EXISTING LEVEL OF UNDERSTANDING OF CONCEPTS IN THE SUBJECT OF CHEMISTRY AMONG CLASS IX STUDENTS AND EFFECTS OF TEACHING CHEMISTRY THROUGH "CONCEPT FORMATION TEACHING MODEL" ON STUDENTS' ACHIEVEMENT

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(15 - SS / Ph.D / Edu – 03)

DEPARTMENT OF EDUCATION
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INTERNATIONAL ISLAMIC UNIVERSITY
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A thesis submitted in partial fulfilment of
the requirements for the award of degree of

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Approval Sheet

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Dedicated

To

Researcher's parents and brothers whose love, patience and sacrifice was a constant source of inspiration during this study.

ABSTRACT

The study aimed at checking the existing level of understanding of concepts in the subject of Chemistry among Class IX students and to investigate the effectiveness of concept formation teaching model over traditional method on Class IX students' achievement. It was an experimental study in which concept formation teaching model was compared with traditional method. A sample of 460 students (300 Boys and 160 girls) were selected from nine Government High Schools for Boys and Girls of Rawalpindi city for administering an achievement test to measure the existing level of understanding of concepts in the subject of Chemistry among Class IX students. For experiment, sample size was 290. One hundred and forty three students in experimental groups and one hundred and forty seven students in controlled groups were selected because the classes were taken "as is". Pre-test-Post-test Nonequivalent-Groups Design was used. The students of experimental and controlled groups were taught concept formation teaching model and traditional method respectively for three months. Pre-test and post-test were administered to experimental and controlled groups at the beginning and end of the experiment. 31 lesson plans were made on the format of direct instruction from chapter No. 7 to 10 of Chemistry textbook for Class IX published by Punjab Textbook Board. To determine the effects of concept formation teaching model on achievement of Class IX students in the subject of Chemistry, the significance of difference between the mean achievement scores of experimental and controlled groups was tested at .05 level by applying *t* Test, Product-Moment Correlation and analyses of covariance. Data analysis reveals that existing level of understanding of concepts in the subject of Chemistry among Class IX students was not up to 50 percent. The students of experimental and controlled groups were equal in pre-test at the beginning of the experiment. The experimental groups outscored significantly the controlled groups on post-test showing the supremacy of concept formation teaching model on traditional method. Hence the ultimate results of the study indicated that concept formation teaching model was more effective as compared to

traditional method. Furthermore, concept formation teaching model appeared to be favorable for both boys and girls for the understanding of Chemistry concepts.

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LIST OF ABBREVIATIONS AND ACRONYMS

1. ABBREVIATIONS

A. I. O. U	Allama Iqbal Open University
ANCOVA	Analysis of Covariance
B. Sc.	Bachelor of Science
B. Ed.	Bachelor of Education
Ch.	Chapter
df	Degree of Freedom
F	F Ratio
H_0	Null Hypothesis
$\overline{X}$	Mean
N	Number of Sample
r	Pearson r
School I	Government Comprehensive Boys High School Dhoke Kashmirian Rawalpindi
School II	Government Comprehensive Girls Higher Secondary School Dhoke Kashmirian Rawalpindi
School III	Government M. C. Girls High School Kali Tanki Rawalpindi
SD	Standard Deviation
t	*t*-Test

2. DEFINITION OF ACRONYMS

The following acronyms were used in the study:

2.1 Academic Achievement

An academic achievement is something you do or achieve at school, college or university- in class, in a laboratory, library or field work. It does not include sport or music ("Academic Achievement", 2009).

2.2 Achievement Tests

Achievement test is a "systemic procedure for determining the amount a student has learned through instruction" (A. I. O. U., 2002).

Super (as cited in Singh, 2005) has defined achievement test as, "achievement test is used to ascertain what and how much has been learned or how well a task can be performed".

2.3 Behavioural Objectives

Instructional objectives stated in terms of observable behaviour are behavioural objectives (Woolfolk, 1998).

2.4 Declarative Knowledge

Declarative knowledge is "knowledge that can be declared, usually in words, through lectures, books, writing, verbal exchange and so on". Declarative knowledge is verbal information; facts; "Knowing that something is the case" (Woolfolk, 1998).

2.5 High Achiever

Student scoring 70% and above marks in a test is to be considered as high achiever (Govt. of Punjab, 2002).

2.6 Instructional Objectives

Clear statements of what students are intended to learn through instruction are instructional objectives (Woolfolk, 1998).

2.7 Method

Method refers to a complete set of ways that we use in teaching or doing (Shahid, 2005).

2.8 Negative Reinforcement

Strengthening behaviour by removing an aversive stimulus is negative reinforcement (Woolfolk, 1998)

2.9 Positive Reinforcement

Strengthening behaviour by presenting a desired stimulus after the behaviour is positive reinforcement (Woolfolk, 1998).

2.10 Procedural Knowledge

Procedural knowledge is “knowing how” to do something (Woolfolk, 1998).

2.11 Reinforcer

Any event that follows behaviour and increases the chance that the behaviour will occur again is reinforcer (Woolfolk, 1998).

2.12 Socioeconomic Status

Socioeconomic status includes parents’ income, occupation and level of education (Eggen and Kauchak, 1997).

2.13 Traditional Method

Traditional methods are subject-centred and teacher-dominated activities because their main concern is to get the pupil to master the subject-matter presented (Chand, 1999).

CHAPTER 1

INTRODUCTION

Teaching is an art as well as a science. As an art, it portrays the imaginative and artistic abilities of the teacher in creating a worthwhile situation in the classroom in which the learners learn and receive the immediate and ultimate goal of education. As a science, it points to the logical, mechanical and procedural steps to be followed to attain an effective accomplishment of goals (Joshi, 2005).

Teaching is not telling or transferring the information to students; it is planning and guiding a student in such a way that he/she learns most. Teaching is a dynamic and well-planned process. Its objective is to acquire maximum learning experiences. In order to achieve this great objective, an almost infinite variety of teaching methods are present. There have been a number of methods devised from time to time to make the teaching of science real and effective. The appropriate teaching method that emphasizes thinking, understanding and learning is required to improve the quality of instruction.

Pakistan is a developing country and the basic aim of science education in Pakistan is to improve quality of instruction (Education Sector Reform, Action Plan 2001-2005). Quality of education is based on the quality of instruction in the classroom. The teacher is the most critical factor in implementing the educational reforms at grass root level. It is generally recognized that academic qualifications, knowledge of the subject matter, competence and skill of teaching affect teaching-learning process (National Education Policy, 1998-2010). Hence, there is a need to use appropriate methods of teaching in order to present the concepts in an effective way.

The quality of teaching science at the secondary level in Pakistan has been questioned frequently. It is generally believed that the methods used in teaching science are outdated and not conducive to the development of clear understanding of scientific phenomena among students.

Generally, the students learning is based on rote memorization and reproduction of learned concepts. Students are not encouraged to participate in the classroom, to take challenging tasks and even they do not perform activities in class-rooms. The students' perception about learning is to produce the learned concepts in the examination for getting good grades. They put all their efforts in mastery of subject matter without understanding of the subject.

Presently, the classroom teaching is merely based on mastery of logically organized subject matter through drills, repetition, recall of memory, fixed curriculum, strict classroom discipline, formalized instructional patterns, recognition of facts, rote memorization for habit formation, reproduction of learned concepts and fixed standards to be achieved by all pupils. Classroom activities are governed by the process of compulsion, rigid control, formality, fear and tension. It is general perception that education is a preparation of adult life, mental discipline, transfer of training, acquiring knowledge for its sake, seeking truth and perfection, and habit formation (Chand, 1999). All these factors have adverse effects on students' academic achievement.

On account of present situation of teaching, there is a need to explore such teaching methods which facilitates students' learning to maximum level. The responsibility of the teacher is to utilize students' time in effective learning and it is only possible when students' learning is based on thinking rather than memorizing, understanding rather than merely accumulating facts and learning through interest rather than coercion. For better learning and personality development, proper stimulation, direction and guidance is necessary (Chand, 1999). The principle aim of teaching is the total growth and development of the child and basic tools for achieving this principle are informality, freedom, encouragement on creative expression, life like situations in the classroom and provision of opportunities for developing initiative and curiosity among students.

Whatever the teaching method is to be used, the important thing is to change the child into an intelligent scientific thinker. The wise and efficient teacher utilizes all the students' capacities, abilities, habits, skills, knowledge and ideas etc. He/she can use any method that is more effective for developing the concepts. The effective teacher stimulates the thinking and reasoning power of the pupil for developing problem-solving ability and capacity of personal achievement to explore new ideas and concepts.

The science teacher must have the desire to teach his subject as effectively as possible for realizing the stipulated purposes of teaching science. One of the purposes of teaching Chemistry is to provide a base to explore new things. This exploration is possible when the students have clear concepts.

Concept clarification is based on appropriate teaching method. A method is not merely a devise adopted for communicating certain items of information to students. It links the teacher and his pupil into an organic relationship with the constant mutual interaction. The quality of students' life may rise by applying good methods and bad methods may debase it. Good methods play a great role in the development of concepts.

A concept is a mental abstraction that allows generalizations and the extension of knowledge from some known objects to other unknown. Concepts can be thought of as information about objects, events and process that allow us to differentiate various things or classes, know relationship between objects and generate ideas about events, things and processes (Siddiqui, 1991). Hence concepts must be formed properly at the initial stage. If concepts are not properly developed the knowledge remains vague and inadequate to cope with a problematic situation. So there is a need to explore other new teaching methods and models besides traditional methods for clarification of concepts. Therefore, the researcher decided to conduct research in this area.

1.1 STATEMENT OF THE PROBLEM

This study was designed to ascertain the veracity of the criticism leveled against methods of teaching science at the secondary school level by checking the present level of understanding of concepts among students in the subject of Chemistry and conduct an experiment to determine the effects of "Concept Formation Teaching Model" on students' achievement.

1.2 OBJECTIVES OF THE STUDY

The objectives of the study were:

1. To explore the present level of concept formation during teaching of Chemistry to Class IX students.
2. To investigate the effects of "Concept Formation Teaching Model" on the teaching of Chemistry to Class IX.
3. To measure the academic achievement of the students taught through "Concept Formation Teaching Model" and traditional method.

1.3 HYPOTHESIS OF THE STUDY

In order to check the existing level of understanding of concepts in the subject of Chemistry among Class IX students, following null hypothesis was formulated:

1. The existing level of understanding of concepts in the subject of Chemistry among Class IX students is not up to 50 percent.

In order to compare the achievement test scores of experimental and controlled groups, following null hypotheses were formulated:

2. There is no significant difference in achievement test scores of experimental and controlled group on pre-test.

3. There is no significant difference in achievement test scores of experimental and controlled group taught through Concept Formation Teaching Model and traditional method respectively on post-test.
4. There is no significant difference in achievement test scores on pre-test and post-test of experimental group.
5. There is no significant difference in achievement test scores on pre-test and post-test of controlled group.
6. There is no significant relationship in achievement test scores on pre-test and post-test of experimental group.
7. There is no significant relationship in achievement test scores on pre-test and post-test of controlled group.

1.4 ASSUMPTIONS OF THE STUDY

The study was based on the following assumptions:

1. The educational background of experimental and controlled groups' students was the same.
2. Students were not taking any other coaching (extra period of Chemistry in schools time table) during the experiment.
3. The teachers of experimental and controlled groups were equal in their teaching competency and qualification.

1.5 SIGNIFICANCE OF THE STUDY

The present study is significant because it may provide guidelines to teachers for bringing about appropriate changes in their teaching by identifying areas that need to be revised, explained and improved in order to make teaching process more relevant and efficient. It may also suggest suitable remedies for removing misconceptions.

For the teacher training program, concept formation teaching model is of great use especially for the teacher trainers of science subjects. When the trainers are trained by this model, their own concepts as well as of their students' concepts in the subject may become stronger and clear.

In case, the teachers use concept formation teaching model, students are likely to be motivated to discover new things. With the help of this model, students' concepts will be clear and it can make them scientific thinkers. Their imaginative power for scientific inquiry may increase. Concept Formation Teaching Model may be helpful for clarification of concepts and for proper understanding of the subject. The study is also significant because it will provide guidelines to teachers to improve their skills. The present study is, therefore, significant and justified.

1.6 METHODS OF THE STUDY

The method and procedure followed in conducting the study is described below:

1.6.1 Population of the Study

The target population of the study consisted of an estimated number of 4530 students of Class IX studying Chemistry as a subject in the Government High Schools of Rawalpindi city. 38 Government High Schools for Girls and 48 Government High Schools for boys were in Rawalpindi city.

1.6.2 Sample of the Study

The following two samples were selected for study:

1. **Sample for Existing Level of Understanding of Students of Nine Selected Schools**

In order to evaluate the existing level of understanding of the concepts in Chemistry subject of Class IX students, the researcher selected five schools from boys and four schools from girls Government High Schools of Rawalpindi city by random sampling. Nine schools made a total sample size of 460 students. These students were tested for their concepts in Chemistry.

2. **Sample for Experiment**

In part II of the study, an experiment was conducted on teaching Chemistry to Class IX students using the concept formation teaching model. A sample of 290 students of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject were selected for experiment. Out of 290 students of these three selected schools, 143 students of experimental groups were taught through concept formation teaching model and 147 students of controlled groups were taught through traditional method.

1.6.3 Design of the Study

The design of the study was the "Pretest-Posttest Nonequivalent-Groups Design". This design is schematically described as below:

O_1 E O_2

O_3 C O_4 (Best and Kahn, 1993)

O_1	Observation of experimental group before teaching by administering pretest	O_3	Observation of controlled group before teaching by administering pretest
E	Experimental Group	C	Controlled Group
O_2	Observation of experimental group after teaching by administering	O_4	Observation of controlled group after teaching by administering

posttest posttest

The study design consisted of two groups: namely experimental and controlled groups. A pretest was administered to experimental and controlled groups before teaching. The experimental and controlled groups were taught through concept formation teaching model and traditional method respectively.

After exposing the experimental groups with the concept formation teaching model and controlled group with the traditional method, a post-test was administered.

1.6.4 Research Instruments

Two achievement tests were developed by the researcher.

1. An achievement test was designed to measure the existing level of understanding of concepts of the sample students in the subject of Chemistry. It contained 80 multiple-choice items from the selected chapters of Class VI to Class VIII of General Science and chapter No. 1 of the Chemistry textbook for Class IX recommended by the Punjab Textbook Board. The achievement test was designed for measuring the knowledge, comprehension and application level of Class IX students in the subject of Chemistry. The achievement test was administered to 460 sample students of Class IX of nine selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject.

2. A pre-test was designed in the subject of Chemistry for measuring the knowledge, comprehension and application level. It contained 80 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX recommended by the Punjab Textbook Board. The pre-test was administered to 143 sample students of experimental groups and 147 sample students of controlled groups making a total sample size of 290 students of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject.

This pre-test was re-administered as post-test on experimental and controlled groups to evaluate the effects of concept formation teaching model and traditional method on academic achievement of Class IX.

In order to teach experimental groups by concept formation teaching model, the lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX of the Punjab Textbook Board were developed on the format of direct instruction prepared by McVittie (2002). The lesson plans were checked and approved by the experts.

1.6.5 Procedure of the Study

The researcher randomly selected one section of Class IX from each selected school as experimental group for teaching Chemistry through concept formation teaching model. The other section was controlled group taught by the school's teacher. The experience and qualification of experimental and controlled groups' teachers was the same i.e. 3-5 years, B. Sc. and B. Ed. The experimental and controlled groups' teachers taught simultaneously the same subject matter in the same period with in same time duration i.e. 40 minutes according to the time table of the school. Training was given by the researcher to experimental groups' teachers for two weeks to teach Chemistry through concept formation teaching model.

1.6.6 Analysis of Data

Mean, standard deviation, *t*-test (Independent Samples Test and Paired Samples Test) and Analysis of Covariance (ANCOVA) and Product-Moment Correlation Method were used for data analysis.

1.7 DELIMITATION

The study was delimited to:

1. Government High Schools of Rawalpindi city;

2. Science group of Class IX; and
3. Chapter No. 7 to 10 of Class IX from Chemistry textbook published by Punjab Textbook Board.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The objectives of study was to check the existing level of understanding of concepts in the subject of Chemistry among Class IX students and to investigate the effectiveness of concept formation teaching model over traditional method on Class IX students' achievement.

The method of teaching refers to the regular ways or orderly procedures used by the teacher in guiding the pupils in order to accomplish the aims of the learning situations. By method, in general is meant the process of reaching a definite end by a series of related acts which tend to secure that end. As applied to classroom teaching, method is a series of related and progressive acts performed by the teacher and the pupils to accomplish the general and specific aims of lesson. Teaching methods involve regular steps to guide the mental processes of the learner in mastering the subject matter being presented to him (Chand, 1999).

In order to teach effectively, the knowledge about learners, subject and appropriate method of teaching is necessary. Modern researches indicate that if proper and suitable methods and techniques of teaching are used, the students can easily learn (Sadker and Sadker, 2003). One of the most outstanding objectives of teaching is to facilitate the overall growth and development of an individual with special emphasis on intellectual development. Intellectual development is possible when the students have clear concepts about the topic. Thousands of studies were conducted between 1960s and 1980s to determine which teaching method is appropriate for clarification and formation of concepts that ultimately lead towards intellectual development (Gerges, 2001).

The conceptual development of learners is one of the most important tasks of the school. Knowledge becomes usable if it is meaningful and so has generality and applicability. Students need clear and comprehensive concepts about the topics they are studying, and the relationships among these concepts should be clear and stable. These kinds of concepts make it easier for learners to acquire new information and to organize it within their broader concept structures (Hudgins *et al.,* 1983). Modern researchers indicate that direct teaching is one of the most effective instructional models for concept formation that brings the students to high achievement. In connection to this, the review of related literature includes the following headings:

1. Concepts
2. Cognition and Cognitive Development
3. Philosophies of Concept formation
4. Promoting Conceptual Change
5. Direct Teaching
6. Principles of Concept Formation
7. Concept Formation Teaching Model
8. Latest Research Studies in the Area

2.1 CONCEPTS

2.1.1 Definitions of Concept

Concepts are the basic building blocks around which people organize their thinking and communication (Arends, 2007). Concepts are important for the structure of knowledge of various academic disciplines. They are considered vehicles of thought process. They are the critical component of an individual's cognitive structure of knowledge. Chauhan (1989) illustrates that concepts are the ideas or understanding of things. It is ordered information about the properties of things and also related to other things. Moreover it is also a mental integration of two or more units possessing the same distinguishing characteristics with their particular measurements.

Hudgins *et al* (1983) say that concepts are general ideas which summarize a large number of examples or cases that have some essential qualities or elements in common but may differ from one another in particular ways.

Concepts enhance the ability to learn subject matter content in a meaningful way. A learner who has a clearly delineated conceptual idea has much better opportunity to learn and remember particular information about it than one who must try to process and store incoming information without any conceptual hooks on which to hang all the details (Hudgins *et al.*, 1983).

A concept is the basic unit of all types of learning. Human beings throughout, from infancy to old age, learn new concepts and use old concepts in new situations of their daily life. Individuals differ in their level of concept formation on the basis of their age, intelligence and experience (Chauhan, 1989).

Concept learning is not based on simple recall or discrimination learning. Gagne's framework of learning outcomes identifies that two important categories do not refer to concepts:

- Verbal information: reciting something from memory, e.g. recall a definition etc.
- The first level of intellectual skills-discrimination: recognizing that two classes of things differ e.g. identify objects, features, symbols etc. as not being the same (Edutechwiki, n.d.).

Concepts can be thought of as information about objects, events and process that allows us to:

a) differentiate various things or classes;

b) know relationship between objects; and

c) generate ideas about events, things and processes (Siddiqui, 1991).

2.1.2 Types of Concepts

There are mainly three types of concepts:

1. Conjunctive Concept: A conjunctive concept is defined as by the joint presence of the appropriate value of several attributes (Chauhan, 1989). These concepts have constant rule structures. Their critical attributes are combined in an additive manner and are always the same (Arends, 2007).

2. Disjunctive Concept: A disjunctive concept involves a critical combination of critical attributes (Chauhan, 1989). These concepts are broader and are more flexible and permit alternative set of attributes. Their rule structures are not constant (Arends, 2007).

3. Relational Concept: The relational concept involves the notion of a common relation among the various elements of attribute thus defining the concept (Chauhan, 1989). Relational concept is one whose rule structure depends on relationships. To understand either of these concepts, one must know the other, plus the relationship between them (Arends, 2007).

2.2 COGNITION AND COGNITIVE DEVELOPMENT

2.2.1 Cognition

Cognition is the scientific term especially used for the process of thought. It is used in different ways according to different disciplines. For example, in psychology and cognitive science, it is used as an individual's psychological function. Other interpretations of the meaning of cognition link it to the development of concepts such as individual mind, groups, organisations and even larger coalition of entities; can be called as "societies" (Society of Mind) which are helpful to form concepts ("Cognition", 2009).

Cognition is a term to describe all of our mental processes such as perception, memory and judgment. The most important mental process is thinking (Crowl, Kaminsky and Podell, 1997).

The higher mental process including understanding, reasoning, knowledge and intellectual capacity is cognition. Cognition is the highest form of learning and consists of the perception, storage and processing of information gathered by sensory receptors.

Cognition is referred as high-level functions of human brain that includes comprehension and use of speech, visual perceptions and construction, calculation ability, attention, memory and executive functions such as planning, problem-solving and self-monitoring (Serono, 2010).

Wagner (2008) defined cognition as the mental process that involves acquisition of knowledge and comprehension, including thinking, knowing, remembering, judging and problem solving. These are higher-level functions of the brain and encompass language, imagination, perception and planning.

2.2.2 Cognitive Development

Cognitive development is the field of study in psychology focussing on the child's development in terms of information processing, conceptual resources, perceptual skill and other topics in cognitive psychology (Wikipedia The Free Encyclopaedia, n.d.).

In cognitive development, gradual, orderly changes occur by which mental processes become more complex and sophisticated. Cognitive development refers to the change in children's pattern of thinking as they grow older. Cognitive development is much more than the addition of new facts and ideas to an existing store of information (Woolfolk, 1998).

