THE EFFECTIVENESS OF TEACHING APPROACHES FOR CONCEPT ATTAINMENT AT ELEMENTARY SCHOOL LEVEL

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ISLAMABAD
2017

Teaching methods

Instructional [illegible]

Mathematical [illegible]

Mathematics - Study and teaching (Elementary

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Submitted in partial fulfillment of the requirements for

Doctor of Philosophy in Education at the Faculty of Social Sciences,

International Islamic University,

Islamabad

Department of Education
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INTERNATIONAL ISLAMIC UNIVERSITY,
ISLAMABAD

2017

CERTIFICATE

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ACKNOWLEDGEMENTS

Above all my humblest praise to Allah, The Almighty and Omnipotent, the Greatest of the great source of inspiration and to the Holy Prophet Muhammad (peace be upon him), the greatest ever human ocean of knowledge and learning.

The researcher is grateful to his supervisor, Prof.Dr.N.B.Jumani for his affectionate supervision and inspiring guidance throughout the study. His towering personality and versatile knowledge was a source of guidance and beacon light for me. Despite his occupied timetable, he spared time and encouraged me in the research study.

The researcher is also grateful to Dr. Muhammad Munir Kayani, and Dr. Asad Abbas Rizvi for their continued support and professional guidance in the research study.

The researcher is also grateful to all those educationists and professionals who provided me the necessary knowledge and information relevant to my study.

I owe my heartiest gratitude to my parents, family and friends who supported me at every moment of my life and without whose support this work would not have been possible.

Assad Nisar

Abstract

Traditionally the process of teaching involved three major components, teacher, learner and content. Teachers' role was to teach the content contained in the text to the learner. Teaching was considered effective when the learner was able to retrieve the information when and where necessary and was able to apply it accurately. Now teaching is known as the systematic process which involves teacher, learner, material and learning environment. Effective teaching is that which enables the learners to incorporate new information into their memories and master new knowledge. This study analyzes the effectiveness of teaching approaches i.e. inductive and deductive for Mathematical concept attainment at elementary level. The major objectives of the study were to analyze the effect of deductive teaching method on students' concept attainment, to measure the effect of inductive teaching method on students' mathematical concept attainment and to analyze the comparative effectiveness of inductive and deductive teaching methods on elementary students' mathematical concepts attainment. All the 7^{th} class students in Federal Government schools of Islamabad were the population of the study. One secondary school was selected through convenience sampling for the study. The independent variable of teaching methodology was manipulated into inductive teaching approach and deductive teaching approach for the experimental and control group respectively. An overall sample of 60 students was taken from the selected school using stratified sampling technique. These 60 students were divided equally into experimental and control groups through random sampling. A pre test – post test control groups design was followed in the study. Twenty five concepts from 7^{th} class textbook were selected keeping in view the representation of sets, algebra and geometry portions. The researcher developed 25 lesson plans each in light of the principles of concept attainment model using inductive and deductive approach to teach the students of experimental and control groups respectively. A researcher-made 100 item academic achievement test, based on 8 tasks paradigm was administered to each group as pre test as well

as post test. The mean difference between post test and pre test scores was taken as the academic achievement of the students. The results of the study approved that all three groups i.e. low, average and high achievers of experimental group taught through inductive teaching approach performed better than the control group which was taught through deductive teaching method. It is therefore concluded that inductive teaching approach is significantly more effective than deductive teaching approach for concept attainment at elementary level. The major recommendations of the study included that teachers may use inductive teaching method for teaching concepts of mathematics at elementary level. Moreover this methodology should be encouraged at higher grades as well.

Table of Contents

CHAPTER 1 ..... **1**

INTRODUCTION **1**

1.1 Statement of the Problem 3

1.2 Objectives of the Study 4

1.3 Operational Definitions 4

1.4 Variables: 6

1.4.1 Independent Variables: 6

1.4.2 Dependent variables: 6

1.4.3 Situational variables: 6

1.5 Hypotheses 7

1.6 CONCEPTUAL FRAMEWORK OF THE STUDY 13

1.7 Significance of the Study 14

1.8 Delimitations of the Study 15

1.9 Limitations of the Study 15

CHAPTER 2 ..... **16**

REVIEW OF LITERATURE **16**

2.1 What is Concept? 176

2.2 Elements of a Concept 17

2.3 Concept Learning Measurement 19

2.4 The Teaching-Learning of Concepts 21

2.4.1 Concept Definition 23

2.4.2 Creating Instances 24

2.4.3 Presenting the Concept Label and Attribute Definition 25

2.4.4 Presenting Instances 26

2.4.5 Guiding Learner Practice 27

2.5 Theory of Mathematical Teaching 27

2.6 Strategies Used For Teaching Concepts 28

2.7 Inductive Teaching and Learning Methods 32

2.8 Jerome Bruner's Theory of Learning 33
2.8.1 Piaget's Stages of Mental Growth 35
2.8.2 Piaget's and Bruner's conceptual interrelation 36
2.8.3 Application of Bruner's Theory 38
2.9 Strategies for Learning Concepts 38
2.9.1.2 Selection Model of Concept Attainment 41
2.9.1.3 Unorganized Material Model 42
2.10 Ausubel Learning Theory 42
2.11 The Deductive Method of Teaching 46
2.12 Model for the Deductive Method of Teaching 47
2.13 Review of Related Research Studies 48
CHAPTER 3 55
RESEARCH METHODOLOGY 55
3.1 Research Design 55
3.2 Population of the study 56
3.3 Sample and Sampling technique 56
3.3.1 Sampling of School 56
3.3.2 Sampling of Students 57
3.4 Instruments for data collection 58
3.4.1 Validity of the Experimenter's Tools 59
3.4.2 Reliability of the Experimenter's Tools 61
3.4.3 Piloting of the Instrument 61
3.5 Procedure of the study 62
3.5.1. Contents of the study 63
3.5.2 Development and Validation of Lesson Plans 64
3.5.3 Time Table 65
3.6 Control of Variables of the Study 65
3.7 Data Analysis 68
CHAPTER 04 70
ANALYSIS AND INTERPRETATION OF DATA 70
CHAPTER 5 94
SUMMARY, FINDINGS, CONCLUSIONS, AND 94
RECOMMENDATIONS 94
5.1. Summary 94

5.2 Findings 95
5.3 Discussion of Results 98
5.4 Conclusions 99
5.5 Recommendations 100
APPENDIX 'A' **109**
PRETEST / POSTTEST **109**
APPENDIX "B" **120**
Group Formation (Experimental and Control) **120**
APPENDIX "C" **121**
Pre Test Achievement Scores **121**
APPENDIX "D" **122**
Post Test Achievement Scores **122**
APPENDIX "E" **123**
Difficulty Index and Discriminating Power **135**
APPENDIX "F" **137**
Model Lesson Plans **137**

List of Tables

Table 4.1: Summary of 6th grade annual examination scores of experimental and control group 71

Table 4.2: result of independent sample t test on pre-test scores of experimental and control Groups 72

Table 4.3: Summary of mean achievement scores of experimental group in pre and post- test 73

Table 4.4: Summary of mean achievement scores of control group in pre and post- test 73

Table 4.5:Summary of mean achievement scores of experimental and control group in post- test 74

Table 4.6: Summary of mean achievement scores of high achievers of experimental and control group in post test 75

Table 4.7: Summary of mean achievement scores of average achievers of experimental and control group in post test 76

Table 4.8: Summary of mean achievement scores of low achievers of experimental and control group in post test 77

Table 4.9: Summary of mean achievement scores of students of experimental and control groups in first component of concept (name and definition) in post test 78

Table 4.10: Summary of mean achievement scores of students of experimental and control groups in 2nd component of concept (examples and non examples) in post test 79

Table 4.11: Summary of mean achievement scores of students of experimental and control groups in 3rd component of concept (essential and non essential attributes) in post test 80

Table 4.12: Summary of mean achievement scores of students of experimental and control groups in 4th component of concept (subordinate and super ordinate concept) in post test 81

Table 4.13:Summary of mean achievement scores of high achievers of experimental and control groups in first component of concept (name and definition) in post test 82

Table 4.14: Summary of mean achievement scores of high achievers of experimental and control groups in second component of concept (examples and non examples) in post test 83

Table 4.15: Summary of mean achievement scores of high achievers of experimental and control groups in 3rd component of concept (essential and non essential attributes) in post test 84

Table 4.16:Summary of mean achievement scores of high achievers of experimental and control groups in 4th component of concept (subordinate and super ordinate 85

Table 4.17: Summary of mean achievement scores of average students of experimental and control groups in first component of concept (name and definition) in post test 86

Table 4.18: Summary of mean achievement scores of average students of experimental and control groups in second component of concept (examples and non examples) in post test 87

Table 4.19: Summary of mean achievement scores of average students of experimental and control groups 3rd component of concept (essential and non essential attributes) in post test 88

Table 4.20: Summary of mean achievement scores of average students of experimental and control groups in 4th component of concept (subordinate and super ordinate concept) in post test 89

Table 4.21: Summary of mean achievement scores of low achievers of experimental and control groups in first component of concept (name and definition) in post test 90

Table 4.22: Summary of mean achievement scores of low achievers of experimental and control groups in second component of concept (examples and non examples) in post test 91

Table 4.23: Summary of mean achievement scores of low achievers of experimental and control groups in 3rd component of concept (essential and non essential attributes) in post test 92

Table 4.24: Summary of mean achievement scores of low achievers of experimental and control groups in 4th component of concept (subordinate and super ordinate concept) in post test 93

CHAPTER 1

INTRODUCTION

Education is known as the powerful catalyst which enables the individuals to have full consciousness of their mission, of their purpose in life and equip them to achieve that purpose by providing mental, physical, ideological and moral training. (Noddings, 1995). Teaching is simply defined in most of the dictionaries as something that is taught i.e. the ideas and beliefs that are taught by a person, religion, etc. The word instruction is defined as giving others detailed information about a task so that they can accomplish that task. (Merriam Webster Dictionary, 2011).Traditionally teaching is known as the act of disseminating information to the learner in the class room. In a traditional classroom teaching, teacher follows chalk and talk approach in which the students remain passive learners. The famous Greek philosopher Socrates used question and answer method for teaching. As the time passed and due to the expansion of knowledge, teaching methodologies were changed and improved.

As a result of researches in the field of education, these traditional definitions of teaching have been challenged in the last decade and the role of teacher is redefined. In the opinion of Davis (1997) the nature of subject matter and the question of how students learn should always be kept in mind while designing and selecting the teaching methods.

Mathematics is an abstract subject and it deals with patterns and relations. The contents of subject of mathematics include concepts and generalizations. The students must use cognitive processes such as inferring and comparing to form mathematical ideas. In

teaching mathematics the teacher's role is to encourage learners to use cognitive processes. (Jonassen, Strobel & Gottdenker, 2005).

Traditionally the process of teaching involved three major components, teacher, learner and content. Teaches role was to teach the content contained in the text to the learner. Teaching was considered effective when the learner was able to retrieve the information when and where necessary and was able to apply it accurately. Now teaching is known as the systematic process which involves teacher, learner, material and learning environment. Effective teaching is that which enables the learners to incorporate new information into their memories and master new knowledge. (Woolfolk, 2007)

Teaching of mathematics in Pakistani schools is restricted to giving some information on solving formula type questions. Mathematics has become a least understood subject by students because it is taught in total isolation from real life and without exposing its significance, beauty and strength of communication to students. Teachers do not explain mathematical concepts to students rather they use some form of mechanical techniques to solve a sum. (Krishna, 2002)

Researches in the field of mathematics show that concepts are taught to students both inductively and deductively. There is a difference among researchers about the best approach for concept attainment. Ausubel was in favor of deductive while Bruner advocated inductive approach for concept attainment. Review of research studies on concept attainment showed that concept attainment model developed by Joyce and Weil and which is based on the theory of James Bruner is effective in teaching concepts. The most of the research studies were focused on the performance of students in achievement tests. It was believed that if the

students achieve high scores in achievement test, they have attained the concepts. (Slavin, 2006).

In our classrooms teachers transmit textbook facts to students, who in turn are expected to memorize and reproduce the content in the examinations. The teachers are so ingrained that they find this method of lecture and recitation as a good way of teaching a large number of students in their classrooms. (Quddus, Jafar & Naseem, 1990).In mathematics students memorize rules without understanding their rationale. There is no doubt that the timely reward to this way is more immediate and more apparent but this instrumental learning doesn't bring desired results subsequently.(Krishna, 2002).The memorized rules may work for a limited range of similar problems but students do not feel comfortable when they face different or challenging tasks. Keeping in mind the earlier research work in the field of concept attainment and the actual classroom teaching practices in our schools the researcher decided to conduct a study based on the effectiveness of teaching approaches i.e. deductive and inductive teaching approaches for concept attainment at elementary level.

1.1 Statement of the Problem

It can be seen that mathematics is a product of pure thought and mathematics learning is essentially based on basic mathematical concepts, gradually building up of logical structure of various concepts. In the context of Pakistan, mathematics is usually taught through a very traditional method in which teacher gives questions with the formula to solve, the emphasis is on providing solution to a number of similar questions, and ignoring the importance of concept attainment, which is in fact a prime factor in mathematical learning.

The researchers are of the view that level of mathematics achievement depends upon the level of concept attainment of mathematics. The present study is conducted to have a comparative analysis of the effectiveness of two teaching approaches i.e. inductive and deductive for concept attainment at elementary school level.

1.2 Objectives of the Study

The objectives of the study were:

1. To measure the effectiveness of inductive teaching approach in attaining the mathematical concepts at elementary level.
2. To measure the effectiveness of deductive teaching approach in mathematical concept attainment at elementary level.
3. To compare the effectiveness of inductive and deductive teaching approaches for the mathematical concept attainment of elementary level students.
4. To compare the effectiveness of inductive and deductive teaching approaches for the high achievers of experimental and control groups in attaining the concepts.
5. To compare effectiveness of inductive and deductive teaching approaches for the average students of experimental and control groups in attaining the concepts.
6. To compare the effectiveness of inductive and deductive teaching approaches for the low achievers of experimental and control groups in attaining the concepts.

1.3 Operational Definitions

- **Deductive Teaching Method:** The researcher used deductive method of teaching in mathematical concepts to control group. The researcher has used this method in a way

that it progresses from general concept to the specific use or application. Beginning with the rule stated by the authority of textbook and instructor, teacher exemplifying, followed by guided practice and independent practice; reception-learning, ordinarily traditional lecture instruction.

- **Inductive Teaching Method:** The inductive teaching method goes from the specific to the general and is based on specific experiments or experimental learning exercises. In this research the researcher has used it in a way as the concept begins with the examples, allowing the student to infer a rule, validating the rule and reinforcing the rule with guided and independent practice; focus on discovery-learning, experimental or laboratory instruction. The researcher used the Concept Attainment Model as inductive teaching strategy.
- **Attainment of Concepts:** For this research, attainment of concepts is total achievement of the students in terms of the concepts learned and this has been measured by the scores obtained by students in the post test used in the study.
- **Concept Attainment Model:** The concept attainment model which is used in this research is developed by Joyce and Weil (1985) and based on Bruner's theory of concept attainment. It is an indirect instructional strategy designed to teach the concepts to learners.

1.4 Variables:

Different variables used in this study are:

1.4.1 Independent Variables:

The two teaching methods i.e. inductive teaching method and deductive teaching method were used as independent variables. These treatment variables were manipulated to study their comparative effectiveness. Two groups i.e. experimental and control were taught by structured lesson plans based on these two teaching methods.

1.4.2 Dependent variables:

The dependent variable was the performance of students in the test which was developed by the researcher and was administered at the end of treatment.

1.4.3 Situational variables:

Situational variables like time, duration of treatment, teacher, subject to be taught, condition of instruction, sample size, medium of instruction were controlled administratively and through selection of the sample and with the help of research design.

1.5 Hypotheses

To achieve the objectives of the study, following hypotheses were formulated:

H_o1: There is no significant difference between the performance of the students taught through inductive teaching approach and deductive teaching approach.

$H_1$1: There is a significant difference between the performance of the students taught through inductive teaching approach and deductive teaching approach.

H_o2: There is no significant difference between the performance of the high achievers taught through inductive teaching approach and deductive teaching approach.

$H_1$2: There is a significant difference between the performance of the high achievers taught through inductive teaching approach and deductive teaching approach.

H_o3: There is no significant difference between the performance of the average achievers taught through inductive teaching approach and deductive teaching approach.

$H_1$3: There is a significant difference between the performance of the average achievers taught through inductive teaching approach and deductive teaching approach.

H_o4: There is no significant difference between the performance of the low achievers taught through inductive teaching approach and deductive teaching approach.

$H_1$4: There is a significant difference between the performance of the low achievers taught through inductive teaching approach and deductive teaching approach.

H_o5: There is no significant difference between the performance of the students of experimental and control groups in learning the first component of concept (name and definition).

$H_1$5: There is a significant difference between the performance of the students of experimental and control groups in learning the first component of concept (name and definition).

H_o6: There is no significant difference between the performance of the students of experimental and control groups in learning the second component of concept (example and non example).

$H_1$6: There is a significant difference between the performance of the students of experimental and control groups in learning the second component of concept (example and non example).

H_o7: There is no significant difference between the performance of the students of experimental and control groups in learning the third component of concept (essential and non essential attributes).

$H_1$7: There is a significant difference between the performance of the students of experimental and control groups in learning the third component of concept (essential and non essential attributes).

H_o8: There is no significant difference between the performance of the students of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

$H_1$8: There is a significant difference between the performance of the students of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

$H_0$9: There is no significant difference between the performance of the high achievers of experimental and control groups in learning the first component of concept (name and definition).

$H_1$9: There is a significant difference between the performance of the high achievers of experimental and control groups in learning the first component of concept (name and definition).

$H_0$10: There is no significant difference between the performance of the high achievers of experimental and control groups in learning the second component of concept (example and non example).

$H_1$10: There is a significant difference between the performance of the high achievers of experimental and control groups in learning the second component of concept (example and non example).

$H_0$11: There is no significant difference between the performance of the high achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

$H_1$11: There is a significant difference between the performance of the high achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

$H_0$12: There is no significant difference between the performance of the high achievers of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

$H_1$12: There is a significant difference between the performance of the high achiever of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

H_o13: There is no significant difference between the performance of the average achievers of experimental and control groups in learning the first component of concept (name and definition).

$H_1$13: There is a significant difference between the performance of the average achievers of experimental and control groups in learning the first component of concept (name and definition).

H_o14: There is no significant difference between the performance of the average achievers of experimental and control groups in learning the second component of concept (example and non example).

$H_1$14: There is a significant difference between the performance of the average achievers of experimental and control groups in learning the second component of concept (example and non example).

H_o15: There is no significant difference between the performance of the average achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

$H_1$15: There is a significant difference between the performance of the average achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

H_o16: There is no significant difference between the performance of the average achievers of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

$H_1$16: There is a significant difference between the performance of the average achievers of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

H_o17: There is no significant difference between the performance of the low achievers of experimental and control groups in learning the first component of concept (name and definition).

$H_1$17: There is a significant difference between the performance of the low achievers of experimental and control groups in learning the first component of concept (name and definition).

H_o18: There is no significant difference between the performance of the low achievers of experimental and control groups in learning the second component of concept (example and non example).

$H_1$18: There is a significant difference between the performance of the low achievers of experimental and control groups in learning the second component of concept (example and non example).

