandth D hundred}

Find an equivalent decimal for the given decimal

59. 0.6

{A 0.06 B 0.60 C 6.06 D 6.60}

Find out the like decimal for the given decimal

60. 1.72

{A 17.2 B .172 C 3.45 D 8.9}

Questions 61 to 65 fill in the blanks

61. 3.620 kg = ...

{A 3620 gm   B 3 gm 620 kg   C 3kg 620kg   D 3gm 620gm}

62. 21.03 = ...

{A 21 m 3 cm   B 2103 mm   C 21mm 3cm   D 21.03 mm}

63. Rs 10.75 = ...

{A 10.75 paisee   B 1075 rupees   C 107500 paisee   D 1075 paisee

64. 23.50 lt. = ...

{ A 2350 ml.   B 2350 lt   C 2350 lt   D 235000 lt

65. 7.705 km

{A 7705 km   B 7.705 m   C 7705 m   D 77.05 m}

Questions 66 to 70, find the given in appropriate units

66. 50.400 km

{A 50400 km   B 50.4 km   C 50km 4m   D 50km 400m}

67. 7.3 cm

{A 73cm   B .73cm   C 73mm   D 7cm 3mm}

68. 74.050kg

{A 74kg 05gm   B 74kg 50gm   C 74kg 5gm   D 74kg 500 gm}

69. 8.360 lt

{A 8l 36 ml   B 8360 l   C 8 l 036 ml   D 8 1360 ml}

70. 3.47 m

{A 3m 47cm   B 347 m   C 3cm 47m   D 3m 047 cm}

In questions 71 to 78 fill the blanks using appropriate symbol.

71. 0.875........0.857

{ A >   B =   C <   D none of these}

72. 65.087.........65.0870

{A >   B <   C #   D =}

73. 12.125 .... 12.215

{A >   B <   C =   D none of these}

74. 18.7 .... 18.699

{A =   B <   C >   D none of these}

75. 14.7............ 14.81

{ A >   B <   C =   D none of these}

76. $\frac{3}{10}$ 0.3

{A >　　B <　　C #　　D =}

77. $\frac{1}{10}$ 0.3

78. 0.6 .... $\frac{4}{100}$

{A =　　B <　　C >　　D none of these}

Aarrange the decimal in the asending oeder

79. 98.11, 65.45, 101.61, 6.05

{ A 101.61, 98.11, 65.45, 6.05

B 6.05, 65.45, 98.11, 101.61

C 101.61, 65.45, 98.11, 6.05

D 6.05, 98.11, 65.45, 101.61, }

80. Arrange the decimals in the descending order

25.251, 25.521, 25.125, 25.215

{ A 25.125, 25.215, 25.521, 25.521

B 25.125, 25.521, 25.215, 25.521

C 25.521, 25.251, 25.215, 25.125

D 25. 521, 25.215, 25.251, 25.125}

Simplify questions 81 to 95

81. 0.1 + 0.9

{A 0.10　　B 1.1　　C 10　　D 1}

82. 0.4 + 0.73

{ A 2.113　　B 3.13　　C 2.77　　D 2.33}

83. 17.13 + 13.07

{A 30 . 137　　B 20.20　　C 30.20　　D 30.110}

84. 10.23 + 3.01 + 2.1

{ A 15.34　　B 15.1124　　C 15.43　　D 16}

85. 8.6 - 4.3

{ A 4.3　　B 3.4　　C 4.2　　D 3.2}

86. 7.87- 5. 09

{ A 1.87　　B 1.88　　C 1.78　　D 2.78}

87. 5.07 - 4.2

{ A 0.78　　B 0.87　　C 1.87　　D 1.05}

88. 24.59×10

{ A 2.459 B 24.59 C 245. 9 D 2459}

89. 8.30×2

{ A 1.660 B 16.06 C 1.66 D 16.6}

90. 0.2×0.3

{ A 0.06 B 0.6 C 0.006 D 6}

91. 0.07×0.8

{ A 0.56 B 0.0056 C 5.6 D 0.056}

92. $2.4 \div 6$

{ A 40 B 4 C 0.4 D 0.04}

93. $8.64 \div .02$

{ A 4320 B 432 C 43.2 D 4.32}

94. $0.5 \div 0.25$

{ A 20 B 0.2 C 0.02 D 2}

95. $0.8 \div 4$

{ A 0.2 B 0.02 C 2 D 20}

Questions 96 to 100 , simplify.