Schmidt (2008) defined cognitive development as a process of thinking, problem solving, concept development and understanding, information processing and overall intelligence.

2.2.2.1 APPROACHES TO COGNITIVE DEVELOPMENT

i) Piaget's Approach to Cognitive Development

Jean Piaget was a Swiss psychologist whose insightful description of children's thinking changed the way we understand cognitive development. He devised a model describing how humans go about making sense of their world by gathering and organizing information (Woolfolk, 1998).

Piaget's theory of cognitive development is based on the idea that people make a sense of the world and actively create their knowledge through direct experience with objects, people and ideas. Maturation, activity, social transmission and the need for equilibrium, all these influence on the way of thinking and as a result of this process knowledge is developed. In response the influences, according to Piaget's theory, thinking process and knowledge develop through adaptation (including the process of assimilation and accommodation) and changes in the organization of thought (Woolfolk, 1998).

In Piaget's theory, cognitive development occurs in a series of distinct and universal four stages. Each stage is characterized by increasingly sophisticated and abstract levels of thought. These stages always occur in the same order and each builds on what was learned in the previous stage. They are as follows:

a) Sensorimotor stage (infancy): In this period, which has six sub-stages, intelligence is demonstrated through motor activity without the use of symbols. Knowledge of the world is limited, but developing, because it is based on physical interactions and experiences. Children acquire object permanence at about seven months of age (memory). Physical development (mobility) allows the child to begin developing new intellectual abilities. Some symbolic (language) abilities are developed at the end of this stage.

b) Pre-operational stage (toddler-hood and early childhood): In this period, which has two sub stages, intelligence is demonstrated through the use of symbols, language use matures, and memory and imagination are developed, but thinking is done in a non-logical, non-reversible manner. Egocentric thinking predominates.

c) Concrete operational stage (elementary and early adolescence): In this stage, characterized by seven types of conservation (number, length, liquid, mass, weight, area and volume), intelligence is demonstrated through logical and systematic manipulation of symbols related to concrete objects. Operational thinking develops (mental actions that are reversible). Egocentric thought diminishes.

d) Formal operational stage (adolescence and adulthood): In this stage, intelligence is demonstrated through the logical use of symbols related to abstract concepts. Early in the period there is a return to egocentric thought. (Huitt and Hummel, 2003).

At heart, his theory is:

a) a genetic one, in that higher processes are seen to evolve from biological mechanism which are rooted in the development of an individual's nervous system;

b) a maturational one, because he believes that the processes of concept formation follow an invariant pattern through several clearly definable stages which emerge during specific age ranges;

c) a hierarchical one, in that the stages he proposes must be experienced and passed through in a given order before any subsequent stages if development are possible (Child, 1995).

ii) Vygotsky's Approach to Cognitive Development

Lev Semenovich Vygotsky was a pioneering Russian cognitive psychologist who made an enormous contribution to our understanding of language and thinking (Crowl, Kaminsky and Podell, 1997).

In Vygotsky's theory, language is the most important symbol system for learning. Language is critical for cognitive development. It provides a means for expressing ideas and asking questions, the categories and concept for thinking and the links between the past and the future. When we consider a problem, we generally think words and partial sentences. He places much more emphasis on the role of language in cognitive development. He viewed that language in the form of private speech (talking to yourself) guides cognitive development (Woolfolk, 1998).

Three stages of concept formation were proposed by Vygotsky: first, there is *vague syncretic* ('syncretic' in this context means random rather than reasoned grouping of objects, in which the child sort out a shapeless, disorganized heap of objects, designated by a word, often without any internal relation between them (Child, 1995).

The second stage is *thinking in complexes*. These are a kind of primitive concept in which a child groups attributes by criteria which are not the recognized properties which could be used for the classification of concepts (Child, 1995). At this stage complexes are formed. Groups and families of objects are classified on the basis of their objective, common features and immediate image.

The third stage identified by Vygotsky is called the *potential concept* stage in which children can cope with one attribute at a time but is not yet able to manipulate all the attributes at ones. Maturity in concept attainment is reached when the child can do this (Child, 1995).

Vygotsky distinguishes three stages in the development of concept formation in children:

1) Sorting out a shapeless, disorganized heap of objects, designated by a word, often without any internal relation between them;

2) Formation of complexes, groups and families of objects on the basis of their objective, common features and immediate images;

3) Formulation of true fully developed concepts (Duric, 1989).

An indispensable role in concept formation is played by the word, the language. The word represents a means of uniting the psychic experience into a concept.

With concept attainment, the situation is different from that of concept formation. The process of concept attainment in the guided learning of pupils means that the pupils purposefully acquire the concept used by adults, formed in the long process of social development. In this way the results of human cognition and activity are transmitted to pupils. Therefore it is said that conceptual learning has two aspects. One aspect represents the concept formation by the subject themselves (with the adults help), while the other is composed of the attainment of ready-made concepts formed by the society. The concept acquired by purposeful, systemic learning and study is called scientific concepts and the ones formed by the child himself are called experiential concepts (Duric, 1989).

Vygotsky (1978) believed that two levels of mental functions exist in every individual i.e. elementary and higher mental functions. The individuals are born with elementary mental functions i.e., no learning is required for their use. Thinking is not required for such functions and they occur naturally such as hunger and sensing. But in higher mental functions, the creation and use of self-generated stimulation such as memory, attention, thinking and language are involved (Galant, 1998).

Vygotsky emphasized the development of higher level thinking and problem solving in education. If opportunities are provided to students to utilize critical thinking skills, their thought processes will be challenged and new knowledge will be gained. Behaviour modification of every individual depends upon the knowledge achieved through experience (Dahms, *et al,* 2008).

iii) Taba's Strategy to Cognitive Development

Hilda Taba and associates (1964) have focussed their intensive research largely on the development of a strategy for the generation and the enhancement of independent thought process (Woods, 2002).

Taba built her approach around three assumptions:

1. Thinking can be taught (through engaging students in practice, in particular inductive reasoning).

2. Thinking is an active transaction between the individual and data. This relies on earlier theories.

3. Processes of thought evolve by mastery learning (Joyce, Weil and Calhoun, 2000).

Taba identified three categories of thought processes or cognitive tasks: (a) concept formation, (b) interpretation of data and the making of inferences, and (c) the application of known principles and facts to explain new phenomena, to predict consequences from known conditions and events or to develop hypotheses by using known generalizations and facts.

a) Concept Formation

Since concept formation is considered the basic form of cognition on which all cognitive processes depend, Taba utilized basic concept formation and defined it as consisting of three different processes or operations: i) the differentiation of the specific properties of objects or events (this differentiation involves the process of analysis in the sense of breaking down the global complexes representing objects and events into specified properties); ii)grouping or a process of assembling specified properties across many objects and events; and iii) labelling or categorizing, i.e. explicitly identifying the basis for grouping and subsuming the items under some label or category (Woods, 2002).

b) Interpretation of Data

Interpreting data and making inferences from them is essentially an inductive process of developing generalizations, although never accomplished without some application of what is previously known. This task involves four basic operations. One is that of assembling concrete information, either by instigating a process of recall and retrieval of previously learned information or by being presented new information and identifying the specific points in this set of data. Second is that of explaining or giving reasons for certain events. The third operation consists of relating different point of processed information and relating the information thus obtained to its possible connection with standards. The fourth operation is that of formulating generalizations or inferences (Woods, 2002).

c) Application of Principles

A third cognitive task has to do with applying previous knowledge, principles, generalizations or facts to explain new phenomena and to predict consequences from known conditions.

Essentially, two different operations are involved: that of predicting and that of establishing the parameters either of logical relationships or of information with which to test the validity of predictions. The level of prediction or a hypothesis can be judged according to the extant of the leap from a given condition. But equally important is the completeness of the parameter, the chain of links which connects the predictions and the conditions (Woods, 2002).

Woods (2002) explains that application of principles invites a greater degree of divergence than either of the preceding cognitive tasks. Each condition presented as data invites a divergent line of predictions. For this reason, this process contains opportunities for creative and divergent use of knowledge).

The operations involved in applying principles are quite crucial to developing productive pattern of thought. This process is the chief vehicle for transfer of knowledge. This process is, therefore, crucial for getting mileage out of the little that student can acquire directly during their schooling. It is a chief means for creating new knowledge by logical processes and a way of acquiring control over wide areas of new phenomena. It is also the process by which models for hypothesizing can be created, freeing the individual from the necessity of being bound to the immediate stimulus (Woods, 2002).

Taba's strategies focus on the teacher as the mediator rather than as the lecturer. When utilizing the Taba approach, the teacher leads the discussion by sharing their opinions and relating their own ideas to their peers' ideas. The teacher should not judge the students by their answers and can neither agree nor disagree with their responses. The teacher should use verbal feedback to strengthen their concepts. The teacher should avoid nonverbal cues during students' responses. Encouragement should be given by the teacher to the students to expand their classmates' ideas or to invite students to clarify their own ideas by discussing them (Wikipedia The Free Encyclopaedia, n.d.).

iv) Bruner's Approach to Cognitive Development

Jerome Bruner is an American psychologist who developed a theory of cognitive development to help teachers to promote student learning and thinking. Jerome Bruner formulated a concept formation theory that involved cognitive processes, i.e. hypothesis testing about a concept by making guesses about which attributes are essential for defining the concept.

The Concept Attainment Model (CAM) of teaching has been presented by Bruner, Goodnow and Austin. It is developed by their study of Thinking. The Concept Attainment Strategy as model of teaching is concerned with two separate but related ideas:

a) nature of the concepts themselves; and

b) thinking process used by individual to learn concepts

a) Nature of Concepts

A concept is assumed to be a set of specific objects or events, which share common characteristics and they can be labelled as a particular name. So the identification of generalized concept attributes to newly encountered examples and discriminate examples from non-examples is concept learning.

b) Thinking Strategies of Concept Attainment

Bruner analyses any concept as having five elements.

i) Name-It is a term given to the category.

ii) Examples-They refer to the instances of the concept. Examples of a concept may be positive or negative.

iii) Attributes-The basic characteristics of the concepts are called attributes. Each attribute has an attribute value.

iv) Attribute Value-This refers to the specific content of that category of concept. Most attributes have a range of accepted value.

v) The rule is a definition or statement of specifying the essential attributes of a concept (A. I. O. U., 2002).

His approach was characterised by three stages which he calls enactive, iconic and symbolic for the formation of concepts. The first, the enactive level, is where the child directly manipulates the matter. The second is the iconic level, where he deals with mental images of objects but still he is not able to manipulate them directly. The third is the symbolic level, where he is strictly manipulating symbols and mental images or objects are no longer in use. The optimum learning process takes place by these stages.

1. Enactive Stage. Infants are in the enactive stage and acquire knowledge by actively engaging in activities. Young children need lots of opportunities to engage in "hands-on" activities with a variety of objects if they are to learn effectively.

2. Iconic Stage. In the iconic stage, children learn through visual stimuli (the word icon means "picture"). At this stage, children rely on visual representations to aid their thinking. Students' visual representations determine how they understand the world. Teachers of students in the early grades should use many pictures and visual aids to promote learning.

3. Symbolic Stage. In the symbolic stage, children can understand symbols, including words and mathematical and scientific notations. Once students have reached the symbolic stage, they are able to take in large amounts and varied types of information. Symbolic material includes written passages, scientific and mathematical formulas and abstract charts (Crowl, Kaminsky and Podell, 1997).

Bruner advocates the use of guided discovery in which the teacher guides students to induce the underlying structure of the material that they are studying (Crowl, Kaminsky and Podell, 1997).

According to Hollyman (2009), Bruner suggested that people remember things "due to meaning and signification, not toward the end of somehow 'preserving' the facts themselves." A constant theme in Bruner's work is that education is a process of discovery. Bruner believes that personal discovery is involved in effective learning. Bruner advocated that if opportunities are provided to the students to pursue concepts on their own pace, then a chance of better understanding will be increased. Within the education system, a teacher should engage students in discussion and guide them so that students become able to think independently rather than be taught. He argued that the study materials, activities and tools that are matched to and capitalise their developing cognitive capabilities should be provided to the students for maximum learning.

2.3 PHILOSOPHIES OF EDUCATION: ORIGIN OF CONCEPT FORMATION

The origin of concept formation is as old as education itself. Different philosophers define concepts in different ways and they recommended different theories and schools of thought to form and strengthen the concepts. The following schools of thoughts give the information about how to form concepts and what are the responsibilities of teachers to make concepts more clear and sound.

2.3.1 Idealism

Idealism's proponents are Berkeley, Butler, Froebel, Hegel and Plato. They say that knowing is the rethinking of latent ideas. Idealist knowledge is based on the recognition or reminiscence of latent ideas that are already present in the mind. Such ideas are a priori; that is, they concern knowledge or concepts that exist prior to and independent of human experience about them. The teacher's task is to bring this latent knowledge to consciousness. The idealist educator refers the order and pattern of a subject-matter curriculum that relates ideas and concept to each other (Ornstein and Levine, 1985).

The teacher should act as a guide to develop critical thinkers and should deal with broad concepts rather than specific skills. This is a content-centred approach in which emphasis is given on universal truths and values (Conti, 2007).

Idealists are of the view that teacher should be a skilful questioner, who should be a model for children to promote self realization and self education. While teachers cannot always be present when learning occurs, they must attempt to stimulate students so that learning occurs even in their absence. Project based learning is recommended by idealists which is self directed learning activity where learning can occur without a teacher's presence (Martinez, n.d.).

To form the concept, classroom management leads to transference of few discipline problems to student. With the involvement of students, the teacher handles any problem about their behaviour. Teaching method focuses on handling ideas through lecture, discussion and Socratic dialogue, introspection, intuition, insight and whole part logic to bring ideas into consciousness that are latent in the mind (Cohen and Gelbrich, 1999).

2.3.2 Realism

Realism's proponents are Aquinas, Aristotle, Broudy, Martin and Pestalozzi. They say that knowing is the process that involves two stages: sensation and abstraction. First, the knower sees an object and records the sensory data about it such as colour, size, weight, smell or sound. These sensory data are sorted out in the mind into those qualities that are always present in the object and those qualities that are sometimes present in the object. Upon the abstraction of the necessary qualities of an object, the learner comes to a concept of the object. Conceptualization results when the mind has abstracted the form of an object and has recognized the object as belonging to a class (Ornstein and Levine, 1985).

Realists are in favour of inquiry, verification of ideas in the world of experience, teaching those concepts which are essential and practical and develop the learner's rational powers by teaching fundamentals through scientific method. The teacher has to present material in a systematic way, encourage the use of objective criteria and be effective and accountable (Conti, 2007).

Ideas, like things, always exist and always resist change and seek self-preservation. Some ideas may be driven due to consciousness but the excluded ideas continue to exist in an unconscious form and tend to return spontaneously to consciousness.

The formation of character by the development of an enlightened will, capable of making judgments is the ultimate aim of realists. In the classroom, the aim of the lessons is to introduce new conceptions, to bind them together and to order them.

Realists stress the accountability. Realists emphasize the concept acquisition as the curriculum. The teacher adopts new technology to develop the concept by emphasizing realistic novel and by stressing precision and accuracy in mathematics, science, social studies and writing.

2.3.3 Existentialism

Existentialism's proponents are Roger, Sartre, Marcel, Morris and Soderquist. They believe that the universe is indifferent to human wishes, desires and plans. Human freedom is total. They also hold that one's responsibility for choice is total. The child has the possibility of being an inner-directed and authentic person. An authentic person is one who is free and aware of his or her freedom. Such a person knows that every choice is really an act of personal value creation. The authentic person is his or her own definer and is aware that self-definition is the personal responsibility (Ornstein and Levine, 1985). They think that concept formation is possible by emphasizing individual choice. For doing this, the teacher stresses individual freedom; empowerment of student to make choices about what and how they will learn.

Existentialists promote self-understanding, involvement in life, an awareness of alternatives and the development of a commitment to choices. Learning is a process of personal development in which options are provided to learners. The instructor's role is to be a facilitator. In this philosophy, trust is developed between the teacher and learner (Conti, 2007)

Existentialism places the highest degree of importance on student perceptions, decisions and actions and individuals themselves are responsible for determining true or false, right or wrong, beautiful or ugly. To sum it up, students make choices and then take the time to evaluate those choices. The teachers help the students to define their own goals and by creating an environment in which they can freely choose their way. In it, students think for themselves and are aware of responsibilities assigned to them. Individual are the focal point in teaching method that have the unique talents. Their learning is self-paced, self directed and includes a great deal of individual contact with the teacher, who relates to each student openly and honestly. The teacher views that each student has an individual identity and each student should learn how to achieve his full potential by trying new concepts (Gibbs, n.d.).

2.3.4 Pragmatism

Pragmatism's proponents are Childs, Dewey, James and Peirce. Another name is experimentalism. Pragmatists believe that human purposes and plans could be validated only by acting on them and judging them by their consequences. For this, they stress the methodology or the process of problem-solving. They argue that learning occur as the person engages in problem-solving. The learner, as an individual or as a member of a group, utilizes the scientific methods to solve both personal and social problems. The problem-solving method can be developed into a habit that is transferable to a wide variety of situations (Ornstein and Levine, 1985).

They are of the view that education is the necessity of life so its aims are to seek understanding, coordinate all environments into a whole, teach a process of inquiry and promote personal growth and democracy. As every individual is different so the instructional process should be flexible for problem solving and discovery. In this learner-centred approach, the role of teacher is as a resource person who identifies the needs of the learner. The role of the teacher is to educate the child successfully by capturing the child's interest and build on the natural motivation. Teachers should use different teaching methods to accommodate each individual learning style. Due to individual difference, the teacher must vary his/her teaching style. They believe that knowledge should be organized and relate to current experiences (Woodson, 2007). They apply democratic methods for concept formation by considering classroom as a community of learner. Teacher encourages students to test ideas by corruption and competition.

2.3.5 Perennialism

Perennialism's proponents are Adler, Hutchins and Maritain. It is rooted in realism. Perennialists say that human nature never changes; hence there should be uniformed education everywhere for each nation of the world. They agree that the fundamental components of the soul are intention, reason and aesthetic sense. These concepts can be taught by arranging such methods that enable the students to settle their affair successfully, when they enter the field of practical life (Amin, 2000). Because of this, the teacher emphasizes searching for the truth and rationalization. They want to make a learner as an avid reader and writer. By using lecture method, didactic learning and Socratic `Method, they form the concepts. They form the concepts by encouraging students to organize, clarify and connect thoughts to make accurate quantitative comparisons.

The focussing area of perennials is to teach everlasting ideas and enduring truths. They are of the view that out-dated and incorrect information should not be taught to students. They recommend that schools should allot more time for teaching and explaining meaningful concepts (Theodore, n.d.).

2.3.6 Essentialism

Essentialism's proponents are Bagley, Bestor, Conant and Morrison. It is rooted in idealism and realism. Essentialists hold that it is the task of school to channel the accumulated experience of human kind into organized, coherent and differentiated disciplines. Only after mastering these basic disciplines can the student be expected to use them to solve personal, social and civic problems. For this, the teacher has the knowledge of his own subject and it is his obligation to impart education to the children. It is the duty of the students to benefits from the teachers and collect, as much as possible, the educational facts and hints from them (Amin, 2000).

The teachers can develop the concepts by teaching basic skills (reading, writing and arithmetic) and knowledge. They use previous concepts to develop students' higher thinking skills (Ornstein and Levine, 1985). They are in the favour of traditional methods to sharpen the mind and clarify the concepts. Command over the educational material is gained, comparatively, in better form through the traditional methods (Amin, 2000).

For essentialists, students are required to master information about the people, events, ideas and institutions. Essentialists argue that classrooms should be teacher-oriented and the whole responsibility is of the teacher. The teacher should serve as an intellectual and moral role model for the students. Essentialists hope that when students leave school, they will not only possess basic knowledge and skills but they will also have disciplined, practical minds, capable of applying lessons learned in school in the real world (Theodore, n.d.).

2.3.7 Progressivism

Progressivism's proponents are Dewey, Johnson, Killpatrick, Parker and Washburne. It is rooted in pragmatism. Progressive education focus on the child as the learner rather than on the subject; emphasized activities and experiences rather than verbal and literary skills; and encouraged cooperative group learning activities rather than competitive individualized lesson learning (Ornstein and Levine, 1985). Progressivists say that the teacher should guide and lead the students when ever the need arises. He should not, in person, dominate each thing every time. His right and suitable role is to act as a consultant or advisor (Amin, 2000).

Student-centred teaching methods are recommended by progressivists, in which the teacher is the facilitator of knowledge. For them, the teacher is responsible to get each student's attention and interest on various topics and concepts and then allows the students to learn about each topic and concept through discovery and inquiry. This will help the students to engage in deeper thinking about the material. The classroom environment should be designed in such a way that freedom is given to every student to ask questions without feeling unsure or insecure and feel comfortable to share their interests and concerns about the subject matter (Wagner, n.d.).

So they recommend that the teacher should assist learning by using intrinsic rewards and use students-centered methods to develop concepts by self-directed learning. They hold the view that teacher should be a resource person and a guide to learning activities.

2.3.8 Reconstructionism

Reconstructionism's proponents are Brameld, Counts and Stanley. It is rooted in pragmatism. Education is designed to awaken the students' consciousness about social problems and to engage them actively in the solving of problems. To awaken social consciousness, students are encouraged to question the status quo and to investigate the controversial issues (Ornstein and Levine, 1985).

Reconstructionists are not in favour of predetermined curriculum. They recommend the subject matter from any or all disciplines when there is a need to solve a problem. They prefer the subject matter of social experience in solving problems. The reconstructionists are in favour of applying the problem-solving method (scientific method) to real-life problems. After one has reached an "intellectual solution" to a problem, he should carefully thought-out social action to remedy the problem (Ozman, n.d.).

By this, teacher develops the concepts by encouraging students to address and attempt to solve social problem. The education should undertake the experimentation of new social system immediately. The teacher may convince about the need of reconstruction. It is obligatory for a teacher to present honestly all aspects of the problems faced by the society and should not hide any one of them. Similarly, he may express, his own point of view to develop and strengthen the concepts, if need be, but should never intentionally try to impose it on them (Amin, 2000).

