CHAPTER II

THEORETICAL OVERVIEW

- LEARNING THEORIES AND THEIR IMPLICATIONS FOR INSTRUCTION
- MODELS OF TEACHING: DEFINITION
- CONCEPT ATTAINMENT MODEL
- THEORY UNDERLYING ADVANCE ORGANIZER MODEL
- INQUIRY TRAINING MODEL
CHAPTER II
MODELS OF TEACHING- A THEORETICAL OVERVIEW

This chapter is devoted to the presentation of the theoretical background of Models of Teaching with special reference to the Information Processing Models. The three models of teaching coming under Information Processing Family are Concept Attainment Model (CAM), Advance Organizer Model (AOM) and Inquiry Training Model (ITM). These three models are treated specially in this chapter.

2.1 LEARNING THEORIES AND THEIR IMPLICATIONS FOR INSTRUCTION

Learning theories come to focus as one begins to formulate objectives for a teaching-learning stimulation and to develop instructional strategies in order to realise the objectives formulated. Though learning theories encompass affective and psychomotor development to a certain extent, they are basically set for the realisation of the objectives coming under cognitive domain.

Learning theories have evolved into two main branches: 1) Behaviouristic, the focus of which is on behaviour as evidence of cognitive growth and 2) Cognitive, the focus of which is perception as evidence of cognitive growth.

2.1.1. Behaviourist or Connectionist Theories

In stimulus-response approach, learning is assumed to be a function of stimulus-response connections, particularly as reflected in conditioning and psychologists who restrict themselves to studying overt behaviour are known as behaviourists (Munn et al., 1972).
2.1.2 Gagne’s Theory of Learning and Instruction

Gagne, like Skinner, lays emphasis on the role of instrumental conditioning in learning. In Gagne's opinion, the factors that influence growth are to a large extent generically determined, whereas the factors that influence learning are determined chiefly by environmental events (Gagne, 1985). From the environment, the learner receives stimulation that activates receptors and is transformed to neural information. During the course of an act of learning, a number of different processes are at work. These processes may occur in a sequence. The processes of learning form the basic structure of information processing theories of learning. In Gagne's theory of learning, the instrumental conditioning is largely a matter of information processing.

Effective instruction according to Gagne (1985), requires a careful ordering of learning tasks. According to Gagne, for each task learners are to be carefully prompted or guided in their attempt to respond correctly. Gagne gives much importance to the external stimuli to activate the learners' mindset and this implies that the need for independent discovery is minimised.

Gagne identified six varieties of performances that can be the result of learning. They are:

1. specific responding
2. chaining
3. multiple discrimination
4. classifying
5. rule learning and
6. problem solving.

Gagne believes that these six classes of learning form an ascending hierarchy, thus, learning occurs in the order of increasing complexity. Gagne’s hierarchy is useful in selecting models appropriate for varieties of educational goals (Joyce and Weil, 1997).

2.1.3 Cognitive Theories of Learning

They belong to the Gestalt school of learning and cognitive school of psychology. Much of the work using cognitive approaches to learning finds its origin in the work of Jean Piaget (1971) and his colleagues, often referred to as the Genevan school. Their model of learning generally characterised as a stage theory, in that the thought process of the child developed through four distinct stages—sensory-motor, pre-operational, concrete operational and formal operational—which unfold in a fixed sequence. At each stage, the ‘structures’ of the previous stage are reconstructed in a process called equilibration. This process simultaneously involves assimilation and accommodation.

Cognitive revolution brings forth the appearance of such important works as Miller’s paper on Processing Information (Miller, 1956), Bruner’s volume on ‘Thinking’ (Bruner, 1961), Chomsky’s Syntactic structures (Chomsky, 1968).

Study of cognition is the study of processes. The second aspect in cognition is the faculty of knowing which includes such activities such as memory, imagination, judgement and reason. Meta cognition is the name for the knowledge that people have about the way that cognitive processes work.
The processes of learning form the basic structure of information processing theories of learning.

Learning theorists have been advocating the improvement of classroom instruction by the application of the insight gained from a related field of inquiry. Skinner's programmed instruction, Gagne's hierarchical learning, Piaget's self-discovery learning, Bruner's discovery learning, Ausubel's meaningful reception learning, Suchman's inquiry oriented process approach are the significant contributions to the improvement of classroom instruction.

One of the important debates in the field of instruction today revolves around the relative efficiency of varying methods of presentation of subject matter.

2.1.4 Methods, Techniques and Strategies

There is tremendous semantic confusion in the use of such words as methods, techniques and strategies because they are used interchangeably in educational literature. Basically there are three methods of teaching: transmission method, inquiry method and eclectic method. A method is an overall procedure or process to achieve certain goals. A technique of teaching refers to the specific ways of presenting instructional material for a particular lesson. On the other hand a strategy deals with the organisation and co-ordination of various techniques to practise the method which would involve the achievement of desired goals.

Models of teaching are considered as prescriptive teaching strategies designed to accomplish particular instructional goals. There is a continuum in the application of teaching strategies.
Fig. 2.1 A Continuum of Teaching Strategies

Expository strategies

Interactive strategies

Reactive strategies

Discovery strategies

Self-directed strategies

Placement on this continuum is determined by the degree to which teachers share with pupils control over the teaching situation and the degree to which certain areas of decision making are left open to negotiation.

Models of teaching are a via-media between the two extremes of the continuum that is transmission or expository strategies and self-directed strategies.

In expository strategies pupils are exposed or presented with all facts, concepts, and principles they are to learn. In interactive strategies the teacher integrates different strategies in accordance with curriculum requirements and pupil’s individual requirements. Reactive teaching strategy is characterised by the teachers’ willingness to adjust instructional objectives in accordance with the pupils’ concerns or reactions. In discovery teaching, the teacher withholds from the pupils the concepts and principles they are to learn but gives them the instances, examples, and problems from which they can induce these concepts and principles.
Ausubel (1963) devised the concept of verbal reception learning (expository strategy) which is characterised by instruction that presents to students the entire content of the subject matter to be learned in final form. Students' role in the expository strategy is to understand and internalise the information presented before them in a receptive manner.

Bruner and Suchman established the framework of process oriented inquiry strategy. The process oriented curricula emphasises discovery or inquiry learning.

The term discovery learning has two different connotations: learning to discovery and discovery learning. Bruner (1961) asserts that in discovery learning the learner becomes the organiser of his own knowledge. Discovery is a process: it is a way of approaching problems rather than a product or a particular item of knowledge.