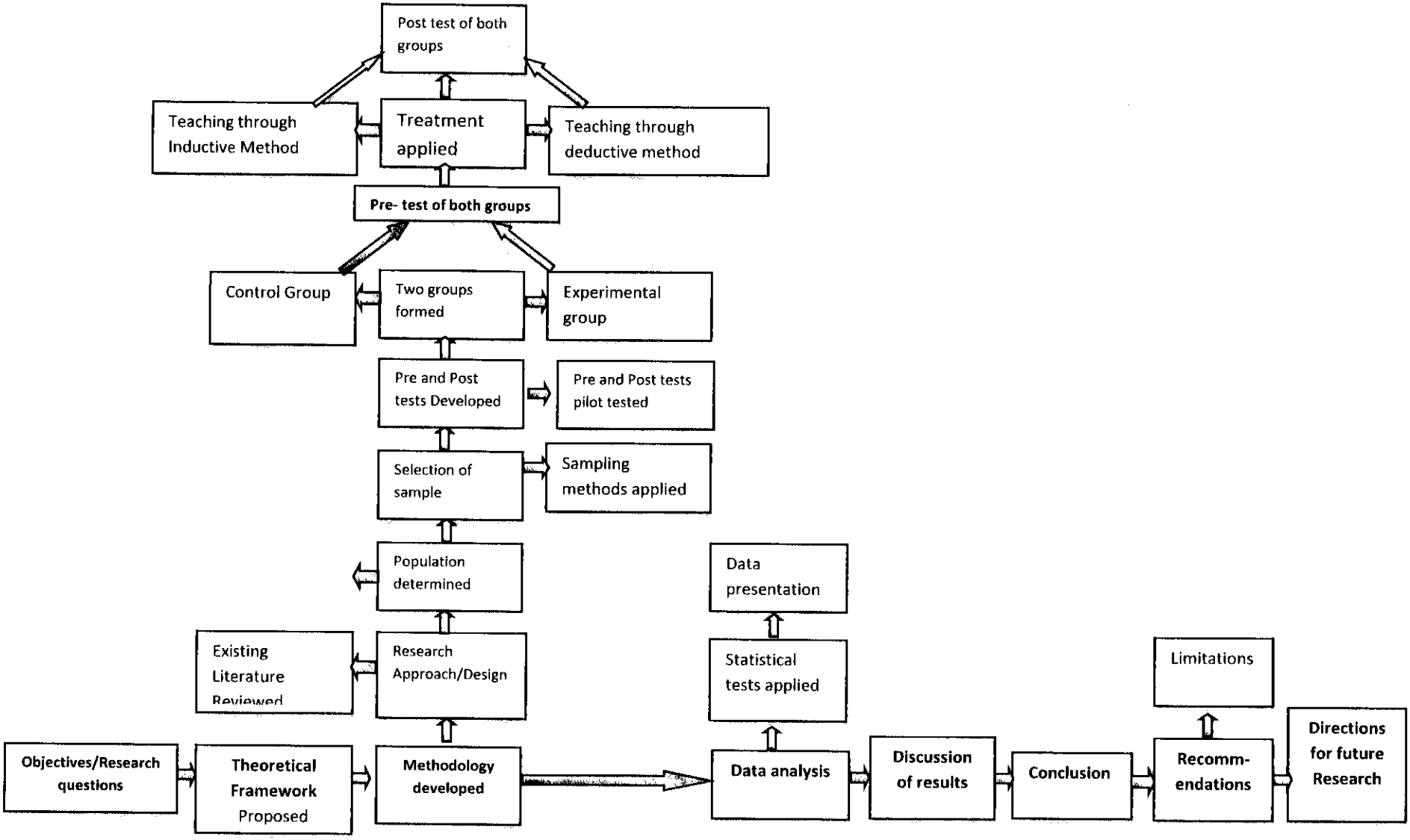
H_o19: There is no significant difference between the performance of the low achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

H_I19: There is a significant difference between the performance of the low achievers of experimental and control groups in learning the third component of concept (essential and non essential attributes).

H_o20: There is no significant difference between the performance of the low achievers of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

H_i20: There is a significant difference between the performance of the low achievers of experimental and control groups in learning the fourth component of concept (subordinate and super ordinate concept).

1.6 CONCEPTUAL FRAMEWORK OF THE STUDY



1.7 Significance of the Study

Mathematics teachers generally use deductive teaching approach to teach mathematical concepts at elementary level in Pakistan. According to the knowledge of the researcher no study was conducted to find the effectiveness of inductive teaching approach for attainment of mathematical concepts. In past different research studies have been conducted to find out the relative effectiveness of different teaching approaches at different levels on the achievement of students. The present action research study is designed to find the solution of two basic questions i.e. which method is more effective to teach concepts and how concept attainment can be measured. This research is different from those past studies in a way that it is designed to measure the comparative effectiveness of inductive and deductive teaching approaches for concept attainment. For this purpose a research tool was developed to measure the concept attainment of students.

The present study may help future researchers in the area of mathematics teaching to use these findings as guidelines to carry on the research on instructional methods. This study may be very helpful for teachers to make the decisions regarding selection/adoption of teaching methods in their mathematics teaching. It may help teachers, administrators, and planners, in short, all the concerned people in the education field.

The results of this research may also help teachers' training institutions, academic mangers in deciding which method of teaching should be taught to the trainee teachers for having better classroom performance at their jobs. It may help them to reach and understand every child in the classroom and to instruct at the same pace using the full efficiency and potential that they have of teaching. The curriculum planners and administrators may plan

accordingly and incorporate techniques regarding the effectiveness of Deductive versus Inductive methods of instruction. Last but the most important stakeholder and beneficiary of this research would be the students themselves; they can use their knowledge of mathematics in more practical and challenging situations, if taught properly.

1.8 Delimitations of the Study

1. The study was delimited to only one school i.e. Federal Government Model Secondary Schools located in Islamabad, working under FDE (Federal directorate of education), Islamabad.
2. Only few concepts from Arithmetic, algebra and geometry of grade 7^{th} were picked for the purpose of research.
3. Only students of 7^{th} grade were included in the study.

1.9 Limitations of the Study

1. The study was limited to only mathematical concepts.
2. This study was limited to only male students.
3. School for the study was selected through convenience sampling.

CHAPTER 2

REVIEW OF LITERATURE

The present study was conducted to analyze the effectiveness of different teaching approaches for the attainment of mathematical concepts by the elementary level students. Review of literature brought forth many related researches conducted for exploring the comparative effectiveness of different teaching methods. Besides providing a deep insight into the problem under study, this review helped the researcher in avoiding the duplication of any previous research. Maximum effort was put in to find out all the relevant researches conducted nationally and internationally on the different aspects of the topic under study. However the review facilitated the researcher in selection of appropriate methodology for the present research. The review is focused on the elements of a concept, Concept learning measurement, and approaches of teaching a concept. It involves the inductive and deductive approaches of concept teaching. Moreover Piaget's stages of growth and learning have been linked up with the concept building. The theories of learning presented by some psychologist i.e. Bruner, Ausubel etc. have also been added to build a clear understanding of what fundamental elements are involved in concept development of learners. The review would help the readers in going through concept attainment building blocks.

2.1 What is a Concept?

A concept is a very difficult term to define and understand, but simply in order to understand the concept, think about the common features an object or event have. For example the concept of quadrilateral includes all the shapes which have four sides. Bruner (1966) defined concept as "a class or grouping of response, an act of categorization, of

'rendering equivalent'. The act of categorization involves rendering discriminably different things equivalent, to group the objects and events and people around us into classes, to respond to them in terms of their class membership rather their uniqueness".

According to Dececco (1968) "a concept is a class of stimuli which has common characteristics. These stimuli may be objects, events or persons". A concept can be defined as a category used to group the events, ideas, object, or people of same characteristics. For example the concept of a student refer to a category of people who are similar to one another as they all study. They may be different from one another in many characteristics such as age, height, color etc. But the common characteristic which groups them is that they study. Concepts are not the real things rather they are abstracts. In real world only examples of the concepts exist (Selvens, 1993).

According to Galotti (2000) concept is the mental representation of some events, objects or patterns. For example the concept of a dog for many people would include information that it is a pet animal, having four legs and a tail. Concepts provide the building blocks for logical thought, because by comparing concepts we are able to think and reason. The ability to form concepts is not simply to intelligent thought; it is critical to our ability to function. The ability to group similar events together in concepts allows us to impose coherence on the turbulent stream of our perceptions (Liberman, 2000).

2.2 Elements of a Concept

From the above mentioned definitions given by researchers (Galotti, 2000; Selvens, 1993; Liberman, 2000; Dececco, 1968) it can be interpreted that every concept has a set of elements. These elements are briefly described below:

- **Name**: Every concept has a name. The term or label which is given to a category is called name. For example banana, dog, quadrilateral, triangle, democracy, table, verb, noun etc. all these are the name given to different categories. The label is necessary for understanding the concept, but knowing the label does not mean that a person understands the concept. For example a person may know the "animal" name, but may not understand that cat, rat, cow and dog as animals (Safayeni, Derbentseva & Canas , 2005).

- **Attributes**: these are the features or characteristics of objects. Each object or a category has its features or characteristic. For example a quadrilateral is a concept. A plane figure, four sides, four angles, closed figure are the attributes of quadrilateral. These attributes are further divided into two groups, essential and non essential attributes.

- **Essential attributes**: the common characteristics or features of a concept are called its essential attributes. All the examples should have these attributes. For example all quadrilaterals are plane four sided closed figures. Square and rectangle are quadrilaterals because they have these attributes.

- **Non essential attributes**: some examples of the concept differs slightly, this difference is due to the non essential attributes. For example square and rectangle both are quadrilaterals, they have many characteristic common but they also have some un common attributes. In a square all the four sides are equal in length, while in a rectangle opposite sides are of equal in length. The relevant length of sides is the non essential attribute of a quadrilateral. Similarly measure of relative angles is also a non essential attribute of quadrilateral (Charles & Dills, 1997).

- **Examples**: examples of the concept include all the essential attributes. Majority of the concepts have more than one example. The examples differ from each other due to the presence or absence of non essential attributes. Bruner named those examples which include all the essential attributes as positive examples and examples which do not contain all the essential attributes (at least one of the essential attribute is missing) as negative examples

- **Definition**: a rule or definition is a statement which includes all the essential attributes of a concept. For example a quadrilateral is defined as the plane closed figure having four sides. According to Klausmeier (1992) a reference to any more general category and a statement including the defining attributes are two elements necessary for a good definition.

2.3 Concept Learning Measurement

There are different theoretical perspectives regarding how concept learning occurs (Merrill & Tennyson, 1977; Tennyson & Cocchiarella, 1986; & Morrison, Ross, & Kemp, 2001). But in contrast to that there is a great similarity in how concept attainment can be measured. Concept learning or concept attainment occurs when the learner is able to discriminate among the attributes of the concept and can also elaborate the examples and non-examples (Klausmeier, 1992).

Tennyson & Park (1980) defined concept learning as "the identification of concept attributes which can be generalized to newly encountered examples and discriminate examples from non examples". Concept learning and the assessment of learning focuses on both recall as well as on application of the learned concept (Morrison, Ross, & Kemp, 2001).

While measuring the concept learning or concept attainment the role of attribute isolation, instance discrimination and concepts in use is described as follows:

a) Attribute isolation

The focus of assessment of concept learning is on student's ability to understand the nature of instances which are generally based upon defining attributes to the concept category (Bruner, Goodnow, & Austin, 1967). Concept learning assessment focuses on the learner's ability to discriminate the relevant criteria by which the attributes are grouped into the concept categories (Joyce & Weil, 1972). Two types of attributes (defining attributes and critical attributes) are of major concern while measuring the concept attainment. Concept attainment is therefore measured through the ability of a learner to isolate the critical attributes and defining attributes.

b) Instance Discrimination and Generalization

Instance discrimination is the ability of a student to discriminate between examples and non examples of the concept. This ability has an important role in concept learning assessment. Concept learning assessment also focuses on learner's ability to generalize new examples (Lee, 2004). Therefore comprehensive assessment of concept learning is based on the student's ability to identify and place the examples in the relevant exemplar class and to identify the essential attributes of an exemplar class as a whole (Gagne, 1965). Learners should not over generalize or under generalize while discriminating on members from members of the class. Incorrectly judging non example as example is called over generalizing and under generalizing means incorrectly judging examples as non examples (Markle & Tiemann, 2001).

c) Concept in Use

Johnson (1979) reviewed the theory and research on the role of concepts in instruction and learning. According to him the relation of concept with super ordinate concept and generalization were ignored and total focus of concept learning and assessment was on concept attainment as a discrete and terminal outcome. He suggested that concept learning should be based upon concepts as mental model building blocks. Concept instruction and assessment should focus on how the learned concepts are organized within the learners overall conceptual framework.

2.4 The Teaching-Learning of Concepts

Mathematics and science are traditionally taught through deductive method. The instructor introduces a topic by lecturing on general principles, then uses the principles to derive mathematical models, shows illustrative applications of the models, gives students practice in similar derivations and applications in homework, and finally tests their ability to do the same sorts of things on exams. Little or no attention is initially paid to the question of why any of that is being done—what real world phenomena can the models explain, what practical problems can they be used to solve, and why the students should care about any of it. The only motivation to learn that students get—if they get any at all—is suggestions that the material will be important later in the curriculum or in their careers.

A well-established precept of educational psychology is that people are most strongly motivated to learn things they clearly perceive a need to know (Smith, 2006). Simply telling students that they will need certain knowledge and skills some day is not a particularly effective motivator. A preferable alternative is inductive teaching and learning. Instead of

beginning with general principles and eventually getting to applications, the instruction begins with specifics—a set of observations or experimental data to interpret, a case study to analyze, or a complex real-world problem to solve.

Concept learning and assessment focuses on recall as well as on application of the learned concept (Morrison, Ross, & Kemp, 2001). Johnson (1979) reviewed the theory and research on the role of concepts in learning and instruction. According to him the relation of concept with super ordinate concept and generalization were ignored and total focus of concept learning and assessment was on concept attainment as a discrete and terminal outcome. He suggested that concept learning should consider concepts as mental models or building blocks. Concept instruction and assessment should focus on how the learned concepts are organized within the learners overall conceptual framework. He was of the opinion that concept learning and assessment should focus on the learner's ability to describe conceptual patterns as in concepts maps, word association and model building.

A review of concept teaching models shows a great similarity regarding instructional presentation, learner practice and guidance. Three major components of concept instruction are; presentation of concept definition, presentation of examples and practice in elaboration of examples and non examples (Tennyson & Cocchiarella, 1986). Although there is a great similarity in concept teaching models, some differences along behavioral, cognitive or social cognitive theoretical lines also exist. The major differences occur in the areas such as sequencing, the learners' freedom to discover attributes and examples and the terminal objectives of the lesson. In general there are two different instructional strategy approaches used for concept instruction. These two are expository approach and inquiry approach. In

expository approach, attributes and instances are directly presented while in inquiry approach learner discovers the attributes and instances (Smith & Ragan, 2006).

Common techniques used in a variety of inquiry and expository approaches are as follows:

2.4.1 Concept Definition

Presentation of a concrete definition enhances the learning and it is as effective as a single set of examples and non examples (Klausmeier, 1992). It is suggested that for concept instruction learners should be provided the stated definition of the concept based on the attributes of the concept class (Markle & Tiemann, 2001).

Some researcher advocates that the definition of a concept should include the name of concept, the attributes and the way attributes are combined to determine category (Merrill & Tennyson, 1977). The attributes presentation may vary in characteristics. On the basis of characteristics, attributes are divided in to two groups named as critical or essential attributes and variable or non essential attributes. Critical attributes are presented in all the members of the class while variable attributes are in some members of the class (Merrill & Tennyson, 1977). Attributes of constant dimension are those which remain stable across contexts, while attributes of variable dimension vary or change (Tennyson & Cocchiarella, 1986).

Some researcher suggested that the defining attributes are based on their intrinsic properties, functional properties and relational properties. Intrinsic properties are referred to observable and invariant properties, functional properties are referred to how something function and relational properties are referred to the invariant relationship between items (Klausmeier, 1992).

When concepts are defined on the basis of relational properties, they may be categorized as conjunctive concepts or disjunctive concepts or relational concepts. Conjunctive concepts are those which are defined by one attribute and another, disjunctive concepts are defined by one attribute or another while relational concepts are defined by relationship between attributes (Fleming & Levie, 1978).

2.4.2 Creating Instances

Research studies show that the concept learning is influenced by the use of instances. Further the instances may vary in number, type and range. Instances may be positive or negative examples of the concept and depends upon the form of the concept. The concept may be physical or abstract; accordingly the instances take the form of a referent, an isomorphic representation or symbolic representation including words or other symbols (Merrill & Tennyson, 1977).

It is suggested that the concept definition is augmented from the multiple rational sets of examples and non examples (Markle & Tiemann, 2001). Many other researchers suggested that a wide variety of examples be included (Fleming & Levie, 1978). Another opinion is that the set of examples and non examples should be matched (Merrill & Tennyson, 1977).

The rational used in both instruction and testing of concepts involve

i. Identification of attributes (critical and variable)
ii. Examples including all the critical attributes
iii. Non examples (essential attributes missing)

The ideal non example is that which includes all the critical attributes except the one (Markle & Tiemann, 2001).

Many researchers suggest the use of prototype examples in concept instruction (Tennyson & Cocchiarella, 1986). They are in the opinion that a concept is encoded in memory as a prototypical example of a category (Klausmeier, 1992). The prototype which is also referred as central example is assumed to be constructed on learner's experiences.

2.4.3 Presenting the Concept Label and Attribute Definition

Concept labels and definitions establish the dimensions and boundaries of the learning task and hence assist the learners in concept attainment (Tennyson & Cocchiarella, 1986). It is suggested by some researchers that the definition of the concept containing critical attributes should be presented before the presentation of examples and non examples (Tennyson & Park, 1980). It is also suggested that presentation of a definition should be followed quickly by a recall or recognition activity (Merrill & Tennyson, 1977).

However, other researchers advocate the sequence in which example is presented first and it is followed by the rule. This sequence is used in teaching difficult concepts (Fleming & Levie, 1978). Another opinion is that teaching should begin instructional activities that encourage learners to identify the essential attributes based on presentation of instances (Joyce & Weil, 1972).

Although there is some variation in approaches across different teaching models with respect to the sequencing of presentation of concept label and attribute definition, but generally early initial presentation or discovery of the concept label and attribute definition is advocated.

2.4.4 Presenting Instances

The presentation of instances is included in each concept teaching strategy although there is a variation in approach regarding emphasis and sequencing of instance presentation. Two major approaches regarding the sequencing of examples and rules are used in concept teaching strategies. One approach suggests presentation of examples prior to rule and the other advocate the presentation of rule before the example. The methods of presentations of instances fall along two lines, either set of examples and non examples are presented or prototypical examples are presented. Researchers advocate inquiry approach for instance presentation, so that learner is able to discriminate the critical attributes (Joyce & Weil, 1972).

Some other researcher suggest the use of either expository or inquiry approach for presentation of carefully selected examples and non examples (Merrill & Tennyson, 1977). In inquiry approach learners are presented with positive or negative examples and asked to identify whether it belongs to a concept category. In contrast in expository presentation, learner's response is not required and the instance is presented isolating critical attributes. In a prototypical example presentation, the learners are presented with the best example of the typical class. Expository and interrogatory examples and non examples are presented after the presentation of the best examples (Tennyson & Cocchiarella, 1986). It is suggested that presentation of the best example forms a prototype for the learner and the elaboration of key dimensions of the prototype are made through additional examples.