Reconstructionist teachers are social reformers. They believe that continuous thoughtful change is required for the improvement of society and the best change agent is the educational process. Teachers should focus on critical issues and allow students to have an active discussion about these issues (Goodly, n.d.).

Reconstructionists believe that the teacher should be an educational activist. The teacher should be a person who is aware of what is going on in society and have an opinion and is able to discuss this with the students. Teachers need to be freed from passivity and fear of working for change. They need to focus on critical issues not generally found in textbooks or made a part of the school curriculum. They also need to make students more critical about the knowledge they receive (Bazile and Nauman, 2004). Reconstructionists stress experimentation and problem solving as teaching methods.

Different philosophies have different concepts about knowledge. Idealists see cognition as the recall of latent ideas of mind to strengthen the concepts. For realist knowledge begins with our sensation of objects to form concepts that correspond to the objects in reality. Existentialists state that the individuals choose the knowledge to grasp that they wish to possess. Pragmatist said that we create knowledge by interacting with environment; hence concepts are formed due to this interaction. Perennials are of the view that the mind forms the concepts when they are organized, clarified and connected with one another to form new and complex concepts. They said that concepts can be developed into higher thinking skills by clarifying them. Progressivists view that concepts are learnt through discovery and inquiry in which students are engaged in deeper thinking. By reconstructionists, concepts can be developed and strengthened when students address and attempt to solve problems.

All philosophers put emphasis on concept clarification. They have different opinions about the development of concepts. However they recommend different methods and strategies to form concepts. They provide a base to change old and simple concepts into new and complex ones. The focusing area of all schools of thought is concept formation, concept clarification and promotion of conceptual change.

2.4 PROMOTING CONCEPTUAL CHANGE

2.4.1 Cognitive Development and Science Learning

Cognitive development takes place during the student years; the problems of conceptual change in learning and in development are interrelated. The psychologists have proposed a theory that the processes of conceptual change in cognitive development take the form of theory formation and change. The interdisciplinary research area of cognition and instruction has made considerable use of the history of scientific change in considering the problem of how to help students learn the conceptual structure of a science. Students are thought to have to undergo a major conceptual restructuring in order to learn a physical theory (Nersessian, 2004).

Significantly, though, even if the kinds of change required are strikingly similar in learning, development and science, this does not mean that the processes of change will in any way be alike. It is an open question in need of investigation whether historical conceptual changes can provide models for either learning or cognitive development at the level of processes or mechanisms of change (Nersessian, 2004).

Nersessian (2008) stated that from childhood through adulthood, ordinary and scientific reasoning and representation processes lie on a continuum, because they originate in modes of learning which evolution has equipped the human child with for survival into adulthood. The cognitive activity of scientists is potentially quite relevant to learning. But again, there are quite difficult questions that need to be addressed in exploring and testing this hypothesis, such as how maturation might complicate learning. Further, in addition to the similarities, there are significant differences that need to be addressed. For example, in cognitive development, change seems just to happen but in education it requires explicit teaching and in science it requires explicit and active investigation. In the scientific case conceptual change is truly creative. Exploring the fundamental questions about the nature and processes of conceptual change in science, cognitive development and learning in a collaborative undertaking promises to yield richer, possibly unified accounts of this aspect of human cognition.

2.4.2 Promoting Conceptual Change

The general definition of conceptual change is "learning that changes an existing conception" (i.e., belief, idea, or way of thinking). It is not merely accumulating new facts or learning a new skill, in it, a fundamental change or even replacement of an existing conception is done and as a result, the conceptual framework is formulated. On the basis of that conceptual framework, students solve problems, explain phenomena and function in their world (Davis, 2001).

To Vosniadou (2007), (as cited in Suping, 2003) conceptual change is a process by which students synthesize different models in their minds, starting from their existing explanatory frameworks. It is a gradual process that results in a progression of mental models.

Chi and Roscoe (2002), (as cited in Suping, 2003) conceive of conceptual change as repair of misconceptions. The students must identify their faulty conceptions by starting with their naive conceptions and repair them in the light of that misconception. In this view, misconceptions are miscategorizations of concepts, so conceptual change is the reassignment of concepts to correct categories.

Teaching for conceptual change primarily involves uncovering students' preconceptions about a particular topic or phenomenon and using various techniques to help students change their conceptual framework. Conceptual change instruction can help students overcome misconceptions and learn difficult concepts in all subject areas. Conceptual change is helpful to teach the content areas but it is also applicable to the professional development of teachers and administrators (Davis, 2001).

Zirbel (2008) said that if we wish the student go beyond the conceptual change, then we are requiring the student not only to willingly change his opinion but also to integrate the newly acquired knowledge into his neural thinking network to the degree that it can readily be used to construct further concepts upon that whole knowledge.

It is very difficult to change learner preconceptions because learners rely on these existing notions to understand and they may not easily change their ideas and adopt a new way of thinking. Thus, simply presenting a new concept or telling the learners that their views are inaccurate will not result in conceptual change. Teaching for conceptual change requires an active role of learners by which reorganization of their knowledge is possible. Cognitive conflict strategies are effective tools for conceptual change instruction. These strategies involve creating situations where learners' existing conceptions about particular phenomena or topics are made explicit and then directly challenged to create a cognitive conflict or disequilibrium. The common goal is to create necessary conditions for conceptual change i.e. learners must become dissatisfied with their current conceptions and accept an alternative notion as intelligible, plausible and fruitful (Davis, 2001).

The student of conceptual change instruction depends not only on the complexity of the concept itself but also on the character and upbringing of the student that involves his entire personality; his general, cultural and personal belief systems; his acquired and inherited intellect; his ability to follow and think through arguments and his personal attitude towards undergoing conceptual change. Initially the student has to become dissatisfied with his own preconceptions. He has to be able to logically follow and understand the new theory and find that it does a better job than his preconceptions in explaining the situation. At last, the student will need to find the new theory fruitful in the sense that he can apply it to other situations and solve new problems (Zirbel, 2008).

Zirbel (2008) suggested that to form new concepts or change old inadequate ones, the student has to be led through several processes. First, he has to consciously notice and understand what the problem is; second, he has to assimilate more information and try to fit it into already existing neural networks; third, he has to critically think through all the argumentation in his own words and reorganize this thoughts – he has to accommodate the knowledge and evaluate against his prior beliefs; and finally, he has to work towards obtaining fluency in the newly acquired and understood concept so that this concept itself has then become a mere building block for future, more advanced concepts.

During the process of conceptual change what happens in the student's mind is a reorganization of his thoughts, the creation of new ideas and the rewiring of old ones. This process is difficult to provoke and requires the student to work hard at this. It is suggested that a good instructor can help with the process of conceptual change. But his task goes beyond clearly explaining the new theory; ideally he plays the role of a facilitator. He might confront the student with the problem (so that the student becomes dissatisfied with his prior belief), prompt the student to not only to regurgitate the new theory but also explain it in his own words and provide further examples of where to apply the new theory. Throughout this process, a good instructor would also be understanding and supportive to the student and challenge the student at the right moment (Zirbel, 2008).

2.4.3 Concept Teaching

It is generally accepted that students do not enter the classroom as a "blank slate". When students enter into the classroom, they have already formed ideas on many topics and interpret the world around themselves and have their own individual present knowledge, beliefs and ways of thinking (Zirbel, 2008).

Concept teaching models have been developed primarily to teach key concepts that serve as foundations for student higher-level thinking and to provide a basis for mutual understanding and communication. Such models are not designed to teach large amounts of information to students. However, by learning and applying key concepts within a given subject, students are able to transfer specific learning to more general areas. In fact, without mutual understanding of certain key concepts, content learning in some subject areas is nearly impossible (Arends, 2007).

The main purpose of concept teaching is to learn new concepts. The learning of concepts and the development of higher level thinking skills of students including inductive reasoning, hypothesis formation, logical reasoning and concept building strategies are based on concept teaching. Concepts serve as the foundation for knowledge, increase complex conceptual understanding and facilitate social communication. In concept teaching, teacher- directed activities are used to construct, refine and apply the concepts by which students learn to classify, recognize members of a class, identify critical and non-critical attributes and define and label particular concepts (Instructional Strategies, 2002).

Another important aspect underlying concept teaching comes from the field of human development. The way concepts are learned is affected by the learner's age, language development and level of intellectual development (Arends, 2007).

Concept teaching approaches are process oriented which aimed at teaching students to think questions and discover rather than to solely memorize by encouraging their inductive thinking so as the students move from particular facts to generalization. Appropriate and solid concepts are constructed through the inventive act of concept formation (Saskatchewan Learning, n.d.).

Teaching for conceptual change is not an easy process. It is more time-consuming than traditional teaching methods. It requires a supportive classroom environment in which students feel confident in expressing and discussing their ideas. The possession of well-developed facilitation skills and a thorough understanding of the topic is the basic requirement of the teachers of conceptual change instruction (Davis, 2001).

Conceptual change learning results in better conceptual understanding by the students. Consistent evaluation and clarification of conceptions helps students develop metaconceptual awareness; that is, they come to understand how they develop their beliefs. The unique features of conceptual change instruction are that;

1. students make their conceptions explicit so that they become aware of their own ideas and thinking; and,

2. that students are constantly engaged in evaluating and revising their conceptions.

The goal of teaching for conceptual change is for students to adopt more fruitful conceptions while discarding the misconceptions they bring to the learning environment. Students are more likely to rid themselves of conceptions that they have evaluated than those that they have not examined at all (Davis, 2001).

The concept teaching tests the students' understanding of the concept and its attributes. A concept lesson concludes with the teacher asking students to analyze their thinking patterns, strategies and decisions in order to develop more effective thinking skills and to help students integrate the new concepts into existing knowledge (Instructional Strategies, 2002).

Tennyson and Cocchiarella (1986) suggested a model for concept teaching that has three stages: establishing a connection in memory between the concept to be learned and existing knowledge; improving the formation of concepts in terms of relations; and facilitating the development of classification rules. The declarative and procedural aspects of cognition are acknowledged by this method.

On a practical level, Posner *et al.* (1982) (as cited in Suping, 2003) listed four conditions that foster accommodation in student thinking:

1. There must be dissatisfaction with existing conceptions
2. A new conception must be intelligible
3. A new conception must appear initially plausible
4. A new concept should suggest the possibility of a fruitful research program.

Teachers who give consideration to these four conditions are encouraged to take deliberate steps to create classroom interactions that produce these conditions. Students organize their lives around views that they hold about phenomena, so some conceptual changes that teachers want to change may be highly resistant to change and potentially threatening to students. To become more effective in nurturing conceptual change, teachers should seek to understand students' preconceptions (Suping, 2003).

2.4.4 Concept Formation

Concept teaching involves the process of constructing knowledge and organizing information into comprehensive and complex cognitive structure. The term concept formation or concept learning is generally used by psychologists for the development of the ability to respond to common features of objects, events or ideas that have a common set of features (Edutechwiki, n.d.).

Ausubel (1968) states that concept formation is characteristic of the pre-school child's inductive and spontaneous (untutored) acquisition of generic ideas from concrete-empirical experience. It is a type of discovery learning involving, at-least in primitive form, such underlying psychology processes as discriminative analysis, abstraction, differentiation, hypothesis generation and testing, and generalization. Thus, in concept formation, the learner discovers relationships (the similarities within a class of objects) and gradually obtains a working concept through experience within the classroom or in real life situations (Thornburg, 1973).

Concept formation is the process of integrating features to form ideas by the recognition that some objects or events belong together while others do not. Once the objects or events have been grouped according to a particular categorization scheme, a label is given to the group. The end result of concept formation activities is the connections among the common characteristics of a concept (Saskatchewan Learning, n.d.).

The main concern of concept formation is stimulation, direction and guidance. It places more emphasis on thinking and less upon memorizing, more on understanding and less on merely accumulating facts and more on learning through genuine interest and less on learning through coercion (Edutechwiki, n.d.).

In concept formation, students are provided with data about a particular concept and they are encouraged to classify the data. This data may be generated by the teacher or by the students themselves.

In concept formation, opportunities are provided to the students to explore new ideas by making connections and see relationships between different types of information. This model develops and refines the students' abilities to recall and differentiate key ideas, see common characteristics and identify relationships, formulate concepts and generalizations, explain how they organize data and present evidence to support their organization of the data (Saskatoon Public Schools, n.d.).

Concept formation lessons are highly motivational because opportunities are provided to the students to participate actively in independent learning. In addition, the thinking process helps them to create new and expanded meanings of the world as they organize and manipulate information from other lessons in new ways (Saskatoon Public Schools, n.d.).

The process of concept formation cannot be merely reduced to associations, attention, conception, judgments and determining tendencies, even though all these functions are indispensable for this synthesis. The most essential feature of this process is the functional use of signs or words that directs students' activity for solving the problems (Saskatoon Public Schools, n.d.).

Concept formation teaching model is helpful for the development of conceptual thinking by enabling students to select and organize diverse material. It provides an opportunity to analyse each experience and to enhance students' understanding of the concepts they form and acquire (Saskatchewan Learning, n.d.).

Two essential tools are required to complete the concept formation. Definition is the first tool for specification of important characteristics of the concept and this is the basis of integration. It also specifies the method of differentiation, which means that everything is not encompassed by the concept. The word is the second tool which is a cognitive trigger for the concept by which the concept is stored and referenced later (Saskatoon Public Schools, n.d.).

There are numerous approaches to form concepts but only one direct teaching approach has been selected for this study.

2.5 DIRECT TEACHING AND CONCEPT FORMATION

Direct teaching is also known as Explicit Teaching. It is a systematic method which is based on the presentation of material in small steps and checking the students' understanding through active and successful participation of all students (Conway, 1997).

Direct instruction focuses on both "what" to teach (i.e., the design of the curriculum) and "how" to teach (i.e., specific teaching techniques). Specifically, it refers to teaching behaviours and organizational factors (i.e., the "how" to teach) that are associated with positive student learning outcomes (Gagnon and Maccini, 2007).

For imparting basic knowledge or developing skills in a goal-directed and teacher-controlled environment, direct instruction is used. The teacher identifies clearly defined objectives, transfers new information or demonstrates a skill and provides guided practice. In direct instruction, maximum academic learning time is utilized through a highly structured environment in which students are "on task" and experience high degrees of success. Direct instruction can be used effectively to promote acquisition of well structured knowledge in a step-by-step fashion. The responsibility of students' learning rests on the teacher's design and delivery of instruction (Texas Statewide Leadership for Austin, 2009).

Direct teaching is a tool to form sound concepts. With direct teaching, teachers carefully explain what teachers must do to accomplish a task and then present a carefully structured lesson that is usually broken down into small, manageable steps.

Direct teaching emphasizes the importance of a structured lesson in which presentation of new information is followed by student practice and teacher feedback. In it, the teacher acts as the strong leader structures the classroom and sequences subject matter to achieve the pre-determined goals (Sadker and Sadker, 2003).

Direct instruction is a highly structured approach to teaching procedural skills, characterized by teacher modeling and student practice. Direct instruction is particularly effective for teaching procedural skills, which are forms of content that have three essential characteristics

1. They have a specific set of identifiable operations or procedures;
2. They can be illustrated with a large and varied number of examples; and
3. They are developed through practice (Eggen and Kauchak, 1997).

The direct instruction approach includes:

1. Use explicit, systematic instruction based on scripted lesson plans.
2. Emphasize pace and efficiency of instruction.
3. Use simple instructions to ensure clear communication.

4. Conduct frequent assessments to help place students in ability groups and identify students who require additional intervention (Texas Statewide Leadership for Austin, 2009).

Rosenshine and his colleagues (Rosenshine, 1988; Rosenshine and Steven, 1986) have identified six teaching functions based on the research on effective instruction (Woolfolk, 1998).

Sadker and Sadker (2003) explain that direct instruction is based on daily review (review of prior learning, the teacher focus on assigned homework, clarify points of confusion, provide extra practice), presentation of new material in a clear manner (begins from objectives, divide new information into smaller bits, illustrate main points), guided practice (students use new skills under direct teacher supervision), specific feedback (appraise correct answers, correct inaccurate responses immediately), independent practice (provide opportunities for students till responses are approximately 95 percent accurate), weekly and monthly reviews (provide opportunities for more practice).

1. Daily Review. At the beginning of the lesson, teachers review prior learning. Teachers focus on assigned homework, clarify points of confusion and provide extra practice for facts and skills that need more attention (Sadker and Sadker, 2003). The review acts as an informal assessment to check whether students have the necessary prerequisite skills or if re-teaching of the content is required prior to the teaching of new lesson (Gagnon and Maccini, 2007).

2. New Material. Teachers begin by giving information to the students about objectives to be attained. New information is broken down into smaller bits and is covered at a brisk pace. Teachers illustrate main points with concrete examples. Teachers ask questions frequently to check for students understanding and make sure that students are ready for independent work using new skills and knowledge (Sadker and Sadker, 2003).

3. Guided Practice. Students use new skills and knowledge under direct teacher supervision. Teachers ask many questions from subject matter. Teachers check student responses for understanding, offering prompts and providing corrective feedback. Guided practice continues until students answer with approximately 70 to 80 percent accuracy (Sadker and Sadker, 2003). The teacher uses the initial practice by walking the students through, step-by-step and giving feedback on their responses, then the teacher moves to guided practice in which students work independently under the supervision of teacher. Individual feedback is also given where needed. In it, teachers' questioning, assessment of independent work and quiz and observation of a live performance may also be appropriate. Specific feedback is given as soon as possible after practice that focused only on desired behaviour.

4. Specific Feedback. Correct answers to questions are praised clearly, so that students will understand when their work is accurate. Teachers correct inaccurate responses immediately, before errors become habitual (Sadker and Sadker, 2003). Corrective feedback is provided immediately to reduce student errors.

5. Independent Practice. The teacher monitors the students' performance and provides additional explanations or re-teaching as needed. Prior to performing the task with a higher level of accuracy and speed, students performed the task slowly with some errors (Gagnon and Maccini, 2007). Independent practice continues until responses are assured, quick and at a level of approximately 95 percent accuracy (Sadker and Sadker, 2003).

6. Weekly and Monthly Reviews. Weekly and monthly reviews are important for addressing maintenance of skills and for determining if re-teaching is necessary. It is recommended that teachers provide frequent reviews for assessing the adequacy of the pace of instruction (i.e., too fast or slow) (Gagnon and Maccini, 2007). Regular reviews offer students the opportunity for more practice, a strategy related to high achievement. Direct teaching

recommends a weekly review every Monday, with a monthly review every fourth Monday (Sadker and Sadker, 2003).

Arends (2007) says that direct teaching is specifically designed to promote student learning of well-structured factual knowledge that can be taught in a step by step fashion and to help students master the procedural knowledge required to perform simple and complex skill.

Direct teaching is a systematic instructional method that requires a masterful command of the subject by knowing more than the facts about content. Direct teaching is a systematic way of planning, communicating and delivering in the classroom. One does not become proficient at this, or any skill without practice and relevant feedback.

Direct teaching is particularly helpful for imparting new and complex information in small bits. It works well for development of concepts in more clear and easy way. The highly structured learning environment is set by the teacher in which students are careful listeners and keen observers.

2.6 Principles of Concept Formation

Principles of concept formation teaching model are:

1. Use of Advance Organizer
2. Use of Guided Discovery
3. Use of Elaboration
4. Use of Guided Practice
5. Use of Inductive Reasoning
6. Use of Deductive Reasoning (Huitt, 2003)
7. Use of Experiential Learning

2.6.1 Use of Advance Organizer

David Ausubel introduced advance organizers. He describes them as something to be used in advance of learning itself that enhances the organizational strength of the cognitive structure (Phoenix, 2006). It is a method of bridging and linking old information with something new. An advance organizer is information presented prior to learning and used by the learner to organize and interpret new incoming information (Mayer, 2003).

An advance organizer is an introductory statement of a relationship to encompass all the information that will follow (Woolfolk, 1998).

The advance organizers are organizational frameworks presented in advance of lessons that emphasize the essential ideas in a lesson or unit. They focus student attention on the topic and help them draw connections between what they already know and the new knowledge to be learned (Hill and Flynn, 2001).

The teachers can use advance organizers as a tool to convey large amount of meaningful material in an efficient manner. This is a bridge technique that utilizes the student's prior knowledge to introduce a new concept. The strength of advance organizers is that they give a preview of what is to come. The big picture is presented before details are explored. The student then has a "hook" upon which to hang new concepts. A structure is also established to show how ideas and concepts fit together (Phoenix, 2006).

2.6.2 Use of Guided Discovery

The process in which teachers introduce new materials, explore centers or areas of the classroom and prepare children for various aspects of the curriculum is guided discovery. In this process, an opportunity is given to children in whom they creatively and actively engage with the new tool or area, ask questions and practice making appropriate choices with regard to the focus of the discovery. True excitement is generated when children have a safe environment to explore. It is based on the premise that we should not take for granted that children will automatically know how to use things right away (Reynolds and Richardson, 2007).

By this, students personalize the concepts under study; create an understanding that cannot be matched by other method of instruction. The teacher must guide the students toward the discovery by providing appropriate materials, conducive environment and allotting time for students to discover (Labush, 2005). It is a whole-class lesson where controlling and coordinating the learning experience is in the hands of teachers. In the presentation portion of the lesson, the teacher provides something for students to examine and guide students to discover details through the use of guiding questions and instruction.

2.6.3 Use of Elaboration

Elaboration is the process of increasing the number of associations in information (it makes information more meaningful) either by forming additional links in existing knowledge or by adding new knowledge (Eggen and Kauchak, 1997).

Elaboration is the addition of meaning to new information through its connection with already existing knowledge (Woolfolk, 1998). It is a process whereby the learner expands upon the information given to them during a lecture, reading assignment etc. It is an act of empowerment, addition of extra material, refinement and expansion of previous knowledge.

Elaboration is the process of adding details or information in order to be more specific. It enhances the ideas and concepts by providing more detail. The additional detail and clarity improves interest in, and understanding of, the topic (Henkel, 2002).

deductive reasoning, a child is able to get more perfect comprehension of principles or generalizations.

2.6.7 Use of Experiential Learning

The experiential learning is based on the notion that understanding is not a fixed or unchangeable element of thought but is formed and re-formed through experiences (Fry, Ketteridge and Marshal, 2004).