Inquiry training was developed by Richard Suchman (1962) to teach students the process for investigating and explaining unusual phenomena. It is designed to bring students directly into the scientific process Inquiry training originated in a belief in the development of independent and self-directed learners.

2.1.5 Processes, Observation and Inferences

Items of information gathered through senses are called observations. The observed information is processed into more abstract and useful forms by constructing patterns, predicting future observations and through explaining events. These extensions and interpretations are called inferences (Eggen, Kauchak and Harder, 1979). The information gathered in one's brain from the world around him is called knowledge. Facts, concepts and generalisations are called the building blocks
of knowledge. These forms of content often can isolate and taught individually using specific instructional strategies. Often, however, facts, concepts and generalisations are all embodied in larger contexts where the focus is on the interrelationship among them. We call these relationships as organised bodies of knowledge.

2.1.6 Concepts, Facts and Generalisations

Concepts represent a major portion of our school curriculum. How do young children learn concepts? The process begins with examples and non-examples. In both cases the concept is learned by identifying its essential characteristics and discriminating them from closely related concepts. Providing adequate examples is the crucial element in concept learning.

Facts are units of information that are used to form concepts and generalisations. Facts are isolated pieces of information. They are the building blocks of more advanced form of knowledge. Meaningfulness is a term used to describe the number of associations or connections between one idea and other ideas in our memory. The most powerful and widely applicable way of teaching facts stresses their meaningful integration into large conceptual framework.

2.1.7 Forms of Discovery-Reception Strategies

a) Inductive-deductive approach.

Discovery and reception, as methods of instruction, have most often been equated with inductive and deductive learning. Inductive learning may be defined as being based on the presentation, to the learner, of a sufficient number of specific examples to enable him to arrive at a definite rule or principle or fact”. On the other hand, deductive learning is a method “that proceeds from rules or
generalisations to the examples and subsequently to conclusions or applications of the generalisations" (Good, 1973).

The first systematic approach to reasoning, attributed to Aristotle and the Greeks, was the deductive method. Inductive learning is characterised by its emphasis on the verbalisation of what has been discovered by the learner. The deductive method of Aristotle and the inductive method of Bacon were fully integrated in the work of Charles Darwin in the nineteenth century. This inductive and deductive method is now recognised as an example of scientific approach.

Deduction and induction are clearly distinguishable and at the same time are a part of the continuous process of explanation. John Dewey (1938) suggested a pattern that is helpful in identifying the elements of inductive and deductive process.

i) identification and definition of the problem

ii) formulation of a hypothesis

iii) collection, organisation and analysis of data

iv) formulation of conclusions and

v) verification, rejection or modification of the hypothesis by the test of its consequence in a specific situation

Many modern curriculum designers attempted to translate Dewey's ideas into educational practice, by giving much stress on problem solving as Dewey wanted to develop children's thinking ability.
b) Egrule and Ruleg Presentation

Another variation of inductive and deductive learning or discovery-expository dichotomy is egrule and ruleg presentation. Egrule sequence is equated with inductive or discovery learning and ruleg with expository or deductive learning. The essential features of egrule presentation is that "certain number of examples are given with instructions to derive a concept, principle or generalisation". The essential features of ruleg presentation is that "the concept, principle or generalisation is presented first followed by examples (Turney, et al., 1977).

c) Problem Solving and Discovery

Problem solving as a method of learning requires that the learners discover the higher order rule without specific help. A study by Worthen (1968) strongly suggests that achieving a higher order rule by means of a problem solving produces a highly effective capability that is well retained and transferred over considerable periods of time. A study by Guthri (1967) of problem solving in cryptograms showed a marked advantage of the discovery method of instruction for retention and transfer of the newly acquired information.

Problem solving is not the automatic application of established habits or behaviour patterns to stereotyped situations, nor is it the application of definite principle (Wertheimer, 1945). In his opinion, problem solving is not just the sum of several steps not an aggregate of several operations, but the growth of one line of thinking out of the gaps in the situation. Suchman’s inquiry training model is based on Wertheimer's insight on problem solving.
Problem solving occupies highest position in the hierarchy of learning proposed by Gagne (1985). Thinking, learning and problem solving are closely related. Psychologists study thinking by examining the behaviour of people attempting to solve problems and by manipulating the characteristics of the problem, the problem solver, and the nature of the information given to the subject (Solso, 1995). In Gagne's opinion, problem solving is a natural extension of rule learning (Gagne, 1985). The sequence of events involved in problem solving is often referred to in the writings of John Dewey (Dewey, 1916).

d) Piaget's and Neo-Piagetian View on Cognitive Development

In Piaget's opinion cognitive development occurs as an orderly process in a bio-social context and it is a long term, continuous and dynamic interaction between the organism and the physical environment. The important factors which account for the sequence of development being maturation (biological), experience of the physical environment and the equilibration by the organism.

Neo-Piagetians, such as Sinclair (1973) and John (1990) have attempted to combine the Piagetian and the information processing approaches. They proposed stage theories but have incorporated the development of working memory from the information processing approach.

e) Rote Mode (Learning by rote) Learning and Meaningful Learning

Rote learning involves injecting isolated bits of information into existing cognitive structures, whereas, meaningful learning involves relating and connecting newly introduced knowledge and information to more general and prior-learned material. Learning becomes rote whenever and to the extent that the material
to be learned lacked logical meaningfulness, the learner lacks relevant ideas in his cognitive structure and the learner lacks a meaningful mindset (Miller et al., 1982). The meaningfully learned material would have more retention power and transfer ability. They are more relatable and anchorable to relevant and more inclusive concepts in the existing cognitive structure.

f) Concept mapping: A Metacognitive Strategy

Based on Ausubel's ideas and theories on concept learning and cognitive structure, and meaningful learning has been evolved giving rise to different strategies for learning the concepts namely, Govin's Vee Heuristic and Concept mapping. Concept mapping is a learning strategy that was developed first as a research tool to represent learner's prior knowledge, and later as a tool to enhance meaningful learning. Concept maps attempt to render a concrete representation of the structural knowledge of an individual and the ways in which these concepts are perceived to be connected to one another and to the existing structures. Concept mapping is a meta learning strategy based on the Novak and Gowin (1984) theory of meaningful learning. It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, integrative reconciliation and cognitive bridging. Concept map provides a schematic summary of what has been learned. Concept maps are designed to parallel human cognitive structure in that they show concepts organised hierarchically because concepts are subsumed under broader, and more inclusive concepts. In its simplest form, a concept map would be just two concepts connected by a linking word to form a proposition. Concepts are generally isolated by circles and connected by lines. Lines are labelled with linking
words which describe how the connected concepts are related to each other. In short, concept mapping is a technique for externalising concepts and propositions.