2.4.5 Guiding Learner Practice

A common approach used for guiding learners to recall or apply the learned concept is to offer learner various practice opportunities to classify new instance as a member or non member of the concept category (Merrill & Tennyson, 1977). Inquiry and generative approaches are also recommended by some researchers, which are often geared towards learner's application of the concept. Some advocate that concept mapping as a form of model building help the learners to organize definitions and examples. It also helps the learners to infer relationship within a larger conceptual framework (Tessmer, Wilson & Driscoll, 1990). Model building is viewed as an ideal practice and guidance strategy for concept learning. The learners not only understand the concepts but also the conceptual relationships (Jonassen, Strobel & Gottdenker, 2005).

2.5 Theory of Mathematical Teaching

Despite of traditional deductive approach of teaching mathematics most mathematical theories have both an experimental and inductive character. They arise out of tentative searching and speculative trial & error; they gain the deductive character only after a sufficient period of investigation. Investigations, as described in Kopka (2004), is a method of teaching & learning the mathematics in which students enter and penetrate deeply into the vast world of mathematics and most other teaching approaches fail to do so. If a teacher wants to orient students about how mathematics evolves, then the first step should be to tell them how mathematical theories come into existence, how they develop and how they finally gain their form and nature. In the classrooms, most of the teachers expose the students to mathematics in its final and approved form.

Using investigations is one method of teaching involved in the full range of the development of a mathematical theory. Investigations also provide students with insights into what it is like to be a mathematician and to experience mathematical thinking at work. Students should be able to investigate certain mathematical situations and consequently to formulate problems and hypotheses. This inductive approach should be completed by validation of the hypotheses, i.e. by return deduction. Clearly, the inductive way is much more time-consuming and difficult for teachers and students than traditional one. On the other hand, it contains very important and worth student activities which are all about making the students more active participants in the learning process – an observation, an investigation, formulation and solving of problems and formulation and validation of hypotheses.

2.6 Strategies Used For Teaching Concepts

The major focus of concept learning is to enhance the ability of a learner to identify specific properties of a particular concept. The teaching strategy which promotes meaningful learning must be selected for teaching concepts. Concepts are taught and learnt by describing them, defining them or providing examples of them.

Foster (1977) worked on concept teaching and provided different teaching strategies. The strategy in which listing, grouping and labeling sequence was used had the following procedure:

1. The teacher provides a list of many items.
2. The students are asked to group the items, they think similar.
3. The students are asked to label the groups

Foster's second strategy was also inquiry oriented. The sequence used was experiencing, hypothesizing and testing. The procedure used was as follows:

1. Direct first hand exploratory experience with the concept are provided to students
2. Important terms are defined
3. On the basis of student's observation and firsthand experience, they are encouraged to make statements explaining the main concept.
4. With the help of new example of concept, these statements are tested.
5. The statements are then refined according to the basic principles of the main concept
6. The learners are encouraged to produce new examples

This teaching strategy is successfully used in teaching many concepts of mathematics, science and social studies. The next strategy which Foster used in teaching concepts involves recognizing examples and non examples. The procedure of this strategy is as follows:

1. The name of concept word or symbol
2. Major attributes of the concept are defined
3. Examples containing the essential attributes of concepts are provided
4. Non examples of concept are provided
5. Set of examples and non examples are provided to students and they have to identify them as examples or non examples on the basis of essential attributes
6. Students are encouraged to generate their own examples and non examples of the concept
7. Assessment is made on the ability of students to discriminate examples and non examples

Teaching of concepts is different from the teaching of ideas and facts. The major concern of most of the teachers is about the different activities used for teaching different concepts. Since there is a great variation among concepts e.g. a simple concept such as a man or a tree and abstract concept such as law of gravitation, therefore teaching strategies also vary. Although there exist a variation in teaching of different concepts, there are certain fundamental processes that are relevant at all levels of concept learning. Stones (1994) summarized the work on concept teaching and presented a three phase model. He divided the teaching into three phases preactive, interactive and evaluative.

A. Preactive

1. Identification of key concepts involved, methods of presentation, learners activities and method of evaluation
2. Knowing the learners prior knowledge

B. Interactive

1. Give introduction of the new concept
2. Explain the important terms
3. Provide a series of single examples
4. Discriminate between critical and non critical attributes
5. Provision of examples containing all the attributes
6. Provide the non examples
7. Provide the mixture of examples and non examples and learners are asked to identify
8. The students are encouraged to explain the concepts in their own words

C. Evaluative

For evaluation purpose, novel examples of the concepts are presented and the pupils are able to identify them as examples or non-examples. The method adopted by Harrison (1990) for concept teaching has the following steps:

1. Present name, definition and example of a concept
2. Common attributes should be emphasized
3. Students generate examples
4. Critical analysis of examples given by students
5. Application of the concept
6. Discussion regarding consequences in terms of variable solution

Dececco & Crawford (1974) suggested the following steps for teaching concepts:

1. Describe the objectives, expected to achieve after teaching the particular concept
2. Enlist the attributes and major focus should be on important attributes
3. Familiarize the students with the vocabulary to be used
4. Provision of positive and negative examples
5. Presentation of examples as a mixture of positive and negative examples or separately
6. Students should be encouraged to give examples
7. Assessment of the learnt concept

There is no one best method for teaching concepts to learners. Borich (1996) was in the opinion that both inductive and deductive methods help the students to learn concepts. Since concept teaching is different from the teaching of facts and rules, therefore it enables the students to distinguish examples from non examples. Example of the concept includes all the critical attributes and one or more critical attributes are missing in non example of the

concept. Therefore in order to teach the concepts, both examples and non examples are needed. It enables the students to clearly discriminate between other related concepts.

2.7 Inductive Teaching and Learning Methods

The most commonly used inductive teaching and learning methods are inquiry learning, problem-based learning, project-based learning, case-based teaching, discovery learning and just-in-time teaching (Prince & Felder, 2007). The investigation according to Kopka (2004) is possible to consider as a method of the first category. The inquiry learning means that students are presented with questions to be answered, problems to be solved, or a set of observations to be explained (Bateman, 1990). If the method is implemented effectively, the students should learn to formulate good questions, identify and collect appropriate evidence, present results systematically, analyze and interpret results, formulate conclusions, and evaluate the worth and importance those conclusions" (Lee, 2004).

Joyce and Weil (1996) presented the models of teaching in a summarized form. The importance of three major components of teaching i.e. teacher, student and subject matter was recognized in the models approach to teaching. The most important factor which influences the effect of teaching procedures is teacher; the second factor which influences the choice of a teaching method is students. All students are not of similar nature, and their responses to different teaching strategies vary (Cosmo & Snow, 1986). Many research studies indicate that one teaching strategy which is effective for some students proves to be ineffective for others (Coker, Medley & Soar, 1980). The third factor which influences the choice of teaching strategy is the content to be taught. There are different teaching methodologies for teaching

different contents. If one topic is taught inductively and proved to be effective, it may not be concluded that all the topics if taught inductively will produce the same results.

Each situation in teaching demands different approach. Keeping in mind the three factors (teacher, student and content) the best teaching approach is used. There is no single best teaching strategy for all the situations. The best strategy is the one which is most effective in the given situation in order to achieve the goals. Therefore it is necessary for a teacher to have knowledge of different teaching strategies.

Teaching models are developed as prescriptive teaching strategies and are designed to accomplish particular instructional goals. A teaching model is very much helpful for the teachers as it provides structure and direction to them. They can make their teaching more effective by making it systematic and efficient with the help of teaching models. A teaching model is a tool in the hand of a teacher and he has to use this tool with the help of skills, he have, to make his teaching effective and to achieve the required goals.

2.8 Jerome Bruner's Theory of Learning (Theoretical ground of the study)

The theory presented by Jerome Bruner and after wards the three models on concept attainment proposed by Joyce and Weil become the theoretical background of the current study.

Bruner focused on the concept of discovery learning. He believed that science should be taught as a tool subject and simply the transfer of facts is not the appropriate way to teach science. He focuses on the way children know, 'how to learn' instead suggesting any recipe for the teaching (Chitriv, 1988). Johnson (1979) was of the opinion that Bruner's work

influenced the educational practices in four different ways. These include process of learning, formation of learning structure, importance of intuition and emphasis on intrinsic motivation.

Bruner stressed the importance of the process of acquiring knowledge. He argued that learning is not just the memorization of facts rather it is a matter of rearranging or transforming evidence. The learner gains new insights and generalizations on the basis of information provided. The role of teacher is not only to teach facts, principles, generalizations or rules rather he/she has the role to involve students in the induction process and guides them to discover.

Inquiry and discovery approaches both are similar in away as both these approaches are inductive but they differ from each other in terms of outcome and procedure of each approach. The teacher and the learner both are familiar with the outcome, when inquiry approach is used while the students discover the designed outcome under the guidance of teacher in discovery learning (Shah, 2004).

Bruner (1966) was against the opinion that students have to discover every bit of information by themselves. He suggested that they have to discover the relationship between their post knowledge and pre knowledge. The teacher's role is to facilitate the students in developing their self confidence and promoting the ability in them to learn,' how to learn'.

Bruner (1986) advocated that a carefully designed curriculum and skillful teacher can make a significant difference to the intellectual development of a child. He thought learning as an active process. During learning the learner on the basis of his current and past knowledge, construct new ideas and concepts. The process of learning involves transformation of information, construction of hypothesis and making of decisions depending upon their

cognitive structures. The experiences gain the meaning and organization through cognitive structure and it enable the individual to go beyond the information given (Bruner, 1971).

2.8.1 Piaget's Stages of Mental Growth

The three stages which form a sequence in the growing child as described by Piaget were sensory motor stage, pre operational stage and concrete stage. As Bruner was inspired by the work of Piaget, he described these three stages as enactive representation, ionic representation and symbolic representation. Bruner believed that when a child discovers a new concept, idea or principle, he passes through these stages i.e. enactive, ionic and symbolic. These stages involve the thought process to answer three basic questions: what action to perform, how to represent through visual imagery and how to represent by means of symbols.

If we compare both psychologists, first stage of Bruner i.e. enactive resembles the sensory motor stage of Piaget. Intelligence as described by the Piaget is the scheme of coordinating motor actions. He believed that action is the basis of thought and the things are lived rather than thought. Ionic stage of Bruner and pre operational stage of Piaget are highly perceptual in nature. At this stage the child has to react on the basis of data gathered. At this stage the child can easily be distracted. He needs central control over his perceptions. He focuses on imagery and asks the questions, "what does a given label stands for"? During this process the child learns a concept through discovering common representations and the linkage among the several perceptual objects. At this stage the emphasis is on naming, identifying and classifying. The third stage i.e. symbolic resembles the concrete stage of Piaget. It shows the internalized overall view of concept. Language is used for expression and it accelerates the acquisition of concepts.

Piaget was primarily concerned with universal child development while Bruner focused on the role of language and culture in education. The similarity between their opinions is that both involve the child in knowledge getting process. When a child discovers a concept, principle or a rule, then he actively uses his intuition, imagination and creativity. Discovery learning encourages students to actively participate in the knowledge getting process. The sequence in discovery learning is from specific to general. The teacher's role is to present examples and students discover the relationships among these examples. Bruner (1966) suggested inductive approach for learning. He advocated the use of specific examples to formulate a general principle.

2.8.2 Piaget's and Bruner's conceptual interrelation

Bruner was a great admirer of Piaget's work on cognitive development of individual. Bruner and Piaget approaches for cognitive development of a child have many common features. It is their common approach that learners can construct knowledge if they are presented with suitable opportunities to learn. These approaches form the basis of constructivist approach. However the difference in constructivist approach is that it focuses on the problem arising from misconstructions, while Bruner's approach focuses on the process through which knowledge is constructed.

Bruner (1971) was in the opinion that it is necessary for the students of early primary school stages to learn the structure of the body of knowledge. He was against the traditional learning process in which students memorize the given information. He argued that teacher should encourage students to discover information by themselves.

The students desire to learn is the key in discovery learning and it makes possible for the teacher to develop learning situation where students can discover and construct their own understanding. Discovery learning is not an easy task and sometimes it may prove to be very difficult. The discoveries of some concepts, rules or principles which are developed after centuries of work of best intellects may not be done in a few hours in a classroom.

The students use inductive process of learning as they participate in discovery learning and form the learning structures, which consist of concepts and coding systems. The main advantages of structures in teaching as mentioned by Bruner are as follows:

- Fundamental structure of a subject must be understood first as it makes subject more comprehensible.
- If appropriate learning experiences are given, then a structure allows the students to bridge the gap between elementary and advance knowledge. Bruner claims that even a small child can understand some of the basic concepts in subject area if he is provided the appropriate learning experiences.
- Unorganized material tends to be rapidly forgotten. One can remember more material and will be able to retrieve from memory when this material is logically organized.
- If someone understands the fundamental principles and ideas, he may be able to transform his knowledge.

According to Bruner each individual living in this world uses categorization or conceptualization to interact with the world. Categorization helps him to reduce the complexity of the environment and through conceptualization; the concepts are organized into the coding system.

Piaget talked about the universal child while Bruner focused on the role of language and culture in education and perceived children as diverse personalities under the influence of language and cultural teachings. The similarity between their opinions is that both involve the child in knowledge getting process. When a child discovers a concept, principle or a rule, then he actively uses his intuition, imagination and creativity. Discovery learning encourages students to actively participate in the knowledge getting process. The sequence in discovery learning is from specific to general. The teacher's role is to present examples and students discover the relationships among these examples. Bruner (1966) suggested inductive approach for learning. He advocated the use of specific examples to formulate a general principle.

2.8.3 Application of Bruner's Theory

Bruner theory of learning is based on the child centered approach. Active participation of a child in the knowledge getting process is necessary for clear understanding. Teacher's role is to guide the learners to discover.

In order to apply the Burners' theory in the classroom for teaching concepts, following sequence should be followed:

- Presentation of examples and non examples of a concept
- Students make connections among concepts
- Students find the answers of questions posed by the teacher
- Students make intuitive guesses

2.9 Strategies for Learning Concepts

Bruner (1977) defined strategy as the sequence of decisions people make as they encounter each instance of a concept. A person not always perceives strategies of thinking consciously and they do not remain fixed. Different strategies are used by people for different types of concepts. Bruner, Goodnow & Austin (1967) identified some ideal compromise strategies that minimize the cognitive strain and also provide the rapid solution. They identified six strategies to learn a concept under two broad categories i.e. selection and reception strategies. When the teacher is free to choose exemplar or non-exemplar of the concept to test the hypothesis, selection strategies are used. The learner is free to adopt the hypothesis about the concept in reception strategies.

When the teacher uses selection strategies for teaching concepts, he presents unlabelled examples and students ask as to which of the instances are examples and non examples. The selection strategies are further divided into two groups, scanning and focusing strategies. Scanning strategies are used when the objectives to test the learner's hypothesis about the concept, whereas focusing strategies are used when the learner is concerned with concept attributes. Scanning strategies are further divided into two groups i.e. successive and simultaneous. In successive scanning one hypothesis is tested at one time while in simultaneous scanning more than one hypothesis are tested at a time. Conservative and gamble focusing are two types of focusing strategies and the difference between them is that in conservative focusing only one attribute at a time is changed while in focus gambling more than one attributes at a time are altered.

In the reception strategies the teacher presents labeled examples of the concept under yes and no headings. The reception strategies are of two types i.e. wholist and partist. Using the wholist, the first example is used as ones initial hypothesis. Each successive example is

examined on the basis of original hypothesis used in first example and is modified accordingly. The choice of hypothesis about part of the example initially provided is given in partist strategy. When this hypothesis fails to confirm in the next example, then it is changed by referring back to all instances previously used and modifications are made accordingly (Bruner, Goodnow & Austin, 1977).

Joyce and Weil (1996) developed a concept attainment model based on the early work of James Bruner. They presented three types of concept attainment models;

- The reception oriented concept attainment model
- Selection model of concept attainment
- Un organized material model

2.9.1.1 The Reception Oriented Concept Attainment Model

The reception oriented concept attainment model consists of three phases. This model is more direct in teaching learners the elements of concept. The syntax of this model is as follows:

Phase I: Presentation of data and identification of concept

i. Presentation of labeled examples
ii. Students are asked to compare and justify the attributes of positive and negative examples
iii. Students develop hypothesis
iv. Students are asked to state the definition according to critical attributes

Phase II: Testing the attainment of the concept

i. Students have to identify unlabelled examples as positive or negative

ii. Teacher confirms or rejects the students hypothesis

iii. Concept name is provided by the teacher

iv. Teacher refines the definition and restates according to essential attributes

v. Students generate more examples

Phase III: The analysis of thinking strategies

i. Students describe their thinking patterns

ii. Role of hypothesis and attributes is discussed by the students

iii. Students discuss type and number of hypothesis they made about the concept

iv. Teacher evaluates the different strategies adopted by the students

2.9.1.2 Selection Model of Concept Attainment

The syntax is as follows:

Phase I: Presentation of data and identification of concept

i. Presentation of several unlabeled examples

ii. Teacher introduces an instance which illustrates the positive example of the concept

iii. On the basis of the first positive instance given by teacher, student inquire which examples are positive

iv. Students are generate the hypothesis and test them

Phase II: Testing the attainment of the concept

i. Students categorized un labeled examples as positive or negative

ii. Teacher probes the reasons and confirm the hypothesis

iii. Teacher name the concept and restates the definition according to the essential attributes.

Phase III: The analysis of thinking strategies

i. Students describe their thoughts

ii. Students are asked to discuss the role of the hypothesis and attributes

iii. Types and number of hypotheses are discussed

iv. Teacher evaluates the different strategies adopted by the students

2.9.1.3 Unorganized Material Model

This model is different from selection and reception models. In this model the role of teacher is to facilitate the group discussion. The concepts are analyzed in the unorganized material as follows:

i. Locating the concept

ii. Attribute identification

iii. Adequacy and appropriateness of attributes is discussed

iv. Comparison of examples with other data for the same concept (Prabhakaram & Digumarthi, 1998).

2.10 Ausubel Learning Theory

Ausubel was an educational psychologist. His cognitive learning theory is considered to be useful guide for teaching learning process. His major focus was on the acquisition of

meaningful learning. According to Ausubel (1967) meaningful learning occurs when the existing knowledge of learner interacts with the new learning.

The major emphasis in Ausubel's work was to find the answer of the question, "how meaningful learning takes place". He believed that prior knowledge is a major factor which influences learning. The most important factor which influences learning according to Ausubel, Novak & Hanesian (1978) is the quantum, clarity and organization of learner's present knowledge. He called this present knowledge which is available to learner at any time as his cognitive structure. Arends (2004) described the job of organizers to delineate clearly, accurately and explicitly the similarities and differences between the ideas in a new learning passage and as well as the use of advance organizers as the major pedagogical strategy proposed by Ausubel.

Advance organizers are different from overviews and summaries. Overviews and summaries simply put emphasis on key ideas. Organizers act as a linkage between new learning and existing related ideas (Ausubel, 1963).The role of concept maps is very important in Ausubel's learning theory. The major purpose of concept map is to relate the concepts in logical organization with mega concepts. It clarifies the link between new and old knowledge. The learner is focused to externalize those links.

Concept maps and advance organizers, the two basic tools used in Ausubel's learning theory are very useful to help students to learn their knowledge structure. Using these tools students are able to learn the process of knowledge construction. These tools also help the learner to learn, how to learn. Ausubel (1968) differentiated the meaningful learning from rote learning. According to him, meaningful learning occurs when learner relates the new

knowledge to relevant concepts, he already knows while in rote learning new knowledge is acquired through memorization.