The experiential learning is inductive, learner centred and activity oriented. Personalized reflection about an experience and the formulation of plans to apply that learned concepts to other contexts are critical factors in effective experiential learning (Saskatoon Public Schools, n.d.).

The learning based on experiences that students acquire during the lesson is experiential learning.

2.7 LATEST RESEARCH STUDIES IN THE AREA

2.7.1 Latest Research Studies in other Countries

Experimental results have shown that concept formation is not the same thing as the development of any other habit.

Pallrand (1996) conducted a research to find out the relationship of assessment to knowledge development in science education. According to his findings, through examining students' performance, the teacher can gain insight into many aspects of the ways students seek and analyze information as well as the weak areas in their knowledge structure and misunderstandings. In short, continuous assessment and providing detailed performance feedback is necessary for students to improve their understandings and learning.

Carey (2000) wrote an article on science education as conceptual change. The respective literature on science and math learning provide many detailed analyses of the alternative conceptual frameworks that students bring to the classroom and of the conceptual changes necessary for students to learn the concepts that are the targets of instruction. This paper showed that, for the average student, the conceptual change approaches was proved to be successful for the formation of scientific concepts.

Unlu (2000) conducted a research to investigate the effectiveness of conceptual change approach on students' achievement of atom, molecule and matter concepts. The results findings indicated that treatment was effective alone in increasing students' achievement, gender differences found as not effective in changing students' attitudes toward science significantly.

Mikkila-Erdmann (2001) proposed a study to investigate the effect of text design on 5th grade learners' comprehension of photosynthesis. The study was theoretically motivated by the recent research on conceptual change and on text comprehension. Children who studied the conceptual change text design performed statistically better than the traditional text group on questions which demanded construction of an adequate mental model of photosynthesis.

Alibali, Johnson and Siegler (2001), developed a relationship between conceptual understanding and procedural skill in mathematics. The results proved that the relation of conceptual and procedural knowledge is very strong and improved problem representation is one mechanism in this process.

Marsh, Kong and Hau made an extension of internal/external frame of reference model of self-concept formation (2001) that showed subject achievement had a positive effect on subject self-concept but negative effects on other subjects.

The study was conducted by Sungur, Tekkaya and Geban (2001) to investigate the contribution of conceptual change texts accompanied by concept mapping instruction to 10th-grade students' understanding of the human circulatory system. It was found that the conceptual change texts accompanied by concept mapping instruction produced a positive effect on students' understanding of concepts.

Hewson and Hewson (2003) wrote an article on effect of instruction using students' prior knowledge and conceptual change strategies on science learning. This study was concerned primarily with students' alternative conceptions and with instructional strategies to effect the learning of scientific conceptions; i.e., to effect conceptual change from alternative to scientific conceptions. The results showed a significantly larger improvement in the acquisition of scientific conceptions as a result of the instructional strategy and materials which explicitly dealt with student alternative conceptions.

Smagorinsky, Cook and Johnson (2003) conducted a research on twisting path of concept development in learning to teach. They found that teacher educators should strive to teach concepts to any subject in the twisting path of concept development.

Hayes, Goodhew, Heit and Gillan (2003) presented an article on the role of diverse instruction in conceptual change. They examined how a fundamental principle of induction and scientific reasoning, information diversity could be used to promote change in children's mental models of the earth's shape. The findings showed that instruction that challenges diverse aspects of children's naive scientific beliefs is more likely to produce conceptual change.

Oliveira (2004) conducted a research on critical thinking as a strategy to promote conceptual change and to enhance better physics problem solvers. To enlighten the relation between problem solving, critical thinking and conceptual change, this study was outlined to find out if enhancing conceptual change by developing critical thinking can be a strategy to promote better physics problem solvers. The results seemed to point out that the teacher's practices promoters of conceptual change by being facilitators of the development of critical thinking seem to be important factors that can influence if a pupil is a good or a week problem solver.

Gulcan, Hamide and Geban (2004) investigated the effectiveness of conceptual change texts oriented instruction accompanied by demonstrations in small groups on students' ecology achievement and attitude towards biology. The results revealed that the conceptual change approach oriented instruction made a statistically significant difference between experimental and controlled groups in students' ecology achievement in favor of experimental group, although there was no statistically significant mean difference between experimental and controlled groups in students' attitude towards biology.

A research on analysis of undergraduate students' misconceptions related to phase equilibrium in Chemistry was conducted by Azizoglu in 2004. She stated that more meaningful learning occurs if students are asked to think about appropriate questions for a given situation and explain the relationships involved. She also stated that better acquisition of concepts can be because of continuous process of exchange and differentiation of the existing concepts and integration of these concepts with the new concepts.

Snead and Snead (2004) examined the effect of concept mapping on the science achievement of middle grade science students. The results showed that the effect of concept mapping on science achievement is not clear but that lower ability students appeared to have better success with concept mapping than higher ability students.

Jackson, Porter and Kanjanapongpaisal (2004) presented a paper on creating conceptual change using web quests and inspiration. They argued that conceptual change is a process necessary for modifying misconceptions into correct, scientific concepts. This paper was a review of conceptual change literature designed to iterate the importance of addressing conceptual change in instruction. Basic cognitive processes begin at an early age through one's environment and experiences. These schemata are the foundations from which all new knowledge will be assimilated. During the process of growth and knowledge acquisition, there is the potential for misconceptions. Unless identified and either extinguished or restructured, the misconceptions become increasingly embedded into the cognitive structures of the brain and, thus, become more difficult to correct. The existence of misconceptions interferes with the procurement of new knowledge and impedes learning. They explained possible causes of misconceptions, characteristics of misconceptions, the conditions that bring about conceptual change and instructional strategies that facilitate conceptual change.

Nersessian (2004) presented a paper on conceptual change in science and science education. There is substantial evidence that traditional instructional methods are not conducive to restructure students' conceptions. This paper argued that the nature of the changes and the kinds of reasoning required for conceptual restructuring of a domain are fundamentally the same in the discovery and in the learning processes.

Yavuz (2005) conducted a research on effectiveness of conceptual change instruction accompanied with demonstrations and computer assisted concept mapping on students' understanding of matter concepts. The results indicated that conceptual change instruction accompanied with demonstration and computer assisted concept mapping caused a better acquisition of scientific conceptions related to matter concepts and produced more positive attitude toward science as a school subject than traditionally designed science instruction. The results also proved that there was no significant effect of gender difference on students' understanding of matter concept and their attitudes toward science as a school subject.

Cetingul and Geban (2005) conducted a research on understanding of acid-base concept by using conceptual change approach. This study explored changes of the tenth-grade students' conceptions about acids and bases by using conceptual change text oriented instruction accompanied with analogies. Since conceptual change is viewed not only as a process of replacement of old concepts but also a process of learning to relate ideas to appropriate contexts. The instruction and conceptual change text were designed to convince the students that some situations which they understand are actually analogous to other situations which they misunderstand. The results of the study showed that students in experimental group taking conceptual change oriented instruction performed much better than the students in controlled group taking traditional instruction. Thus, one could deduce that establishing analogical thinking during the course of instruction together with a conceptual change text could be a powerful tool for generating an understanding of unknown and misunderstood situations as in the case of acids and bases concept.

The two working groups of University of Haifa and the Max Planck Institute, Berlin (2006) conducted a research on generating experimental knowledge: experimental systems concept formation and the pivotal role of error for developing a broader understanding of how knowledge is gained, shifted and revised. They explored the links and dynamics between these three focal issues in 2007.

Onder and Geban (2006) presented a study that aimed to investigate the effect of conceptual change texts oriented instruction on 10th grade students' understanding of solubility equilibrium concept. The results of the study showed that instruction based on conceptual change approach where conceptual change texts were used was better than the instruction based on traditional methods on remediation of misconceptions and promoting students' understanding of solubility equilibrium concepts.

Lattery and Hewson in 2006 presented a proposal on teaching and learning for conceptual change in Physics education. The results showed that conceptual change can produce a decisive transformation in our image of how science should be learned and taught.

Rethinking concept formation for cognitive agents (Bisbey and Trajkovski, 2006) showed that object, entity, event or word has an effect on concept formation.

The experimental results on joint concept formation (Huan and Wen, 2006) proved that joint system is generalized system of the disjoint system and improves the learning performance in computer.

Lengnink (2006) proposed reflected acting in mathematical learning processes. This is an approach to mathematical concepts from the angle of hands-on activity. Teaching mathematics following this approach contributes in the development of decision-making and capabilities of learners.

Baser (2006) conducted a study on fostering conceptual change by cognitive conflict based instruction on students' understanding of heat and temperature concept. The purpose of this study was to investigate the effectiveness of cognitive conflict based physics instruction over traditionally designed physics instruction on pre-service primary school teachers at grade 2. Results showed that scores of students in experimental group was significantly higher than those of controlled group. Interaction between gender difference and treatment did not make a significant contribution to the variation in achievement.

Ravenscroft (2007) wrote an article on promoting thinking and conceptual change with digital dialogue games. This paper presented a review of design-based research conducted over the past 10 years that has modelled and promoted students' reasoning, conceptual change and argumentative dialogue processes and practices through designing a number of digital dialogue games. This work emphasized an inclusive and personalized approach to learning dialogue that stimulates reasoning, collaborative thinking and the development of argumentative dialogue practices. This is arguably relevant to most learning contexts and especially to contemporary science education.

A qualitative study addressed the effect of concept mapping on the searching behavior of tenth-grade students engaged in research projects based on their instruction in a classroom-based genetics unit proposed by Gardon (2007). Quantitative data verified mappers were more thorough and efficient.

Atilla (2007) presented a paper on effective teaching in Science. She identified six main principles of effective teaching in Science i.e. dealing with students' existing ideas and conceptions, encouraging students to apply new concepts or skills into different contexts, encouraging student participation in lessons, encouraging student inquiry, encouraging cooperative learning among students and offering continuous assessment and providing corrective feedback. She argued that knowledge about effective teaching from both teachers' and students' perspective will give opportunities for student teachers to construct their own knowledge and understanding of effective teaching and develop their own theories of teaching and learning.

Cross domain mathematical concept formation (Steel, Colton, Bundy and Walsh, 2007) is facilitated by the generalization of the data structures and heuristic measures employed by the program and the implementation of a new productive rule. The results explored that an effective automated mathematical discovery package should have the ability to form cross-domain concept and therefore be able to provide the inspiration for such creative steps.

A paper on conceptual change and education was presented by Vosniadou (2007). He argued that in order to understand the advanced, scientific concepts of the various disciplines, students cannot rely on the simple memorization of facts. They must learn how to restructure their naive, intuitive theories based on everyday experience. In other words, they must undergo profound conceptual change. This type of conceptual change cannot be achieved without systematic instruction that takes into consideration both individual, constructivist and socio-cultural factors. Teachers must find ways to enhance individual students' motivation by creating a social classroom environment that supports the creation of intentional learners who can engage in the deep and enduring comprehension activities required for the revision of conceptual knowledge.

Planinic, Krsnik, Pecina and Susac (2008) did a research on overview and comparison of basic teaching techniques that promote conceptual change in students. They argued that for meaningful learning of physics, it is necessary that teachers address students' alternative conceptions during teaching and help students overcome their conceptual difficulties. In other words, teaching should induce conceptual change in students.

Canpolat, Pınarba, Bayrakeken and Geban conducted a research in 2009 on the conceptual change approach to teaching chemical equilibrium. This study investigated the effect of a conceptual change approach over traditional instruction on students' understanding of chemical equilibrium concepts. It was found that students' science process skills made a statistically significant contribution to the variation in students' understanding of chemical equilibrium concepts.

Ozmen, Demircioglu and Demircioglu (2009) presented an article to determine the effect of conceptual change texts accompanied with computer animations on 11th grade students' understanding and alternative conceptions related to chemical bonding. Based on the study, it is concluded that conceptual change texts combined with computer animations can be effective instructional tools to improve students' conceptual understanding of chemical concepts.

2.7.2 Latest Research Studies in Pakistan

Hussain in 2005 conducted an experimental study of teaching English through direct and traditional methods at secondary level. His findings indicated that direct teaching was found to be more effective as teaching-learning technique for the clarification of concepts in English as compared to traditional method of teaching. Students in the direct teaching method outscored than students working in traditional learning situation.

Pardhan and Muhammad presented a paper in 2005 on teaching science and mathematics for conceptual understanding? A rising issue. In this paper, they argued about the need of sound subject matter knowledge of mathematics/science teachers to empower them to be more successful in implementing innovative teaching. Teachers can not teach successfully with their limited understanding of mathematics/science subjects and mathematics/science teaching. They need to develop their own conceptual understanding first before they can make sense of their students' thinking, handle their answers effectively and promote conceptual understanding.

The results of Salami (2007) indicated that students in the PSI (personalized system of instruction) group had more significant improvement in their academic performance in Chemistry than those taught with conventional method. Also there was no significant interaction of treatment and gender on the dependent measure.

Chemistry is introduced as an independent discipline beginning in Class IX. Prior to this, some of its basic elements are incorporated in the component of science taught at the lower stages. The curriculum in vogue at Class IX to X has been formed in continuity of the scope and content of the science curriculum from Class I through VIII. Zaidi and Rahman (2008) presented a paper on the topic chemical education in Pakistan. According to them, Chemistry has been allowed 4 periods of 40 minutes in the scheme of studies. Computing on the bases of an average of 8 months working session in a year, nearly 128 teaching periods are available for the teaching of Chemistry. They said that recently, the Government of Pakistan put emphasis on conceptual teaching. Importance has been laid on problem-solving and building up the concepts governing complex skills. The curriculum has been so developed to emphasis concept formation rather than overload the students with unnecessary and often unrelated facts.

More research work is needed in order to investigate the effect of concept formation teaching model on the achievement in specific subjects among the students of different levels.

CHAPTER 3

METHODS AND PROCEDURE OF RESEARCH

The study was designed to check the existing level of understanding of concepts in the subject of Chemistry among Class IX students and to investigate the effectiveness of "Concept Formation Teaching Model" over traditional method on Class IX students' achievement. The procedure of the study is as under:

3.1 POPULATION OF THE STUDY

The target population of the study consisted of an estimated number of 4530 students of Class IX studying Chemistry as a subject in the Government High Schools of Rawalpindi city. The population of Government Girls High Schools of Rawalpindi city was 1514 in 38 schools. 3016 students of Class IX were studying Chemistry as a subject in 48 Government Boys High Schools of Rawalpindi city. These students belonged to different social strata, possessed different intelligence, educational background and diverse abilities and motivation.

3.2 SAMPLE OF THE STUDY

The following two samples were selected for study:

1. **Sample for Existing Level of Students of Nine Selected Schools**

In order to evaluate the existing level of understanding of the concepts in the subject of Chemistry among Class IX students, five schools from boys and four schools from girls Government High Schools of Rawalpindi city were selected randomly. The names of selected Government High Schools for Boys and Girls of Rawalpindi city are given in Appendix A. The researcher randomly selected one section of Class IX from each school. Nine schools made a total sample size of 460 students. These students were tested for their concepts in Chemistry.

2. Sample for Experiment

In part II of the study, an experiment was conducted on teaching Chemistry to Class IX students using the concept formation teaching model. Principals of School I, School II and School III had permitted the researcher to conduct her research in their schools for three months. The students of these schools represent the population of typical Government High Schools of Pakistan i.e. large classes, spacious rooms, congenial atmosphere and learners having different socio-economic status, different educational background, intelligence, abilities and motivational level. One section of Class IX from each school was randomly selected. Thus three schools were selected for experiment.

A sample of 290 students of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject were selected for experiment. Out of 290 students of these three selected schools, 143 students of experimental groups were taught through concept formation teaching model and 147 students of controlled groups were taught through traditional method.

In order to evaluate the existing level of understanding of the concepts in the subject of Chemistry among Class IX students and to conduct experiment, the total sample of selected Government High Schools for Boys and Girls of Rawalpindi is given below:

Table 1

<table>
<tr><td colspan="4">Sample Distribution</td><td>Total Sample</td></tr>
<tr><td rowspan="2">1</td><td colspan="3">For checking existing level of students of nine selected Government High Schools for boys and girls of Rawalpindi city (Appendix A)</td><td rowspan="2">460</td></tr>
<tr><td colspan="3">Random selection of nine schools and sections</td></tr>
<tr><td rowspan="6">2</td><td colspan="3">For conducting experiment</td><td rowspan="6"></td></tr>
<tr><td rowspan="2">Schools</td><td colspan="2">Groups</td></tr>
<tr><td>Experimental Group</td><td>Controlled Group</td></tr>
<tr><td>School I</td><td>53</td><td>55</td></tr>
<tr><td>School II</td><td>48</td><td>50</td></tr>
<tr><td>School III</td><td>42</td><td>42</td></tr>
<tr><td></td><td>Total</td><td>143</td><td>147</td><td>290</td></tr>
</table>

3.3 DESIGN OF THE STUDY

The design of the study was the "Pretest-Posttest Nonequivalent-Groups Design". This design was schematically described as below:

O_1 E O_2

O_3 C O_4 (Best and Kahn, 1993)

In the above design, O_1 was the observation of experimental groups before teaching by administering pre-test. E represented the experimental group that was taught by concept formation teaching model. O_2 was the observation of experimental group after teaching by administering post-test. O_3 was the observation of controlled group before teaching by administering pre-test. C represented the controlled group that was taught by traditional method. O_4 was the observation of controlled group after teaching by administering post-test.

The above design was selected due to the nature of the study and the study hypothesis. For the study, this design may be the only feasible one because the classes were used "as is", so possible effects from reactive arrangement were minimized. The study was conducted in the natural settings of the schools.

The study design consisted of two groups: namely experimental and controlled group. A pre-test was administered to experimental and controlled groups before teaching. The experimental groups were taught through concept formation teaching model and controlled groups were taught through traditional method.

After exposing the experimental groups with the concept formation teaching model and controlled groups with the traditional method, a post-test was administered.

The difference between the mean of the pre-tests scores and post-tests scores of experimental and controlled groups was tested for statistical significance. The research hypothesis was tested at a significance level of .05. The statistical difference between the post-test of experimental and controlled groups was associated to the effectiveness of concept formation teaching model.

3.4 RESEARCH INSTRUMENTS

3.4.1 Validity of the Test

Two achievement tests were developed by the researcher to collect data for addressing research hypotheses. The researcher constructed these achievement tests after a thorough review of the techniques of test construction. One achievement test was developed to check the existing level of understanding of concepts in the subject of Chemistry among Class IX students for measuring the knowledge, comprehension and application level. It contained 100 multiple-choice items. 25 items were selected from chapter No. 6 to 8 of Class VI of General Science, chapter No. 5 to 8 of Class VII of General Science, chapter No. 6 to 9 of Class VIII of General Science and chapter No. 1 of the Chemistry textbook for Class IX published by the Punjab Textbook Board.

A pre-test was developed to check the effects of teaching Chemistry through concept formation teaching model for measuring the knowledge, comprehension and application level of Class IX students. It also contained 100 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX published by the Punjab Textbook Board. 25 items were selected from each chapter.

Multiple-choice items are the most widely used to assess many complex learning outcomes i.e. knowledge, comprehension and application level of students. They reduce the effect of guessing because there are four to five choices so reliability of each item is increased (A. I. O. U., 2002).

For content validity of these two tests, the tables of specification were made to measure the knowledge, comprehension and application level of Class IX students. These two tests were examined by experts of Chemistry subject and Education subject to check the appropriateness of items (Appendix H).

3.4.2 Pilot Testing

Before the collection of the data for the study, try-out of the study was conducted. In order to measure the existing level of understanding of concepts of the students in the subject of Chemistry among Class IX students, the sample of the try-out was 30 students of Government Johar Memorial Girls High School Rawalpindi.

A pre-test was administered to 30 students of Class IX of Government Islamia Boys High School No. 2 Rawalpindi to check the effects of teaching Chemistry by concept formation teaching model and traditional method on students' achievement. All students completed the tests within the stipulated period of time. Tests were improved after try-out by using item analysis. Kuder–Richardson formula was used to test the reliability of whole test. Too easy and too difficult items were discarded on the basis of the results of the tests. Government Johar Memorial Girls High School Rawalpindi and Government Islamia Boys High School No. 2 Rawalpindi were not included in the final sample.

3.4.3 Reliability of the Test

For item analysis, following formulas were applied.

1. Difficulty Index (p)

$$p = \frac{\text{Number of students selecting correct answers}}{\text{Total number of students attempting the item}}$$ (Kubiszyn and Borich, 1996).

2. Discrimination Index (D)

$$D = \frac{(\text{Number who got item correct in upper group}) - (\text{Number who got item correct in lower group})}{\text{Number of students in either group}}$$

(Kubiszyn and Borich, 1996)

For selecting upper and lower groups, the cut off point was median.

After this, the achievement tests having 80 multiple choice items were prepared.

Rationale equivalence reliability was used to test the reliability of the whole test. The following Kuder - Richardson formula was used:

$$r_{totaltest} = \frac{(K)(SD^2) - \overline{X}(K - \overline{X})}{(SD^2)(K-1)}$$ (Gay, 2005)

Where

K = Number of items in the test

SD = Standard deviation of the scores

$\overline{X}$ = Mean of the scores

The reliability of the test that was used to measure the existing level of understanding of concepts of the students in the subject of Chemistry among Class IX students was found to be .87. The reliability of pre-test that was used to check the effects of teaching Chemistry by concept formation teaching model and traditional method on students' achievement was found to be .89.

3.4.4 Research Instruments

One achievement test was developed to check the existing level of understanding of concepts in the subject of Chemistry among Class IX students of Rawalpindi city. A pre-test was developed to check the effects of teaching Chemistry through "Concept Formation Teaching Model".

1. In order to measure the existing level of understanding of concepts of the sample students in the subject of Chemistry, an achievement test was designed. It contained 80 multiple-choice items. 18 items were selected from chapter No. 6 to 8 of Class VI of General Science; 20 items were selected from chapter No. 5 to 8 of Class VII of General Science; 15 items were

selected from chapter No. 6 to 8 and 7 items were selected from chapter No. 9 of Class VIII of General Science; and 20 items were selected from chapter No. 1 of Chemistry textbook for Class IX published by Punjab Textbook Board. So total 80 multiple choice items were prepared. The achievement test was designed to measure the knowledge, comprehension and application level of Class IX students in the subject of Chemistry (Appendix B). The achievement test was administered to 460 sample students of Class IX of nine selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject (Appendix C).