2.1.8 Evolution of Information Processing Research

At the time of World War II, many psychologists were asked to design equipment and devise training programmes for military personnel. After the war, some of these psychologists were asked to perform similar tasks for industrial concerns. During these post-war applications of psychology, criticisms of behavioural learning theory began to accumulate. The major criticism raised against behavioural learning theory was that the major conclusions should be based on observations of overt behaviour.

In the late 1960s and 1970s techniques of education favoured by cognitive psychologists such as Piaget, Bruner and humanistic psychologists such as Abraham Maslow, and Carl Rogers became popular (Bichler, 1986). Many psychologists of that time were interested in speculating about what goes on in the learner’s mind when he confronted with a problem. But they were dissatisfied with the vague descriptions of cognitive process proposed by Piaget and Bruner. They were kindled with the sudden outburst of computers on the scene. As a consequence, researchers began to study how humans transform input into output and how they encode, store, process and retrieve information.

Information Processing psychology asserts that learning is an interactive process between the learner and the environment (Narrang and Arora, 1996). Information Processing Psychologists suggested several models of the relation between different cognitive processes. The metaphor of human mind as a computer is
subject to several criticisms and also leads to extensive debate on the potential advantage of the computer. A series of provocative studies on how human memory functions triggered a veritable landslide of research. Eventually several theorists developed flow charts similar to those used in the computers to describe how the human mind works. The best general purpose model of human memory was developed by Atkinson and Shiffrin (1968). In this model the human memory was categorised into three interrelated systems: (i) the sensory register being the most transient (ii) short term or primary memory being more enduring and (iii) long term memory or secondary store as the most permanent.

Information Processing Model has a distinct point of view about how people think and how to affect the ways they operate on information (Weil and Joyce, 1985). The word information is used to refer to the signals that undergo various kinds of processing as a Television receives signals that undergo various kinds of processing until a picture is produced. The second meaning of information is something that is simply available in the world.

2.2 MODELS OF TEACHING-DEFINITION

Joyce and Weil (1985) define models of teaching as a plan or pattern that can be used to shape curriculum, to design instructional materials, and to guide instruction in the classroom and other settings. Most of the ideas incorporated in this chapter from the work of Joyce and Weil (1997).

Eggen, Paul et al. (1979) describe Models as prescriptive teaching strategies designed to accomplish particular instructional goals.
It is a step by step procedure that leads to specific learning outcomes (Gunter, Estes and Schwab, 1990).

A model of teaching is a description of a learning environment (Joyce and Weil, 1997)

Dunn and Dunn (1979), Fischer and Fischer (1979) Ellis (1979), Joyce and Weil (1980) Ausubel, Bruner and Skinner (learning Theorists). Hunt, Kohlberg and Piaget (Developmental Psychologists); Browdy, Dewey and James (Philosophers) contributed much to the development of different strategies and teaching models.

Models of teaching are the forerunner of probable theories. Since the early 1960s, there has been an increased use of models and model building in educational research.

Torsten Husen (1994) investigated and give a brief summary of the models developed by Kaplan (1964) and Tatsauoka (1968): They are (i) Analogue Models They are widely used in physical sciences, but rarely used in the field of education. (ii) Semantic Models. They are in common use in the field of educational research. They are expressed in verbal form and they employ figures of speech or metaphors. (iii) Schematic Models: They serve as a link between theory and the real world. It is like a map and generally serves to group and cluster constructs into an ordered relationship. (iv) Mathematical Models: These models lay the foundations for a more formal theory, built around the causal relationships that are implicitly or explicitly contained within the model.

Casual Models Since the early 1970s there has been wide use of these models in the field of educational research.
vi) Confluence model: This is an application of mathematical model to an educational problem.

The International Encyclopaedia of Education (1994) gives a brief description of two more teaching models. They are the models developed by Mosston (1972) and Stallings (1977). Mosston in his enlightening work “From Command to Discovery” discussed seven teaching models:

i) Command style

ii) Task style

iii) Reciprocal style

iv) Individual programme (Teacher’s Design)

v) Guided discovery model

vi) Problem solving model

vii) Individual Programme (Pupil’s design)

Stallings (1977) developed five teaching models

i) The expository models

ii) The group process models

iii) The developmental cognitive models

iv) The programmed models

v) The fundamental model skills.

2.2.1 Kaplan’s Information Processing Model

Among the various models developed by Kaplan and Tatsuoka, the Information Processing Model developed by Kaplan, a semantic model is of foremost importance. Kaplan used the metaphor of landscape preference for this. It is based
on the concept that landscape preference must have evolved as an adaptive process as humans evolved the mental and perceptual capabilities for processing information which is important for survival. In his opinion humans are constantly building models of the environment they experience. The mental models which one develops from environmental encounters are in turn, instrumental in how one interprets future environmental encounters. This mental model or cognitive map provides link between human thought process and the physical environment.

In order to function and thrive in an environment human beings must be able to make sense of that environment and then become involved in it. This is accomplished by relating the perceived structure of a landscape to a cognitive map which is built in mind. This mapping enables an individual to predict and anticipate the information being presented.

**Kaplan's Four Factors from the Framework**

In order to make sense of an environment Kaplan suggested four factors from the framework of his theory. They are:

Coherence - the extent to which the scene 'hang together' through repetition of elements, textures, and structural factors which facilitate comprehension.

Complexity - the amount of variety and diversity in a scene

Legibility - the recognition of an environment that looks as if one could explore it extensively without getting lost.

Mystery - the degree to which more information may be gained by proceeding further into the scene.
In addition to the four factors to make an environment sensible, certain additional factors such as prior experience, context and familiarity are also important. Involvement also requires additional mapping to process new information being present.

2.2.2 Goals and Assumption of Information Processing Models

From among the seven models belonging to the Information Processing Models three models were selected for the study. They are (i) Concept Attainment Model developed by Jerome Bruner, (ii) Advance Organizer Model (David Ausubel) share a common view about the nature of concepts and about conceptual learning. Ausubel's ideas on how knowledge is organised in the mind constitute a very useful framework for teaching concepts. Ausubel's model is concerned exclusively with acquisition and retention of information. The general goal of Inquiry Training Model is to help students develop the intellectual discipline and skills necessary to raise questions and search out answers stemming from curiosity. Inquiry Training originated in a belief in the development of independent learners (Sugandhi and D' Lima, 1986).