96. $12- 8 \div 4 \times 2$

{ A 2 B 11 C 4 D 8}

97. $12 - 9 \div 3+ 4 \times 2$

{ A $\frac{3}{11}$ B 7 C 1 D 10}

98. $2\times15 \div 3 + 4$

{ A 14 B 10 C $\frac{30}{7}$ D $\frac{15}{28}$}

99. $\frac{1}{2} + \frac{3}{10} \div \frac{3}{5} - \frac{1}{3} \times \frac{5}{2}$

{ A $\frac{5}{2}$ B $\frac{1}{6}$ C $\frac{5}{3}$ D $\frac{1}{2}$}

100. $2.2 \div 0.2 \times 2.0 + 2$

{ A 24 B 1.05 C 26 D 2.75}

APPENDIX V - D
ACHIEVEMENT TEST IN MATHEMATICS
SCORE SHEET

Name .... Boy/Girl.........................

Std & Division School..........................

1	A	B	C	D	26	A	B	C	D	51	A	B	C	D	76	A	B	C	D
2	A	B	C	D	27	A	B	C	D	52	A	B	C	D	77	A	B	C	D
3	A	B	C	D	28	A	B	C	D	53	A	B	C	D	78	A	B	C	D
4	A	B	C	D	29	A	B	C	D	54	A	B	C	D	79	A	B	C	D
5	A	B	C	D	30	A	B	C	D	55	A	B	C	D	80	A	B	C	D
6	A	B	C	D	31	A	B	C	D	56	A	B	C	D	81	A	B	C	D
7	A	B	C	D	32	A	B	C	D	57	A	B	C	D	82	A	B	C	D
8	A	B	C	D	33	A	B	C	D	58	A	B	C	D	83	A	B	C	D
9	A	B	C	D	34	A	B	C	D	59	A	B	C	D	84	A	B	C	D
10	A	B	C	D	35	A	B	C	D	60	A	B	C	D	85	A	B	C	D
11	A	B	C	D	36	A	B	C	D	61	A	B	C	D	86	A	B	C	D
12	A	B	C	D	37	A	B	C	D	62	A	B	C	D	87	A	B	C	D
13	A	B	C	D	38	A	B	C	D	63	A	B	C	D	88	A	B	C	D
14	A	B	C	D	39	A	B	C	D	64	A	B	C	D	89	A	B	C	D
15	A	B	C	D	40	A	B	C	D	65	A	B	C	D	90	A	B	C	D
16	A	B	C	D	41	A	B	C	D	66	A	B	C	D	91	A	B	C	D
17	A	B	C	D	42	A	B	C	D	67	A	B	C	D	92	A	B	C	D
18	A	B	C	D	43	A	B	C	D	68	A	B	C	D	93	A	B	C	D
19	A	B	C	D	44	A	B	C	D	69	A	B	C	D	94	A	B	C	D
20	A	B	C	D	45	A	B	C	D	70	A	B	C	D	95	A	B	C	D
21	A	B	C	D	46	A	B	C	D	71	A	B	C	D	96	A	B	C	D
22	A	B	C	D	47	A	B	C	D	72	A	B	C	D	97	A	B	C	D
23	A	B	C	D	48	A	B	C	D	73	A	B	C	D	98	A	B	C	D
24	A	B	C	D	49	A	B	C	D	74	A	B	C	D	99	A	B	C	D
25	A	B	C	D	50	A	B	C	D	75	A	B	C	D	100	A	B	C	D

APPENDIX VI

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

TEST OF ACHIEVEMENT IN MATHEMATICS FOR UPPER PRIMARY PUPILS.

Dr. Kamala. S. Pillai.
Professor of Education (Retired)

Jayasree N.
Research Scholar

INSTRUCTIONS Time: 2 hour

This is a test in fractions and decimals. Answer all the questions. Do not write anything in the question paper. Write your answers in the answer sheet provided . The serial number of the questions are given in the answer sheet. For each question it is written A,B,C and D in the answer sheet. Find out the correct answer for each questions and put a mark 'X' aganist the correct letter A,B,C or D in the response sheet. If you want to change your answers , put a (a small square) on your 'X' and then put another 'X' aganist the correct answer.

Model.

Four fractions are given below. Find out the highest fraction among them.