2. A pre-test was designed in the subject of Chemistry for measuring the knowledge, comprehension and application level of Class IX students. It contained 80 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX published by the Punjab Textbook Board (Appendix D). 20 items were selected from each chapter (Appendix E). The pre-test was administered to 143 sample students of experimental groups and 147 sample students of controlled groups making a total sample size of 290 students of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject (Appendix F).

This test was given to experimental and controlled groups as a pre-test to check the students' understanding of concepts at the beginning of instruction. It was also given to experimental and controlled groups as a post-test to compare the effects of teaching Chemistry through concept formation teaching model and traditional method on students' achievement.

In order to teach the experimental groups by concept formation teaching model, the lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX published by the Punjab Textbook Board were developed on the format of direct instruction prepared by McVittie (2002) (Appendix G). The lesson plans were checked and approved by the experts (Appendix H).

3.5 CONCEPT FORMATION TEACHING MODEL

Concept formation teaching model follows a definite structure with specific steps to guide students toward achieving clearly defined instructional objectives. This model aims at clarification of misconceptions and development of new concepts by active involvement of students in questioning, discussion and activity. This model is helpful in changing a student's conceptions into valid and concrete conceptions by adding new knowledge to what is already there. In this model, students use their existing knowledge to construct the new one when the new concept is intelligible (knowing what it means), plausible (believing it to be true) and fruitful (finding it useful). By this model, the students become able to construct and build their own concepts after removing the misconceptions.

Steps of Concept Formation Teaching Model

Steps of concept formation teaching model are as under:

3.5.1 Instructional Objectives

Objectives of lesson plan of concept formation teaching model are based on Taxonomy of Educational Objectives to check three levels of cognitive domain i.e. knowledge, comprehension and application. These instructional objectives are comprehensive, consistent, attainable, suitable to subject matter, valid, clearly stated, measurable and testable, guided to action and evaluate-able. The purpose of stating the objective is to set the students' expectations of what they will learn.

3.5.2 Previous Knowledge

The lesson is started with assessing the students' previous knowledge. It is checked by using some activity, reviewing previous work, conducting experiments, providing examples and questions by simple statements, moving around the room and voice inflation including a discussion about previously covered content. Connections are made between what is already known and what is to be learned. The purpose of assessing previous knowledge is to:

a) determine students' existing ideas and conceptions;
b) identify students' misconceptions;
c) take measures to correct the students' misconceptions;
d) construct new concepts on students' existing knowledge; and
e) link new concepts with previous knowledge.

Presentation

The following points are kept in mind for presentation:

Statements: Concepts and principles are explained with the help of easy, clear and meaningful words. These concepts and principles are given by using inter-related, relevant and continuous statements and appropriate vocabulary. Vague words or phrases are not used.

Use of Board: Good, legible, neat, appropriate and adequate words of the contents are written on the board.

Getting Student's Attention: Pupils' attention is secured and maintained by varying stimuli like gesture, movement, changing interacting styles, deliberate silence and non-verbal cues.

Students Participation: Pupils' participation is encouraged by verbal and non verbal reinforcers (positive reinforcement and negative reinforcement) and the discussion about students' prior conceptions. Students are encouraged to participate in the class room, respond to the questions, give their own ideas and react to other ideas.

Question Technique: Appropriate questions i.e. well structured and well-stated questions are asked from the students to foster their participation in the lesson. Critical awareness about the concepts and their attributes is brought out by probing questions i.e. prompting, seeking further information, refocusing and redirection.

Management of Classroom: During the lesson, the teacher recognizes both attending and non-attending behaviour of the pupil. For this, attending behaviour is rewarded and non-attending behaviour is eliminated by giving directions to the students. The teacher uses the pupils' feeling and ideas to recognize pupils' attending and non-attending behaviours.

Presentation is based on motivational set and body of the lesson.

a) Motivational Set

A lesson is presented when students are emotionally and mentally prepared to digest new information. It deals with student's existing ideas and conceptions. Information given by the students during discussion and questioning is summarized in an organized manner by using examples, appropriate devices, techniques or activities to link previous knowledge to current lesson.

b) Body of the Lesson

To link previous knowledge with existing one, an overview of the new concepts is given as advance organizers. Prior to teaching, a large amount of meaningful material is presented in an efficient manner to utilize the students' prior knowledge to introduce the new concepts. Concepts and principles are explained with the help of activity, experiment if required and possible, explaining links, discussion and appropriate examples (simple, relevant to the content and up to the interest and mental level of students) through appropriate media i.e. teaching aids and use of student's ideas or responses for furthering the lesson. In this phase, both inductive and deductive methods are used. Logical sequence of concepts and skills are presented in categories in an organised manner i.e. simple to complex. Students get opportunities to elaborate new information by connecting new information to something already known and by looking for similarities and differences among concepts (guided discovery). Important points are stated several times in different ways during the presentation of information. Opportunities are provided to the students for repetition of learning. Schedules are also made for periodic review of previously learned concepts and skills.

3.5.4 Closure/Conclusions

Main concepts of the lesson are consolidated at the end of the lesson by the students. With the discussion of the students, present lesson is linked with the previous lesson and also with the next lesson. Students are encouraged to develop the summary and explanation for constructing and applying concepts. Opportunities are also provided to the students for applying present knowledge in the classroom and at home. It is meant to remind students about what the goals for instruction was.

3.5.5 Generalization

Opportunities are provided for the establishment of certain formulas, principles or laws. Students are encouraged to draw the conclusions themselves. If students' generalization is incomplete or irrelevant, the teacher provides the guidance for clarifying the concepts.

3.5.6 Evaluation

Evaluation is done by checking pupils' progress towards the objectives of the lesson after regular intervals. The teacher diagnoses the pupils' difficulties in understanding a concept or a principle by step-by-step questioning and by under-taking suitable remedial measures. Teacher use specific corrective feedback as needed. Opportunities are provided to the students to repeat important concepts to evaluate students' mastery on that concept. Students are evaluated on specific concepts and their critical attributes, recognition about examples and non-examples, and evaluate example and non-example in terms of their critical attributes.

Home Task:

Regular, relevant, short, challenging and innovative task about the topic according to the mental and interest level of the students is given to the students by explaining the way of working.

Conceptual Framework of Concept Formation Teaching Model

1	Instructional Objectives ↓	Set expectations what students learn
2	Previous Knowledge ↓	Set the stage for new learning
3	Presentation ↓	Overview of new concepts in an efficient manner (Advance Organizer) Provide opportunities to examine and explore details (Guided Discovery) Add new knowledge (Elaboration) Provide opportunities to develop concepts (Guided Practice) Establish generalizations, principles and rules (Inductive Reasoning) Apply principles, rules and conclusion in new situation (Deductive Reasoning) Provide opportunities to learn by experiences (Experiential Learning)
4	Closure/Conclusion ↓	Highlight the main points to link present lesson with previous and next lesson
5	Generalization ↓	Guide students to establish formula, principle or law
6	Evaluation ↓	Check students' concept learning by using appropriate assessment techniques with regular intervals
7	Home Task	Assign home task by explaining the way of working

3.6 PROCEDURE OF THE STUDY

The researcher randomly selected one section of Class IX from each selected school as experimental group for teaching through Chemistry concept formation teaching model. The other section was the controlled group taught by the school's teacher. The experience and qualification of experimental and controlled groups' teachers was same i.e. 3-5 years, B. Sc. and B. Ed. The teachers of experimental and controlled groups taught simultaneously the same subject matter in the same period with same time duration i.e. 40 minutes according to the time table of the school. Training was given by the researcher to experimental groups' teachers for two weeks to teach Chemistry through concept formation teaching model. During the instruction, content of chapter No. 7 to 10 were covered as the part of the regular classroom curriculum.

At the beginning, a pre-test was administered on experimental and controlled groups to determine whether there was any difference between the two groups with respect to understanding of concepts of Chemistry prior to instruction. The study was conducted for three months. On the first day of experiment, the teacher conducted pre-test on experimental and controlled groups. On every Monday, the teacher took the test from the previously learned lessons. On every fourth Monday, the teacher took the monthly test in which all the course that was covered in the whole month were included. The reason of taking these weekly and monthly tests was that they were the part of direct instruction. On other five days of the week, students of experimental groups were taught regularly through concept formation teaching model.

At the end of the study, the same achievement test was re-administered as post-test to experimental and controlled groups to evaluate the effects of concept formation teaching model and traditional method on students' achievement.

In order to teach experimental groups by concept formation teaching model, the lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX published by the Punjab Textbook Board were developed on the format of direct instruction prepared by McVittie (2002).

The lesson plans of concept formation teaching model were based on instructional objectives to check knowledge, comprehension and application level of students. Previous knowledge was checked by activity, review of previous work, experiments, examples, questions and discussion about previously covered content. Lessons were presented when students were emotionally and mentally prepared to learn by checking students' existing ideas and conceptions during discussion and questioning. Information given by the students is summarized in an organized manner by using appropriate devices, techniques or activities to link previous knowledge to current lesson.

In presentation, concepts and principles were explained with the help of easy, clear and meaningful statements. Vague words or phrases were not used. Good, legible, neat, appropriate and adequate words were written on the board. Many stimuli like gesture, movement, changing interacting styles, deliberate silence and non-verbal cues were used to maintain the students' attention. Students were encouraged to participate in the class room, respond to the questions, give their own ideas and react to other ideas by verbal and non-verbal reinforcers. Well structured and well-stated questions were asked. Critical awareness about the concepts and their attributes was brought out by prompting, seeking further information, refocusing and redirection. For the management of the classroom, both attending and non-attending behaviour was recognized by the teacher. Attending behaviour was rewarded and non-attending behaviour was eliminated by giving directions to the students. Pupils' feeling and ideas were used to recognize pupils' attending and non-attending behaviours. To link previous knowledge with existing one, an overview of the new concepts is given as advance organizers. Prior to teaching, a large amount of meaningful material is presented in an efficient manner to utilize the students' prior knowledge to introduce the new concepts. Concepts and principles are explained by activity, experiment if required and possible, explaining links, discussion and appropriate examples that are simple, relevant to the content and up to the interest and mental level of students through teaching aids and students' ideas. Concepts and skills were presented in logical sequence. Opportunities were provided to elaborate new information by connecting new information with previous one and by looking for similarities and differences among concepts. Important points were repeated many times in different ways. Opportunities were also provided to the students for repetition of learning. For periodic review of previously learned concepts and skills, weekly and monthly tests were also scheduled. At the end of the lesson plan, regular, relevant, short, challenging and innovative tasks were given to the students according to their mental and interest level by explaining the way of working.

At the end of the lesson, conclusion was drawn to link present lesson with previous and next lesson with the help of discussion. Students are encouraged to develop the summary and explanation for constructing and applying concepts. Opportunities were provided to the students for applying present knowledge in the classroom and at home. Opportunities were also provided for establishing certain formulas, principles or laws. Encouragement was given to students to draw the conclusions themselves. In case, generalization was incomplete or irrelevant, guidance was provided by the teacher to clarify the concepts.

Objectives of the lesson were checked with regular intervals. The strategy of step-by-step questioning was used to diagnose the pupils' difficulties and suitable remedial measures were also under-taken to remove these difficulties. Specific corrective feedback was also provided by the teacher to check students' mastery. Opportunities were provided to repeat important concepts.

3.6.1 Description of Lesson Plans of Concept Formation Teaching Model and Traditional Method

In order to teach experimental and controlled groups by concept formation teaching model and traditional method respectively, the lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX published by the Punjab Textbook Board were developed. The lesson plans of concept formation teaching model were developed on the format of direct instruction prepared by McVittie (2002) and the lesson plans of traditional method were based on Herbartian steps of lesson planning (Yadav, 2007) (Appendix G).

For example, the lesson plan of concept formation teaching model on the topic "Basicity of an Acid, Acidity of a Base and Neutralization" was based on instructional objectives to check knowledge, comprehension and application level of students. The lesson plan of traditional method on the same topic was based on instructional objectives. But these instructional objectives focused only on knowledge to check the memorization of students.

Both the teachers (experimental and controlled groups) checked previous knowledge by questions. In the lesson of concept formation teaching model, previous knowledge was checked by experiments on ph paper performed by students to identify acids, strong acid, weak acid, base, strong base and weak base. Students' concepts were checked and clarified through discussion and questions. The teacher of controlled group checked previous knowledge by questions from selected students e.g. what is an acid? what is a base? and gave examples of acids and bases.

In experimental group, the lesson was presented when students were emotionally and mentally prepared to learn. Information given by the students during discussion and questioning is summarized in an organized manner with the help of examples from daily life to link previous knowledge with current lesson. The teacher of controlled group did not give examples.

In presentation part of concept formation teaching model, concepts and principles were explained with the help of easy, clear and meaningful statements. Vague words or phrases were not used. For presenting the contents, the teacher of controlled group used ready made statements from book directly.

Students' previous knowledge was linked with new concept of basicity of an acid, mono-basic and neutralization in advance of learning. The concept of heat of neutralization was presented by an experiment performed by students on dilute acid and dilute base. Students observed the chemical reaction and chemical and physical changes during this reaction (Advance Organizer). The concepts of di-basic, tri-basic, acidity of a base, mono-acidic, di-acidic and tri-acidic were given by inviting the students to write chemical equations on the board. Teacher guided the students to examine and discover details by questions e.g. to clarify the concepts of di-basic and tri-basic, teacher asked, "how many ionizable hydrogen (H^+) atoms are present in H_2SO_4 and H_3PO_4?" For concept of mono-acidic, di-acidic and tri-acidic, the teacher asked, "how many ionizable hydroxyl group/groups (OH^-) are present in NaOH, $Ca(OH)_2$ and $Fe(OH)_3$ (Guided Discovery). Concept of acetic acid was induced with the help of equation i.e. $CH_3COOH_{(aq)}+H_2O_{(l)}=H_3O^+_{(aq)}+CH_3COO^-_{(aq)}$ (Inductive Reasoning). The process of neutralization was elaborated with the help of examples i.e. Acid+Base→Salt+Water, $HCl+NaOH = NaCl+H_2O$ and $H_{(aq)}+OH_{(aq)}= H_2O_{(l)}$ (Elaboration). The teacher of controlled group did not use principles of advance organizer, guided discovery, inductive reasoning and elaboration to present the content. He taught these concepts as these were written in the book.

In the lesson of concept formation teaching model, main concepts were consolidated at the end of the lesson by the students to develop the summary and explanation for constructing and applying concepts. Main points were consolidated at the end of the lesson by the controlled group's teacher.

In the lesson of concept formation teaching model, principle i.e. acidity depends upon the number of ionizable hydroxyl (OH^-) groups and basicity depends upon the number of ionizable hydrogen (H^+) atoms was established. In the lesson of traditional method, generalization was not done.

In the lesson of concept formation teaching model, evaluation was done by inviting the students to write chemical equations of HNO_3, H_2CO_3, H_3PO_4, KOH, $Mg(OH)_2$, $Al(OH)_3$ on board. The teacher of controlled group recapitulated the lesson by asking the questions from exercise i. e. what is basicity? and what is acidity?

Objectives of the lesson of concept formation teaching model were checked with regular intervals by step-by-step questioning to diagnose the pupils' difficulties. In controlled groups, proper evaluation was not done to check whether the objectives were achieved or not. There was no provision of corrective feedback.

Home tasks were given by experimental and controlled group's teachers. Thought provoking home task was given by explaining the way of working by experimental group teacher e.g. describe basicity of an acid and acidity of a base with the help of equations. The controlled group teacher assigned the questions from exercise as home work e.g. write notes on basicity of an acid, acidity of a base and neutralization process.

3.6.2 Comparison of Lesson Plans

Steps	Concept Formation Teaching Model	Traditional Method
Instructional Material	Board, Chart, Duster, Beakers, ph paper, Solutions of HCl, H_2SO_4, NaOH, $Ca(OH)_2$	Board, Chart, Duster
Instructional Objectives	Knowledge, comprehension and application level of students were checked.	Knowledge was checked.
Previous Knowledge	Students identified acids, strong acid, weak acid, base, strong base and weak base by ph paper. Students' concepts were checked and clarified through discussion and questions.	Questions were asked e.g. what is an acid? what is a base? and gave examples of acids and bases.
Introduction		Teacher introduced the lesson.
Announcement of the Topic		Topic was announced.
Presentation		These concepts were taught in

	$Ca(OH)_{2(aq)} = Ca^{+2}_{(aq)} + 2OH^{-}_{(aq)}$ $Fe(OH)_{3(aq)} = Fe^{+3}_{(aq)} + 3OH^{-}_{(aq)}$ Teacher guided the students to examine and discover details by questions i.e. how many ionizable hydrogen (H^{+}) atoms and ionizable hydroxyl group/groups (OH^{-}) are present in H_2SO_4, H_3PO_4, NaOH, $Ca(OH)_2$ and $Fe(OH)_3$ respectively (Guided Discovery). Concept of acetic acid was induced with the help of equation i.e. $CH_3COOH_{(aq)}+H_2O_{(l)}=H_3O^{+}_{(aq)}+CH_3COO^{-}_{(aq)}$ (Inductive Reasoning). The process of neutralization was elaborated with the help of examples i.e. Acid+Base→Salt+Water $HCl+NaOH = NaCl+H_2O$ $H_{(aq)} + OH_{(aq)} = H_2O_{(l)}$ (Elaboration).	
Conclusion	Main concepts were consolidated at the end of the lesson by the students to develop the summary and explanation for constructing and applying concepts.	Conclusion was done.
Generalization	Principle was established i.e. acidity depends upon the number of ionizable hydroxyl (OH^{-}) groups and basicity depends	Generalization was not done.

	upon the number of ionizable hydrogen (H^+) atoms.	
Evaluation	Evaluation was done by inviting the students to write chemical equations of HNO_3, H_2CO_3, H_3PO_4, KOH, $Mg(OH)_2$, $Al(OH)_3$ on board.	Total recapitulation was done by asking the questions from exercise i. e. what is basicity? and what is acidity?
Home Work	Home task was given by explaining the way of working i.e. describe basicity of an acid and acidity of a base with the help of equations.	Questions from exercise were given as home work e.g. Write notes on: a) basicity of an acid; b) acidity of a base; and c) neutralization process.

3.7 VARIABLES OF THE STUDY

The independent variables were two different types of instruction: concept formation teaching model and traditional method. The dependent variable was the academic achievement scores of the students in post-test. Controlled variables were time table and time duration of class. Uncontrolled variables were I. Q of students, their previous academic achievement, and prior knowledge of subject matter, socio-economic status, educational background, anxieties, interest and attitude.

3.8 DATA ANALYSIS

For calculating missing data in pre-test and post-test of experimental and controlled groups, following formula was used:

$$\sum (yijk\text{-}m\text{-}ti\text{-}bj) = 0$$ (Cochran and Cox, 2003)

Where

$\sum$ = Sum of

yijk = k^{th} observation in i^{th} row and j^{th} column

m = constant

ti = i^{th} treatment

bj = j^{th} block

From time to time certain observations are missing, through failure to record, gross error in recording or accidents. The omissions naturally affect the method of analysis. When certain observations are absent, the correct procedure is to write down the mathematical model *for all observations that are present* (Cochran and Cox, 2003).

Mean and standard deviation were used to determine the existing level of understanding of concepts in the subject of Chemistry among Class IX students.

Analysis of covariance (ANCOVA) was used to determine and compare the effects of teaching Chemistry through concept formation teaching model on students' achievement. (Garrett and Woodworth, 1967; Best and Kahn, 1993).

Independent sample *t*-Test statistics was used to determine whether there was a significant difference between the mean achievement scores of experimental and controlled groups pre-test, significant difference between the mean achievement scores of experimental and controlled groups on post-test, significant difference between the mean achievement scores of boys and girls on pre-test and significant difference between the mean achievement scores of boys and girls on post-test (Gay, 2005).

Paired sample *t*-Test statistics was used to determine the difference between the mean achievement scores of pre-test and post-test of experimental groups and difference between the mean achievement scores of pre-test and post-test of controlled groups (Gay, 2005).

Coefficient of correlation was calculated by Product-Moment Correlation method to determine the correlation between students' academic achievement test scores of experimental and controlled groups taught through concept formation teaching model and traditional method respectively (Gay, 2005).

Significance was tested at .05 level as the criterion for the rejection of null hypotheses. Predictive Analytics Software (PASW) was used for statistical analyses.

CHAPTER 4

ANALYSIS AND INTERPRETATION OF DATA

The present chapter deals with the analysis and interpretation of data to measure the existing level of understanding of concepts in the subject of Chemistry among Class IX students and to compare experimental group (taught through Concept Formation Teaching Model) and controlled groups (taught through traditional method). This chapter has four parts:

Part I: This part deals with the mean and standard deviation to measure the existing level of understanding of concepts among Class IX students of nine selected Government High School for Boys and Girls of Rawalpindi city. Table No. 2 to 4 deal with the mean and standard deviation of students' achievement scores.

Part II: This part deals with the comparison of mean achievement scores of experimental and controlled groups of School I, School II and School III. Table No. 5 to 16 deal with difference between mean achievement scores of experimental and controlled groups on pre-test and post-test. Table No. 17 to 22 deal with correlation between mean achievement scores on pre-test and post-test of experimental and controlled groups.

Part III: This part deals with the comparison of mean achievement scores of boys and girls on pre-test and post-test of experimental and controlled groups of all the three schools. Table No. 23 and 24 deal with difference between mean achievement scores of boys and girls on pre-test and post-test.

Part IV: This part deals with the comparison of mean achievement scores of all the three schools' students on post-test. Table No. 25 deal with difference between mean achievement scores of all the three schools' students on post-test.

Part I

This part deals with the mean and standard deviation to measure the existing level of understanding of concepts among Class IX students of nine selected Government High School for Boys and Girls of Rawalpindi city. The data have been presented in table 2 to 4:

H_{01} The existing level of understanding of concepts in the subject of Chemistry among Class IX students is not up to 50 percent.