Major Goals of IPM

Helping children learn concepts and teaching them how to learn concepts is the fundamental purpose of schooling (Weil and Joyce, 1978).

According to Eggen et al. (1979) the major goals of Information Processing Models in the classroom are the following:

1. Development of intellectual capabilities such as the ability to reason and think more logically.
2 the acquisition of content
3 The mastery of methods of inquiry.

2.2.3 Human Information Processing (HIP)

The Human Information Processing brands of cognitive psychology are more domain specific compared to Piagetian domain general in approach. Information processing begins when an individual encounters with his environment and begins to organise the information he gathers from it.

The raw materials gathered from the environment are processed or organised into more understandable form. The intellectual skill or capabilities required to analyse information are called process and include the ability to make observations and inference. Of these, observation is the basic. The knowledge that results from processing of information depends upon the type of processing which was used to form it (Eggen, 1979).

Wel and Joyce (1978) developed more than 20 models of teaching which are grouped on the basis of their chief emphasis-the ways they approached educational goals and means. They have organised these models into four families. They are:

1. Information Processing models
2. Social interaction models
3. Personal models and
4. Behaviour Modification models and
1. **Information Processing Models**

Information Processing Models are oriented toward the information capacity of the students. Information Processing refers to the way people handle stimuli from the environment, organise data, sense problems, generate concepts, and solutions to problems and employ verbal and non-verbal symbols (Weil and Joyce, 1978). Some information processing models are to concern with the ability of the learner to solve problems and thus emphasise productive thinking, others are concerned with general intellectual ability.

2. **Social Interaction Models**

The models in this family emphasise relationships of the individual to society or to other persons. With respect to goals, models this orientation gives priority to the improvement of the individual's ability to relate to others, to engage in democratic processes, and work productively in society. While social relations may be emphasised more than other domains, social theorists are also concerned with the development of the mind and the self and the learning of academic subjects.

3. **Personal Models**

The personal models of teaching pay great attention to the individual perspective and seek to encourage productive independence so that people become increasingly self-aware and responsible for their own destinies.

4. **Behaviour Modification Models**

The theoretical base of this family is commonly called social learning theory, behaviour therapy and cybernetics. These models take the stance that human
beings are self-correcting communication systems that modify behaviour in response to information about how successfully tasks are navigated.

Table 2.1 describes models that come under the Information Processing family, the name of the major theorists, goals or mission of each model (Weil and Joyce, 1985). Table 2.2 displays the new version of Information Processing Model with names of the developers and redevelopers (Weil and Joyce, 1997).

**Table 2.1**

**Information Processing Model**

<table>
<thead>
<tr>
<th>Model</th>
<th>Major Theorists</th>
<th>Goals which intended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductive thinking</td>
<td>Hilda Taba</td>
<td>Designed primarily for development of inductive mental process and academic reasoning of theory building, but these capacities are useful for personal and social goals as well</td>
</tr>
<tr>
<td>Classification oriented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inquiry Training</td>
<td>Richard Suchman</td>
<td>Designed to teach the research system of discipline, but also expected to have effects in other domains</td>
</tr>
<tr>
<td>Scientific Inquiry</td>
<td>Joseph J. Schwab</td>
<td>Designed primarily to develop inductive reasoning but also for concept development analysis</td>
</tr>
<tr>
<td>Concept Attainment</td>
<td>Jerome S. Bruner</td>
<td>Designed to increase general intellectual development especially logical reasoning</td>
</tr>
<tr>
<td>Cognitive Growth</td>
<td>Jean Piaget, Irving Sigel, Edmund Sullivan</td>
<td>Designed to increase efficiency of information processing capacities meaningfully, absorbing and relate bodies of knowledge</td>
</tr>
<tr>
<td>Advance Organizer</td>
<td>David P. Ausubel</td>
<td>Designed to increase capacity to memorise.</td>
</tr>
<tr>
<td>Memory</td>
<td>Jerry Lucas</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.2

Information Processing Models (Modified Version)

<table>
<thead>
<tr>
<th>Model</th>
<th>Developers and Redevelopers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductive Thinking</td>
<td>Hilda Taba</td>
</tr>
<tr>
<td>(Classification Oriented)</td>
<td>(Bruce Joyce)</td>
</tr>
<tr>
<td>Concept Attainment</td>
<td>Jerome Bruner (Fred Lighthall)</td>
</tr>
<tr>
<td></td>
<td>Tennyson (Cocchiarella)</td>
</tr>
<tr>
<td>Mnemonics</td>
<td>Bruce Joyce (Michael Pressley)</td>
</tr>
<tr>
<td>(memory assists)</td>
<td>John Levin</td>
</tr>
<tr>
<td>Advance Organizers</td>
<td>Richard Anderson</td>
</tr>
<tr>
<td></td>
<td>David Ausubel</td>
</tr>
<tr>
<td></td>
<td>(Lawton and Wanska)</td>
</tr>
<tr>
<td>Scientific Inquiry</td>
<td>Joseph Schwab</td>
</tr>
<tr>
<td>Inquiry Training</td>
<td>Richard Suchman</td>
</tr>
<tr>
<td>Syntactics</td>
<td>Bill Gorden</td>
</tr>
</tbody>
</table>

2.2.4 Sources of Information Processing Model

Models focusing on Information Processing come from several sources.

1. **Metacognition:** It is the name for the knowledge that people have about the way that cognitive process works. Philosophers have thought about thought, and about how inductive and deductive thinking function etc and these come under metacognition.
2. **Learning Theorists**: The belief that we use previously learned concepts to process incoming information is the heart of these theories. David Ausubel and Jerome Bruner and his associates evolved certain strategies which provide a set of concepts that alter an individual’s thinking processes.

3. **The academic disciplines**: Many models have been developed to teach either the major concepts or the systems of inquiry used by the disciplines.

4. **Developmental studies of human intellect**: Investigators have also studied the development of intellectual processes. In the place of purely mechanical or instrumental approach the developmental theories of human intellect emphasise the role of purpose, insight, understanding, reasoning, memory and other cognitive factors in the process of learning. This school of thought mainly belongs to Gestalt psychologists, and cognitive psychologists. Piaget’s and Erickson’s work serve as a foundation for these models.