$\frac{4}{7}$ $\frac{4}{10}$ $\frac{4}{8}$ $\frac{4}{9}$

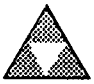
$\left\{ A\ \frac{4}{7} \quad B\ \frac{4}{8} \quad C\ \frac{4}{9} \quad D\ \frac{4}{10} \right\}$

Mark your answer like this

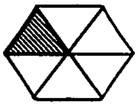
Q. No: ~~A~~ B C D

The correct answer is $\frac{4}{7}$ indicated by the letter A. Put the mark 'X' ons A.Similarly answer all the questions.

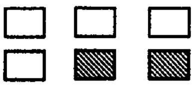
Write the fraction of the shaded portions or objects in the given figures in questions 1,2 & 3. In each question 4 fractions are given, only one is correct.

1. 

{A $\frac{3}{4}$ B $\frac{1}{4}$ C $\frac{1}{3}$ D $\frac{4}{1}$}

2. 

{A $\frac{1}{6}$ B $\frac{6}{1}$ C $\frac{5}{6}$ D $\frac{6}{5}$}

3. 

{A $\frac{3}{6}$ B $\frac{2}{6}$ C $\frac{4}{6}$ D $\frac{1}{6}$}

Four fractions are given in questions 4 and 5 find out the correct fraction.

4. Numerator is 4 and denominator is 7

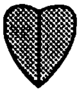
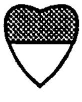
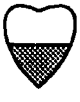
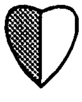
{A $\frac{7}{4}$ B $\frac{4}{7}$ C 4.7 D 7.4}

5. Three -fifth, the correct fraction is

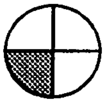
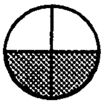
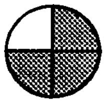
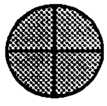
{A 3.5 B $\frac{5}{3}$ C 5.3 D $\frac{3}{5}$}

In questions 6,7,8 and 9 find out the correct figure indicating the given fraction

6. $\frac{1}{2}$

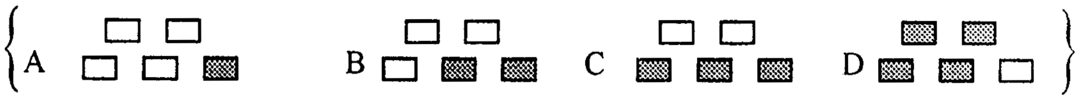
{A  B  C  D }

7. $\frac{4}{4}$

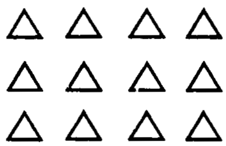
{A  B  C  D }

8. $\frac{1}{3}$

9. $\frac{4}{5}$



10. Find the number of objects in $\frac{1}{3}$ part of the given collection



{A 12 B 6 C 4 D 3}

Choose the correct example from the bracket for the questions 11 to 15.

11. Like fractions

$\left\{ A\ \frac{3}{4}\ \frac{1}{4} \quad B\ \frac{3}{4}\ \frac{4}{1} \quad C\ \frac{4}{3}\ \frac{1}{4} \quad D\ \frac{3}{1}\ \frac{4}{1} \right\}$

12. Unlike fractions

$\left\{ A\ \frac{3}{4}\ \frac{1}{4} \quad B\ \frac{1}{3}\ \frac{4}{3} \quad C\ \frac{1}{3}\ \frac{3}{3} \quad D\ \frac{1}{3}\ \frac{1}{4} \right\}$

13. Proper fraction

$\left\{ A\ \frac{3}{4} \quad B\ \frac{4}{3} \quad C\ \frac{3}{3} \quad D\ \frac{4}{4} \right\}$

14. Improper fraction.

$\left\{ A\ \frac{3}{4} \quad B\ \frac{4}{3} \quad C\ \frac{3}{3} \quad D\ \frac{4}{4} \right\}$

15. Mixed fraction

$\left\{ A\ \frac{3}{4} \quad B\ \frac{4}{3} \quad C\ \frac{3}{3} \quad D\ 1\frac{3}{4} \right\}$

16. Which is the correct fraction of $\frac{15}{3}$ if it is converted in to a mixed fraction.

$\left\{ A\ 2\frac{3}{6} \quad B\ 3\ \frac{2}{6} \quad C\ 6\frac{2}{3} \quad D\ 6\frac{3}{2} \right\}$

17. Which is the correct fraction if $3\frac{2}{3}$ is converted in to im proper fraction

$\left\{ A\ \frac{3}{22} \right.$ B $\frac{11}{3}$ C $\frac{21}{3}$ $\left. D\ \frac{22}{3} \right\}$

Four fractions are given find out the smallest fractions among the them.