Ausubel (1967) explained that variation in meaningful learning depends upon the nature of the learners existing knowledge and interaction of this existing knowledge with the new knowledge. These aspects of existing knowledge were named as 'subsumers' by Ausubel. According to Ausubel a subsumer may be a concept, principle or idea which is already known by the learner and which provide linkage for various components of new knowledge. Ausubel's theory of meaning full learning consists of three basic principles of expository teaching:

1. If the students can visualize the concepts and subsume these concepts in the cognitive structure then these concepts are meaning full.
2. The sequence used in teaching concepts should proceed from the most generic concepts to the most specific ones.
3. Student's readiness and integration with new and old ideas through comparison and cross referencing (Johnson, 1979).

Ausubel (1968) explained that for a meaningful learning of the external world, the learner had to convert it into the contents of consciousness. According to him two major processes are involved in the meaningful verbal learning; reception and discovery. Discovery is involved in concept formation and problem solving. Ausubel advocated the reception while Bruner used discovery approach for learning. Both argued in favor of their selection and hence both took the opposite view.

Ausubel indicated that his theory was applicable only to expository learning in school setting. He differentiated his reception learning from rote learning and discovery learning. Rote learning does not involve subsumption and in the discovery learning the learner has to discover information through problem solving.

Ausubel was among those people who believed that knowledge is primarily acquired through reception rather than discovery. He believed that concepts, principles and rules cannot be discovered, they are presented and understood. The presentation of these concepts, principles and rules should be in organized form so that the learners will be able to learn easily (Shah, 2004).

Ausubel was against the rote reception learning and he proposed his expository teaching model. In his model, the teacher presents the material in an organized, sequenced and finished form. Students receive the information provided by the teacher in an efficient way. This approach according to Ausubel is most appropriate in teaching about the relationship among the several concepts. Ausubel's strategy begins with an introductory statement which encompasses all the information that follows. This introductory statement is called advance organizers. The purpose of advance organizers is to divert the attention of the learners to what is important in the coming material, highlights the relationship among ideas and remind the already acquired information (Woolfolk, 2007).

Although the work of all these three theorists was of great importance but in the opinion of the researcher, work of James Bruner was more effective for concept attainment.

2.11 The Deductive Method of Teaching

The deductive method, also called "expository teaching technique" (Hernandez, 1973), "reception learning" (Ausubel, 1966), the "ruleg" method (Hermann, 1969), the traditional method (Lindgren & Suter, 1985), is defined as "a scientific form of reasoning that proceeds from general statements (such as those found in theories) to statements about specific situations" (Clifford, 1981); "a method in teaching that proceeds from rules of generalizations to examples and subsequently to conclusions or to the applications of the generalizations" (Belcastro, 1966).

2.11.1 Characteristics of the Deductive Method

In the deductive approach, according to Lindgren (1985), students are presented with a pre-processed information in a final form. He further mentioned the role of teachers being that of expounding and explaining simply because they want students to learn rules before they tackle problems. In the deductive concept learning approach, according to Clifford (1981), students learn concepts by having them labeled, defined, and sometimes even exemplified. According to Ausubel (1963), the principal content of what is to be learned is presented to the learner in more or less final form. According to Davis (1951) and Hernandez (1973), from postulation view point, a mathematical subject is built upon a set of fundamental assumptions or postulates with the aid of definitions and the process is wholly deductive.

Educators have tried to evaluate the deductive method of teaching. It has the advantage of stressing the importance of the well-known, familiar theory without theoretical concepts (Lindgren & Suter, 1985); it takes less time as a result of which wide range of material can be covered since concepts are immediately labeled and defined (Clifford, 1981). It's possible

drawbacks are that the theories the deductive method requires us to learn may be inappropriate and incomprehensible, furthermore, students learned by this method are likely to feel insecure and to flounder when placed in learning situations in which they receive little direction (Lindgren, 1985); it makes students receptive and passive Ausubel (1967.); it does not help students to see mathematics as a creative, dynamic subject.

2.12 Model for the Deductive Method of Teaching

The deductive method of teaching, as already described, is a method that proceeds from generalizations, rules, principles to particular instances. Steinhoefel (1976) developed a model for teaching mathematical concepts. The model consists of deductive reasoning in which the rules, generalizations, definitions are given and the follow-up operations in which students' actions to the given generalization in practicing the patterns. The model consists of following steps.

Teaching Concepts of Mathematics Deductively

Deductive Reasoning

- Stating the principle, law, theory generalization, of a given concept
- Stressing the defining attributes
- Providing examples that represent the concept
- Proving that the examples posses all attributes of the concept defined

Follow-up Operations

- Developing operational patterns for doing the actions: identification, exemplification, application based on the definitions, rules, generalizations

- Practicing the patterns
- Checking whether students master the concept or not
- Deciding whether to repeat or to proceed

2.13 Review of Related Research Studies

The review of different studies revealed contradictory results. Some studies found the deductive method more effective others concluded the inductive method more beneficial and there were those which suggested that there is no significant difference of the comparative effectiveness of the two approaches. Trying to compare the effects of inductive and deductive approaches in teaching mathematics, Herron and Tomasello (1992) conducted an experiment using 35 students who were learning mathematics. The researchers developed the teaching material themselves, and tested the achievement level through the post test and a delayed post test strategy in order to check the effectiveness regarding the method of teaching mathematics.

The findings suggested that the learning and concept attainment of inductive group was significantly better than the deductive group of students and the inductive approach resulted in better retention and rule remembrance. A decade later, Erlam (2003) conducted another experiment on 58 students. Interestingly the results of this study were exactly opposite to the previous one. The deductive group was better performer when compared with the post test performance of the inductive group.

In another experimental study carried out by Seliger (1975), 48 students were selected to probe the effects of inductive and deductive methods in teaching. The researcher developed the material himself and two types of tests were used i.e. recall and retention test to check out

the performance of the students. On the test of recall there were no significant differences between the two groups whereas on the retention test deductive group significantly outperformed the inductive one.

In a study conducted by (Savin & Major, 2004) the effects of inductive and deductive teaching approaches to the teaching of mathematics was evaluated. The study was conducted on 72 students and two groups were formed. One group was instructed using deductive approach and the other group was instructed using inductive approach. The material and tests were developed by the researchers. This study revealed no significant differences on the effect of any of the methods of teaching. Both the groups performed at the same level. The high achievers of deductive group remained high achievers in the post test and the low achievers of deductive group remained low achievers and the same was the case with the inductive group as well.

Oeballos (1986) compared the effectiveness of inductive and deductive teaching approaches for teaching concepts to fourth grade students. He found no significant difference between the effectiveness of these two approaches. Chirtriv (1988) conducted a study to find out the relative effectiveness of Ausubel and Bruner strategies for acquisition of concepts in mathematics. The sample was divided into three groups. First group was taught using Ausubel strategy, second group by Bruner strategy and third by conventional method. Twenty lessons were taught to each group. The results of the study revealed that both the Ausubel and Bruner strategies were equally effective for teaching concepts and both were significantly more effective than conventional method.

Mayer (2002) examined the effects of deductive and inductive approaches in teaching mathematics to seventy eighth graders of a junior high school. The results revealed that there was no difference between inductive and deductive groups. Both the approaches had an equal effect on students' conceptual learning. However, high achievers benefited more from the deductive method.

Another study by (Fasko, 2003) was conducted on understanding of the ideas of science. Results of his study showed no significant difference between deductive expository and inductive discovery teaching strategies. Joyce & Weil (1996) observed that through inductive process of concept formation the students were able to develop mental structures which also allow them to hold the information better than the structures which are provided for them. It was also observed that inductive process of concept attainment increases students' retention of information and develops observational and analytical abilities.

Prince & Felder (2007) used different teaching strategies for teaching mathematical concepts. One group was taught through inductive strategy in which labeled examples were provided without explanation, second group was taught through deductive strategy in which defined concepts were given with labeled examples and explanation and third group was taught through cued inductive strategies in which relevant attributes of concept were presented in such a way that verbal emphasis and direct attention was given to relevant attributes. It was found that all the strategies were equally effective. The variance was due to the general mental ability rather than cognitive style.

Břehovský (2010) studied two different strategies for acquisition of mathematical concepts. The first strategy was based on the presentation of list of attributes and the best

example of the concept. Second strategy consisted of enquiry and inquisitory forms. It was observed that concept learning was facilitated by presentation of best example.

Ata, Ayyaz & Nawaz (2015) conducted a study to compare the effectiveness of inductive and deductive methods of teaching mathematics at elementary level. Pre-test post-test control group design was used. Thirty students of 8th class were selected as a sample of study and were divided into two groups (control and experimental group). Two chapters of mathematics were selected and taught to both groups. The control group was taught by deductive method while experimental group was taught by inductive method. Results showed that students of experimental group performed significantly better than the control group. It was concluded that inductive method was better than the deductive method for teaching mathematics at elementary level.

Silas & Bright (2012) Inductive method of teaching model is found to be more effective for teaching circle geometry and trigonometry than Transmitter of Knowledge teaching model, considering the results obtained. So, it is recommended that Inductive method of teaching model should be used in the teaching of circle geometry and trigonometry.

Shaffer (1989) to check the effects of inductive-deductive methods in teaching investigator select three hundred and nine pupils of various levels from three various American high schools who were taught French and Spanish. In the light of this study eight classes were separated into two groups of even language ability. From these groups one group was instructed using the deductive method of teaching and the other group using the inductive method of teaching. Investigator developed material and a close test were the instruments

used for the purposes of this research study. Shaffer concluded that an inductive method was much better than the deductive approach to all ability levels.

Nejla (2000) conducted a research study to compare the effectiveness of inductive-deductive method of teaching on students' chemistry achievement, attitude toward chemistry and academic self-concept. The result of this research study shows that inductive method of teaching play very important role as compared to deductive method regarding students' achievement and attitude.

Barbara (1972) in his study compared the effectiveness of expository lesson and discovery lesson. He found that expository lessons were more effective than discovery lessons for attaining the concepts.

Koran (1971) designed an experiment to investigate individual differences in learning from inductive and deductive sequences of programmed instruction. 167 upper division university students were selected and were taught concepts selected from statistics and test interpretation and were programmed based on inductive and deductive principles. Results revealed that inductive and deductive instructional procedures were about equally effective.

Sobel (1956) conducted a study to discover whether or not there is any relationship between the learning of certain algebraic concepts and the deductive and inductive methods of teaching. He chose seven algebra classes from a group of six schools at ninth-grade level. The students were grouped into high I.Q. groups and average I.Q. groups. Results showed that there was no significant difference between the effectiveness of the two methods of teaching, i.e., they are equally effective. But the inductive method of teaching was found to be superior

to the high I.Q. group. The two methods resulted in no real difference in learning for the average I.Q. groups.

Grabber (1974) conducted his study on understanding of the ideas of science. Results of his study showed no significant difference between deductive expository and inductive discovery teaching strategies.

Jaimini (1991) studied the effectiveness of concept attainment model in developing concepts of chemistry. Students were divided in two groups. One group was taught using concept attainment model and the other group was taught through traditional method. It was found that the students taught through concept attainment model performed better than the students taught through traditional method.

Ayishabi (1996) conducted an experimental study to compare the effectiveness of concept attainment model and traditional teaching method in teaching selected topics of zoology. It was found that both the groups performed equally.

Contessa (1980) used the different teaching strategies for teaching mathematical concepts. One group was taught through inductive strategy in which labeled examples were provided without explanation, second group was taught through deductive strategy in which defined concepts were given with labeled examples and explanation and third group was taught through cued inductive strategies in which relevant attributes of concept were presented in such a way that verbal emphasis and direct attention was given to relevant attributes. It was found that all the strategies were equally effective. The variance was due to the general mental ability rather than cognitive style.

Summary

This chapter covered the review of literature on the inductive and deductive methods of teaching. The review underpinned important dimensions of the research under study. It started with the meaning of 'concept' in terms of mathematics. The definition of concept was given and it was discussed by the researcher. It entails the approaches of teaching the concept. What are the best strategies through which concept can be taught? Some very useful researches on theories of teaching mathematics have been included to build a baseline of how mathematics has been taught. Then a review of learning theories was presented i.e. Bruner's, Piaget and Ausubel. The researches regarding how these learning theorists emphasized the importance of conceptual understandings and reasoning have been included. An argument has been built on the effectiveness of both inductive and deductive methods of teaching mathematics with the support of the recent research studies available in the literature.

CHAPTER 3

RESEARCH METHODOLOGY

The study was carried out to compare the effectiveness of teaching approaches i.e. inductive and deductive approaches of teaching for concept attainment at elementary school level. This chapter includes research design of the study, research approach, population of the study, sample and sampling technique used for the study. Moreover the procedure of experimental design is included and a brief description of data analysis is added.

3.1 Research Design

The study was focused at effectiveness of teaching approaches i.e. inductive and deductive for concept attainment at elementary school level. The two variables used in this experimental study were teaching approaches and academic achievement. However certain variables i.e. history, maturation, instrumentation, multiple treatment interference, pre-test treatment interaction, and experimenter's effect, as detailed at forthcoming section number 3.6, were controlled keeping in view the diverse nature of human beings in the study. Teaching approaches were manipulated into inductive and deductive teaching approach. The research is based on pre-test post-test control groups design. This design involved two groups, both of which were formed by random assignment; both groups were administered a pretest of the dependent variable, one group was taught using inductive teaching approach, and the other group was taught using usual method i.e. deductive teaching approach. Both groups were then post tested.

3.2 Population of the study

The target population of the study included all the 7th grade students studying in Federal Government elementary/secondary schools located in Islamabad. The accessible population of this study included all the 7th grade students enrolled in the Federal Government boys' schools of Islamabad working under Federal Directorate of Education during the session 2012- 2013.

3.3 Sample and Sampling technique

The sample of the study was comprised of one school and 60 students for conducting the experiment. The sample has the limitation with respect to generalizability of the findings. As this experiment has been done on the specific group of students in specific circumstances so the variables i.e. history of participants, pre-testing, selection bias, maturity level of the students and physical conditions of the classroom etc. may vary in any other similar study.

The sample technique and detail of sample is given below:

3.3.1 Sampling of School

The sample of the study consisted of 60 students from one school i.e. Federal Government (FG) Model School for Boys Humak which is functioning under the Federal directorate of education. The school was selected using convenient sampling method as the study was experimental in nature and the researcher had to teach one class for a certain amount of time. Therefore it was convenient to select this school due to the assurance of administrative support required for conducting the experiment. Prior to the study the researcher ensured following factors:

- Number of students in 7th grade was more than 60

- Adequate number of classrooms to have an arrangement of class for control and experimental groups separately.
- Conducive environment for the experimental study

3.3.2 Sampling of Students

The sample included 60 students of 7th grade from one school. In total there were four sections of 7th grade and number of students was 210. The selection of students was made using stratified sampling technique through the following procedure in order to ensure a representative sample of the three groups of students' i.e. high achievers; average and low achievers.

The previous annual results of the 6th class in the subject of mathematics of all the students were obtained from the examination section of the school. Then the researcher arranged the marks of the students in descending order and numbered. The scores occurred more than once numbered randomly. Mean score was calculated by dividing total score by total number of students and was found to be 60. Standard deviation was calculated and found to be 10. Student obtaining scores between 50 and 70 were named as average achievers and were counted 138 in total. Student scoring more than 70 were named as high achievers and were counted 33 in total. Students scoring less than 50 were named as low achievers and were counted 39 in total. From this list, 20 students from high achievers, 20 from average achievers and 20 from low achievers were selected randomly. The rest of the students were excluded from the study. From these 60 selected students, 10 students from high achievers, 10 from average achievers and 10 from low achievers were randomly selected and were kept in one

group. Second group consisted of remaining 30 students (10 high achievers, 10 average achievers and 10 low achievers).

These two groups of 30 students were randomly named as control and experimental group. There were 10 high achievers, 10 average achievers and 10 low achievers in each group.

3.4 Instruments for data collection

Pre and post-tests were the instruments to check the difference in the achievement of both the groups, which was the purpose of the study. The purpose of pre test was to confirm that both the groups were at the same level regarding the knowledge about the new concepts which were to be taught during the experiment.

As the study was experimental in nature, so, researcher made tests were used to assess the comparative effectiveness of deductive and inductive teaching approaches for attainment of mathematical concepts at elementary school level. Twenty five mathematical concepts were included in the study. Each concept was analyzed to determine its name, definition, examples, subordinate and supraordinate concepts. The test items included were based on a paradigm for testing level of concept attainment (Frayer, Fredrick, & Klausmeier, 1969).

The eight tasks used from this paradigm were:

- Given the name of a concept, select the definition of the concept.
- Given the definition of the concept, select the name of the concept.
- Given the name of a concept, select the relevant attribute.
- Given the name of the concept, select the irrelevant attribute.

- Given the name of a concept, select the example of the concept.
- Given the name of the concept, select the non example of the concept.
- Given the name of a concept, select the subordinate concept.
- Given the name of the concept, select the supraordinate concept.

The test was developed keeping in view the above mentioned paradigm. Eight items were developed for each concept, one of each task type. Since there were 25 concepts and 8 task types, therefore 200 items were constructed. One item from Task 1 & 2, task 3&4, task 5 & 6 and task 7 & 8 were included in the test, so the final test was consisted of 100 items. In order to avert the learning effect which would occur if all items of particular concept were arranged sequentially, all the items were randomly ordered and tested as a unit. All the items were multiple choice items. The tests are administered to assess the performance of students before and after the experiment. The researcher constructed the test item based on the paradigm developed by Frayer, Fredrick, &Klausmeier, 1969.

3.4.1 Validity of the Experimenter's Tools

Although the tests were prepared on the basis of proper specification yet to ensure the content validity of the questions /test items, three professionals in the field of mathematics education, assessed the bank of test questions for content validity. In the light of their suggestions, some items were revised.

Construct validity is the relationship of variables that are theoretically related to that scale and has to measure in a study (Sirkin, 2006). In this study, the concepts were selected from the topics Set, Algebra and Geometry. The investigator organized the concepts in logical order and gave adequate representation in the achievement test prepared. The sentence style

varied in variety and also in length. Effective use of words was made by selecting the precise meaning and variety. Easily readable and comprehensible sentences were used in all questions. Construct validity of the test was established by using the paradigm developed by Frayer, Fredrick, & Klausmeier (1969) to measure the concept attainment. Hence the test has good construct or concept validity.

3.4.1.2. Convergent validity

It measures the relationship between items or statements within a factor. The values vary from the total number of items, like as the number of items increases the correlation becomes stronger. It is calculated by finding spearman's rho (r) values (Wagenmakers; et.al, 2008).

The tables-01 shows the convergent validity values calculated by Spearman's rho method. The range of calculated values of inter-item correlation among the individual items is 0.311-0.378.

Table-1: Convergent values

Factor	*Range of Spearman's r-value between items*
Pre-test	0.311-0.378

All the values are within acceptable range therefore it can be concluded that the research tool is reliable with respect to inter-item correlation. Let us see what happened in the next step with this tool.

3.4.1.3. Discriminate validity

It is agreement or association among variables in a tool and is calculated by spearman's correlation coefficient value between major variables. It is judged on the basis of whether an indicator corresponds to theoretical expectations.

There were four components of concepts measured through this tool; concept name and definition; examples and non-examples; essential and non-essential attributes and subordinate and super ordinate concept. All the items about the same variable were sum up and Spearman's correlation value among these variables was calculated. In the table-2 the range of the values is 0.348-0.621. All the values are within acceptable range as none of the values is less than 0.3 (Field, 2005).

Table-2: Discriminate validity

Factor	*Range of Spearman's r-value between items*
Pre-test	0.348-0.621

3.4.2 Reliability of the Experimenter's Tools

The reliability of the Experimenter's Tools was estimated by using split half method (by using formula KR-21), and was found to be 0.80 which showed that research tool was reliable.