**Definition of Information Processing Models**

Generally the Information Processing Models refer to the information-processing capability of the students and the ways by which they can improve their ability to master information. It deals with the ways people handle stimuli from the environment, organise data, sense problems, generate concepts, and solutions to problems, and employ verbal and non-verbal symbols (Weil and Joyce, 1985). Some Information Processing Models are concerned with the ability of the learner to solve problems and others are concerned with general intellectual ability.
In Information Processing Theory, the individual is viewed as a processor of information (Broadbent, 1958, 1971; Lachman et al., 1979; Massaro, 1975; Weissner, 1967).

The processing of information depends on the nature of sensory system, prior experience, context, and the goals of the participant. The central assumption in information processing model is that teaching is a process by which teacher and students create a shared environment in the classroom.

Information Processing psychologists assert that learning is an interactive process between the learner and the environment. According to the schema theory, the learner is not just a passive receiver of stimuli, he organises what he learns according to the patterns or schema, which help him to make sense of the multiple stimuli he constantly receives from the environment. So learning becomes a continuous process by which the student either relates new data to existing pattern or must create new schema in order to understand.

2.2.5 Computer Analogy in Information Processing Model

Cognitive psychology has replaced behaviourism as the dominant school of thought in American Psychology regarding learning and development. The metaphor of the human mind as a computer coupled with the central role of the computer today favours the use of Information Processing Model.

2.2.6 Major Concepts Underlying the IPM

Each model can be analysed in terms of four major concepts: i) syntax ii) social system iii) principles of reaction iv) support system. These descriptions are
all operational heart of each model. It stands as a way of communicating the basic procedure in implementing any instructional model.

1. Syntax

Syntax or phasing of the model describes the model in action. It is described in terms of sequences of events which are called phases. Each model has a distinct flow of phases.

2. The Social System

The social system describes the student and teacher roles and relationships and the kinds of norms that are encouraged. In some models the teacher is the centre of activity. In some other models teacher takes the role of a facilitator, in others a counsellor or a task master. The teacher can tighten or loosen the structure considerably.

3. Principles of Reaction

Principles of reaction tell the teacher how to regard the learner and to respond to what the learner does.

4. Support System

The support system refers to additional requirements beyond the usual human skills, capacities and technical facilities necessary to implement the model. Without the use of support system the model will be empty.

2.2.7 Description of the Effects of the Model

The effects of the model can be categorised as the direct or instructional effects and the indirect or nurturant effects.
Direct or Instructional Effect

The instructional effects are those directly achieved by leading the learner in certain directions. It is designed to come from the content and skills on which the activities are based. It is more explicit in the learning environment.

Indirect or Nurturant Effect

The indirect or nurturant effect comes from experiencing the environment created by the model. It is possible to defend the selection of the model chiefly on the basis of its nurturant effects, even though it might not have high direct efficiency.

The direct and indirect effects are usually indicated with the help of a diagram as follows.

![Diagram](image)

Direct or Instructional
Indirect or Nurturant

Fig. 2.2 Instructional and Nurturant Effect of a Model
2.3 CONCEPT ATTAINMENT MODEL

Three Domains of Educational Goals

Educational goals are typically divided into three families or domains viz. cognitive domain, affective domain and psychomotor domain. Cognitive goals address the development of students' intellect. Within the cognitive family an important set of goals is called information processing. Information processing can be thought of as the way people gather and organise information from the environment, in order to form useful patterns which can be used to explain and predict events in their own experience. Since the establishment of the cognitive paradigm in psychology, models are increasingly used in educational research which rely on the assumption that man is an information processing system (Karlinger, 1981). Models are heuristics for theorists and researchers. They guide thinking by simplifying and representing complex phenomena as a set of relationships among a few important variables.

Teachers who focus on information processing goals have dual set of objectives, the first one is to help students acquire bodies of useful information and the second one is to help them develop the thinking skills. The long-term goal of all information processing models is to teach students how to think effectively. Complex intellectual strategies allow students to absorb more concepts and information. Information processing models are basically approaches to metacognition- i.e., learning to learn. It increases the capability to learn more easily and effectively in the future. The range of information processing models is considerable. They offer the teacher several views as to how students think and a good variety of techniques for
trying to improve **thinking skills**. From the days of earliest Greeks, philosophers theorised about how the mind works and how *inductive as well as deductive thinking* functions. In modern times computer simulations are widely used to represent how mental processes are going on. *Cognition and cognitive process* is stressed in the information processing models of teaching. By adopting information processing model students learn the processes and ideas of the discipline, they incorporate them into their own system and behave differently.

The models selected from the information family are designed to teach both content and thinking skills. The core of information processing in the arrangement of the environment within which the student can interact and study how to learn effectively and efficiently.

### 2.3.1 Discovery Learning in CAM

By selecting concept attainment model, it is designed that the learner takes up the position of a discoverer, whereby he controls his own attending, learning and thinking power. Here the major stress is on the process involved in and the strategies followed in attaining the concepts. Concept Attainment Model also helps students to learn concepts for organising information and helps students to become effective at learning concepts. It includes an efficient method for presenting organised information from the wide range of areas of study to students of every stage of development.

### 2.3.2 Bruner's Theory of Learning and of Instruction

Jerome S. Bruner (1960) developed a cognitive developmental theory of learning and instruction as an alternative to that of Piaget in his book *The Process
of Education and subsequent publications. The themes around which his theory of learning revolves are mainly four. They are the themes of structure, readiness, intuition and interest.

According to Bruner (1966), a theory of instruction has four main features. They are as follows.

1) Predisposition to learning
2) Structure of knowledge
3) Sequence
4) Reinforcement

Bruner recognises three important sequential stages in the intellectual development of the child. They are enactive, iconic and symbolic. There is a closer comparison between the stages of development proposed by Piaget and Bruner. Bruner’s enactive stage corresponds to Piaget’s sensori-motor and preoperational stages, iconic stage corresponds to Piaget’s concrete operational and symbolic stage corresponds to formal operations.

Instruction according to Bruner, should make learners self-sufficient problem solvers or discoverers. But it should be noted that Bruner does not restrict discovery to an act of finding out something that before was unknown to mankind. Discovery includes all forms of obtainable knowledge for oneself by the use of one’s own mind (Bruner and Anglin, 1973).