18. $\frac{3}{7}$ $\frac{1}{7}$ $\frac{4}{7}$ $\frac{2}{7}$

$\left\{ A\ \frac{1}{7} \right.$ B $\frac{2}{7}$ C $\frac{3}{7}$ $\left. D\ \frac{4}{7} \right\}$

19. $\frac{5}{4}$ $\frac{5}{3}$ $\frac{5}{1}$ $\frac{5}{2}$

$\left\{ A\ \frac{5}{1} \right.$ B $\frac{5}{2}$ C $\frac{5}{3}$ $\left. D\ \frac{5}{4} \right\}$

20. Find the fraction in between $\frac{7}{8}$ and $\frac{3}{4}$ having 32 as denominator.

$\left\{ A\ \frac{18}{32} \right.$ B $\frac{26}{32}$ C $\frac{20}{32}$ $\left. D\ \frac{22}{32} \right\}$

21. Choose the correct symbol to match the blank

$\frac{5}{9}$ .... $\frac{4}{9}$

{A > B< C = D none of these}

Questions 22 to 25 choose the correct number from the bracket to fill the blank

22. $\frac{3}{7} = \frac{6}{\square}$

{A 7 B 14 C 21 D 3}

23. $2\frac{1}{4} = \frac{27}{\square}$

{A 7 B 8 C 9 D 12}

24. $\frac{4}{3} = \frac{\square}{12}$

{A = 5 B 15 C 16 D 20}

25. $\frac{7}{2} = \square\frac{1}{2}$

{A 4 B 3 C $\frac{4}{6}$ D 5}

112

26. Which of the given fraction is equal to $\frac{'2'}{3}$

{A $\frac{2}{3}$ B $\frac{4}{9}$ C $\frac{4}{6}$ D $\frac{6}{6}$ }

27. If the fractions $\frac{3}{7}$ $\frac{3}{5}$ $\frac{3}{4}$ $\frac{3}{6}$ are arranged in the ascending order,

{A $\frac{3}{7}$ $\frac{3}{6}$ $\frac{3}{5}$ $\frac{3}{4}$

B $\frac{3}{7}$ $\frac{3}{5}$ $\frac{3}{6}$ $\frac{3}{4}$

C $\frac{3}{4}$ $\frac{3}{7}$ $\frac{3}{5}$ $\frac{3}{6}$

D $\frac{3}{4}$ $\frac{3}{5}$ $\frac{3}{6}$ $\frac{3}{7}$ }

28. If the fractions $\frac{7}{11}$ $\frac{9}{11}$ $\frac{6}{11}$ $\frac{8}{11}$ are arranged in the descending order

{A $\frac{7}{11}$ $\frac{9}{11}$ $\frac{8}{11}$ $\frac{6}{11}$

B $\frac{6}{11}$ $\frac{7}{11}$ $\frac{8}{11}$ $\frac{9}{11}$

C $\frac{9}{11}$ $\frac{8}{11}$ $\frac{7}{11}$ $\frac{6}{11}$

D $\frac{8}{11}$ $\frac{6}{11}$ $\frac{7}{11}$ $\frac{9}{11}$ }

29. Which is the lowest form of the fraction $\frac{3}{12}$

{A $\frac{4}{8}$ B $\frac{2}{4}$ C $\frac{2}{8}$ D $\frac{1}{4}$ }

Which whole number for make the statement true for questions 30 and 33.

30. $\frac{5}{9} + \frac{\square}{9} = \frac{13}{9}$

{A 9 B 8 C 5 D 3}

31. $\frac{11}{15} - \frac{4}{15} = \frac{\Box}{15}$

{A 3 B 4 C 7 D 11}

32. $\frac{1}{6} + \frac{2}{6} + \frac{3}{6} = \frac{\Box}{6}$

{A 1 B2 C 3 D6}

33. $\frac{\Box}{4} - \frac{1}{4} = \frac{1}{4}$

{ A 3 B 2 C 1 D 4}

34. Is the value of $\frac{1}{5} + \frac{1}{5} + \frac{1}{5}$ equal to $3 \times \frac{1}{5}$

{A true B false C none of these D all the above}

Simplify the questions 35 to 46.