3.4.3 Piloting of the Instrument

The pre-test was piloted on a group of 30 students of 7th grade level. The students were asked to read the instructions and questions carefully, and then answer these. They were asked

to clarify where required. Keeping in view their queries and statements that were unclear to them, the items were revised in a way to be understood by all. Before administering this tool on students, three experts were involved to critically look into the items keeping in view the understanding level of 7th grade students. Based on their suggestions and students feedback, some of the items were revised.

Item analysis was done to calculate the difficulty index and discriminating power. As per the results the item difficulty level was satisfactory for all the items except two, for which it was below the satisfactory index i.e. (0.3- 0.7). The two difficult items were replaced afterwards in the final tool. The results of the discrimination power depicted that all the items were well discriminating between the high achievers' and low achievers of the group i.e. (above 0.4). The detailed question-wise calculation of the difficulty index and discrimination power of the items included in the test is attached at Annexure "G".

3.5 Procedure of the study

The study was conducted to analyze the effect of inductive and deductive teaching approaches on the concept attainment of 7th grade mathematics students. The researcher selected Federal Government Model School for Boys, Humak as sample and 60 students from 7th grade were selected and grouped under control and experimental group of 30 students each. The pretest of both the groups was taken which was developed by the researcher himself. After having the pre-test, the researcher taught both the groups' experimental group was taught using inductive teaching methodology and control group was taught using deductive teaching method.

During the course of experiment following precautions were observed:

- The experiment was conducted in a natural setting

- It was ensured that the concepts were first time taught to the students of both the groups.
- The allocated time for each period was fully utilized and time was not wasted during experiment.

3.5.1. Contents of the study

The contents of the study were selected considering the following criteria:

- The concepts should be new to students
- Consultation with working teachers
- Scheme of study adopted by the selected school

The following chapters from the textbook of Mathematics for grade VII published by the Punjab Text Board, Lahore were selected for the experimentation. Selected concepts from these units were taught to experimental and control groups. The concepts were selected on the basis of representation from the three broad areas of mathematics i.e. Sets, Algebra Geometry.

Unit 1: Sets

- Set
- Empty set
- Singleton set
- Finite set
- Infinite set
- Equal set
- Equivalent set
- Disjoint sets
- Union of sets
- Intersection of sets

Unit 7: Algebra

- Constant
- Variable
- Algebraic term
- Like terms
- Unlike terms
- Algebraic expression
- Algebraic sentence
- Open sentence
- Polynomial
- Linear equation

Unit 8: Geometry

- Quadrilateral
- Parallelogram
- Rectangle
- Square
- Trapezium

3.5.2 Development and Validation of Lesson Plans

The researcher developed 25 lesson plans keeping in view the requirements of concept attainment model. The basic principles of the Concept Attainment Model (CAM) were strictly followed. The researcher followed the reception oriented concept attainment model developed by Joyce and Weil (1996). The syntax of this model is as follows:

- Presentation of data and identification of concept
- Testing the attainment of the concept
- The analysis of thinking strategies

Twenty five lesson plans were arranged according to inductive teaching approach i.e. from specific to general and 25 lesson plans were arranged according to deductive teaching

approach i.e. from general to specific. The layout used in inductive teaching approach was, providing examples, students compare attributes, students generate hypothesis, definition of concept, and name of concept, evaluation. While layout used in deductive lesson plan was name of concept, definition of concept, explanation of the concept, examples of the concept, evaluation. Time duration for both the lessons was 40 minutes. These lesson plans were pilot tested in Federal Government Boys Secondary School Mohra Nagyal. All the lesson plans were discussed with the working teachers, and experts of the subject.

3.5.3 Time Table

The research work was carried out for the period of six weeks (16th April 2012 to 27th May, 2012) in the two sections of 7th grade of Islamabad Model School for Boys Humak, Model Town. When divided up by duration of treatment, the meta-analysis indicates that studies with a treatment lasting between five and seven weeks had a higher impact on student learning than those that lasted up to one week. (Seidel & Shavelson, 2007). The experimental group was given a treatment (inductive method of teaching) by the researcher himself for five days per week from Monday to Friday. The control group was also taught by the researcher himself using deductive teaching strategy (usual method) in the same days. Daily both control and experimental groups were taught for one period each of 40 minutes duration, suitable changes were made in the class time table so that the researcher was able to take second and third period in control and experimental groups. In total the contact hours for the experimental group were 20 and same were for the control group as well.

3.6 Control of Variables of the Study

The detail of different confounding variables which might affect the internal and external validity of the study and the steps taken by the researcher to minimize their effect are as follows:

a. **Intervening variables:** The intervening variables such as anxiety, boredom, excitement, fatigue were controlled by assigning the subjects randomly to control and experimental group. Providing the same environment and learning conditions except treatment, ensured that intervening variables did not affect the validity of the study.

b. **Extraneous variables:** These are the uncontrolled variables that may significantly affect the results of the study. The detail is as follows:

- **History and maturation**: The internal validity of the study was not affected by the history as no such incident took place during the experiment which might affect the results of the study. Maturation can affect the internal validity of the study; this threat to internal validity was controlled by randomly assigning the subjects to experimental and control groups.

- **Testing**: Pre test may produce a change in subjects and the students may become more proficient in subsequent test performance. This threat to internal validity is common in pre test- post test research design. Presence of control group along with experimental group controlled the affect of this threat. As both the groups were affected by the test in a same way.

- **Instrumentation**: The research tool used by the researcher was validated before using it in the experiment. Same tool was used for pre-test and post-test. The reliability of the test

was accomplished through split half method. The test consists of multiple choice items so the threat of measurement of observer reliability was removed.

- **Statistical regression**: This threat to internal validity was controlled by selecting the students randomly for experimental and control groups.

- **Selection bias**: This threat was controlled by the random sampling of the groups.

- **Interaction of selection and maturation**: It occurs when the students have the option to choose the experimental or control group. The students were randomly assigned to experimental and control group, hence this threat might not affect the internal validity.

- **Mortality**: The duration of this experiment was 6 week. During this period no dropout occurred. All the students remained present during the study period. Mortality factor did not affect the study results.

- **Pretest treatment interaction**: This threat to external validity was controlled by the researcher by administering a pre-test which was consisted of unseen concepts. Those concepts were new for all the students. Pos-test consisted of same items but the order of the items was changed.

- **Multiple treatment interference**: The students selected for this study did not involve in any research study in the past. Also single treatment was given to each group.

- **Interaction of selection and treatment**: It was controlled by applying systematic random sampling to select the students and equivalent groups were formed on normal distribution.

- **Experimenter effects**: It was controlled by the researcher by teaching both the groups himself. It was difficult for the researcher to train the teacher to teach according to the

demand of the study. As the researcher had a theoretical knowledge as well as fifteen years of actual classroom teaching experience. Researcher used the lesson plans according to the true spirit of two teaching approaches. Researcher recorded his class lessons and with the help of senior mathematics teachers, make it sure that lessons were delivered according to the demand of the study. Also researcher found many research studies such as Cheydleur (1932), Huang & Tang (2010), Talib, Azhar & Abdullah(2006) and Ashtiani (2015) in which researcher himself gave treatment to both groups.

3.7 Data Analysis

The data collected for this study was:

- Annual examination scores in 6^{th} grade.
- Pre-test scores
- Post-test scores

Annual examination score was used to make the selection of the students for the experiment and it was done to ensure representation from the three groups i.e. high achievers; average students and low achievers.

The statistical tool i.e. t-test, was used to compare the scores of pre-test and post-test scores of the experimental and control groups. For data analysis a computer program named Statistical Package for Social Sciences and MS Excel were used. t-test for independent sample was used to find out the significant difference between the two mean scores at a specific probability level, for example, it indicates that for a given sample size how often the difference between the mean scores of both experimental and control groups, is larger when there is not true population difference. An independent-samples t-test is used when the researcher wants to compare the mean score, on some continuous variable, for two different

groups of participants (Cone & Foster, 2006). The data collected through the experimental study was comprised of the means scores of two different groups of participants; therefore the significance was calculated using independent sample t-test.

CHAPTER 4

ANALYSIS AND INTERPRETATION OF DATA

The study was conducted to examine the comparative effectiveness of two different teaching approaches i.e. Inductive Teaching Approach and Deductive Teaching Approach for concept attainment at elementary level. The subject of mathematics was chosen for the study. A true experimental design was used for the study. Sixty students of 7^{th} grade of Islamabad model school for boys Humak were selected on the basis of their marks obtained in 6^{th} grade annual examination and were divided into two groups. The groups were made using systematic random sampling. Both the groups were administered pre-test. The purpose of pre test was to confirm that both the groups were unfamiliar with the concepts of mathematics which were taught during the study. The control group was taught by deductive teaching approach and the experimental group was taught by inductive teaching approach. Both groups were taught twenty five concepts of mathematics. The experiment was conducted for the period of six weeks. At the end of the experiment a researcher made post test was given to subjects of experiment in order to find the effect of two different treatments on the attainment of concepts. The data obtained from the sample were tabulated and analyzed using different statistical procedures in order to test the tenability of the hypothesis. In this chapter, the detailed analysis of data is presented.

Previous result from examination section of the school was obtained. The marks obtained in the subject of mathematics in annual examination of 6^{th} grade of both experimental and control groups were tabulated.

Table 4.1

Summary of 6th Grade Annual Examination Scores Of Experimental and Control Group

Groups	N	Mean	SD	t- value	P
Experimental	30	60.6	16.6	0.08 df = 58	. 46 > .01
Control	30	60.3	16.7		

The results showed that there is no significant difference between mean scores of experimental group (M = 60.6, SD = 16.6) and control group (M= 60.3, SD = 16.7) as the calculated t-value (0.08) is less than the tabulated t- value (2.0).

It is concluded that both the groups were same in achievements in mathematics before the treatment.

A researcher made pre test was administered to both the groups. The purpose of pre test was to confirm that both the groups were at the same level regarding the knowledge about the new concepts which were to be taught during the experiment.

Table 4.2

Result of Independent Sample t- test on Pre-Test Scores of Experimental and Control Groups

Groups	N	Mean	SD	t- value	P
Experimental	30	24.5	5.73	-0.47	
Control	30	25.2	6.34	df = 58	.64 > .05

The results showed that there is no significant difference between mean scores of experimental group (M = 24.5, SD = 5.73) and control group (M= 25.2, SD = 6.34) as the calculated t-value (-0.47) is less than the tabulated t- value (2.0).

It was concluded that both the groups were same in achievements in new mathematical concepts before the treatment.

Table 2 also shows that mean scores of both experimental and control groups are 24.5 and 25.2. This score indicates that both the groups scored almost 25% in pre test. The pre test was consisted of 100 multiple choice question. Each question had one correct answer and three distracters. So the chance of guessing a correct answer was 25 %.

It was concluded that subjects of the experiment had little knowledge almost at equal level about the new concepts to be taught by the researcher for the purpose of experimentation.

Table 4.3

Result of T Test on Pre-Test And Post Test Scores of Experimental Group

Groups	N	Mean	SD	t- value	P
Pre test	30	24.5	5.73	20.8	
Post test	30	69.7	10.4	df = 58	< .00001

The results showed that there is a significant difference between mean scores of pre test (M = 24.5, SD = 5.73) and post test (M= 69.7, SD = 10.4) as the calculated t-value (20.8) is greater than the tabulated t- value (2.0).

It was concluded that experimental group which was taught through inductive teaching approach performed better in post test than in pre test.

Table 4.4

Result of T Test on Pre-Test and Post Test Scores of Control Group

Groups	N	Mean	SD	t- value	P
Pre test	30	25.2	6.34	15.9	
Post test	30	57.7	9.2	df = 58	< .00001

The results showed that there is a significant difference between mean scores of pre test (M = 25.2, SD = 6.34) and post test (M= 57.7, SD = 9.2) as the calculated t-value (15.9) is greater than the tabulated t- value (2.0).

It was concluded that control group which was taught through inductive teaching approach performed better in post test than in pre test.

$H_0$1: There is no significant difference in the attainment of concepts by students either taught through Inductive or Deductive teaching approach.

Table 4.5

Summary of Mean Achievement Scores of Experimental and Control Group in Post- Test

Groups	N	Mean	SD	t- value	P
Experimental	30	69.7	10.4	4.73	
Control	30	57.7	9.2	df = 58	< .0001

The results indicated that mean score of experimental group (M = 69.7, SD = 10.4) was significantly greater than the mean score of control group (M= 57.7, SD = 9.2). The calculated t-value (4.73) was greater than the tabulated t -value (2.0). Therefore the null hypothesis which stated that there is no significant difference concept attainment of students either taught through Inductive or Deductive method of teaching was rejected and the research hypothesis was proved which states that inductive teaching method is more effective in mathematical concept attainment as compared to deductive teaching method.

H_o2: There is no significant difference between high achievers of experimental and control group in attainment of concepts.

Table 4.6

Summary of Mean Achievement Scores of High Achievers of Experimental and Control Group in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	78.9	5.82	5.59 df = 18	< .0001
Control	10	65.1	5.20		

The results indicated that mean score of experimental group (M = 78.9, SD = 5.82) was significantly greater than the mean score of control group (M= 65.1, SD = 5.20). The calculated t-value (5.59) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in the attainment of concepts by students either taught through Inductive or deductive teaching approaches" was rejected.

It was concluded that inductive teaching approach is more effective for high achievers in attaining concept of mathematics than deductive teaching approach.

H_o3: There is no significant difference between average achievers of experimental and control group in attainment of concepts.

Table 4.7

Summary of Mean Achievement Scores of Average Achievers of Experimental and Control Group in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	71.9	6.31	4.49 df = 18	< .0003
Control	10	61.5	3.72		

The results indicated that mean score of experimental group (M = 71.9, SD = 6.31) was significantly greater than the mean score of control group (M= 61.5, SD = 3.72). The calculated t-value (4.49) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in the attainment of concepts by students either taught through Inductive or deductive teaching approaches" was rejected.

It was concluded that inductive teaching approach is more effective for average achievers in attaining concept of mathematics than deductive teaching approach.

$H_0$4: There is no significant difference between low achievers of experimental and control group in attainment of concepts.

Table 4.8

Summary of Mean Achievement Scores of Low Achievers of Experimental and Control Group in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	58.3	5.62	5.42 df = 18	< .0001
Control	10	46.5	3.98		

The results indicated that mean score of experimental group (M = 58.3, SD = 5.62) was significantly greater than the mean score of control group (M= 46.5, SD = 3.98). The calculated t-value (5.42) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in the attainment of concepts by students either taught through Inductive or deductive teaching approaches" was rejected.

It was concluded that inductive teaching approach is more effective for low achievers in attaining concept of mathematics than deductive teaching approach.

$H_0$5: There is no significant difference in attaining first component of concept (name and definition) between students of experimental and control group.

Table 4.9

Summary of Mean Achievement Scores of Students of Experimental and Control Groups in First Component of Concept (Name and Definition) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	30	19.7	2.31	2.36 df = 58	< .022
Control	30	18.2	2.40		

The results indicated that mean score of experimental group (M = 19.7, SD = 2.31) was significantly greater than the mean score of control group (M= 18.2, SD = 2.40). The calculated t-value (2.36) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in the attainment of concepts by students either taught through Inductive or deductive teaching approaches" was rejected

It was concluded that students taught by inductive teaching approach learn the name and definition of concept better than the students taught by deductive teaching approach.

H_o6: There is no significant difference in learning second component of concept (examples and non examples) between students of experimental and control group.

Table 4.10

Summary of Mean Achievement Scores of Students of Experimental and Control Groups in 2nd Component of Concept (Examples and Non Examples) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	30	17.8	2.45	5.34 df = 58	< .0001
Control	30	14.3	2.54		

The results indicated that mean score of experimental group (M = 17.8, SD = 2.45) was significantly greater than the mean score of control group (M= 14.3, SD = 2.54). The calculated t-value (5.34) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in attaining second component of concept (examples and non examples) between students of experimental and control group" was rejected.

It was concluded that students taught by inductive teaching approach learn the examples and non examples of concept better than the students taught by deductive teaching approach.

$H_0$7: There is no significant difference in attaining third component of concept (essential and non essential attributes) between students of experimental and control group.

Table 4.11

Summary of Mean Achievement Scores of Students of Experimental and Control Groups in 3rd Component of Concept (Essential and Non Essential Attributes) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	30	16.7	3.18	5.01 df = 58	< .0001
Control	30	13.0	2.50		

The results indicated that mean score of experimental group (M = 16.7, SD = 3.18) was significantly greater than the mean score of control group (M= 13.0, SD = 2.50). The calculated t-value (5.01) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in attaining third component of concept (essential and non essential attributes) between students of experimental and control group" was rejected.

It was concluded that students taught by inductive teaching approach learn the essential and non essential attributes of concept better than the students taught by deductive teaching approach.

H_o8: There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between students of experimental and control group.

Table 4.12

Summary of Mean Achievement Scores of Students of Experimental and Control Groups in 4th Component of Concept (Subordinate and Super Ordinate Concept) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	30	15.6	2.88	4.65 df = 58	< .0001
Control	30	12.2	2.78		

The results indicated that mean score of experimental group (M = 15.6, SD = 2.88) was significantly greater than the mean score of control group (M= 12.2, SD = 2.78). The calculated t-value (4.65) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between students of experimental and control group" was rejected.

It was concluded that students taught by inductive teaching approach learn the subordinate and super ordinate concept of concept better than the students taught by deductive teaching approach.

H_o9: There is no significant difference in learning first component of concept (name and definition) between high achievers of experimental and control group.

Table 4.13

Summary of Mean Achievement Scores of High Achievers of Experimental and Control Groups in First Component of Concept (Name and Definition) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	21.8	1.48	1.72 df = 18	0.10 > .05
Control	10	20.9	0.738		

The results indicated that mean score of experimental group (M = 21.8, SD = 1.48) was not significantly greater than the mean score of control group (M= 20.9, SD = 0.738). The calculated t-value (1.72) was less than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in learning first component of concept (name and definition) between high achievers of experimental and control group" was accepted.

It was concluded that high achievers learn equally the name and definition of a concept whether taught by inductive or deductive teaching approach.

$H_0$10: There is no significant difference in learning second component of concept (examples and non examples) between high achievers of experimental and control group.

Table 4.14

Summary of Mean Achievement Scores of High Achievers of Experimental and Control Groups in Second Component of Concept (Examples and Non Examples) In Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	20	1.15	5.88 df = 18	< .0001
Control	10	16.2	1.69		

The results indicated that mean score of experimental group (M = 20, SD = 1.15) was significantly greater than the mean score of control group (M= 16.2, SD = 1.69). The calculated t-value (5.88) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in learning second component of concept (examples and non examples) between high achievers of experimental and control group" was rejected.

It was concluded that high achievers taught by inductive teaching approach learn the examples and non examples of concept better than the students taught by deductive teaching approach.

$H_0$11: There is no significant difference in learning third component of concept (essential and non essential attributes) between high achievers of experimental and control group.

Table 4.15

Summary of Mean Achievement Scores of High Achievers of Experimental and Control Groups in 3rd Component of Concept (Essential and Non Essential Attributes) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	19.5	1.35	7.49 df = 18	< .0001
Control	10	15	1.33		

The results indicated that mean score of experimental group (M = 19.5, SD = 1.35) was significantly greater than the mean score of control group (M= 15, SD = 1.33). The calculated t-value (7.49) was greater than the tabulated t -value (2.0). Therefore the null hypothesis "There is no significant difference in learning third component of concept (essential and non essential attributes) between high achievers of experimental and control group" was rejected.

It was concluded that high achievers taught by inductive teaching approach learn the essential and non essential attributes of concept better than the students taught by deductive teaching approach.

H_o12: There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between high achievers of experimental and control group.