2.3.3 Theory Underlying Concept Attainment Model

The Concept Attainment Model was developed from the works of Jerome Bruner, Jacqueline Goodnow, and George Austine (1956; 1961; 1966, 1971).
Their work 'The Study of Thinking' leads to many years of research on the processes by which people acquire concepts, nature of concepts, concept learning, elements of concepts and the teaching strategy used for attaining concepts.

In Webster's Dictionary a concept is defined as a "a mental image of things formed by generation from particles, also an idea of what a thing in general is to be".

A concept may be viewed initially as a summary of an essential characteristic of a group – ideas or facts that optimise important common features of factors from a large number of ideas (Ausubel, 1978).

The process of primitive categorisation is called concept formation (Bruner, 1960). According to Bruner, categorising activity has two components: the act of concept formation and the act of concept attainment. Concept formation is the first step toward concept attainment. Bruner and his associates are mainly concerned with the process of concept attainment.

2.3.4 Elements of the Concepts

Bruner sees any concept as having three elements:

1. Examples (also exemplars or instances)
2. Attributes
3. Attribute values

In concept attainment model the positive and negative examples are tested and searched for their features. Each example is described in terms of its basic characteristics. These basic characteristics are called attributes. These attributes can be classified as essential attributes and non-essential attributes. The distinguishing
attributes and their value ranges are called criterial attributes. The non-essential attribute of a concept is also called noisy attribute.

2.3.5 Strategies Used for Attaining Concepts

The term 'strategy' is used to refer to the sequence of decisions people make as they encounter each instances of a concept (Bruner and his associates, 1967). In their opinion, an ideal strategy is one that is most efficient in attaining the concept but has the least amount of cognitive strain due to memory overload and ambiguity.

2.3.6 Types of Thinking Strategies

Bruner and his associates have identified six strategies for attaining concepts. Out of these, four of them are selection strategies and two are reception strategies. In selection conditions the examples of the concept are not marked as 'yes' for the positive and 'no' for the negative examples. In reception strategies the examples are marked as 'yes' or 'no'.

2.3.7 Selection Strategy

1. Simultaneous scanning
2. Successive scanning
3. Conservative focusing
4. Focus gambling

2.3.8 Reception Strategy

1. Wholist
2. Partist

The two scanning strategies followed in selection conditions used concept hypothesis as a basis of searching, in the simultaneous scanning many
hypotheses are used at a time, in successive scanning only one hypothesis is taken at a time. In conservative focusing attributes are used as a basis of searching and in conservative focusing many attributes are taken at a time and in focus gambling only one attribute is taken at a time for searching the concept. Purpose of thinking strategies:

1. to understand the nature of concepts
2. to teach specific concepts
3. to become more aware of conceptualising activity

Based on the six strategies of thinking process Bruner and his associates formulated three versions of concept attainment model namely:

1. Reception Oriented Concept attainment Model
2. selection Oriented Concept attainment Model and
3. Unorganized Material Model

In the reception strategy, the most structured, students must be guided carefully in early classes. Students analyse the positive exemplars for common attributes, contrasting them with absence of those attributes in negative exemplars. Then students must identify unlabelled sentences or examples as positive or negative exemplars.

The major difference between reception and selection oriented models or concept Attainment is in the labelling and sequencing of the examples. The third version is much more a group discussion than an instructional game. In this version the teacher’s role is to facilitate discussion and insure that it focuses on the development of a concept in the material.
The selection strategy begins with unlabelled exemplars. The students must group them and develop hypotheses about their attributes.

The unorganised materials strategy requires students to identify attributes of concepts asserted verbally in the text.

All three strategies use analytical and evaluative thinking skills during the concept attainment lesson, focusing on teacher objectives, general content, and the process being used it helps them think and participate more actively.

2.3.9 Definition of CAM

Concept Attainment Model (CAM) is a teaching strategy based on analysis of the nature of concepts and how they are acquired. It also helps students to develop skills for inductive and deductive thinking while learning subject matter in any field in a constructive and meaningful way.

Planning for teaching with the concept attainment model involves (i) identifying concept (ii) analysing its essential and defining features and (iii) designing exemplars from which the concept can be derived.

2.3.10 Analysis of Concept Attainment Model

1. Syntax

Phase one: Presentation of data and Identification of concept

Teacher presents labelled examples

Students compare attributes in positive and negative examples

Students generate and test hypotheses

Students state a definition according to essential attributes
Phase two: Testing attainment of the concept

Students identify additional unlabeled examples as 'yes' or 'no'.

Teacher confirms hypotheses, names concept, and restates definitions, according to essential attributes.

Students generate examples.

Phase three: Analysis of Thinking Strategies

Students describe thoughts.

Students discuss the role of hypotheses and attributes.

Students discuss type and number of hypotheses.

2. The Social System

The three major functions of the teacher during concept attainment activity are to record, prompt, and present additional data. In the initial stage of concept attainment, it is helpful for the students if the teacher selects and organizes the material into positive, negative, and also decides the sequence of the examples as reception or selection.

3. Principles of Reaction

During the flow of the lesson, the teacher needs to be supportive and should encourage analysis of the merits of various strategies rather than attempting to seek the one best strategy for all people in all situations.

4. Support System

The concept attainment lessons require material that has been designed so that concepts are embedded in the material. The data source needs to be known beforehand and the aspects of the concept attainment activity made visible. The
students need work sheets to record the attributes of the concept when the students are presented with positive and negative examples.

Fig. 2.3 Effects of Concept Attainment Model

2.4 THEORY UNDERLYING ADVANCE ORGANIZER MODEL

The Advance Organizer Model of Teaching is based on the Theory of Meaningful Verbal Learning propounded by David P. Ausubel. Meaningful Learning presupposes two things: first, the learner manifests a meaningful learning set, i.e., a disposition to relate new material non-arbitrarily and substantively to his cognitive structure and that material he learns be potentially meaningful to him, namely, relatable to his structure of knowledge on a non-arbitrary and non-verbatim basis (Ausbel, 1961). The central idea in Ausbel's theory is that of meaningful learning, which he defines as non-arbitrary, substantive, verbatim incorporation of new
knowledge into cognitive structure. Based on Ausbel’s ideas and theories, concept learning has been evolved which gives rise to different types of strategies for teaching and learning namely, advance organizer model of teaching and a concept learning strategy called Gowin’s Vee Heuristic and Concept Mapping.

2.4.1. Rote–Meaningful Dimension of Learning

Rote learning involves ingesting isolated bits of information into the existing cognitive structures whereas meaningful learning involves relating new materials to the existing structure (Ausbel, 1963).