35. $5\frac{1}{4} + 4\frac{2}{5}$

{A $9\frac{1}{9}$ B $\frac{193}{20}$ C $9\frac{1}{4}$ D $9\frac{1}{5}$ }

36. $2\frac{2}{3} + 1\frac{1}{2}$

{A $\frac{37}{2}$ B $\frac{3}{5}$ C $\frac{25}{6}$ D $5\frac{3}{3}$ }

37. $\frac{3}{8} - \frac{1}{4}$

{A $\frac{3}{4}$ B $\frac{4}{4}$ C $\frac{8}{3}$ D $\frac{1}{8}$ }

38. $3\frac{1}{2} - 1\frac{1}{3}$

{A $\frac{1}{2}$ B $\frac{13}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$ }

39. $4\frac{1}{5} - 1\frac{1}{3}$

{A $\frac{28}{15}$ B $\frac{7}{6}$ C $\frac{1}{3}$ D $\frac{7}{3}$ }

40. $4\frac{1}{2} \times 4$

{A $16\frac{1}{2}$ B $4\frac{5}{2}$ C $4\frac{1}{10}$ D $22\frac{1}{2}$ }

41. $\frac{2}{5} \div \frac{6}{15}$

{A $\frac{8}{5}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D 1 }

42. $4\frac{1}{2} \times 2\frac{2}{3}$

{A $8\frac{2}{18}$ B 10 C 4 D $8\frac{1}{18}$ }

43. $\frac{1}{7} \times \frac{35}{3}$

{A $\frac{28}{7}$ B $\frac{5}{3}$ C $\frac{28}{10}$ D $\frac{4}{3}$ }

44. $\frac{3}{5} \div \frac{3}{2}$

{A $\frac{2}{5}$ B $\frac{9}{5}$ C $\frac{3}{15}$ D $\frac{5}{3}$ }

45. $10\frac{1}{2} \div 1\frac{3}{4}$

{A 3 B $30\frac{1}{2}$ C $30\frac{1}{4}$ D 6 }

46. $5\frac{1}{3} \div 1\frac{1}{3}$

{A $\frac{16}{9}$ B $\frac{1}{5}$ C 4 D 16 }

In questions 47 to 50 some statements are given Choose the correct answer from the bracket.

47. When we multiply the denominator and numeratorwith same number we will get an equivalent fraction

A always false B always true

C sometimes false D some times true

48. The product of the fractional number and the multiplicative inverse of the fractional number will be Zero

A always true C may be true

B sometimes true D none of these

49. A number has morethan one multiplicative inverse.

A false B true C sometimes false D sometimes true

50. One is the only number whose multiplicative inverse is the number itself

A Both true and false B false C true D none of these

Find out the decimal for the given in questions 51 to 54

51. $\frac{7}{10}$

{ A .07 B .007 C .7 D 7.0}

52. $9\frac{1}{100}$

{ A 91.0 B 9.01 C 9.1 D .91}

53. 8 tens + 4 oneth + 6 tenths

{A 84.06 B .846 C 8.46 D 84.6}

54. 6 tens + 9 hundreths

{A 60.09 B 60.009 C 60.9 D 60.090}

For questions 55 and 56 find the correct fraction.

55. 0.50

$\left\{ A\ \frac{50}{10} \quad B\ \frac{5}{10} \quad C\ \frac{5}{100} \quad D\ \frac{50}{1000} \right\}$

56. 7.04

$\left\{ A\ \frac{704}{1000} \quad B\ \frac{74}{1000} \quad C\ 7\frac{4}{10} \quad D\ 7\frac{4}{100} \right\}$

Find out place valueof the digit underlined in the given decimals for questions 57 and 58.

57. $28.\underline{6}4$

{A thousandth B hundredth C ones D thenth}

58. $8.00\underline{9}$

{A tenth B hundredth C thousandth D hundred}

Find an equivalent decimal for the given decimal

59. 0.6

{A 0.06 B 0.60 C 6.06 D 6.60}

Find out the like decimal for the given decimal

60. 1.72

{A 17.2 B .172 C 3.45 D 8.9}

Questions 61 to 65 fill in the blanks

61. 4.620 kg = ...

{A 4620 gm B 4 gm 620 kg C 4kg 620kg D 4gm 620gm}

62. 51.03 = ...

{A 51 m 3 cm B 5103 mm C 51mm 3cm D 51.03 mm}

63. Rs 30.75 = ...

{A 30.75 paisee B 3075 rupees C 307500 paisee D 3075 paisee

64. 83.50 lt. = ...