Table 2 : Mean and Standard deviation of Achievement scores of boys in Chemistry

Variable	**N**	$\bar{X}$	**SD**
Achievement Scores	300	19.61	5.95

Table 2 indicates that mean and standard deviation of achievement scores of boys are 19.61 and 5.95 respectively which implies that the spread of scores around the mean score of 19.61 is about 6 points. It indicates that the existing level of understanding of concepts of boys in the subject of Chemistry was not up to 50 percent. The calculated mean achievement scores of boys (19.61) in Chemistry was less than actual scores (80). The high and low levels of achievement were determined against cut off point of 50 percent.

Table 3 : Mean and Standard deviation of Achievement scores of girls in Chemistry

Variable	**N**	$\bar{X}$	**SD**
Achievement Scores	160	25.99	7.38

Table 3 indicates that mean and standard deviation of achievement scores of girls are 25.99 and 7.38 respectively which implies that the spread of scores around the mean score of 25.99 is about 7 points. It indicates that the existing level of understanding of concepts of girls in the subject of Chemistry was not up to 50 percent. The calculated mean achievement scores of girls (25.99) in Chemistry was less than actual scores (80). The high and low levels of achievement were determined against cut off point of 50 percent.

Table 4 : Mean and Standard deviation of Achievement scores of boys and girls in Chemistry

Variable	N	$\overline{X}$	SD
Achievement Scores	460	21.83	7.15

Table 4 indicates that mean and standard deviation of achievement scores of boys and girls are 21.83 and 7.15 respectively which implies that the spread of scores around the mean score of 21.83 is about 7 points. It indicates that the existing level of understanding of concepts of boys and girls in the subject of Chemistry was not up to 50 percent. The calculated mean achievement scores of boys and girls (21.83) in Chemistry was less than actual scores (80). The high and low levels of achievement were determined against cut off point of 50 percent.

Part II

This part deals with the comparison of mean achievement scores of experimental and controlled groups of School I, School II and School III. Table No. 5 to 16 deal with difference between mean achievement scores of experimental and controlled groups on pre-test and post-test. Table No. 17 to 22 deal with correlation between mean achievement scores of experimental and controlled groups on pre-test and post-test which have been presented as under:

H_{o2} There is no significant difference in achievement test scores of experimental and controlled group on pre-test.

Table 5 : Significance of difference between mean achievement scores of experimental and controlled group in School I on pre-test

Group	N	$\overline{X}$	SD	*t*
Experimental	53	19.58	5.92	
				-.43
Controlled	55	20.07	5.66	

df =106 $p > .05$ Table value of $t = 1.98$

Table 5 indicates that mean achievement scores of experimental and controlled group on pre-test were 19.58 and 20.07 respectively. The difference between two mean was non-significant at .05 level hence H_o 2 was accepted. It indicates that experimental and controlled group did not differ in their academic achievement on pre-test.

Table 6 : Significance of difference between mean achievement scores of experimental and controlled group in School II on pre-test

Group	N	$\overline{X}$	SD	*t*
Experimental	48	21.58	5.02	
				-.87
Controlled	50	22.56	5.98	

df =96 $p > .05$ Table value of $t = 1.99$

Table 6 indicates that mean achievement scores of experimental and controlled group on pre-test were 21.58 and 22.56 respectively. The difference between two mean was non-significant at .05 level hence H_o 2 was accepted. It indicates that experimental and controlled group did not differ in their academic achievement on pre-test.

Table 7 : Significance of difference between mean achievement scores of experimental and controlled group in School III on pre-test

Group	N	$\overline{X}$	SD	*t*
Experimental	42	23.21	4.13	
				-.36
Controlled	42	23.55	4.32	

df =82 $p > .05$ Table value of $t = 1.99$

Table 7 indicates that mean achievement scores of experimental and controlled group on pre-test were 23.21 and 23.55 respectively. The difference between two mean was non-significant at .05 level hence H_o 2 was accepted. It indicates that experimental and controlled group did not differ in their academic achievement on pre-test.

H_{o3} There is no significant difference in achievement test scores of experimental and controlled group taught through Concept Formation Teaching Model and traditional method respectively on post-test.

Table 8 : Significance of difference between mean achievement scores of experimental and controlled group in School I on post-test

Group	N	$\overline{X}$	SD	*t*
Experimental	53	57.36	5.70	
				33.45
Controlled	55	21.35	5.48	

df =106 $p < .05$ Table value of t = 1.98

Table 8 indicates that mean achievement scores of experimental and controlled group on post-test were 57.36 and 21.35 respectively. The difference between two mean was significant at .05 level hence H_o 3 was rejected. It indicates that the students of experimental group showed better performance on post-test than the students of controlled group.

Table 9 : Significance of difference between mean achievement scores of experimental and controlled group in School II on post-test

Group	N	$\overline{X}$	SD	*t*
Experimental	48	56.50	4.89	
				32.83
Controlled	50	21.74	5.55	

df =96 $p < .05$ Table value of t = 1.99

Table 9 indicates that mean achievement scores of experimental and controlled group on pre-test were 56.50 and 21.74 respectively. The difference between two mean was significant at .05 level hence H_o 3 was rejected. It indicates that the students of experimental group showed better performance on post-test than the students of controlled group.

Table 10 : Significance of difference between mean achievement scores of experimental and controlled group in School III on post-test

Group	N	$\overline{X}$	SD	*t*
Experimental	42	55.02	4.02	
				33.15
Controlled	42	23.74	4.60	

df =82 $p < .05$ Table value of t = 1.99

Table 10 indicates that mean achievement scores of experimental and controlled group on post-test were 55.02 and 23.74 respectively. The difference between two mean was significant at .05 level hence H_0 3 was rejected. It indicates that the students of experimental group showed better performance on post-test than the students of controlled group.

H_{o4} There is no significant difference in achievement test scores on pre-test and post-test of experimental group taught through Concept Formation Teaching Model.

Table 11 : Significance of difference between mean achievement scores on pre-test and post-test of experimental group in School I

Group	N	$\overline{X}$	SD	*t*
Pre-test	53	19.58	5.92	
				-143.38
Post-test	53	57.36	5.70	

df =52 $p < .05$ Table value of t = 2.01

Table 11 indicates that mean achievement scores of experimental group on pre-test and post-test were 19.58 and 57.36 respectively. The difference between two mean was significant at .05 level hence H_0 4 was rejected. It indicates that the students of experimental group showed better performance on post-test.

Table 12 : Significance of difference between mean achievement scores on pre-test and post-test of experimental group in School II

Group	N	$\overline{X}$	SD	*t*
Pre-test	48	21.58	5.02	
				-173.21
Post-test	48	56.50	4.89	

df =47 p < .05 Table value of t = 2.02

Table 12 indicates that mean achievement scores of experimental group on pre-test and post-test were 21.58 and 56.50 respectively. The difference between two mean was significant at .05 level hence H_o 4 was rejected. It indicates that the students of experimental group showed better performance on post-test.

Table 13 : Significance of difference between mean achievement scores on pre-test and post-test of experimental group in School III

Group	N	$\overline{X}$	SD	t
Pre-test	42	23.21	4.13	
				-46.42
Post-test	42	55.02	4.02	

df =41 p < .05 Table value of t = 2.02

Table 13 indicates that mean achievement scores of experimental group on pre-test and post-test were 23.21 and 55.02 respectively. The difference between two mean was significant at .05 level hence H_o 4 was rejected. It indicates that the students of experimental group showed better performance on post-test.

H_{o5} There is no significant difference in achievement test scores on pre-test and post-test of controlled group taught through traditional method.

Table 14 : Significance of difference between mean achievement scores on pre-test and post-test of controlled group in School I

Group	N	$\overline{X}$	SD	t
Pre-test	55	20.07	5.66	
				-6.52
Post-test	55	21.35	5.48	

df =54 p < .05 Table value of t = 2.01

Table 14 indicates that mean achievement scores of controlled group on pre-test and post-test were 20.07 and 21.35 respectively. The difference between two mean was significant at .05 level hence H_o 5 was rejected. It indicates that the students of controlled group showed better performance on post-test.

Table 15 : Significance of difference between mean achievement scores on pre-test and post-test of controlled group in School II

Group	N	$\overline{X}$	SD	*t*
Pre-test	50	22.56	5.98	
				1.73
Post-test	50	21.74	5.55	

df =49 $p > .05$ Table value of $t = 2.02$

Table 15 indicates that mean achievement scores of controlled group on pre-test and post-test were 22.56 and 21.74 respectively. The difference between two mean was non-significant at .05 level hence H_o 5 was accepted. It indicates that the students of controlled group showed same performance on post-test.

Table 16: Significance of difference between mean achievement scores on pre-test and post-test of controlled group in school III

Group	N	$\overline{X}$	SD	*t*
Pre-test	42	23.55	4.32	
				-1.24
Post-test	42	23.74	4.60	

df =41 $p > .05$ Table value of $t = 2.02$

Table 16 indicates that mean achievement scores of controlled group on pre-test and post-test were 23.55 and 23.74 respectively hence H_o 5 was accepted. The difference between two mean was non-significant at .05 level. It indicates that the students of controlled group showed same performance on post-test.

Table No. 17 to 22 deals with correlation between mean achievement scores on pre-test and post-test of experimental and controlled groups which have been presented as under:

H_{o6} There is no significant relationship in achievement test scores on pre-test and post-test of experimental group taught through Concept Formation Teaching Model.

Table 17 : Correlation between mean achievement scores on pre-test and post-test of experimental group in School I

Group	r
Pre-test and Post-test	.94

df =52 $p < .05$ Table value of r = .27

Table 17 indicates that correlation coefficient between mean achievement scores of experimental group on pre-test and post-test (.94) was significant. It was higher than critical r value (.27) at .05 level hence H_o 6 was rejected. It indicates that students' achievement was associated with experimental variable (Concept Formation Teaching Model).

Table 18 : Correlation between mean achievement scores on pre-test and post-test of experimental group in school II

Group	r
Pre-test and Post-test	.96

df =47 $p < .05$ Table value of r = .27

Table 18 indicates that correlation coefficient between mean achievement scores of experimental group on pre-test and post-test (.96) was significant. It was higher than critical r value (.27) at .05 level hence H_o 6 was rejected. It indicates that students' achievement was associated with experimental variable (Concept Formation Teaching Model).

Table 19 : Correlation between mean achievement scores on pre-test and post-test of experimental group in school III

Group	r
Pre-test and Post-test	.40

df =41 $p < .05$ Table value of r = .27

Table 19 indicates that correlation coefficient between mean achievement scores of experimental group on pre-test and post-test (.40) was significant. It was higher than critical r value (.27) at .05 level hence H_o 6 was rejected. It indicates that students' achievement was associated with experimental variable (Concept Formation Teaching Model).

H_{o7} There is no significant relationship in achievement test scores on pre-test and post-test of controlled group taught through traditional method.

Table 20 : Correlation between mean achievement scores on pre-test and post-test of controlled group in school I

Group	r
Pre-test and Post-test	.96

df =54 $p < .05$ Table value of r = .27

Table 20 indicates that correlation coefficient between mean achievement scores of controlled group on pre-test and post-test (.96) was significant. It was higher than critical r value (.27) at .05 level hence H_o 7 was rejected. It indicates that students' achievement was associated with controlled variable (Traditional Method).

Table 21 : Correlation between mean achievement scores on pre-test and post-test of controlled group of in school II

Group	r
Pre-test and Post-test	.83

df =49 $p < .05$ Table value of r = .27

Table 21 indicates that correlation coefficient between mean achievement scores of controlled group on pre-test and post-test (.83) was significant. It was higher than critical r value (.27) at .05 level hence H_o 7 was rejected. It indicates that students' achievement was associated with controlled variable (Traditional Method).

Table 22 : Correlation between mean achievement scores on pre-test and post-test of controlled group in school III

Group	r
Pre-test and Post-test	.97

df =41 $p < .05$ Table value of r = .27

Table 22 indicates that correlation coefficient between mean achievement scores of controlled group on pre-test and post-test (.97) was significant. It was higher than critical r value (.27) at .05 level hence H_o 7 was rejected. It indicates that students' achievement was associated with controlled variable (Traditional Method).

Part III

This part deals with the comparison of mean achievement scores of boys and girls on pre-test and post-test of experimental and controlled groups of all the three schools. The data have been presented in table 23 and 24:

H_{o2} There is no significant difference in achievement test scores of experimental and controlled group on pre-test.

Table 23 : Significance of difference between mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on pre-test

Group	N	$\bar{X}$	SD	*t*
Boys	108	19.83	5.77	
				-4.42
Girls	182	22.68	4.99	

df = 288 $p < .05$ Table value of t = 1.97

Table 23 indicates that mean achievement scores of boys and girls of experimental and controlled group of all the three schools on pre-test were 19.83 and 22.68 respectively. The difference between two mean was significant at .05 level hence H_o 2 was rejected. It indicates that girls showed better performance on pre-test than boys.

H_{o3} There is no significant difference in achievement test scores of experimental and controlled group taught through Concept Formation Teaching Model and traditional method respectively on post-test.

Table 24 : Significance of difference between mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on post-test

Group	N	$\overline{X}$	SD	*t*
Boys	108	39.02	18.92	
				-.01
Girls	182	39.05	17.32	

df = 288 p > .05 Table value of *t* = 1.97

Table 24 indicates that mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on post-test were 39.02 and 39.05 respectively. The difference between two mean was non-significant at .05 level hence H_o 3 was accepted. It indicates that boys and girls showed same performance on post-test.

Part IV

This part deals with the comparison of mean achievement scores of all the three schools' students on post-test. The data have been presented in table 25:

H_{o3} There is no significant difference in achievement test scores of experimental and controlled group taught through Concept Formation Teaching Model and traditional method respectively on post-test.

Table 25: ANCOVA Summary (All three schools)

Source	df	SS	MS	F
Group	1	6255.16	6255.16	772.49
Pre-test	1	5305.14	5305.14	655.17
Group * Pre-test	1	52.58	52.58	6.49

Error	286	2315.83	8.09	

$F < .05$ Table value of $F = 3.87$

The result showed that there was a significant difference between the post-test mean achievement scores of the students taught through concept formation teaching model and those taught through traditional method. The difference between mean was significant at .05 level hence H_o 3 was rejected. The experimental group scored significantly higher than controlled group ($\overline{X}$ Concept Formation Teaching Model = 56.59, $\overline{X}$ Traditional Method= 21.91).

Discussion

The main purpose of the study was to explore the present level of concept formation during teaching of Chemistry to Class IX students and to investigate the effects of "concept formation teaching model" and traditional method on the teaching of Chemistry to Class IX.

The present study supports the findings of Hayes, Goodhew, Heit and Gillan, 2003; Atilla, 2007 and Vosniadou, 2007. Based on the statistical analysis, it is concluded that the present level of understanding of concepts of Class IX students in the subject of Chemistry was low. Generally most of the students perceive that Chemistry is a difficult subject to learn and believe that they cannot be successful in understanding the concepts of Chemistry. Hence, they do not put the required effort for understanding these concepts. Secondly, initiating conceptual change is a difficult job, perhaps because concepts become deeply rooted in the students' mind and because their formation and change requires several personal experiences. The responsibility of the teachers is to make the best use of the previous knowledge of students.

The present study supports the findings of Planinic, Krsnik, Pecina and Susac (2008) who argued that teaching should induce conceptual change in students. The importance of conceptual teaching is also recognized by the Government of Pakistan. Zaidi and Rahman (2008) in their paper Chemical Education in Pakistan said that Government of Pakistan lays emphasis on conceptual teaching. The curriculum has been so developed to emphasise concept formation rather than overload the students with unnecessary and often unrelated facts. The findings of this study also support this view as it reveals that concept formation teaching model is very useful for the clarification of the students' previous concepts and understanding of new and complex concepts.

The finding of the present study is similar to the findings of Bisbey and Trajkovski, 2006 and Lengnink, 2006. The findings of the present study indicated that explanation of the concepts and principles in an organized manner with the help of experiments, discussions, examples, use of audio-visual aids, definitions (method of specifying the essential characteristics of the concept and method of differentiation) and word (cognitive trigger for the concept) play a great role for understanding of concepts.

The finding of present study is similar to the finding of Azizoglu (2004) who argued that if students are able to ask appropriate questions for a given situation and explain their relationship, then more meaningful learning occurs. The present study findings also indicated that by using concept formation teaching model, the teacher focused to make the concepts as clear as possible. For this, the teacher explained the lesson by using students' existing ideas and concepts. Concepts were generally defined as advance organizers. Opportunities were also provided to the students to elaborate new information by connecting it to something already known and by looking for similarities and differences among concepts. During lesson, the teacher asked many questions to check students' responses for understanding and providing corrective feedback. So students did not become habitual in errors and they grasped the concepts more strongly. The teacher always encouraged students' responses and ideas by verbal and non-verbal reinforcers. Students felt comfortable in that environment of the classroom. These reasons may have caused a better acquisition of scientific knowledge for the experimental groups.

The study results of Azizoglu, 2004; Yavuz, 2005; and Onder and Geban, 2006 showed that instruction based on conceptual change approach was better than the instruction based on traditional methods on remediation of misconceptions and promoting students' understanding of science concepts. The present study also showed that traditional method was based on declarative knowledge. Students were asked to hold the scientific facts from teachers' explanation and recall these facts in the future lectures or tests. However, concept formation teaching model favoured a procedural knowledge i.e. knowledge about knowing how to do certain activities. In the experimental groups, the teacher introduced the lesson by using prior knowledge. By connecting prior knowledge to the new one, the teacher explained and clarified the concepts. It is not enough for the students to become aware of their existing ideas but also try to change their incorrect views by interacting with the teacher and class fellows. For this, the teacher asked many questions to check accuracy of students' responses and opportunities were also provided to them to do work and learn independently. This might have caused the difference in the achievement test score of students in the experimental and controlled groups. Although students of controlled groups could explain certain concepts and give examples from daily life but they had difficulties to explain the relationship between concepts and the reasons of why these relationships exist. On the other hand, the students of experimental groups applied their knowledge to explain the concept and its relationship with other concepts.

The present study has similar findings with other research studies using specific feedback. For example the researches of Wallberg, 1991; Pallrand, 1996; Littledyke, 1998; Svinicki, 1999; Hipkins *et al*, 2002; Cimer, 2004 and Jackson, Porter and Kanjanapongpaisal, 2004 proved that in order to correct students' mistakes at an early stage before they become too deeply rooted and students become habitual of that mistake, teachers need to continuously monitor and evaluate students' understanding.

A positive relationship between concept formation and achievement has been found in several studies. For example, Carey, 2000; Sungur, Tekkaya and Geban, 2001; Alibali, Johnson and Seigler, 2001; Mikkila-Erdmann, 2001; Marsh, Kong and Hau, 2001; Gulcan, Hamide and Geban, 2004; Snead and Snead, 2004; Cetingul and Geban, 2005; Baser, 2006; Gardon, 2007; Canpolat, Pınarba, Bayrakeken and Geban, 2009; and Ozmen, Demircioglu and Demircioglu, 2009 who favoured this view that the conceptual change approaches was proved to be successful for the formation of scientific concepts. Similar finding is reported by this study that concept formation teaching model and students' academic achievement were positively related. The results also indicated that concept formation teaching model appeared to be favourable for the clarification of concepts for both lower and higher ability students.

The present study supports the findings of Mueen (1992) who summarized that in traditional method, the lesson is conducted mostly in lockstep (all students engaged or locked into the same activity), with the teacher in full command, standing before the students and very seldom moving from her place as cited by Khan (2008). According to him, the teachers only move in the classroom when the students are giving the test or when they are doing some work. Usually teachers read one paragraph or some lines and explain it without writing the concepts that need to be clarified on the board and without participation of all students. They point out the selected students who are high achievers and are very quick to give answers. So the remaining students are only passive learners. Students' participation is limited while the teachers play an active role. The teachers explain the exercises of each chapter orally or may even mark them on the book. Students have to reproduce their answers on their copies. So the understanding and clarification of the ideas and concepts are at the minimum level. The students hardly get a chance to write on the board or ask questions when they have any confusion. Teachers do not allow any communication between the students. Even they do not provide opportunities to the students to discuss in the classroom. They argue that due to communication and discussion, the classroom discipline would be at stake and the syllabus would not be covered. Teachers also avoid experiments. There in no concept of experiments or activities in the laboratory. The classroom environment is very rigid and strict. Students are punished severely when they do any wrong. Students' personality is destroyed and their creative thinking is sapped. Such a teaching plan reflects monopoly, boredom and fatigue for both teachers and students. The findings of the present study also indicated that traditional method and students' academic achievement were also related but this relationship is not up to 50 percent. The reason for this low relationship is that students' learning was based only on rote-memorization. Students had to copy their concepts on papers in examination. Those students who reproduce the concepts as they were written in the books, considered as successful. There is no question about the understanding of concepts. In this way, students' creative thinking is destroyed. In such atmosphere, there is no room for bringing up of child. The main focus of the teachers was only to cover the syllabus without having this consideration whether the students grasped the concepts or not.

This study supports the other research studies i.e. Unlu, 2000; Yavuz, 2005; Baser, 2006 and Salami, 2007. Their results showed that interaction between gender difference and treatment did not make a significant contribution in the variation of academic achievement. The findings of the present study also proved that there was no significant mean difference between male and female students with respect to understanding Chemistry concepts.

This study proves the results of Hewson and Hewson, 2003; Nersessian, 2004 and Lattery and Hewson, 2006. The research findings of the present study show that concept formation teaching model is helpful for the change old ideas into new ones. The statistical difference between pre-test and post-test indicated that this model is valid for the formation, clarification and transformation of concepts. By this model, students become able to learn, integrate and correlate different concepts.

The present study supports the finding of Hussain (2005) who conducted an experimental study of teaching English through direct and traditional methods at secondary level. He reported that direct teaching was more effective for English as compared to traditional method of teaching. The students of experimental groups outscored than students working in traditional learning situation. Statistical analysis of the present study also reveals that direct teaching is very helpful for concept clarification and formation of Chemistry concepts. The students who were taught by direct teaching performed well than those students who were taught by traditional method.