Ausbel has contributed much to the field of meaningful learning of concepts through his two theories namely.

i) Psychology of meaningful verbal learning

ii) Assimilation theory of cognitive learning.

2.4.2 Psychology of Meaningful Verbal Learning

Meaningful verbal learning consists of two processes concerned with perception and cognition. The distinction between perceptual and cognitive processes is difficult to define because both kinds of processes involve interaction between verbal stimulus input and cognitive structure. Perception involves an immediate content awareness before the intervention of complex cognitive processes. On the other hand, cognition involves such processes as relating the new material to relevant aspects of existing cognitive structure and recording it in more familiar and idiosyncratic language.
2.4.3 Assimilation Theory of Cognitive Learning

Ausubel’s (1963) Assimilation Theory of Cognitive Learning has been a guide to research in concept teaching. Ausubel emphasis that each of the academic disciplines has a structure of concepts that are organised hierarchically. Ausubel conceptualises a discipline as levels of these hierarchically organised concepts that begin with perceptual data at bottom and proceed through increasing levels of abstraction to the most abstract concepts at the top. Thus we may imagine a discipline as having composed of a pyramid of concepts all linked together with the most concrete concepts at the bottom and more abstract concepts at the top.

The Advance Organizer Model is designed to strengthen student’s cognitive structures, which is the foremost factor governing whether the new material will be meaningful and how well it can be acquired and retained.

2.4.4 Definition of Advance Organizer Model

Advance Organizer Model is a deductive information processing model designed to teach interrelated bodies of content. Ausubel believed that acquisition of information is a valid goal of schooling. The learner’s primary role is to master ideas and information.

In order to explain his ideas Ausubel introduces certain concepts that can be applied to the design of instruction and research in education.

Influenced by the German Gestalt psychologists and Wuzberg school in Europe, cognitive psychologists began to view the learner as an active information processor. The Gestalt school of psychologists believed that experience could not be understood by breaking it down into simpler units. When people perceive things they
tend to do so holistically. People organize their experience so as to make it as simple and coherent as possible (Flavel, 1978). The Genevan school proposed that thought processes depended upon the ability to create, hold and modify internal representations of things which are experienced in the environment. In their opinion, the meaningful learning of complex material is an active, constructive, cumulative, self-regulated and goal oriented process (Weiner and Lerman, 1979). In order to be meaningful and capable of being understood the body of knowledge must be structured and organized.

2.4.5 Hierarchical Arrangement of Content

In *Advance Organizer Model*, David Ausubel is of the view that each of the disciplines has a structure of concepts that are arranged hierarchically. The methods used to form the structure of the content are:

i) Organizing the content through the use of inter-related and inter-connected conceptual systems and

ii) Analysis of concepts into subordinate, co-ordinate and superordinate relationships.

The advance organizer model is designed to strengthen the student's cognitive structures. Ausubel maintains that a person's existing cognitive structure is the foremost factor governing whether the new material will be meaningful and how well it can be acquired and retained. By cognitive structure Ausubel means "a person's knowledge of a particular subject matter at any given time and how well organized, clear and stable it is" (Ausubel, 1963). Ausubel holds the view that like
academic disciplines mind is a hierarchically organized set of ideas that provide anchors for information and ideas and that serve as a storehouse for them. Ausubel used certain important terms to explain his theory of meaningful verbal learning, namely:

1. **Advance Organizer**

The Advance Organizer Model of teaching is a derivative of the theory of meaningful verbal learning developed by David P. Ausubel. According to Ausubel's theory of meaningful verbal learning, advance organizers are introduced in advance of new learning tasks. Ausubel describes 'advance organizer' as "introductory material that is presented ahead of the learning task and at a higher level of abstraction and inclusiveness than the learning task itself" (Ausubel, 1968).

In the actual teaching situation the use of advance organizers is the primary means of strengthening the cognitive structures and enhancing retention of new information.

**Purpose of Advance Organizer**

The purpose of introducing Advance Organizers is to explain, integrate and interrelate the material in the learning task with the previously learned material. An Advance Organizer is a bridging strategy that provides a connection between the known and the unknown. It is a means of capitalizing on student's prior knowledge about the material and it acts as a technique for aiding learning and retrieval of information and ultimately it leads to transfer of knowledge. An Advance Organizer acts as a bridging strategy by allowing the learner to bridge the gap between what they have already known and what they must learn. This connectivity is achieved through the use of advance organizer which organizes the new material to be
presented by outlining, arranging, logically sequencing the main ideas or procedures in the new material based on the learner's prior knowledge

**Form of Advance Organizer**

An Advance Organizer can take any of the forms, viz. 

(i) a concept definition (ii) an analogy (iii) a generalization

(i) **Concept definition**

Advance Organizers are generally based upon the major concepts, propositions, principles and laws of a discipline. When the new material to be taught is new or unfamiliar to the student, definitions are valuable organizers of the content. The defining statement should possess the characteristic of a concept definition i.e., it states the concepts, superordinate concepts and characteristics of the concepts.

(ii) **Analogy**

The most effective type of Advance Organizer is analogy. Analogies are effective as organizers because they can be customised to fit the background of a particular subject population.

(iii) **Generalizations**

Generalizations can also be used as Advance Organizer. One must be certain that each of the concepts in the generalization is familiar to the students.

**Types of Advance Organizers**

The above three forms of Advance Organizers were classified into expository and comparative organizers (Ausubel, 1978).
Expository organizers They are used when the learning material is relatively new. They provide ideational scaffolding for unfamiliar material by giving a general model of class relationship or general subsumer for a new class before more subsumers are provided for a particular class.

Comparative Organizers: Comparative organizers are designed to integrate new concepts with basically similar concepts existing in the cognitive structure, yet they are designed to discriminate between the old and the new concepts to prevent the confusion caused by similarity.

Concepts form the major portion of our school curriculum to teach concepts meaningfully, we link the concepts with other concepts. Concepts are divided into super ordinate co-ordinate and subordinate concepts. The expository organizers provide a basic concept at the highest level of abstraction, viz. the super ordinate concepts, the co-ordinate and subordinate concepts.