{ A 8350 ml. B 8350 lt C 8350 lt D 835000 lt

65. 1.705 km

{A 1705 km B 1.705 m C 1705 m D 17.05 m}

Questions 66 to 70, find the given in appropriate units

66. 20.400 km

{A 20400 km B 20.4 km C 20km 4m D 20km 400m}

67. 3.3 cm

{A 33cm B .33cm C 33mm D 3cm 3mm}

68. 64.050kg

{A 64kg 05gm B 64kg 50gm C 64kg 5gm D 64kg 500 gm}

69. 18.360 lt

{A 18 l 36 ml B 18360 l C 18 l 036 ml D 18 l 360 ml}

70. 9.47 m

{A 9m 47cm B 947 m C 9cm 47m D 9m 047 cm}

In questions 71 to 78 fill the blanks using appropriate symbol.

71. 0.275........0.257

{ A > B = C < D none of these}

72. 73.087.........73.0870

{A > B < C # D =}

73. 32.125 .... 32.215

{A > B < C = D none of these}

74. 48.7 .... 48.699

{A = B < C > D none of these}

75. 44.7........... 44.81

{ A > B < C = D none of these}

Questions 61 to 65 fill in the blanks

61. 4.620 kg = ...

{A 4620 gm　　B 4 gm 620 kg　　C 4kg 620kg　　D 4gm 620gm}

62. 51.03 = ...

{A 51 m 3 cm　　B 5103 mm　　C 51mm 3cm　　D 51.03 mm}

63. Rs 30.75 = ...

{A 30.75 paisee　　B 3075 rupees　　C 307500 paisee　　D 3075 paisee

64. 83.50 lt. = ...

{ A 8350 ml.　　B 8350 lt　　C 8350 lt　　D 835000 lt

65. 1.705 km

{A 1705 km　　B 1.705 m　　C 1705 m　　D 17.05 m}

Questions 66 to 70, find the given in appropriate units

66. 20.400 km

{A 20400 km　　B 20.4 km　　C 20km 4m　　D 20km 400m}

67. 3.3 cm

{A 33cm　　B .33cm　　C 33mm　　D 3cm 3mm}

68. 64.050kg

{A 64kg 05gm　　B 64kg 50gm　　C 64kg 5gm　　D 64kg 500 gm}

69. 18.360 lt

{A 18 l 36 ml　　B 18360 l　　C 18 l 036 ml　　D 18 l 360 ml}

70. 9.47 m

{A 9m 47cm　　B 947 m　　C 9cm 47m　　D 9m 047 cm}

In questions 71 to 78 fill the blanks using appropriate symbol.