Table 4.16

Summary of Mean Achievement Scores of High Achievers of Experimental and Control Groups in 4th Component of Concept (Subordinate and Super Ordinate Concept) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	17.6	2.32	4.37 df = 18	< .0004
Control	10	13.1	2.28		

The results indicated that mean score of experimental group (M = 17.6, SD = 2.32) was significantly greater than the mean score of control group (M= 13.1, SD = 2.28). The calculated t-value (4.37) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between high achievers of experimental and control group" was rejected.

It was concluded that high achievers taught by inductive method of teaching learn the sub ordinate and super ordinate concept of concept better than the students taught by deductive method of teaching.

H_o13: There is no significant difference in learning first component of concept (name and definition) between average students of experimental and control group.

Table 4.17

Summary of Mean Achievement Scores of Average Students of Experimental and Control Groups in First Component of Concept (Name and Definition) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	19.9	1.52	2.82 df = 18	.01 < .05
Control	10	18	1.49		

The results indicated that mean score of experimental group (M = 19.9, SD = 1.52) was significantly greater than the mean score of control group (M= 18, SD = 1.49). The calculated t-value (2.82) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning first component of concept (name and definition) between average students of experimental and control group" was rejected.

It was concluded that average students taught by inductive method of teaching learn the name and definition of concept better than the students taught by deductive method of teaching.

H_o14: There is no significant difference in learning second component of concept (examples and non examples) between average students of experimental and control group

Table 4.18

Summary of Mean Achievement Scores of Average Students of Experimental and Control Groups in Second Component of Concept (Examples and Non Examples) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	18.1	1.79	3.93 df = 18	< .001
Control	10	15.5	1.08		

The results indicated that mean score of experimental group (M = 18.1, SD = 1.79) was significantly greater than the mean score of control group (M= 15.5, SD = 1.08). The calculated t-value (3.93) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning second component of concept (examples and non examples) between average students of experimental and control group" was rejected.

It was concluded that average students taught by inductive method of teaching learn the examples and non examples of concept better than the students taught by deductive method of teaching.

$H_0$15: There is no significant difference in learning third component of concept (essential and non essential attributes) between average students of experimental and control group.

Table 4.19

Summary of Mean Achievement Scores of Average Students of Experimental and Control Groups 3rd Component of Concept (Essential and Non Essential Attributes) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	17.6	2.07	4.55 df = 18	< .0002
Control	10	14	1.41		

The results indicated that mean score of experimental group (M = 17.6, SD = 2.07) was significantly greater than the mean score of control group (M= 14, SD = 1.41).The calculated t-value (4.55) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning third component of concept (essential and non essential attributes) between average students of experimental and control group" was rejected.

It was concluded that mediocre students taught by inductive method of teaching learn the essential and non essential attributes of concept better than the students taught by deductive method of teaching.

H_o16: There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between average students of experimental and control group.

Table 4.20

Summary of Mean Achievement Scores of Average Students of Experimental and Control Groups in 4th Component of Concept (Subordinate and Super Ordinate Concept) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	17.6	1.89	2.55 df = 18	.02 < .05
Control	10	14	1.97		

The results indicated that mean score of experimental group (M = 17.6, SD = 1.89) was significantly greater than the mean score of control group (M= 14, SD = 1.97).The calculated t-value (2.55) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between average students of experimental and control group" was rejected.

It was concluded that mediocre students taught by inductive method of teaching learn the subordinate and super ordinate concept of concept better than the students taught by deductive method of teaching.

$H_0$17: There is no significant difference in learning first component of concept (name and definition) between low achievers of experimental and control group.

Table 4.21

Summary of Mean Achievement Scores of Low Achievers of Experimental and Control Groups in First Component of Concept (Name and Definition) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	17.3	1.16	2.92 df = 18	.009 < .01
Control	10	15.8	1.14		

The results indicated that mean score of experimental group (M = 17.3, SD = 1.16) was significantly greater than the mean score of control group (M= 15.8, SD = 1.14).The calculated t-value (2.92) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning first component of concept (name and definition) between low achievers of experimental and control group" was rejected.

It was concluded that low achievers taught by inductive method of teaching learn the name and definition of concept better than the students taught by deductive method of teaching.

H_o18: There is no significant difference in learning second component of concept (examples and non examples) between low achievers of experimental and control group.

Table 4.22

Summary of Mean Achievement Scores of Low Achievers of Experimental and Control Groups in Second Component of Concept (Examples and Non Examples) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	15.2	1.32	7.30 df = 18	< .0001
Control	10	11.3	1.06		

The results indicated that mean score of experimental group (M = 15.2, SD = 1.32) was significantly greater than the mean score of control group (M= 11.3, SD = 1.06).The calculated t-value (7.30) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning second component of concept (examples and non examples) between low achievers of experimental and control group" was rejected.

It was concluded that low achievers taught by inductive method of teaching learn the examples and non examples of concept better than the students taught by deductive method of teaching.

H_o19: There is no significant difference in learning third component of concept (essential and non essential attributes) between low achievers of experimental and control group.

Table 4.23

Summary of Mean Achievement Scores of Low Achievers of Experimental and Control Groups in 3rd Component of Concept (Essential and Non Essential Attributes) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	13.1	1.60	4.76 df = 18	< .0002
Control	10	10.1	1.20		

The results indicated that mean score of experimental group (M = 13.1, SD = 1.60) was significantly greater than the mean score of control group (M= 10.1, SD = 1.20).The calculated t-value (4.76) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning third component of concept (essential and non essential attributes) between low achievers of experimental and control group" was rejected.

It was concluded that low achievers taught by inductive method of teaching learn the essential and non essential attributes of concept better than the students taught by deductive method of teaching.

H_o20: There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between low achievers of experimental and control group.

Table 4.24

Summary of Mean Achievement Scores of Low Achievers of Experimental and Control Groups in 4th Component of Concept (Subordinate and Super Ordinate Concept) in Post Test

Groups	N	Mean	SD	t- value	P
Experimental	10	12.8	2.04	4.62 df = 18	< .0002
Control	10	9.30	1.25		

The results indicated that mean score of experimental group (M = 12.8, SD = 2.04) was significantly greater than the mean score of control group (M= 9.30, SD = 1.25).The calculated t-value (4.62) is greater than the tabulated t -value (2.1). Therefore the null hypothesis "There is no significant difference in learning fourth component of concept (subordinate and super ordinate concept) between low achievers of experimental and control group" was rejected.

It was concluded that low achievers taught by inductive method of teaching learn the subordinate and super ordinate concept of concept better than the students taught by deductive method of teaching.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

In this chapter the summary, findings, and conclusions of the study are presented. On the basis of findings and conclusion recommendation are made for future work.

5.1. Summary

In Pakistan, teachers follow the traditional approach of teaching in their classrooms. They found the chalk and talk method very easy and effective in producing good results. Almost all the subjects are taught using lecture method in which the major responsibility lies on the shoulder of a teacher to transfer the information to the students. Rote learning is considered to be the most useful tool for achieving good scores in the examination. Unfortunately the examination system of the country also promotes such practices. The only advantage of such practices is that it is easy to use and teachers are familiar with the traditional techniques. The major drawbacks are the inability of students to understand the concepts and the inability of the learners to apply the information in new conditions. Since the students are not involved in the learning process and they simply got the information passively therefore they are unable to understand the concepts. Mathematics is an abstract subject. It is taught as a compulsory subject up to secondary level.

The researcher felt the need to take benefit from the previous researches in the field of mathematics education and find the effective method of teaching concepts of mathematics at

elementary level. The present study was conducted to explore and compare the effectiveness of different teaching approaches for concept attainment at elementary level. For this study inductive and deductive teaching approaches were used and the concepts of mathematics were taught to students. The main objective of the study was to compare the effect of inductive and deductive teaching methods on concept attainment of the students. Null hypotheses were formulated and tested in order to achieve the objectives of the study.

This study was conducted in Islamabad Model College for boys Humak. The sample of the study consisted of 7^{th} grade students. The students were divided randomly into two groups on the basis of their achievement scores in 6^{th} grade annual examination in the subject of mathematics. Both the groups were taught by the researcher himself for a period of six weeks. Experimental group was taught by inductive teaching method and the control group was taught by deductive teaching method. Twenty five concepts of mathematics were taught during the experiment. At the end of experiment researcher made post test was administered to examine the attainment of concepts.

The collected data were tabulated and analyzed using t-test. The results show that inductive method of teaching is more effective than deductive method for concept attainment of 7^{th} grade mathematics students.

5.2 Findings

Keeping in view the objectives of the study the hypotheses were formulated and tested. The major findings of the study are as follows:

1. Experimental group which was taught through Inductive teaching approach performed better in post test than in pre test. (t= 20.8 > 2.0 at α 0.05). (Table 4.3).
2. Control group which was taught through deductive teaching approach performed better in post test than in pre test. (t= 15.9 > 2.0 at α 0.05). (Table 4.4).
3. Experimental group which was taught through Inductive teaching approach performed better than control group which was taught through deductive teaching approach in teaching mathematical concepts. (t = 4.73 > 2.0 at α 0.05). (Table 4.5).
4. Students taught by inductive teaching approach learnt the name and definition of concept better than the students taught by deductive teaching approach. (t = 2.36> 2.0 at α 0.05) (table 4.9).
5. Concept of examples and non examples was better learnt through inductive teaching approach than the deductive teaching approach. (t = 5.34> 2.0 at α 0.05) (table 4.10).
6. Students taught by inductive teaching approach learnt the essential and non essential attributes of concept better than the students taught by deductive teaching approach (t = 5.01> 2.0 at α 0.05) (table 4.11).
7. Students taught by inductive teaching approach learnt the subordinate and super ordinate concepts better than the students taught by deductive teaching approach (t = 4.65> 2.0 at α 0.05) (table 4.12).
8. Inductive teaching approach was more effective for high achieving students in attaining concept of mathematics than deductive teaching approach (t = 5.59 > 2.0 at α 0.05) (table 4.6).

9. There was no difference in learning name and definition of the concept by the high achievers whether taught through inductive or deductive teaching approach ($t = 1.72 < 2.0$ at α 0.05) (table 4.13).
10. High achievers taught by inductive teaching approach learnt the examples and non examples of concept better than the students taught by deductive teaching approach ($t = 5.88 > 2.0$ at α 0.05) (table 4.14).
11. High achievers taught by inductive teaching approach learnt the essential and non essential attributes of concept better than the students taught by deductive teaching approach ($t = 7.49 > 2.0$ at α 0.05) (table 4.15).
12. High achievers taught by inductive method of teaching learnt the sub ordinate and super ordinate concept of concept better than the students taught by deductive method of teaching ($t = 4.37 > 2.0$ at α 0.05) (table 4.16).
13. Average achievers performed better with respect to concept attainment of mathematics, when taught through inductive teaching approach as compared to deductive teaching approach ($t = 4.49 > 2.0$ at α 0.05) (table 4.7).
14. Average students taught by inductive method of teaching learn the name and definition of concept better than the students taught by deductive method of teaching ($t = 2.82 > 2.0$ at α 0.05) (table 4.17).
15. Average students taught by inductive method of teaching learn the essential and non essential attributes of concept better than the students taught by deductive method of teaching ($t = 4.55 > 2.0$ at α 0.05) (table 4.18).

16. Mathematical concept attainment of low achievers was enhanced when taught through Inductive teaching approach as compared to deductive teaching approach($t = 5.42 > 2.0$ at α 0.05) (table 4.8).
17. Low achievers taught by inductive method of teaching learn the examples and non examples of concept better than the students taught by deductive method of teaching ($t = 7.30 > 2.0$ at α 0.05) (table 4.22).
18. Low achievers taught by inductive method of teaching learn the essential and non essential attributes of concept better than the students taught by deductive method of teaching ($t = 4.76 > 2.0$ at α 0.05) (table 4.23).

5.3 Discussion of Results

The present study was conducted to explore and compare the effectiveness of different teaching approaches for concept attainment at elementary level. For this study inductive and deductive teaching approaches were used and the concepts of mathematics were taught to students. The main objective of the study was to compare the effect of inductive and deductive teaching methods on concept attainment of the students. Null hypotheses were formulated and tested in order to achieve the objectives of the study.

The most common method used to teach the subject of mathematics in our classrooms is lecture method in which teacher presents the concepts, facts and principles to the learners. But educationists and researchers are working seriously to improve the quality of mathematics education in the country. A lot of work has been done in the world by the researchers in the field of education to find the different teaching techniques to teach concepts to learners effectively.

During the treatment researcher felt very positive attitudes of students in learning of mathematical concepts. Students were more active and responsive when they were taught using deductive method technique. The reason for their responsiveness was of the fact that they were involved in their learning process and in smaller bits they were taken from simple to complex concepts. A well-established principle of educational psychology is that people are most strongly motivated to learn things they clearly know what they are learning and how they will get to it. (Smith & Ragan, 2006). The role of students in discovery learning assigned by Snelbecker (1974) is to participate in decision making about what, how and when something is to be learned. The students are not 'told' the content by the teacher, it is expected from the students that they will explore examples and discover the rule or concept. So while teaching the concepts, students were not dragged towards the content rather they were required to explore their targets, and this approach led to a more meaningful learning during the experimental group teaching.

The experimental group was involved in their concept attainment and the concepts were built using the method of application of the things in their near surroundings. This helped the students in situation analysis and recall of the learned concept in situational application. This has been supported by the group of psychologists who are of the view that success of the concept learning and assessment is due to the factors of recall as well as on application of the learned concept in a given situation (Morrison, Ross, & Kemp, 2001).

5.4 Conclusions

In the light of above findings, following conclusions were drawn:

1. Inductive and deductive teaching approaches had positive impact in attaining the mathematical concepts. (findings1&2)

2. The mathematical concept attainment of the Experimental group which was taught through Inductive teaching approach was better than the control group which was taught through deductive teaching approach.(findings3,4,5,6,&7).

3. Inductive teaching approach is more effective for high achieving students in attaining concept of mathematics than deductive teaching approach. (findings 8,9,10,11&12).

4. Average achievers performed better in attaining mathematical concepts, when taught through inductive teaching approach as compared to deductive teaching approach.(findings 13,14 &15)

5. Mathematical concept attainment of low achievers was better when taught through Inductive teaching approach as compared to deductive teaching approach. (findings 16,17 &18).

5.5 Recommendations

On the basis of conclusions of the study following recommendation were made:

- Inductive method may be practiced at elementary level to teach mathematical concepts for better concept attainment.
- A group of teachers may be trained as master trainers to teach the mathematics through inductive teaching approach at elementary level.
- Inductive and deductive teaching strategies should be incorporated in the teacher education programs at different level.

- This research was conducted to 7^{th} grade students and it was found that at this level the students were reluctant to participate and answer the questions, it is recommended that child centered teaching approaches may be used in lower classes.
- In this study Inductive teaching approach was proved to be useful in teaching mathematical concepts at elementary level therefore it is recommended that mathematical concepts at secondary level may also be taught inductively.
- Curriculum designers and textbook writers may use inductive teaching approach to present concepts in each topic and give training to teachers in developing their own lessons based on inductive teaching approach.

Suggestions for future researchers:

- The sample of this study consisted of only male students; in future same study may be conducted taking female students as a sample.
- The effectiveness of deductive and inductive methods of teaching for concept attainment in the subject of mathematics can be analyzed at other levels of school education.
- The skills of teachers in using deductive and inductive methods can be studied in any other research study.
- In this study effectiveness of two different teaching approaches for concept attainment was found, in future study may be conducted to find the comparative effectiveness of inductive and deductive teaching approaches for overall performance of students.

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APPENDIX 'A'

PRETEST / POSTTEST

TEST MATHEMATICS GRADE 7th

Name: ..... Group: .....

Roll No: ..... Time: 100 Minutes

Date: ..... Total Marks: 100

Test: ..... Obtained Marks:

General Instructions:

1. Attempt all questions.
2. Please read the questions carefully before answering.
3. Write your Name, Roll No. and group / class.
4. This test comprises 100 questions. Every question carries one mark each.
5. Cutting and more than one answer for each question carries no marks
6. Encircle the correct answer.

---

1. Which one of the following is an infinite set?
   A. The set of natural numbers.
   B. The set of whole numbers less than 20
   C. Empty set
   D. Players of the football team
2. Which of the following is true for all infinite sets?
   A. They are equal sets.
   B. They have less than 100 elements.
   C. They are empty.
   D. They have unlimited number of elements.

3. If numbers of elements of a set are unlimited then it is called?
   A. equal set
   B. finite set
   C. infinite set
   D. disjoint set
4. All infinite sets are kind of:
   A. measurement
   B. set
   C. point

D. empty set

5. Which of the following is empty set?
   A. The set { }
   B. The set {n}
   C. The set {cat}
   D. The set {o}
6. Which of the following is true for all empty sets?
   A. They are subsets of natural numbers.
   B. They have no members.
   C. They are universal sets.
   D. They are subsets of finite sets.
7. The set without any member is called :
   A. The disjoint set.
   B. The equivalent set
   C. The singleton set
   D. The empty set.
8. All empty sets are a kind of:
   A. group of points
   B. group of fractions
   C. subsets
   D. equal sets
9. In which of the following are both sides made up of equal sets?
   A. {1,4,5} = {1,3,7}
   B. {6 Ö 3} = {2}
   C. $\{\frac{1}{4}\} = \{\frac{2}{4}\}$
   D. {4 + 25} = {25, 4}
10. What is true for all equal sets?
    A. They are empty.
    B. They have members which are fractions.
    C. They are on graphs.
    D. They have the same members.
11. When two sets have the same members, the sets are called :
    A. equal
    B. empty
    C. straight
    D. equivalent
12. All equal sets are also:
    A. Equivalent sets.
    B. Empty sets.
    C. Fractional sets.
    D. Singleton sets.
13. Which of the following sets are equivalent?
    A. {two apples} and {two oranges}
    B. {1,9,10} and {8,9}
    C. {mouse, rat} and {cat}
    D. {1,2,3,.....9} and {a.b.c,.....g}
14. What is true for all equivalent sets?
    A. They are sets about animals.
    B. They have three members in each set.
    C. They have the same number of members.

D. They are empty.

15. Any two sets which have the same number of elements are called :
    A. Empty sets
    B. open sets
    C. Equal sets
    D. Equivalent sets
16. Equivalent sets are kind of:
    A. sub sets
    B. closed sets
    C. open sets
    D. power sets
17. Which of the following is a finite set?
    A. The set of natural numbers.
    B. The set whole numbers greater than 20.
    C. The set of whole numbers less than 20.
    D. The set of stars in the sky
18. Which of the following is true for all finite sets?
    A. They are equal sets.
    B. They have less than 100 elements.
    C. They are empty.
    D. They have limited number of elements.
19. If numbers of elements of a set are limited then it is called?
    A. disjoint set
    B. equal set
    C. finite set
    D. infinite set
20. All finite sets are kind of:
    A. set
    B. measurement
    C. point
    D. empty set
21. The intersection of set {a,b} and set {b,c,d} is :
    A. {b}
    B. {a,b,d}
    C. {a,b,b,c,d}
    D. {a,b,c,d}
22. Which of the following statement is always true for intersection of two sets?
    A. Intersection of two sets is finite.
    B. Intersection of two sets is infinite.
    C. Intersection of two sets has only common elements.
    D. Intersection of two sets has all the elements of two sets.
23. A set which consists of those elements which are common to set A and set B is called:
    A. Power set
    B. subset
    C. union set
    D. intersection set
24. intersection of sets A and B is also:
    A. Power set of A and B
    B. Equal set of A and B
    C. Universal set
    D. subset set of A and B

25. Which of the following is a set?
    A. Group of intelligent boys in your school.
    B. Collection of beautiful flowers.
    C. Collection of even numbers between 4 and 12.
    D. Collection of best players
26. Which of the following is true for all sets?
    A. They have well defined objects or numbers.
    B. They have at least two members.
    C. They contain integers.
    D. They contain the names.
27. A collection of well defined and distinct objects or numbers is called :
    A. Set
    B. Team
    C. Bunch
    D. Flock
28. All sets are a kind of:
    A. group
    B. team
    C. collections
    D. herd
29. Which one of the following is a singleton set?
    A. The set { }
    B. The set {0, Φ}
    C. The set {cat, dog}
    D. The set {o}
30. Which of the following is true for all singleton sets?
    A. They have natural numbers.
    B. They have only one member.
    C. They are universal sets.
    D. They are subsets of groups of fractions.
31. A set having only one element is called :
    A. The disjoint set.
    B. The empty set.
    C. The equivalent set
    D. The singleton set

32. All singleton sets are a kind of:
    A. Finite sets
    B. Group of fractions
    C. Infinite sets
33. Which of the following shows two sets which are disjoint?
    A. {1,4,6} and {1,4,6}
    B. {22,33,55} and {11,44,66}
    C. {2,4,6,.....} and {4,8,12,.....}
    D. {1,2,3.....20} and {11,12,13,.....30}
34. Which of the following is true for all disjoint sets?
    A. They are equal sets.
    B. The sets contain five members.
    C. They have no common members.
    D. They are finite.