To sum up, this study shows that the existing level of understanding of concepts of Class IX students in the subject of Chemistry was low. The students had difficulty in understanding of these concepts. By using concept formation teaching model, students performed well in the achievement test as they have clear concepts. This study also proved that concept formation teaching model was equally beneficial for both boys and girls.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

The purpose of the study was to ascertain the veracity of the criticism leveled against methods of teaching science at the secondary school level by checking the present level of understanding of concepts among students in the subject of Chemistry and to conduct an experiment to determine the effects of "Concept Formation Teaching Model" on students' achievement. The objectives of the study were to explore the present level of concept formation during teaching of Chemistry to Class IX students, to identify the weaknesses in teaching Chemistry in secondary classes, to investigate the effects of "Concept Formation Teaching Model" on the teaching Chemistry to Class IX and to measure the academic achievement of the students taught through "Concept Formation Teaching Model".

A sample of 460 students (300 Boys and 160 Girls) was selected from nine Government High Schools for Boys and Girls of Rawalpindi city (Appendix A). Data was collected through an achievement test to measure the existing level of understanding of concepts in the subject of Chemistry among Class IX students (Appendix C). A pre-test was administered to the sample of 290 students (143 students of experimental groups and 147 students of controlled groups) of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject (Appendix F).

The experimental groups were taught through concept formation teaching model and controlled groups were taught by traditional method. Lesson plans for experimental and controlled groups were based on the same subject matter (Appendix G). The duration of experiment was three months i. e. 21st January 2008 to 12th April 2008. 31 lesson plans were made on the format of direct instruction from chapter No. 7 to 10 of Chemistry textbook for Class

IX published by the Punjab Textbook Board. The academic achievement of experimental and controlled groups was examined through a post-test (Appendix F). The reliability of the achievement test that was used to measure the existing level of understanding of concepts of the sample students in the subject of Chemistry was found to be .87. The reliability of pre-test in the subject of Chemistry was found to be .89. Content validity of these two tests was judged by the table of specifications (Appendix B and E) and experts in Chemistry subject and Education subject (Appendix H).

After scoring the achievement tests, the data were tabulated and analyzed by using mean, standard deviation, *t*-Test (Independent Samples Test and Paired Samples Test), Product-Moment Correlation Method and ANCOVA (Analysis of Covariance).

5.2 FINDINGS

The study included the following findings:

5.2.1 Findings about existing level of understanding of students of nine selected schools

1. The existing level of understanding of concepts in the subject of Chemistry among Class IX students of nine selected Government High Schools for Boys and Girls of Rawalpindi city was checked by computing means. It was found that the calculated mean achievement scores of boys (19.61), girls (25.99) and boys and girls (21.83) in Chemistry were less than actual scores (80). The existing level of understanding of concepts of nine selected Government High Schools for Boys and Girls of Rawalpindi city was not up to 50 percent. The high and low levels of achievement were determined against cut off point of 50 percent.

5.2.2 Findings of conducted experiment

2. The difference between the mean achievement scores of experimental and controlled groups on pre-test was tested through *t*-Test (Independent Samples Test). It was found

that the calculated values of *t* of School I (-.43), School II (-.87) and School III (-.36) were lesser than the table value (1.99) at .05 level of significance. Hence H_o 2 was accepted. It means that there was no significant difference between mean achievement scores of experimental and controlled groups on pre-test.

3. The difference between the mean achievement scores of experimental and controlled groups on post-test was tested through *t*-Test (Independent Samples Test). It was found that the calculated values of *t* of School I (33.45), School II (32.83) and School III (33.15) were greater than the table value (1.99) at .05 level of significance. Hence H_o 3 was rejected. It means that there was a significant difference between mean achievement scores of experimental and controlled groups on post-test.

4. The difference between the mean achievement scores on pre-test and post-test of experimental groups was tested through *t*-Test (Paired Samples Test). It was found that the calculated values of *t* of School I (-143.38), School II (-173.21) and School III (-46.42) were greater than the table value (2.02) at .05 level of significance. Hence H_o 4 was rejected. It means that there was a significant difference between mean achievement scores on pre-test and post-test of experimental groups.

5. The difference between the mean achievement scores on pre-test and post-test of controlled groups was tested through *t*-Test (Paired Samples Test). It was found that the calculated value of *t* of School I (-6.52) was greater than the table value (2.01) at .05 level of significance. Hence H_o 4 was rejected. It means that there was a significant difference between mean achievement scores on pre-test and post-test of controlled groups in School I.

6. The difference between the mean achievement scores on pre-test and post-test of controlled groups was tested through *t*-Test (Paired Samples Test). It was found that the calculated values of *t* of School II (1.73) and School II (-1.24) were lesser than the table value (2.02) at .05 level of significance. Hence H_o 5 was accepted. It means that there was no

significant difference between mean achievement scores on pre-test and post-test of controlled groups in School II and School III.

7. The correlation between the mean achievement scores on pre-test and post-test of experimental groups was tested through Product Moment correlation. It was found that the calculated correlation coefficients of School I (.94), School II (.96) and School III (.40) were greater than the critical r value (.27) at .05 level of significance. Hence H_o 6 was rejected. It means that there was a significant correlation between mean achievement scores on pre-test and post-test of experimental groups.

8. The correlation between the mean achievement scores on pre-test and post-test of controlled groups was tested through Product Moment correlation. It was found that the calculated correlation coefficients of School I (.96), School II (.83) and School III (.97) were greater than the critical r value (.27) at .05 level of significance. Hence H_o 7 was rejected. It means that there was a significant correlation between mean achievement scores on pre-test and post-test of controlled groups.

9. The difference between the mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on pre-test was tested through *t*-Test (Paired Samples Test). It was found that the calculated value of *t* (-4.42) was greater than the table value (1.97) at .05 level of significance. Hence H_o 2 was rejected. It means that there was a significant difference between mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on pre-test.

10. The difference between the mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on post-test was tested through *t*-Test (Paired Samples Test). It was found that the calculated value of *t* (-.01) was lesser than the table value (1.97) at .05 level of significance. Hence H_o 3 was accepted. It means that there was no

significant difference between mean achievement scores of boys and girls of experimental and controlled groups of all the three schools on post-test.

11. The difference between the mean achievement scores of experimental and controlled groups of all the three schools on post-test was tested through Analysis of Covariance (ANCOVA). It was found that the calculated value of F (6.49) was greater than the table value (3.87) at .05 level of significance. Hence H_o 3 was rejected. It means that there was a significant difference between mean achievement scores of experimental and controlled groups of all the three schools on post-test.

5.3 CONCLUSIONS

On the basis of findings, following conclusions were drawn:

1. The existing level of understanding of concepts in the subject of Chemistry of Class IX students was not up to 50 percent. However, the girls had clear concepts in the subject of Chemistry.
2. The academic achievement of students of experimental and controlled groups of all the three schools did not differ in pre-test.
3. Better performance was depicted from the students of experimental groups of all the three schools in post-test.
4. The students of experimental groups of all the three schools showed better performance in post-test than pre-test.
5. The students of controlled group of School I had given better results on post-test than pre-test.
6. There was no significant difference between the academic achievement of controlled groups of School II and School III in pre-test and post-test.

8. Traditional ways of assigning home work may be avoided. Home task may be assigned in such a way by which the teacher evaluates the students' understanding of concepts. By this, if the students have any inquiry or confusion, the teachers should clear it on the beginning of the next day lecture. Different styles should be used for assigning the home task.
9. Curriculum programme may be based on conceptual change perspective. Textbooks and teaching materials should be improved so that misconceptions can be minimized.
10. This study can be replicated with a larger sample size for a generalization to a bigger population.
11. Studies can be carried out for different grade levels to investigate the effectiveness of concept formation teaching model.
12. Concept formation teaching model can be used to teach different science subjects.
13. Further studies can be conducted in different school systems i. e. Federal Government schools and Private schools to provide a generalization for all educational systems.
14. The results of the study may be disseminated to the Curriculum Wing of Ministry of Education and Provincial Bureaus of Curriculum. These results may serve as a guide line for revising and improving Chemistry course for secondary classes.
15. The results of the study may be disseminated to planners and policy makers to take useful decisions and allocate the proper amount of training for the teachers for conceptual change.
16. The International Islamic University may benefit from the results by inducting concept formation teaching model in teacher training programmes. This new model may be included in the teaching of elective subjects especially in the teaching of Chemistry.

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Appendix A

Names of Government Boys High Schools Rawalpindi

Schools	Number of Students
Government Faizul Islam High School Rawalpindi	57
Government High School DAV College Road Rawalpindi	61
Government High School Khayaban-e-Sir Syed Rawalpindi	59
Government Islamia High School No. 3 Rawalpindi	65
Government Muslim High School No. 2 Rawalpindi	58
Total	300

Names of Government Girls High Schools Rawalpindi

Schools	Number of Students
Government Girls High School Dheeri Hassanabad Rawalpindi	35
Government Girls High School M.C. Nia Mohallah Rawalpindi	40
Government Girls High School Muslim Town Rawalpindi	44
Government Simla Islamia Girls High School B Block Rawalpindi	41
Total	160

Appendix B

TABLE OF SPECIFICATION FOR ACHIEVEMENT TEST OF CLASS IX (EXISTING LEVEL)

Contents	Objectives			
	Knowledge	Comprehension	Application	Total
Elements Compounds Mixture (Ch.6, Class VI)	3	1	2	6
Structure of Atom (Ch.6, Class VI)	4		2	6
Solution (Ch.8, Class VI)	2	2	2	6
Atoms and its Structure (Ch.5, Class VII)		1	4	5
Elements (Ch.6, Class VII)	2	2	1	5
Some Common Gases (Ch.7, Class VII)	2		3	5
A Common Compound (Ch.8, Class VII)	3	2		5
Symbols and Formulae (Ch.6, Class VIII)	3	1	1	5
Chemical Change and Chemical Bond (Ch.7, Class VIII)	2	2	1	5
Acids, Bases and Salts (Ch.8, Class VIII)	1	3	1	5
Carbon and its Compounds (Ch.9, Class VIII)	5	2		7
Chemistry An Introduction (Ch.1, Class IX)	8	9	3	20
Total number of items	35	25	20	80
Percent of Evaluation	44	31	25	100

Appendix C

ACHIEVEMENT TEST (EXISTING LEVEL)

1. Matter is divided into:
   a. 2 Groups b. 3 Groups c. 4 Groups
   d. 5 Groups e. 6 Groups
2. Elements loose their identity in:
   a. Compound b. Mixture c. Substances
   d. Residues e. Precipitates
3. A process that involves the conversion of a powdered solid into crystalline form is called:
   a. Filtration b. Sublimation c. Crystallization
   d. Distillation e. Diffusion
4. The shapes of crystals of solid substances are:
   a. Circular b. Oval c. Irregular
   d. Regular e. Definite
5. The example of mixture is:
   a. Sulphur b. Sulphur and Iron fillings
   c. Sulphur dioxide d. Iron Sulphide e. Soil
6. Distillation can be used to separate soluble substances from:
   a. Mixture b. Liquid c. Compounds
   d. Aqueous Solution e. Gas
7. The smallest particle of an element that possesses all properties of that element is called:
   a. Ion b. Radical c. Molecule
   d. Electron e. Atom
8. Major part of an atom is:
   a. Empty b. Full c. Dense
   d. Half full e. One Third
9. Particles present in the nucleus have a charge:
   a. Negative b. Positive c. No Charge
   d. Both Positive and Negative e. Unknown
10. An element is recognized by its:
    a. Atomic Mass b. Atomic Size c. Atomic Numbers
    d. Atomic Radius e. Valency
11. Molecule is the smallest particle of an element or a compound that exists in nature as:
    a. Free b. Combined c. Fused
    d. Active e. Reactive
12. Central portion of an atom is:
    a. Electron b. Proton c. Duetrium
    d. Protium e. Nuclues
13. Liquid in the solution is called:
    a. Solute b. Solvant c. Residue
    d. Filtrate e. Mixture
14. Slurry is the mixture of:
    a. Soil and Sand b. Cement and Sand c. Soil and Water
    d. Water and Sand e. Cement and Water
15. The dissolved solute can be separated easily from:
    a. Water b. Chlorine c. Sodium Chloride
    d. Hydrogen e. Sulphur

16. Milk is a:
a. Solution b. Saturated Solution c. Suspension
d. Supersaturated Solution e. Unsaturated Solution
17. Components of solutions are:
a. Solute b. Solvent c. Solute and Residues
d. Filtrate and Residues e. Solute and Solvent
18. Atomic mass is:
a. Number of Protons Only b. Number of Neutrons Only
c. Number of Electrons Only d. Number of Protons and Neutrons
e. Number of Electrons & Protons
19. The formula to calculate the maximum number of electrons in outermost shell of an atom is:
a. n b. n^2 c. 2n
d. $2n^2$ e. 3n
20. The maximum number of electrons in L shell is:
a. 2 b. 4 c. 6
d. 8 e. 10
21. The number of neutrons in protium is:
a. 0 b. 1 c. 2
d. 3 e. 4
22. Oxygen atom has six electrons in its outermost shell, its valency is:
a. 2 b. -2 c. 4
d. -4 e. 0
23. Everything in this world is made up of:
a. Atoms b. Elements c. Compounds
d. Molecules e. Mixture
24. Percentage of oxygen found in earth crust is:
a. 10% b. 20% c. 30%
d. 40% e. 50%
25. At room temperature metals are in the state of:
a. Solid b. Liquid c. Gas
d. Amorphous e. Aqueous
26. Metalloides react with oxygen and form:
a. Oxides b. Acidic Oxides c. Basic Oxides
d. Acidic and Basic Oxides e. Hydroxides
27. Graphite is used in:
a. Pen b. Pencil c. Ink
d. Paints e. Fibers
28. The total numbers of neutral elements are:
a. 88 b. 90 c. 92
d. 94 e. 96
29. Carbon dioxide gas is found in:
a. Rare gases b. Volcanic gases c. Normal gases
d. Noble gases e. Combustible gases
30. Oxygen gas is produced when Potassium Chlorate is:
a. Heated b. Cooled c. Condensed
d. Burnt e. Evaporated

31. Hydrogen burns in air with a flame:
 a. Yellow b. Orange c. Red
 d. Black e. Blue

32. Carbon dioxide gas is heavier than air:
 a. 0.5 times b. 1 times c. 1.5 times
 d. 2 times e. 2.5 times

33. When calcium carbonate reacts with hydrochloric acid, the product is:
 a. O_2 b. H_2 c. CaO
 d. H_2O e. H_2O_2

34. Aeration is the method of killing germs by:
 a. Air and Sunlight b. Only Air
 c. Only Sunlight d. Passing gases e. Passing Water

35. Water exists as:
 a. Gas b. Liquid c. Solid
 d. Liquid and Solid e. Liquid, Solid and Gas

36. Excess amount of salts on earth is:
 a. Water-Table b. Water Logging c. Filtration
 d. Absorption e. Salinity

37. Temporary hard water contains:
 a Calcium and Magnesium Carbonates
 b. Calcium and Magnesium Bicarbonates
 c. Calcium and Magnesium Oxides
 d. Calcium and Magnesium Sulphates
 e. Calcium and Magnesium Bisulphates

38. Potash Alum acts as:
 a. Germicides b. Pesticides c. Antiseptic
 d. Purifier e. Insecticides

39. The abbreviation instead of full names is:
 a. Atom b. Symbol c. Radical
 d. Ion e. Formula

40. The symbol of Mercury is:
 a. H b. He c. Mg
 d. Hg e. Mn

41. The Chemical formula of glucose is:
 a. $C_6H_{12}O_5$ b. $C_5H_{12}O_5$ c. $C_2H_{10}O_6$
 d. $C_6H_{12}O_6$ e. C_4H_{10}

42. Haemoglobin contains:
 a. 1 thousand atoms b. 5 thousand atoms c. 10 thousand atoms
 d. 15 thousand atoms e. 20 thousand atoms

43. Chemical formula of Zinc Nitrate is:
 a. $Zn(NO_2)_3$ b. $ZN(NO)_3$ c. $ZnNO_2$
 d. $Zn(NO_3)_2$ e. $ZnNO_3$

44. When caustic soda and hydrochloric acid reacts, the product is:
 a. Sodium chloride and Water b. Sodium hydroxide
 c. Sodium chloride and Hydrogen gas d. Sodium Oxide
 e. Sodium chloride and Oxygen gas

45. Combination of two or more elements or compounds is the process of:
 a. Decomposition b. Synthesis c. Displacement
 d. Double Displacement e. Hydrolysis
46. When one electron is removed from an atom, positive ion is:
 a. One b. Two c. Three
 d. Four e. Five
47. Tooth decay is prevented by:
 a. NaCl b. Na_2O c. NaOH
 d. NaBr e. NaF
48. A pure chemical compound obtained from different sources always has a constant ratio of the masses of different elements present in it, is:
 a. Law of Multiple Proportions b. Law of Definite Proportion
 c. Law of Reciprocal Proportions d. Law of Constant Proportions
 e. Law of Conservation of Mass
49. Formic acid is present in:
 a. Vinegar b. Ants c. Curd
 d. Apples e. Tomatoes
50. All acids turn Methyl Orange solution into:
 a. Red b. Blue c. Orange
 d. White e. Transparent
51. Acid neutralizes base to form:
 a. Salt and Water b. Carbonates c. Bicarbonates
 d. Salt, Water and Carbonates
 e. Salt, Water and oxygen
52. Dehydrating agent is:
 a. HCl b. HNO_2 c. HNO_3
 d. H_2SO_4 e. NaOH
53. The formula of Aqua Regia is
 a. $HCl+HNO_3$ b. $HCl+2HNO_3$ c. $2HCl+3HNO_3$
 d. $3HCl+2HNO_3$ e. $3HCl+HNO_3$
54. Percentage of Carbon in all compounds is:
 a. 40% b. 60% c. 80%
 d. 100% e. 120%
55. When elements exist in more than one form having different physical properties but identical chemical properties, they are:
 a. Isomers b. Isotopes c. Catenation
 d. Allotrops e. Catalysts
56. Organic Chemistry deals with:
 a. Sulphates b. Thiosulphates c. Carbon Compounds
 d. Hydrocarbons e. Hydrogen Compounds
57. Acids and Alkalies do not react with:
 a. Diamond b. Gold c. Mercury
 d. Silver e. Graphite
58. Graphite's density is:
 a. 2 g/cm^3 b. 2.1 g/cm^3 c. 1.2 g/cm^3
 d. 2.2g/cm^3 e. 2.3 g/cm^3

59. Dry ice is used for:
   a. Extinguishing Fires b. Bread Making c. Refrigeration
   d. Respiration e. Making Carbonated Beverages

60. The colour of non-luminous zone is:
   a. Red b. Blue c. Pale Blue
   d. Pink e. Dark Red

61. The search of man for collecting knowledge and integrating it, is:
   a. Biology b. Chemistry c. Microbiology
   d. Physics e. Science

62. Information acquired through careful observation is called:
   a. Fact b. Knowledge of Science
   c. Prediction d. Principle/Law
   e. Theory

63. Sulphuric Acid was discovered by:
   a. Al-Beruni b. Al-Jahiz c. Aristotle
   d. Berzelius e. Jaber Bin Hayan

64. The western scientists think that universe:
   a. Came into being on its own b. Was created by an idol
   c. Was created by Almighty Allah d. Was created by an accident
   e. Is imaginary

65. The study of all elements and their compounds except carbon is:
   a. Analytical Chemistry b. Biochemistry c. Chemistry
   d. Inorganic Chemistry e. Organic Chemistry

66. Lavoiser is:
   a. An American scientistb. A British scientist c. A French scientist
   d. A Greek scientist e. A Russian scientist

67. John Delton proposed:
   a. An atomic theory b. An electrolytic theory
   c. Phlogiston theory d. Quantum Theory
   e. Magnetic theory

68. In radioactivity, the valuable research is done by:
   a. Bo Ali-Sina b. Bohr c. Faraday
   d. Mandeleef e. Madam Curie

69. The discipline of chemistry is divided into:
   a. Branches b. Families c. Groups
   d. Types e. Sub-discipline

70. Muslims knowledge transferred to:
   a. America b. All world c. Brazil
   d. Europe e. Russia

71. The scientific method is expressed by:
   a. Cyclic process b. Dynamic process c. Integrated process
   d. Open process e. Non-cyclic process

72. The sequence of the steps of scientific method is:
   a. Experiment, inference, observation, and prediction
   b. Experiment, prediction, inference and observation
   c. Inference, observation, experiment and prediction
   d. Observation, inference, prediction and experiment
   e. Prediction, experiment, observation and inference

73. Conversion of solids into liquids and liquids into gases is done by:
a. Dalton b. Faraday c. Gibbs
d. Mess e. Rutherford

74. Observation and inferences are:
a. Empirical knowledge b. Rational knowledge
c. Real knowledge d. Systematic knowledge
e. Scientific knowledge

75. Chemistry makes a variety of fertilizers:
a. Actual b. Chemical c. Artificial
d. Organic e. Non-chemical

76. Crops are protected by:
a. Artificial rain b. By spraying c. Germs
d. Insecticides e. Pesticides

77. Accurate measurement of temperature is done by a:
a. Calorimeter b. Physical balance c. Thermometer
d. Screw gauge e. Wire gauge

78. Variable valencies of Sulphur are:
a 1 & 2 b. 2 & 3 c. 2 & 4
d. 3 & 5 e. 2, 4 & 6

79. Symbol of carbon monoxide is:
a. CO_2 b. Co_2 c. cO
d. CO e. cO_2

80. The simple ratio of ammonia is:
a. 1:1 b. 1:2 c. 1:3
d. 1:6 e. 2:1

Appendix D

CONTENTS OF CHEMISTRY TEXTBOOK FOR CLASS IX

Sr. No.	Chapter Title
1	Chemistry- An Introduction
2	Chemical Combination and Chemical Equations
3	Atomic Structure
4	Periodicity of Elements and Periodic Table
5	Chemical Bonding
6	States of Matter
7	Solution and Suspension
8	Electrochemistry
9	Acids, Bases and Salts
10	Chemical Energetics

Appendix E

TABLE OF SPECIFICATION FOR ACHIEVEMENT TEST OF CLASS IX (PRE-TEST/POST-TEST)