71. 0.275........0.257

{ A >　　B =　　C <　　D none of these}

72. 73.087.........73.0870

{A >　　B <　　C #　　D =}

73. 32.125 .... 32.215

{A >　　B <　　C =　　D none of these}

74. 48.7 .... 48.699

{A =　　B <　　C >　　D none of these}

75. 44.7............ 44.81

{ A >　　B <　　C =　　D none of these}

1128

76. $\frac{7}{10}$ 0.3

{A > B < C # D =}

77. $\frac{1}{100}$ 0.3

78. 0.7 .... $\frac{4}{100}$

{A = B < C > D none of these}

Aarrange the decimal in the asending oeder

79. 68.11, 65.45, 101.61, 26.05

{ A 101.61, 68.11, 65.45, 26.05

B 26.05, 65.45, 68.11, 101.61

C 101.61, 65.45, 68.11, 26.05

D 26.05, 68.11, 65.45, 101.61, }

80. Arrange the decimals in the descending order

55.251, 55.521, 55.125, 55.215

{ A 55.125, 55.215, 55.521, 55.521

B 55.125, 55.521, 55.215, 55.521

C 55.521, 55.251, 55.215, 55.125

D 55. 521, 55.215, 55.251, 55.125}

Simplify questions 81 to 95

81. 0.3 + 0.7

{A 0.10 B 1.1 C 10 D 1}

82. 1.4 + 0.73

{ A 2.113 B 2.13 C 2.77 D 2.33}

83. 22.13 + 13.07

{A 30 . 137 B 20.20 C 35.20 D 30.110}

84. 10.23 + 13.01 + 2.1

{ A 25.34 B 15.1124 C 15.43 D 16}

85. 7.6 - 4.3

{ A 4.3 B 3.3 C 4.2 D 3.2}

86. 7.87- 4. 09

{ A 1.87 B 1.88 C 3.78 D 2.78}

87. 5.07 - 4.2

{ A 0.78 B 6.7 C 1.87 D 1.05}

88. 24.59×100

{ A 2.459 B 24.59 C 245. 9 D 2459}

89. $8.30 \times .2$

{ A 1.660 B 16.06 C 1.66 D 16.6}

90. 0.2×0.3

{ A 0.06 B 0.6 C 0.006 D 6}

91. 0.7×0.8

{ A 0.56 B 0.0056 C 5.6 D 0.056}

92. $2.4 \div 0.6$

{ A 40 B 4 C 0.4 D 0.04}

93. $86.4 \div .02$

{ A 4320 B 432 C 43.2 D 4.32}

94. $0.05 \div 0.25$

{ A 20 B 0.2 C 0.02 D 2}

95. $0.08 \div 4$

{ A 0.2 B 0.02 C 2 D 20}

Questions 96 to 100 , simplify.

96. $10 - 16 \div 8 \times 2$

(A. 1 B. 3 C. 4 D. 19)

97. $4 + 2 \times 15 \div 3 - 10$

{ A 3 B 4 C 10 D 20}

98. $1 + 27 \div 9 \times 2 - 4$

{ A -5 B -3 C 3 D 4}

99. $\frac{3}{4} \div \frac{5}{8} + \frac{2}{15} - \frac{1}{3}$

{ A 1 B 3 C $\frac{13}{15}$ D $\frac{26}{3}$ }

100. $2.2 \div 0.2 - 2.02 \times 2.0 + 2$

{ A 19.96 B 41.98 C 31.98 D 21.98}

120

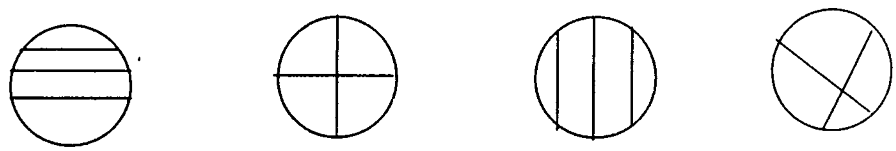
APPENDIX

UNIT TEST 1

(Answer all questions.)

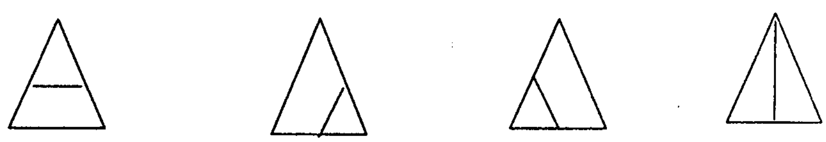
1) Five questions are given below. In each question four figures are given. Put a tick mark ( ) against the figure which is equally divided in each question.

i)



( ) ( ) ( ) ( )

ii)

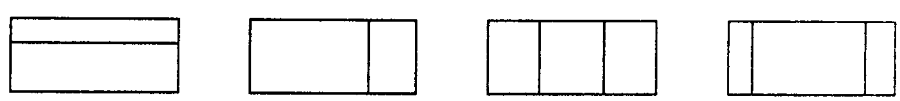


( ) ( ) ( ) ( )

iii)

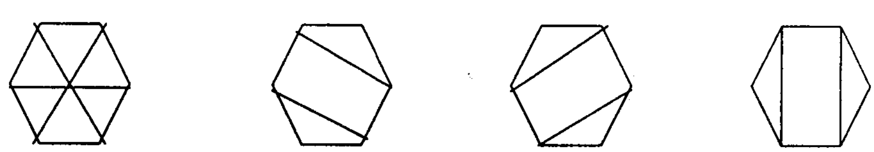
( ) ( ) ( ) ( )

iv)



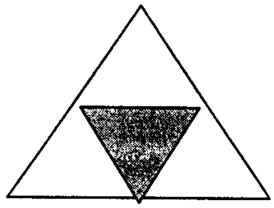
( ) ( ) ( ) ( )

v)

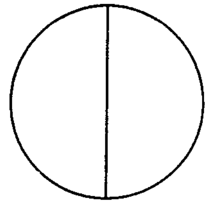


( ) ( ) ( ) ( )

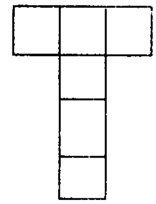
II. Five questions are given in this section.
Write the fractional number which represents the shaded position in each of the following figures.

i) 