35. What are sets called when they do not have any common members?
    A. Intersecting sets.
    B. Equal sets
    C. Empty sets
    D. Disjoint sets
36. Disjoint is a kind of:
    A. Set
    B. Subtraction
    C. Place holder
    D. Operation
37. The union of set {a,b} and set {b,c,d} is :
    A. {b}
    B. {a,b,d}
    C. {a,b,b,c,d}
    D. {a,b,c,d}
38. Which of the following statement is always true for union of two sets?
    A. Union of two sets is finite.
    B. Union of two sets is infinite.
    C. Union of two sets has only common elements.
    D. Union of two sets has all the elements of two sets.
39. A set which consists of those elements which are either in set A or in set B is called :
    A. Power set
    B. subset
    C. union
    D. intersection
40. Union of sets A and B is also:
    A. Power set of A and B
    B. Equal set of A and B
    C. Universal set of A and B
    D. Equivalent set of A and B
41. Which one of the following is not an algebraic expression?
    A. 4
    B. $x + 3$
    C. $a + b + c$
    D. $x + 4 = 7$
42. Which of the following is true for all algebraic expressions?
    A. They have at least one algebraic term.
    B. They have at least two variables.
    C. They use fractions.
    D. They have + *symbol* between two terms.
43. An algebraic expression :
    A. A sentence that uses a place holder.
    B. linkage or relation$(=, \neq, <, >)$ between two algebraic expressions
    C. involves numbers, variables, or constant or both together with operation $+, -, \times, \div$
    D. A sentence that is either true or false
44. A kind of an algebraic expressions is:
    A. An equation
    B. A polynomial
    C. An algebraic sentence
    D. An equation

45. Which one of the following is an algebraic sentence?
    A. $ax^2 + bx + c$
    B. $a + b + c$
    C. $5 + 3 < y$
    D. $x + \frac{1}{x}$
46. Which of the following is true for all algebraic sentences?
    A. They have at least two algebraic expressions.
    B. They have at least two variables.
    C. They use fractions.
    D. They are true.
47. The linkage or relation$(=, \neq, <, >)$ between two algebraic expressions makes:
    A. An algebraic sentence.
    B. polynomial
    C. linear equation
    D. solution set
48. An algebraic sentence is a kind of:
    A. place holder
    B. number
    C. sentence
    D. term
49. Which one of the following is an algebraic term?
    A. $6xyz$
    B. The difference between 6 and 2 is equal to four.
    C. $5 + 3 < y$
    D. $6 \times y = 12.$
50. Which of the following is true for all algebraic terms?
    A. They have "+" or "- "sign between constant and variables
    B. They have more than 2 variables.
    C. They have constant or variable or both.
    D. They are the product of constant and variables.
51. A constant, a variable, or a product or quotient of constant and variables is called :
    A. An open sentence.
    B. a statement
    C. an algebraic term
    D. a solution set
52. An algebraic term is a kind of:
    A. place holder
    B. algebraic expression
    C. sentence
    D. term
53. Which one of the following is a constant?
    A. x
    B. p
    C. $\frac{1}{2}$
    D. $4y$
54. Which of the following is true for all constants?
    A. They have a fixed value.
    B. They belong to whole numbers.
    C. They are integers.

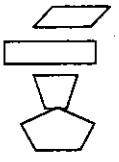
D. They can be assigned any value.

55. The numbers having fixed values are called:
    A. Integers.
    B. polynomial
    C. constants
    D. variables
56. Constants belong to the family of:
    A. place holder
    B. algebraic expression
    C. numbers
    D. sets
57. Which one of the following is a like term of $5x^2y$?
    A. $7xy^2$
    B. $5xy$.
    C. $-3yx^2$
    D. $3x^2y^2$
58. Which of the following is true for all like terms?
    A. The variables and their exponents are same.
    B. The coefficients of variables are same.
    C. They have more than 2 variables.
    D. The exponents are integers
59. Terms containing the same variables and the same corresponding exponents are called :
    A. equal terms
    B. polynomials
    C. like terms
    D. Similar terms.
60. Like terms are a part of:
    A. algebraic expression
    B. monomial
    C. open sentence
    D. statement
61. Which one of the following is an open sentence?
    A. The difference between 6 and 3 is equal to3.
    B. The sum of 2 and some number is the same as 5.
    C. The sum of 5 and 3 is greater than 2.
    D. The sum of 2 and 3 is 5.
62. Which of the following is true for all open sentences?
    A. They are addition problems.
    B. They use letters, like "y".
    C. They have place holders which hold the place for numbers.
    D. They are subtraction problems.
63. A sentence which uses a place holder is called :
    A. An open sentence.
    B. a true statement
    C. a false statement
    D. a closed sentence
64. All open sentences are a kind of:
    A. Sets
    B. Algebraic expressions
    C. True statements

D. Binomials

65. Which one of the following is a polynomial?
    A. $x + \frac{1}{x}$
    B. $6xyz$
    C. $5 + \frac{3}{y}$
    D. $4x^{\frac{2}{3}}y + 6z$
66. An algebraic expression of one or more variables whose exponents are non-negative integers is called:
    A. An algebraic term.
    B. polynomial
    C. algebraic sentence
    D. a statement
67. A polynomial is a kind of:
    A. place holder
    B. algebraic expression
    C. sentence
    D. term
68. Which of the following is true for all polynomials?
    A. They have at least one variable.
    B. They have more than 2 variables.
    C. They are the product of constant and variables.
    D. They have more than two terms.
69. Which one of the following is a statement?
    A. The sum of 2 and some number is same as five.
    B. The difference between 6 and 2 is equal to four.
    C. $5 + 3 < y$
    D. $6 \times y = 12.$
70. Which of the following is true for all math statements?
    A. They are either true or false.
    B. They are about two equal sets.
    C. They use fractions.
    D. They are true.
71. A sentence that is either true or false is called :
    A. An open sentence.
    B. a statement
    C. a place holder
    D. solution set
72. A statement is a kind of:
    A. place holder
    B. number
    C. sentence
    D. term
73. Which one of the following is unlike term of $3xy^2z^3$?
    A. $-3\,xy^2z^3$
    B. $2\,xy^2z^3$
    C. $3\,x^2yz^3$
    D. $\frac{1}{3}xy^2z^3$

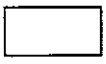
74. Which of the following is true for all unlike terms?
    A. The variables and corresponding exponents are different.
    B. The coefficients of variables are different.
    C. The exponents are integers.
    D. Coefficients are integers.
75. Terms containing the different variables or same variables with different corresponding exponents are called :
    A. equal terms
    B. polynomials
    C. like terms
    D. Unlike terms.
76. Unlike terms are a part of:
    A. algebraic expression
    B. monomial
    C. open sentence
    D. statement
77. The variables used in algebraic expression, $x^2 + 2xy + 3z + 4$ *are* :
    A. x, y, z
    B. x, y
    C. 2,3,4
    D. 2
78. Which of the following is true for all variables?
    A. They are expressed as$xory$.
    B. They do not have a fixed value.
    C. They have integers as coefficients.
    D. They have natural numbers as exponents.
79. The letters used as numbers which do not have fixed values are called:
    A. Integers.
    B. polynomial
    C. constants
    D. variables
80. Variables are a part of:
    A. place holder
    B. algebraic terms
    C. numbers
    D. sets
81. Which one of the following is not a quadrilateral?
    A.
    B.
    C.
    D.



82. All quadrilaterals have------
    A. all sides equal
    B. Two sides equal
    C. Opposite sides parallel
    D. Four sides
83. All plane closed figures with four sides are called:
    A. Rhombus

B. Rectangle
C. Quadrilateral
D. Square

84. All quadrilaterals are also:
A. Square
B. Triangle
C. Polygon
D. Trapezium

85. this is an example of 
A. trapezium
B. Square
C. triangle
D. rectangle

86. All rectangles have:
A. Four equal sides
B. Two sides parallel
C. Two right angles
D. Four right angles

87. A four sided plane closed figure in which two pairs of opposite sides are parallel and equal and all its four angles are right angles is called:
A. trapezium
B. Rectangle
C. parallelogram
D. rhombus

88. All rectangles are also:
A. Squares
B. Parallelograms
C. Rhombuses
D. Trapeziums

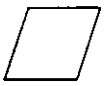
89. this is an example of 
A. trapezium
B. Square
C. rhombus
D. rectangle

90. All squares have:
A. Four right angles
B. Opposite sides equal
C. Two obtuse angles
D. Only two sides parallel

91. A four sided plane closed figure in which all its sides are equal in length and all its four angles are right angles is called:
A. trapezium
B. Rectangle
C. square
D. rhombus

92. All squares are also:
A. rhombuses
B. triangles

C. circles
D. Trapeziums

93. this is an example of 
A. Parallelogram
B. Square
C. trapezium
D. rectangle

94. Which of the following is true for all parallelograms?
A. Four equal sides
B. Two sides equal
C. Opposite sides parallel
D. Four equal angles

95. A four sided plane closed figure in which two pairs of opposite sides are parallel is called:
A. trapezium
B. triangle
C. parallelogram
D. circle

96. A parallelogram is a kind of:
A. Square
B. quadrilateral
C. hexagon
D. trapezium

97. this is an example of 
A. Parallelogram
B. Square
C. Rhombus
D. trapezium

98. All trapeziums have:
A. Four right angles
B. Opposite sides equal
C. One pair of opposite sides is parallel
D. Any two sides of equal length

99. A four sided plane closed figure in which one pair of opposite sides is parallel is called
A. Trapezium
B. Rectangle
C. square
D. rhombus

100. All trapeziums are also:
A. rhombuses
B. parallelograms
C. quadrilaterals
D. rectangles

APPENDIX "B"

Group Formation (Experimental and Control)

Achievement scores in 6th class annual examination in the subject of Mathematics

Experimental group		Control group	
Sr.no	Marks obtained	Sr. no	Marks obtained
1	94	1	95
2	91	2	89
3	83	3	83
4	83	4	82
5	79	5	78
6	78	6	74
7	76	7	73
8	75	8	73
9	72	9	72
10	71	10	72
11	67	11	69
12	66	12	65
13	64	13	65
14	63	14	64
15	62	15	63
16	58	16	62
17	57	17	57
18	55	18	57
19	54	19	54
20	50	20	52
21	47	21	48
22	46	22	48
23	45	23	47
24	45	24	43
25	42	25	42
26	42	26	39
27	42	27	38
28	39	28	36
29	37	29	35
30	35	30	33
Mean = 60. 6		Mean = 60.3	

APPENDIX "C"

Pre Test Achievement Scores

Experimental group		Control group	
Sr.no	Marks obtained	Sr. no	Marks obtained
1	24	1	30
2	33	2	37
3	28	3	25
4	39	4	35
5	25	5	41
6	20	6	20
7	32	7	31
8	28	8	24
9	31	9	28
10	22	10	28
11	23	11	22
12	19	12	26
13	27	13	30
14	20	14	25
15	26	15	25
16	34	16	32
17	18	17	27
18	24	18	23
19	22	19	26
20	29	20	24
21	19	21	22
22	26	22	13
23	15	23	24
24	23	24	19
25	24	25	16
26	23	26	27
27	16	27	21
28	17	28	13
29	19	29	20
30	28	30	22
Mean = 24.46		Mean = 25.2	

APPENDIX "D"

Post Test Achievement Scores

Experimental group		Control group	
Sr. no	Marks obtained	Sr. no	Marks obtained
1	83	1	70
2	87	2	73
3	79	3	61
4	85	4	59
5	82	5	67
6	78	6	72
7	79	7	59
8	68	8	62
9	72	9	63
10	76	10	65
11	74	11	68
12	70	12	58
13	78	13	64
14	74	14	59
15	68	15	67
16	80	16	60
17	77	17	61
18	71	18	58
19	69	19	62
20	58	20	58
21	60	21	48
22	62	22	50
23	65	23	45
24	59	24	49
25	61	25	44
26	55	26	53
27	66	27	46
28	54	28	43
29	52	29	48
30	49	30	39
Mean = 69.7		Mean = 57.7	

APPENDIX "E"

DIFFICULTY INDEX AND DISCRIMINATING POWER

PRE/POST TEST

Sr. no	DI	DP	Sr. no	DI	DP	Sr. no	DI	DP
1	0.32	0.62	35	0.52	0.48	69	0.41	0.48
2	0.45	0.51	36	0.44	0.51	70	0.35	0.64
3	0.33	0.52	37	0.42	0.47	71	0.42	0.58
4	0.42	0.45	38	0.35	0.57	72	0.41	0.57
5	0.40	0.48	39	0.38	0.46	73	0.35	0.52
6	0.46	0.57	40	0.41	0.51	74	0.42	0.47
7	0.51	0.46	41	0.32	0.50	75	0.31	0.67
8	0.39	0.51	42	0.42	0.67	76	0.33	0.60
9	0.42	0.50	43	0.33	0.60	77	0.48	0.52
10	0.35	0.67	44	0.49	0.58	78	0.33	0.68
11	0.38	0.60	45	0.33	0.68	79	0.39	0.48
12	0.41	0.52	46	0.32	0.48	80	0.36	0.51
13	0.35	0.68	47	0.33	0.51	81	0.40	0.49
14	0.42	0.48	48	0.36	0.49	82	0.32	0.57
15	0.33	0.51	49	0.35	0.59	83	0.42	0.46
16	0.41	0.49	50	0.38	0.62	84	0.35	0.51
17	0.43	0.50	51	0.51	0.54	85	0.38	0.50
18	0.32	0.69	52	0.39	0.69	86	0.41	0.67

Sr. no	DI	DP	Sr. no	DI	DP	Sr. no	DI	DP
19	0.37	0.60	53	0.42	0.48	87	0.35	0.60
20	0.33	0.64	54	0.41	0.50	88	0.42	0.48
21	0.39	0.58	55	0.35	0.68	89	0.33	0.59
22	0.36	0.57	56	0.42	0.48	90	0.41	0.55
23	0.40	0.52	57	0.31	0.51	91	0.37	0.57
24	0.49	0.47	58	0.33	0.49	92	0.33	0.46
25	0.33	0.68	59	0.37	0.57	93	0.46	0.51
26	0.32	0.64	60	0.40	0.55	94	0.34	0.50
27	0.33	0.60	61	0.39	0.57	95	0.35	0.67
28	0.36	0.66	62	0.34	0.46	96	0.34	0.60
29	0.35	0.59	63	0.38	0.51	97	0.39	0.57
30	0.38	0.62	64	0.44	0.50	98	0.43	0.46
31	0.40	0.54	65	0.35	0.67	99	0.38	0.67
32	0.34	0.69	66	0.42	0.60	100	0.33	0.60
33	0.39	0.48	67	0.33	0.62			
34	0.42	0.48	68	0.32	0.67			

APPENDIX "F"

MODEL LESSON PLANS

LESSON PLAN
(Inductive Method)

Class: 7th | Subject: Mathematics

Period: 2nd | Time Duration: 40 minutes

Topic: Set | Teacher: Asad Nisar

Unit: Sets **Concept analysis**

Concept Name: Set

Definition: A collection of well defined and distinct objects or numbers is called a set.

Essential attributes: It is a collection.

It is well defined

It has distinct objects

Non essential attributes: It contains numbers

It contains objects

It contains symbols

Super ordinate concept: collections

Subordinate concept: Set of elements having common characteristics

Set of objects having no common characteristics

Examples

Positive examples

- Collection of first five natural numbers
- Collection of days in a week
- Collection of boys in your class
- Collection of months having 31 days
- Collection of planets in the solar system

- Collection of solar months starting with J
- Collection of prime numbers between 3 and 11
- Collection of first six English alphabets
- Collection of five games being played in Pakistan
- Collection of players in Pakistani cricket team.

Negative examples

- Collection of good students in your class
- Collection of beautiful plants
- Collection of good story books
- Collection of best players in Pakistani cricket team
- Collection of tasty fruits
- Collection of best teachers in your school
- Collection of brave boys in your class

Objectives

General objectives

- Enable students to communicate mathematically.
- Enable students to reason and analyze, and to think and act in positive ways.
- Enable students to examine real life situation by reasoning mathematically.
- Enable students to develop cognitive ability skills.
- Develop appreciation towards mathematics.

Specific objectives

- Enable the students to attain the concept of set
- Enable the students to discriminate between relevant and irrelevant attributes of set
- Enable students to differentiate between examples and non examples of a set.

Material required:

Chart, white board, marker

Phases/ stages

- Presentation of data and identification of concept
- Testing attainment of the concept
- Analysis of thinking strategies

Establishment of relaxed atmosphere

Teacher will tell the students that everybody should participate during discussion and share your ideas, don't bother whether you are right or wrong. Teacher will encourage the students to think and make their own judgments.

PHASE I. Presentation of data and identification of concept

- **Providing examples and non examples.**

Teacher will explain the students that now he is going to show you some examples and non-examples of the concept. Teacher will write three examples under "YES" and three non examples under "NO" heading.

YES	NO
Collection of boys in your class	Collection of good students in your class
Collection of first five natural numbers	Collection of best players in Pakistani cricket team
Collection of solar months starting with J	Collection of brave boys in your class

Teacher will ask the students to read the examples and non examples carefully.

- **Students compare attributes of positive and negative examples**

Teacher will ask the following questions:

What are the common characteristics in examples under heading "YES"?

He will write all the responses from the students. Then he will ask the students to think about those characteristics which differs in the items under "NO" heading.

The attributes of the "YES" items will be discussed with the class.

- **Students generate and test hypotheses**

Teacher will provide two more examples and Students will observe them and make sure that their conclusion is correct.

- Collection of days in a week. (YES)
- Collection of good story books. (NO)
- Collection of five games being played in Pakistan. (YES)
- Collection of best teachers in your school. (NO)

Now the teacher will ask them to name the concept and define it according to its essential attributes. At this stage teacher will not accept or reject the hypotheses of students.

PHASE II. Testing attainment of the concept

The teacher will examine whether the students got the concept clearly. He will give some examples, the students will say "YES" if it will be a set, otherwise "NO".

- Collection of first six English alphabets
- Collection of tasty fruits
- Collection of beautiful plants
- Collection of planets in the solar system

Now the teacher will tell the students that they got the idea. All the items under "YES" heading are sets. Teacher will ask the students to define the set. He will refine the statement if needed.