Contents	Objectives			
	Knowledge	Comprehension	Application	Total
Solution and Suspension (Ch.7, Class IX)	9	7	4	20
Electrochemistry (Ch.8, Class IX)	13	5	2	20
Acids, Bases and Salts (Ch.9, Class IX)	9	7	4	20
Chemical Energetics (Ch.10, Class IX)	9	5	6	20
Total number of items	40	24	16	80
Percent of Evaluation	50	30	20	100

Appendix F

ACHIEVEMENT TEST (PRE-TEST/POST-TEST)

1. Sea water contains compounds made from nearly:
   a. 30 elements b. 40 elements c. 50 elements
   d. 60 elements e. 70 elements
2. A solution whose concentration is known is:
   a. Molar Solution b. Standard Solution c. Dilute Solution
   d. Colloidal Solution e. Concentrated Solution
3. Cohesive forces are present in the molecules of:
   a. Suspension b. Compound c. Solution
   d. Mixture e. Substance
4. Dissolution in water occurs due to hydration and:
   a. Ionic Bonding b. Covalent Bonding c. Hydrogen Bonding
   d. Coordinate Covalent Bonding e. Metallic Bonding
5. A solution which can dissolve further amount of a solute at a particular temperature is:
   a. Standard Solution b. Saturated Solution c. Unsaturated Solution
   d. Supersaturated Solution e. Colloidal Solution
6. Ice cream contains 50% by volume of:
   a. Artificial Flavour b. Artificial Colour c. Milk
   d. Water e. Air
7. A solution formed by mixing only two substances is called a:
   a. Binary Solution b. True Solution c. Molar Solution
   d. Standard Solution e. Colloidal Solution
8. The amount of solute in grams which can dissolve in 100gm of the solvent at a particular temperature to give a saturated solution is called:
   a. Dilute Solution b. Concentrated Solution c. Suspension
   d. Precipitates e. Solubility
9. Similar solvent dissolve solutes:
   a. Similar b. Different c. Having Different Physical Properties
   d. Having Same Physical and Chemical Properties
   e. Having Different Chemical Properties
10. Solubility increases with the increase in:
    a. Pressure b. Temperature c. Volume
    d. Weight e. Mass
11. In freezing mixture, the temperature of the mixture gets lowered when certain salts are mixed with:
    a. Normal Water b. Cold Water c. Hot Water
    d. Ice e. Soft Drink
12. Hydrogen bonding is represented by:
    a. Doted line b. Single line c. Double lines
    d. Triple lines e. Arrow
13. Water is solvent:
    a. Good b. Poor c. Weak
    d. Strong e. Excellent
14. A homogeneous mixture of different substances is called a:
    a. Molar Solution b. True Solution c. Solution
    d. Dilute Solution e. Concentrated Solution

15. Heat of energy is evolved in the process of:
a. Hydration b. Synthesis c. Decomposition
d. Neutralization e. Displacement

16. A solution which contains an amount of solute more than that required for the preparation of a saturated solution at a particular temperature is:
a. Dilute Solution b. Saturated Solution c. Unsaturated Solution
d. Super Saturated Solution e. Concentrated Solution

17. The formula of sodium thiosulphate is:
a. $Na_2O_3.5H_2O$ b. $Na_2S_2O_3.4H_2O$ c. $Na_2S_2O_3.5H_2O$
d. $Na_2S_2O_2.5H_2O$ e. $Na_2S_2O_2.4H_2O$

18. In sodium sulphate decahydrate, the numbers of molecules of water are:
a. 2 b. 4 c. 6
d. 8 e. 10

19. Smoke is the mixture of:
a. Gas and Gas b. Solid and Gas c. Solid and Solid
d. Liquid and Liquid e. Liquid and Gas

20. $CaCrO_4$ is the formula of:
a. Calcium Carbonate b. Calcium Bicarbonate c. Calcium Oxide
d. Calcium Chromate e. Calcium Hydroxide

21. Alessandro Volta invented the first electric battery in:
a. 1600 b. 1700 c. 1800
d. 1900 e. 2000

22. In electrolytic cell, electric current is produced due to:
a. Oxidation Reaction b. Reduction Reaction c. Redox Reactions
d. Spontaneous Redox Reaction e. Non spontaneous Redox Reaction

23. When the Lead-Storage Battery is fully charged, the percentage of sulphuric acid by mass is:
a. 15% b. 20% c. 25%
d. 30% e. 35%

24. Ionic theory is proposed by:
a. Faraday b. Nicholson c. Arrhenius
d. Alessandro Volta e. Carlisle

25. An electrolyte splits up into charged particles upon heating or in its aqueous solution is the process of:
a. Ionization b. Electrolysis c. Electroplating
d. Oxidation e. Reduction

26. Degree of ionization is the extent to which an electrolyte ionizes in:
a. Ice b. Water c. Distilled Water
d. Mixture e. Aqueous Solution

27. Electricity is the flow of:
a. Proton b. Neutron c. Positron
d. Deutrium e. Electron

28. An electrolyte which undergoes partial ionization in water is:
a. Insulators b. Conductors c. Strong Electrolyte
d. Weak Electrolyte e. Non conductors

29. In pure water, only one molecule is ionized out of:
a. $6x10^2$ molecules b. $6x10^4$ molecules c. $6x10^6$ molecules
d. $6x10^8$ molecules e. $6x10^{-8}$ molecules

30. Electroplating protects the metals from rusting and from the reaction of organic acids:
a. Inferior Metals b. Superior Metals c. Inferior Non metals
d. Superior Non metals e. Both Inferior and Superior Metals

31. For making hydrogen molecules, the number of hydrogen atom is/are:
a. One b. Two c. Three
d. Four e. Five

32. Zinc-Carbon dry cell has an external cover of cardboard or a metal that protects the cell from:
a. Air b. Environment c. Water
d. Rust e. Hydrogen

33. In copper plating, the electrolyte is:
a. $ZnSO_4$ b. CuO c. $CuSO_4$
d. $Cr_2(SO_4)_3$ e. $NaCl$

34. Cyanide ions move towards the anode to form:
a. AgCN b. AgCn c. Agcn
d. AGCN e. agcn

35. According to the modern theory, electrovalent compounds exist in an ionic form in the:
a. Gaseous State b. Liquid State c. Liquid and Solid State
d. Solid State e. Liquid and Gaseous State

36. Ions of lead nitrate are:
a. $Pb + 2NO^-_3$ b. $Pb^{2+} + NO^-_3$ c. $Pb^{2+} + 2NO^-$
d. $Pb^{2+} + 2NO_3$ e. $Pb^{2+} + 2NO^-_3$

37. In the electrolysis of an aqueous solution of sodium chloride, the solution gradually gets alkaline due to the presence of:
a. Na^+ b. Cl c. Cl^-
d. OH e. OH^-

38. The unit of the quantity of electricity is:
a. Coulomb b. Ampere c. Watt
d. Volt e. Electron Volt

39. The word acid is derived from:
a. English b. French c. Greek
d. Arabic e. Latin

40. Ionization constants are used to compare the strength of:
a. Acids b. Acids or bases c. Bases
d. Acids and Bases e. Neutral Compounds

41. Acids and bases react together to form salts and water in:
a. Neutralization b. Synthesis c. Hydrolysis
d. Decomposition e. Double Composition

42. Citric acid is present in:
a. Milk b. Grapes c. Lemon
d. Honey Bee e. Potato

43. Potash Alum is:
a. Salts b. Double Salt c. Normal Salt
d. Acidic Salt e. Basic Salt

44. Acids react with metals to liberate:
a. Oxygen gas b. Nitrogen gas c. Hydrogen gas
d. Carbon dioxide gas e. Ammonia gas

45. When electrolytes are fused in water, they are split into:
a. Positive Ions b. Negative Ions c. Positive and Negative Ions
d. Solvated Ions e. Hydrated Ions

46. Salts, which neither have replaceable hydrogen atom nor hydroxyl groups are called:
a. Salts b. Normal salts c. Acidic salts
d. Basic salts e. Double salts

47. A compound which can donate proton is:
a. Arrhenius Acid b. Arrhenius Base c. Bronsted Base
d. Bronsted Acid e. Lewis Acid

48. Basicity means the number of ionizable hydrogen atoms in its:
a. Mixture b. Compound c. Molecule
d. Elements e. Filterate

49. Water of crystallization means the number of molecules present in the crystals of a solid:
a. Hydrogen b. Water c. Oxygen
d. Hydrogen and Oxygen e. Ice

50. Concentration of hydrogen ions present in a solution is measured by:
a. ph Scale b. PH Scale c. Ph Scale
d. pH Scale e. P.H. Scale

51. A double salt is formed, when two typical salts are:
a. Crystallized together b. Crystallized separately
c. Neutralized together d. Neutralized separately
e. Hydrolyzed

52. To decrease the acidic nature of soil, soil is mixed with the hydroxide of:
a. Magnesium b. Ammonium c. Calcium
d. Sodium e. Potassium

53. Solvay-ammonia soda process is the most popular method of preparing:
a. Sodium Chloride b. Sodium Hydroxide c. Sodium Carbonate
d. Sodium Bicarbonate e. Sodium Sulphate

54. The formula of lime stone is:
a. CaO b. $Ca(OH)_2$ c. $CaSO_4$
d. $CaCO_3$ e. $Ca(HCO_3)_2$

55. Copper sulphate is used in:
a. Pesticides b. Germicides c. Purifier
d. Medicines e. Insecticides

56. Lead accumulator is usually of:
a. 4 or 10 Volts b. 5 or 11 Volts c. 6 or 12 Volts
d. 6 or 11 Volts e. 6 or 13 Volts

57. Hydrogen gas is liberated when asides react with:
a. Metals b. Non-metals c. Metalloids
d. Halogens e. Transition Elements

58. Ionization constant of an acid is:
a. K b. K_a c. k_a
d. $1/K_a$ e. $1/k_a$

59. Concentration of the strength of acids and bases represents as:
a. Moles dm b. Moles dm^{-1} c. Moles dm^{-2}
d. Moles dm^{-3} e. Moles dm^{-4}

60. Acetic acid has:
a. One Basicity b. Two Basicity c. Three Basicity
d. Four Basicity e. Five Basicity

61. pH of potato is:
  a. 4.0 – 6.0   b. 4.5 – 6.0   c. 4.5 – 6.5
  d. 4.0 – 6.5   e. 4.5 – 7.0

62. pH scale ranges from:
  a. 0 to 7   b. 7 to 14   c. 0 to 14
  d. 0 to 6   e. 0 to 13

63. The reaction of Copper Oxide and Sulphuric Acid is the type of:
  a. Synthesis   b. Neutralization   c. Decomposition
  d. Displacement   e. Double Displacement

64. The branch of chemistry in which we study the heat changes during a chemical reaction is called:
  a. Electrochemistry   b. Biochemistry   c. Physical Chemistry
  d. Analytical Chemistry   e. Thermo chemistry

65. Heat content depends upon:
  a. Physical state of substance   b. Temperature   c. Pressure
  d. Heat of the substance   e. Physical state and temperature

66. In exothermic reactions, the container becomes:
  a. Hot   b. Very Hot   c. Cool
  d. Very Cool   e. Normal

67. When hydrogen reacts with iodine, absorption of heat energy is:
  a. 51.08kj   b. 52.08kj   c. 53.08kj
  d. 53.07kj   e. 53.06kj

68. Hydronium ion is produced when water reacts with:
  a. HCl   b. HBr   c. NaOH
  d. NaCl   e. Na_2Co_3

69. In the solution of hydrochloric acid and sodium hydroxide, the spectator ions are:
  a. $Na^+_{(aq)}$ b. $Cl^-_{(aq)}$ c. $Na^+ + OH^-$
  d. $Na^+_{(aq)} + Cl^-_{(aq)}$ e. OH^-

70. The chemical reactions during which heat is absorbed are called:
  a. Exothermic Reactions   b. Endothermic reactions   c. Heat Content
  d. Heat of Reaction   e. Enthalpy of Reaction

71. In exothermic reactions, the energy of the products:
  a. No change   b. Increases   c. Decreases
  d. First increases then decreases   e. First decreases then increases

72. When a reaction is carried out in a closed vessel, the pressure on the reactants:
  a. Remain constant   b. Does not remain constant   c. Increases
  d. Decreases   e. Become normal

73. Enthalpy of reaction is represented as:
  a. H   b. ΔH c. Δh
  d. $+\Delta H$ e. $-\Delta H$

74. Enthalpy of one mole of liquid water is always:
  a. Less than that of water vapours   b. Greater than that of water vapour
  c. Same as water vapours   d. Double of water vapours
  e. One third of water vapours

75. Endothermic reaction is:
  a. Formation of ammonia gas   b. Burning of sulphur in air
  c. Formation of NO in air due to lightening
  d. Neutralization of an acid and a base   e. Combustion of natural gas

76. In water, a base forms:
   a. Hydrated Ion   b. Solvated Ion   c. Hydronium Ion
   d. Hydroxide Ion   e. Spectator Ion

77. Apparatus used for exothermic reactions gets hot due to the increase of:
   a Heat   b. Temperature c. Pressure
   d. Mass   e. Volume

78. Heat evolved during a neutralization reaction is called its:
   a. Heat Content   b. Heat of Reaction   c. Exothermic Reaction
   d. Enthalpy of Reaction   e. Heat of neutralization

79. Standard value of heat of neutralization of HCl and NaOH is:
   a. 57.12kj   b. 57.22kj   c. 57.32kj
   d. 57.42kj   e. 57.52kj

80. In neutralization reaction, a base forms:
   a. Hydrogen Ion   b. Hydroxide Ion   c. Hydronium Ion
   d. Hydrated Ion   e. Spectator Ion

Answer Sheet

Name: ______________________________ Class ____________________

Subject: ________________________ Date: ____________________

School: ______________________________________

Instructions

1. Five items are given with question, encircle only one right answer.
2. Separate answer sheet is provided so don't tick or mark the question paper.

Answer Sheet

1	a	b	c	d	e	**41**	a	b	c	d	e
2	a	b	c	d	e	**42**	a	b	c	d	e
3	a	b	c	d	e	**43**	a	b	c	d	e
4	a	b	c	d	e	**44**	a	b	c	d	e
5	a	b	c	d	e	**45**	a	b	c	d	e
6	a	b	c	d	e	**46**	a	b	c	d	c
7	a	b	c	d	e	**47**	a	b	c	d	e
8	a	b	c	d	e	**48**	a	b	c	d	e
9	a	b	c	d	e	**49**	a	b	c	d	e
10	a	b	c	d	e	**50**	a	b	c	d	e
11	a	b	c	d	e	**51**	a	b	c	d	e
12	a	b	c	d	e	**52**	a	b	c	d	e
13	a	b	c	d	e	**53**	a	b	c	d	e
14	a	b	c	d	e	**54**	a	b	c	d	e
15	a	b	c	d	e	**55**	a	b	c	d	e
16	a	b	c	d	e	**56**	a	b	c	d	e
17	a	b	c	d	e	**57**	a	b	c	d	e
18	a	b	c	d	e	**58**	a	b	c	d	e
19	a	b	c	d	e	**59**	a	b	c	d	e
20	a	b	c	d	e	**60**	a	b	c	d	e
21	a	b	c	d	e	**61**	a	b	c	d	e
22	a	b	c	d	e	**62**	a	b	c	d	e
23	a	b	c	d	e	**63**	a	b	c	d	e
24	a	b	c	d	e	**64**	a	b	c	d	e
25	a	b	c	d	e	**65**	a	b	c	d	e
26	a	b	c	d	e	**66**	a	b	c	d	e
27	a	b	c	d	e	**67**	a	b	c	d	e
28	a	b	c	d	e	**68**	a	b	c	d	e
29	a	b	c	d	e	**69**	a	b	c	d	e
30	a	b	c	d	e	**70**	a	b	c	d	e
31	a	b	c	d	e	**71**	a	b	c	d	e
32	a	b	c	d	e	**72**	a	b	c	d	e
33	a	b	c	d	e	**73**	a	b	c	d	e
34	a	b	c	d	e	**74**	a	b	c	d	e
35	a	b	c	d	e	**75**	a	b	c	d	e
36	a	b	c	d	e	**76**	a	b	c	d	e
37	a	b	c	d	e	**77**	a	b	c	d	e
38	a	b	c	d	e	**78**	a	b	c	d	e
39	a	b	c	d	e	**79**	a	b	c	d	c
40	a	b	c	d	e	**80**	a	b	c	d	e

Appendix G

MODEL LESSON PLAN (CONCEPT FORMATION TEACHING MODEL)

Chapter 8: "Acids, Bases and Salts"

Topic: Basicity of an Acid, Acidity of a Base and Neutralization **Grade:** 9th

Subject: Chemistry **Duration:** 40 mins.

Instructional Objectives: To enable the students to:

i) Knowledge: define basicity of an acid, acidity of a base and neutralization;

ii) Comprehension: discriminate the basicity with acidity, mono-basic, di-basic and tri-basic with one another and with mono-acidic, di-acidic and tri-acidic; and

iii) Application: make the new equations by taking other radicals and balance them.

Instructional Method: Concept Formation (Direct Instruction)

Instructional Materials: ph paper, Solutions of HCl, H_2SO_4, NaOH, $Ca(OH)_2$. Board, Chalk, Duster

Previous Knowledge: Invite students to perform experiments with different solutions on ph paper to identify acids, strong acids, weak acids, bases, strong bases and weak bases.

Presentation:

a) Motivational Set: Give examples of acids i.e. HCl, H_2SO_4, and bases NaOH, $Ca(OH)_2$. Tell them that acids give proton (H^+) and bases give hydroxide ion (OH^-). Those acids and bases who undergo complete ionization are called strong acids and strong bases e.g. HCl, NaOH. Those acids and bases who undergo incomplete ionization are called weak acids and weak bases respectively e.g. H_2SO_4, $Ca(OH)_2$ and that in today's lesson they will learn basicity of an acid, acidity of a base and neutralization.

b) Body of the lesson:

1. Overview the concept of basicity of an acid, mono-basic, neutralization and heat of neutralization in advance of learning (Advance Organizer).
2. Invite students to write chemical equations H_2SO_4, H_3PO_4, NaOH, $Ca(OH)_2$ and $Fe(OH)_3$ on board (Guided Discovery).
3. Induce concept of acetic acid with the help of equation (Inductive Reasoning).
4. Elaborate heat of neutralization by examples (Elaboration).

Conclusion: At the end, consolidate main points of the lesson.

Generalization: Establish principle about basicity and acidity.

Evaluation: Invite students to write chemical equations of different acids and bases.

Home Task: Assign home task by explaining the way of working.

MODEL LESSON PLAN (TRADITIONAL METHOD)

Name of School: **Strength:**

Class: 9th **Average Age:** 15 yrs.

Subject: Chemistry **Duration:** 40 mins.

Chapter: Acids, Bases and Salts **Date:**

Topic: Basicity of an Acid, Acidity of a Base and Neutralization

Headings	Lesson Notes	Black Board Summary
Apparatus	Classroom, Black Board, Chalk, Duster etc.	
General Objectives	i) To polish the mental abilities of the students; ii) To relate science with daily life; iii) To give the exposure of science to the students about its usability.	
Specific Objectives	To enable the students to define basicity of an acid, acidity of a base and neutralization.	
A. V. Aids		
Method	Lecture Method	
Previous Knowledge	i) What is an acid? ii) What is a base? iii) Give examples of acids and bases.	
Introduction	Strength of an acid is its tendency to give proton (H^+) and the strength of a base is its tendency to gain this proton (H^+). When this acid reacts with base, then the resultant product is salt and water.	
Announcement	Today we will study Basicity of an acid, Acidity of a	<u>Basicity of an acid,</u>

of the Topic	base and Neutralization.	Acidity of a base and Neutralization
Presentation	**Basicity of an acid** Basicity of an acid is defined as the number of ionizable hydrogen atoms present in its molecules e.g. Hydrochloric acid has one hydrogen atom, so its basicity will be one. $HCl_{(aq)} + H_2O_{(l)} = H_3O^+_{(aq)} + Cl^-_{(aq)}$ Sulphuric acid (H_2SO_4) and phosphoric acid (H_3PO_4) are di-basic and tri-basic respectively. $H_2SO_{4(aq)} + H_2O_{(l)} = H_3O^+_{(aq)} + HSO_4^-{}_{(aq)}$ $HSO_4^-{}_{(aq)} + H_2O_{(l)} = H_3O^+_{(aq)} + SO_4^-{}_{(aq)}$ Acetic acid (CH_3CHOOH) contains four hydrogen atoms but only one hydrogen atom is ionizable so it has only one basicity. **Acidity of a base** Acidity of a base is defined as the number of ionizable hydroxyl groups present in its molecule e.g. NaOH is mono-acidic. $NaOH_{(aq)} = Na^+_{(aq)} + OH^-_{(aq)}$ Similarly, calcium hydroxide and ferric hydroxide have acidities 2 and 3 respectively. $Ca(OH)_{2(aq)} = Ca^{+2}_{(aq)} + 2OH^-_{(aq)}$ $Fe(OH)_{3(aq)} = Fe^{+3}_{(aq)} + 3OH^-_{(aq)}$	

	Neutralization Acids and bases react together to form salt and water. This reaction is called neutralization process. The amount of heat evolved during this reaction is called heat of neutralization. The process of neutralization occurs with the combination of H^+ from acid and OH^- from base i.e. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$	
Recapitulation	i) What is basicity? ii) What is acidity?	
Home Work	Write notes on the following: i) Basicity of an acid ii) Acidity of a base ii) Neutralization process	

Appendix H

LIST OF EXPERTS

1. Dr. Abdul Ghafoor Chaudary, Professor, Department of Chemistry, University of Wah, Wah Cantt.
2. Dr. Khalid Hassan Bukhari, Head Department of Education, Faculty of Social Sciences, International Islamic University, Islamabad.
3. Dr. Muhammad Maqsud Alam Bukhari, Professor, College of Liberal Arts and Sciences, Lalazar, Rawalpindi.
4. Muhammad Altaf, Head Department of Statistics, University of Wah, Wah Cantt.
5. Muhammad Usman, Programme/Data Analysist, NIP Centre of Excellence, Quaid-e-Azam University, Islamabad.
6. Dr. Safia Saeed, Head Department of Education, University of Wah, Wah Cantt.
7. Mrs. Shahida Shah, Chief Editor, Allama Iqbal Open University, Islamabad.