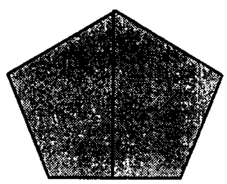
(   )

ii) 

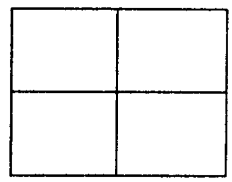
(   )

iii) 

(   )

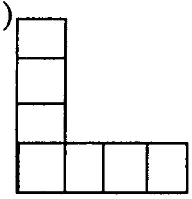
iv) 

(   )

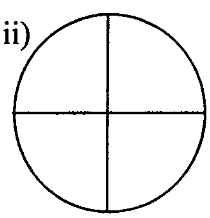
v) 

(   )

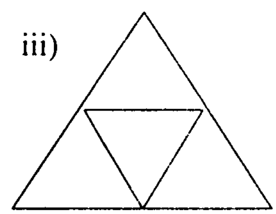
III) Shade the given figures to represent the fraction given in bracket. Answer
five questions.

i) 

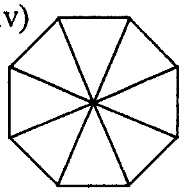
($\frac{4}{7}$)

ii) 

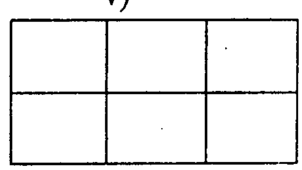
($\frac{2}{4}$)

iii) 

($\frac{3}{4}$)

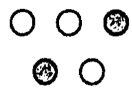
iv) 

($\frac{3}{8}$)

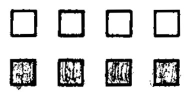
v) 

($\frac{5}{6}$)

4 Write the fractional number which represents the shaded objects in the following collections.. Five questions are given below.

i) 

( )

ii) 

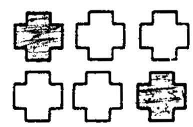
( )

iii) 

( )

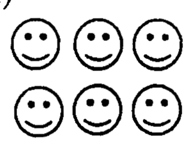
iv) 

( )

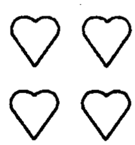
iv) 

( )

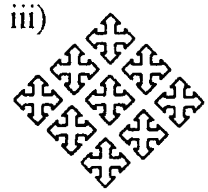
5 Five questions are given in this category , Shade the objects to represent the given fractions for each collection.

i) 

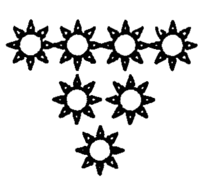
$(\frac{2}{6})$

ii) 

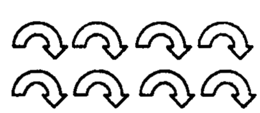
$(\frac{1}{4})$

iii) 

$(\frac{3}{9})$



$(\frac{3}{7})$



$(\frac{3}{8})$

6 Write the fraction. for each questions given below.

i) If the numerator is 3 and denominator is 7 { }
ii) If the numerator is 5 and denominator 6 { }
iii) If the denominator is 10 and numerator is 8 { }
iv) two-fifth { }
v) four-tenth { }

7) Fill in the blanks:-

i) In the fraction, $\frac{3}{7}$ the numerator is ----------

ii) In the fraction $\frac{12}{17}$, the numerator is ....

iii) In the fraction $\frac{20}{20}$, the numerator is ....

iv) In the fraction $\frac{13}{27}$, the denominator is.........

v) In the fraction $\frac{83}{94}$, the denominator is ....

8) Say 'true' or 'false', for each statement.

i) If an object is divided into five equal parts, then the denominator will be 5 (   )

ii) In a collection of 9 objects, 4 of them were selected, then the numerator of the fraction will be 9 (   )

iii) In a fraction, the numerator represents the number of equal parts into which it is divided. (   )

iv) For every fraction there will be a numerator and denominator (   )

v) When an object is divided into two equal part, then two halves makes the whole (   )

vi) If the object is not divided into equal parts then it cannot be represented in a fraction.(   )

vii) The number which is written below the fractional line is called numerator (   )

viii) An object is divided into 4 equal parts, 3 of them were not shaded, the fraction representing the shaded portion will be $\frac{3}{4}$ (   )

ix) $\frac{2}{5}$ means out of 5 equal parts 2 of them were selected. (   )

x) Out of 3 equal parts, only one is taken then the fraction is $\frac{1}{3}$

(   )