"A collection of well defined and distinct objects or numbers is called a set.

Teacher will ask the students to generate the "YES" and "NO" examples. All the students will write at least one example for "YES" and "NO".

PHASE III. Analysis of thinking strategy involved.

The teacher will ask the students to discuss, how they got the idea. Students will share their thinking strategies.

The students will freely share their own approaches for attaining the concept. Teacher will encourage them to explain the way they attain the concept.

Evaluation

Define "Set" and give five "YES" and five "NO" examples, which are not discussed today.

LESSON PLAN

(Deductive Method)

Class: 7th	Subject: Mathematics
Period: 3rd	Time Duration: 40 minutes
Topic: Set	Teacher: Asad Nisar

Unit:	Set
Concept analysis	
Concept Name:	Set
Definition:	A collection of well defined and distinct objects or numbers is called a set.
Essential attributes:	it is a collection.
	It is well defined
	It has distinct objects
Non essential attributes:	It contains numbers
	It contains objects
	It contains symbols
Super ordinate concept:	collections
Subordinate concept:	set of elements having common characteristics
	Set of objects having no common characteristics

Objectives

General objectives

- Enable students to communicate mathematically.
- Enable students to reason and analyze, and to think and act in positive ways.
- Enable students to examine real life situation by reasoning mathematically.
- Enable students to develop cognitive ability skills.
- Develop appreciation towards mathematics.

Specific objectives

- Enable the students to attain the concept of set
- Enable the students to identify the collections as set
- Enable students to differentiate between examples and non examples of a set.

Material required

Chart, white board, marker

Evaluation of previous knowledge

- How many players are there in a cricket team?
- How many boys are sitting in the first row?
- Name the subjects you read in the seventh class?
- Tell the name of beautiful birds?

Introduction of topic

Today we will learn about sets.

Definition: "A collection of well defined and distinct objects or numbers is called a set."

Explanation: The teacher will explain the term well defined and distinct with the help of examples.

Examples

- Collection of first five natural numbers
- Collection of days in a week
- Collection of boys in your class
- Collection of months having 31 days
- Collection of planets in the solar system
- Collection of solar months starting with J
- Collection of prime numbers between 3 and 11
- Collection of first six English alphabets
- Collection of five games being played in Pakistan
- Collection of players in Pakistani cricket team.

Negative examples

- Collection of good students in your class
- Collection of beautiful plants
- Collection of good story books
- Collection of best players in Pakistani cricket team
- Collection of tasty fruits
- Collection of best teachers in your school
- Collection of brave boys in your class

Discussion:

The teacher will discuss the examples and non examples with the class, and explain to them why some examples are sets and some are not sets.

Students generate examples

Teacher will ask students to give some examples of sets.

Teacher will ask the students to give some examples of collections which are not sets.

Evaluation

Teacher will discuss with the class the examples given by the students and make sure that the students got the idea of a set.

Home task

Teacher will ask the students to write the definition and examples of a set.

Lesson plan

(Inductive method)

Class: 7th	Subject: Mathematics
Period: 3rd	Time Duration: 40 minutes
Topic: like terms	Teacher: Asad Nisar

Unit: Algebra

Concept analysis

Concept Name: like terms

Definition: Terms containing the same variables and the same corresponding exponents.

Essential attributes: the variables are same

Corresponding exponents of variables are same

Non essential attributes: coefficients of variables are integers

Coefficients are same

Super ordinate concept: algebraic terms

Examples

Positive examples

- $3xy \; and \; 4xy$
- $-4x \; and \frac{5}{3} \; x$
- $x^2y^3 \; and \; \frac{5}{2}x^2y^3$
- $2 \; x \; y \; z^2 \; and - 3 \; y \; x \; z^2$
- $\frac{6x^2}{5y^2} \; and \frac{x^2}{y^2}$
- $-3abc \; and \; 4abc$
- $-3x^2y \; and \; 5 \; y \; x^2$
- $\frac{2}{3} \; xy \; and \; 4yx$
- $y^2x \; z^3 and \; x \; y^2z^3$
- $13 \; z^{\frac{1}{2}} \; x^3 \; and \; x^3z^{\frac{1}{2}}$

Negative examples

- $3xy\ and\ 3x^2y$
- $-4x\ and\ -4y$
- $x^2y^3\ and\ x^3y^2$
- $2\,x\,y\,z^2\ and\ 3\,y\,x^2\,z$
- $\frac{6x^2}{5y^2}\ and \frac{6y^2}{5x^2}$
- $-3abc\ and\ 4abc^2$
- $-3x^2y\ and\ 5\,y+\ x^2$
- $\frac{2}{3}\,xy\ and\ \frac{2}{3}yz$
- $y^2x\,z^3 and\ x^2\,y^2z^3$
- $13\,z^{\frac{1}{2}}\,x^3\ and\ 13x^3z^{\frac{1}{3}}$

Objectives

General objectives

- Enable students to communicate mathematically.
- Enable students to reason and analyze, and to think and act in positive ways.
- Enable students to examine real life situation by reasoning mathematically.
- Enable students to develop cognitive ability skills.
- Develop appreciation towards mathematics.

Specific objectives

1. Enable the students to attain the concept of like terms.
2. Enable the students to discriminate between relevant and irrelevant attributes of like terms.
3. Enable students to differentiate between examples and non examples of like terms.

Material required

Chart, white board, marker

Phases/ stages

1. Presentation of data and identification of concept
2. Testing attainment of the concept
3. Analysis of thinking strategies

Establishment of relaxed atmosphere

Teacher will tell the students that everybody should participate during discussion and share your ideas, don't bother whether you are right or wrong. Teacher will encourage the students to think and make their own judgments.

PHASE I. Presentation of data and identification of concept

I. **Providing examples and non examples.** Teacher will explain the students that now he is going to show you some examples and non-examples of the concept. Teacher will write three examples under "YES" and three non examples under "NO" heading.

YES	NO
$3xy \; and \; 4xy$	$3xy \; and \; 3x^2y$
$-4x \; and \frac{5}{3} \; x$	$-4x \; and \; -4y$
$x^2y^3 \; and \; \frac{5}{2}x^2y^3$	$x^2y^3 \; and \; x^3y^2$

Teacher will ask the students to read the examples and non examples carefully.

II. Students compare attributes of positive and negative examples

Teacher will ask the following questions:

What are the common characteristics in examples under heading "YES"?

He will write all the responses from the students. Then he will ask the students to think about those characteristics which differs in the items under "NO" heading.

The attributes of the "YES" items will be discussed with the class.

III. Students generate and test hypotheses

Teacher will provide two more examples and Students will observe them and make sure that their conclusion is correct.

YES	NO
$2 \; x \; y \; z^2 \; and \; -3 \; y \; x \; z^2$	$2 \; x \; y \; z^2 \; and \; 3 \; y \; x^2 \; z$
$\frac{6x^2}{5y^2} \; and \frac{x^2}{y^2}$	$\frac{6x^2}{5y^2} \; and \frac{6y^2}{5x^2}$

Now the teacher will ask them to name the concept and define it according to its essential attributes. At this stage teacher will not accept or reject the hypotheses of students.

PHASE II. Testing attainment of the concept

The teacher will examine whether the students got the concept clearly. He will give some examples, the students will say "YES" if they will be like terms, otherwise "NO". The teacher will write the examples and non examples in relevant columns.

YES	NO
$-3abc\ and\ 4abc$	$-3abc\ and\ 4abc^2$
$-3x^2y\ and\ 5\ y\ x^2$	$-3x^2y\ and\ 5\ y+\ x^2$

Now the teacher will tell the students that they got the idea. All the items under "YES" heading are like terms. Teacher will ask the students to define the like terms. He will refine the statement if needed.

"Terms containing the same variables and the same corresponding exponents are called like terms".

Teacher will ask the students to generate the "YES" and "NO" examples. All the students will write at least one example for "YES" and "NO".

PHASE III. Analysis of thinking strategy involved.

The teacher will ask the students to discuss, how they got the idea. Students will share their thinking strategies.

The students will freely share their own approaches for attaining the concept. Teacher will encourage them to explain the way they attain the concept.

Evaluation

Define "like terms" and give five "YES" and five "NO" examples, which are not discussed today.

Lesson plan

(Deductive method)

Class: 7th	Subject: Mathematics
Period: 3rd	Time Duration: 40 minutes
Topic: like terms	Teacher: Asad Nisar

Unit :Algebra **Concept** : like terms

Concept analysis

Definition: Terms containing the same variables and the same corresponding exponents.

Essential attributes: the variables are same

Corresponding exponents of variables are same

Non essential attributes: coefficients of variables are integers

Coefficients are same

Super ordinate concept: algebraic terms

Objectives

General objectives

- Enable students to communicate mathematically.
- Enable students to reason and analyze, and to think and act in positive ways.
- Enable students to examine real life situation by reasoning mathematically.
- Enable students to develop cognitive ability skills.
- Develop appreciation towards mathematics.

Specific objectives

4. Enable the students to attain the concept of like terms.
5. Enable the students to discriminate between relevant and irrelevant attributes of like terms.
6. Enable students to differentiate between examples and non examples of like terms.

Material required

Chart, white board, marker

Evaluation of previous knowledge

- Can you define a constant?
- The exponent in $5x^3$ is?
- Can you define variable
- What is the difference between constant and variable?

Introduction of topic

To day we will learn about like terms.

Definition: "Terms containing the same variables and the same corresponding exponents are called like terms."

Explanation: The teacher will explain the like terms with the help of examples.

Examples

Positive examples

- $3xy\ and\ 4xy$
- $-4x\ and \frac{5}{3}\ x$
- $x^2y^3\ and\ \frac{5}{2}x^2y^3$
- $2\ x\ y\ z^2\ and - 3\ y\ x\ z^2$
- $\frac{6x^2}{5y^2}\ and \frac{x^2}{y^2}$
- $-3abc\ and\ 4abc$
- $-3x^2y\ and\ 5\ y\ x^2$
- $\frac{2}{3}\ xy\ and\ 4yx$
- $y^2x\ z^3 and\ x\ y^2z^3$
- $13\ z^{\frac{1}{2}}\ x^3\ and\ x^3z^{\frac{1}{2}}$

Negative examples

- $3xy\ and\ 3x^2y$
- $-4x\ and - 4y$
- $x^2y^3\ and\ x^3y^2$
- $2\ x\ y\ z^2\ and\ 3\ y\ x^2\ z$
- $\frac{6x^2}{5y^2}\ and \frac{6y^2}{5x^2}$
- $-3abc\ and\ 4abc^2$
- $-3x^2y\ and\ 5\ y + x^2$

- $\frac{2}{3}\ xy\ and\ \frac{2}{3}yz$
- $y^2x\ z^3 and\ x^2\ y^2z^3$
- $13\ z^{\frac{1}{2}}\ x^3\ and\ 13x^3z^{\frac{1}{3}}$

Discussion:

The teacher will discuss the examples and non examples with the class, and explain to them why some examples are like terms and some are not like terms.

Students generate examples

Teacher will ask students to give some examples of like terms.

Teacher will ask the students to give some examples which are not like terms.

Evaluation

Teacher will discuss with the class the examples given by the students and make sure that the students got the idea of like terms.

Home task

Teacher will ask the students to write the definition and examples of like terms.

Lesson plan

(Inductive method)

Class: 7th	Subject: Mathematics
Period: 3rd	Time Duration: 40 minutes
Topic: Quadrilateral	Teacher: Asad Nisar

Unit Geometry

Concept analysis

Concept Name: Quadrilateral

Definition: A plane closed figure having four sides is called a quadrilateral

Essential attributes: closed figure

Plane figure

Four sides

Non essential attributes: size of figure

Relative length of sides

Relative measure of angles

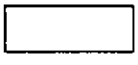
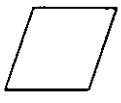
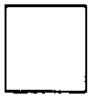
Sides are parallel or not parallel

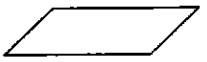
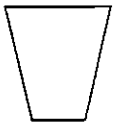
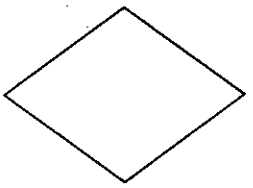
Super ordinate concept: polygon

Subordinate concept: parallelogram, square, rectangle, square, rhombus

Examples

Positive examples

- 
- 
- 

- 
- 
- 
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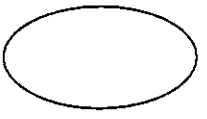
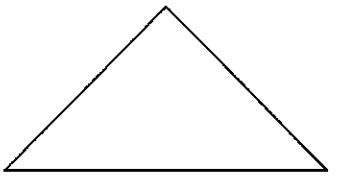
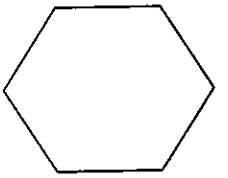
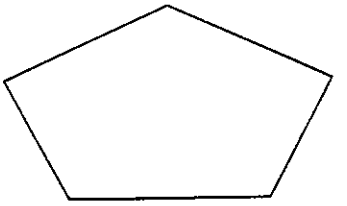
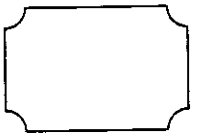
Negative examples

- 
- 

- 
- 
- 
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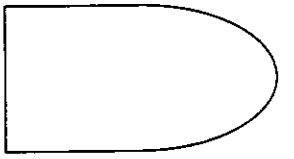
- 

Objectives

General objectives

- Enable students to communicate mathematically.
- Enable students to reason and analyze, and to think and act in positive ways.
- Enable students to examine real life situation by reasoning mathematically.
- Enable students to develop cognitive ability skills.
- Develop appreciation towards mathematics.

Specific objectives

- Enable the students to attain the concept of quadrilateral
- Enable the students to discriminate between relevant and irrelevant attributes of quadrilateral
- Enable students to differentiate between examples and non examples of a quadrilateral.

Material required

Chart, white board, marker

Phases/ stages

4. Presentation of data and identification of concept
5. Testing attainment of the concept
6. Analysis of thinking strategies

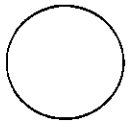
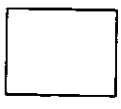
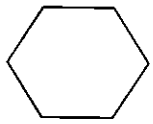
Establishment of relaxed atmosphere

Teacher will tell the students that everybody should participate during discussion and share your ideas, don't bother whether you are right or wrong. Teacher will encourage the students to think and make their own judgments.

PHASE I. Presentation of data and identification of concept

Providing examples and non examples

Teacher will explain the students that now he is going to show you some examples and non-examples of the concept. Teacher will write three examples under "YES" and three non examples under "NO" heading.

YES	NO
	
	
	

Teacher will ask the students to read the examples and non examples carefully.

IV. Students compare attributes of positive and negative examples

Teacher will ask the following questions:

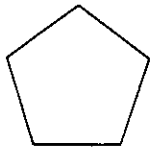
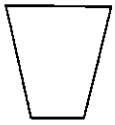
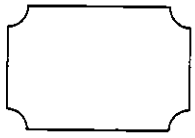
What are the common characteristics in examples under heading "YES"?

He will write all the responses from the students. Then he will ask the students to think about those characteristics which differs in the items under "NO" heading.

The attributes of the "YES" items will be discussed with the class.

V. Students generate and test hypotheses

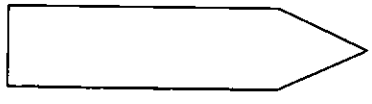
Teacher will provide two more examples and Students will observe them and make sure that their conclusion is correct.

YES	NO
	
	

Now the teacher will ask them to name the concept and define it according to its essential attributes. At this stage teacher will not accept or reject the hypotheses of students.

PHASE II. Testing attainment of the concept

The teacher will examine whether the students got the concept clearly. He will give some examples, the students will say "YES" if it will be a quadrilateral, otherwise "NO". The teacher will write the examples and non examples in relevant columns.

YES	NO
	
	

Now the teacher will tell the students that they got the idea. All the items under "YES" heading are quadrilateral. Teacher will ask the students to define the quadrilateral. He will refine the statement if needed.

"A plane closed figure having four sides is called a quadrilateral".

Teacher will ask the students to generate the "YES" and "NO" examples. All the students will write at least one example for "YES" and "NO".

PHASE III. Analysis of thinking strategy involved.

The teacher will ask the students to discuss, how they got the idea. Students will share their thinking strategies.

The students will freely share their own approaches for attaining the concept. Teacher will encourage them to explain the way they attain the concept.

Evaluation

Define "quadrilateral" and give five "YES" and five "NO" examples, which are not discussed today.

Lesson plan

(Deductive method)

Class: 7th	Subject: Mathematics
Period: 3rd	Time Duration: 40 minutes
Topic: Quadrilateral	Teacher: Asad Nisar

Unit: Geometry

Concept analysis

Concept Name: Quadrilateral

Definition: A plane closed figure having four sides is called a quadrilateral

Essential attributes : closed figure

Plane figure

Four sides

Non essential attributes: size of figure

Relative length of sides

Relative measure of angles

Sides are parallel or not parallel

Super ordinate concept: polygon

Subordinate concept: parallelogram, square, rectangle, square, rhombus

Objectives

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Specific objectives

- Enable the students to attain the concept of quadrilateral.
- Enable the students to discriminate between relevant and irrelevant attributes of quadrilateral
- Enable students to differentiate between examples and non examples of a quadrilateral.

Material required

Chart, white board, marker

Evaluation of previous knowledge

- Can you define a line?
- What is a point?
- Can you define an angle?
- How many corners your classrooms have?

Introduction of topic

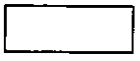
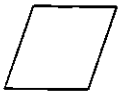
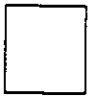
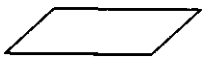
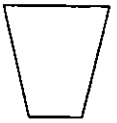
To day we will learn about quadrilateral.

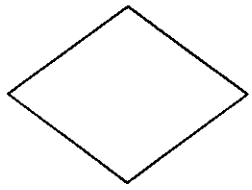
Definition: "A plane closed figure having four sides is called a quadrilateral".

Explanation: The teacher will explain the term quadrilateral with the help of examples.

Examples

Positive examples

- 
- 
- 
- 
- 

- 
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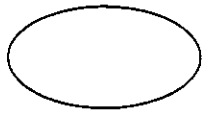
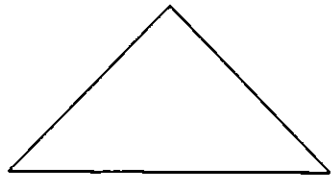
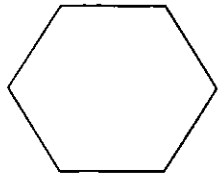
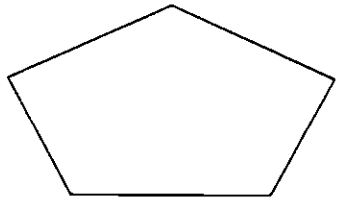
Negative examples

- 
- 
- 
- 
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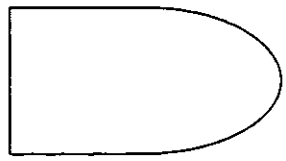
- 

Discussion:

The teacher will discuss the examples and non examples with the class, and explain to them why some examples are quadrilateral and some are not quadrilateral.

Students generate examples

Teacher will ask students to give some examples of quadrilateral.

Teacher will ask the students to give some examples which are not quadrilateral.

Evaluation

Teacher will discuss with the class the examples given by the students and make sure that the students got the idea of quadrilateral.

Home task

Teacher will ask the students to write the definition and examples of quadrilateral.