2. Cognitive Structure

By cognitive structure Ausubel means “a person’s knowledge of a particular subject matter at any given time and how well organized, clear, and stable it is” (Ausubel, 1963)

3. Progressive Differentiation

It means that the most general ideas of the disciplines are presented first, followed by a gradual increase in detail and specificity” (Joyce and Weil, 1997)

4. Integrative Reconciliation

It means that new ideas should be consciously reconciled and integrated with previously learned content.
5. **Subsumption**

For learning to be meaningful the information should be frequently linked or anchored to relevant aspects of an individual's existing structure. This process of linking new information to pre-existing segments of cognitive structure is referred to as subsumption (Ausubel, 1968)

6. **Intellectual Scaffolding**

The Advance Organizer contains many subordinate ideas that can be linked to a particular characteristic of the subject matter presented earlier. The hierarchical organization of the cognitive structure is analogous to the conceptual structure of an academic discipline. These hierarchically organized ideas provide anchors for new information and ideas as they are received and it also reorganizes itself to receive new ideas. Thus this system is in a constant state of change. To provide ideational anchors to the new information, the new information should be related to the already available concepts or propositions. The teacher must organize a sequence of knowledge and present it in such a way that the ideational anchors are provided and Ausubel called it "intellectual scaffolding" for unfamiliar material on which students will hand the new information as they encounter it.

**2.4.6 Analysis of Advance Organizer Model**

**Syntax**

- **Phase one: Presentation of Advance Organizer Model**
  - Clarify the aims of the lesson
  - Present Organizer
  - Identify defining attributes
Give examples or illustrations

Provide context

Repeat

Prompt awareness of learner's relevant knowledge and experience

**Phase Two: Presentation of Advance Organizer Model**

Present material

Make logical order of learning material explicit

Link material to organizer

**Phase three: Strengthening cognitive organization**

Use principles of integrative reconciliation

Elicit critical approach to subject matter

Clarify ideas

Apply ideas actively

**Social System**

The first two phases are highly structured. However, it requires active collaboration between the teacher and the students. In the third phase, the teacher acts as a facilitator and guide. The learning situation is much more interactive.

**Principles of Reaction**

The teacher’s reaction to the learner’s reactions will be guided by the purpose of clarifying the meaning of the new material. The teacher helps the students to connect the organizer and the learning material and the teacher prompts critical approach of knowledge.
Support System

Data-rich, well-organized material is the critical support requirement of this model. Preparation and use of concept mapping technique and the collection and use of paper cuttings, audio and visual aids serve as support system.

Fig. 2.4 Effects of Advance Organizer Model

2.5 INQUIRY TRAINING MODEL (ITM)

This model was first developed by Richard Suchman (1962) it was designed to teach students to engage in causal reasoning, and to become more fluent in asking questions, building concepts and hypotheses and testing them (Weil and Joyce, 1997).
The chief learning outcomes of inquiry training model are the processes involved—observing, collecting and organizing data, identifying and controlling variables, making and testing hypothesis, formulating explanations and drawing inferences. This model splendidly integrates these process skills into a single, meaningful unit of experience.

The format of the model promotes active, autonomous learning as the students formulate questions and test ideas. The Inquiry Training Model emphasises inquiry process; nevertheless the content in any subject can be taught to elementary as well as secondary level students (Singh, 1995)

The general goal of inquiry is to help students develop the intellectual discipline and skills necessary to raise questions and search out answer stemming from curiosity.

Inquiry training originated in a belief in the development of independent and autonomous learners. Inquiry Training begins by presenting students with a puzzling event. The basic principle behind Suchman’s theory is that

i) People make inquiries naturally when they are puzzled

ii) they can become conscious of and learn to analyse their thinking strategies

iii) New strategies can be taught directly

iv) Co-operative inquiry enriches thinking and helps students to learn about the tentative nature of knowledge.

Inquiry Training begins with a puzzling event. After the presentation of the puzzling situation the students ask the teacher questions. The questions, however, must be answered by a ‘yes’ or ‘no’ by the teacher. The construction of
puzzling situation is the critical task, because it transforms curriculum content into problems to be explored. Discrepant events can be developed through print, film or audio means, and task cards directing student to respond according to the model can be developed.

Although its emphasis is on process, inquiry training results, too, in the learning of content in any curriculum area from which problems are selected (Weil and Joyce, 1997). While the individuals are faced with a puzzling situation, they are motivated to pursue meaning in it. In order to understand the puzzling situations, individuals must increase the complexity of their thinking and understand better how to link data into concepts and how to apply these concepts towards the identification of principles of causation. While we prepare the puzzling situation, when objects or other learning materials are not available, or appropriate to the problem situation the teachers can make up a problem statement for students and prepare discrepant event and the fact sheet provides further information about the problem. Co-operative inquiry enriches thinking and helps students to learn about tentative, emergent nature of knowledge and to appreciate alternative explanations.

2.5.1 Analysis of Inquiry Training Model

Syntax

Phase One: Confrontation with the problem

   Explain Inquiry procedures

   Present Discrepant Event

Phase Two: Data gathering-Verification

   Verify the nature of objects and conditions
Verify the occurrence of the problem situation

**Phase Three: Data Gathering-Experimentation**

Isolate relevant variables

Hypotheses and test casual relationships

**Phase Four: Organizing, Formulating and Explanation**

Formulate rules or explanations

**Phase Five: Analysis of the Inquiry process**

Analyse Inquiry Strategy and develop more effective ones

**Social System**

Inquiry Training model can be highly structured, with the teacher controlling the interaction and prescribing the inquiry procedures. Intellectual environment is open to all relevant ideas. Interaction among students should be encouraged.

**Principles of Reaction**

During the process of Inquiry the teacher should ensure that questions are phrased in such a way that they can be answered by 'yes' or 'no'.

1. There should be no double barrel questions
2. Ask students to rephrase invalid questions
3. Use the language of the Inquiry Process
4. Try to provide a free intellectual environment by not evaluating theories.
5. Ask the students to make clear statement of the theories and provide for their generalisation.
**Encounter with the Problem**

During the phase one of the model, the teacher presents the problem situation and explains the inquiry procedure to the students. The teacher explains the rules of the game and the type of questions they should ask.

**Data Gathering and Verification**

During the phase two of the model the teacher guides the students to ask fact finding questions. Data gathering and theorising are the two major intellectual operations in the second phase. During data gathering, students verify and experiment with four types of information—information about objects, properties, conditions and events. Students' inquiries during data gathering are usually guided by theories. To enable the pupil to think in definite lines and thereby make the inquiry process an easy and systematic one, the teacher should guide the students' inquiries towards the above mentioned four types of information—information about objects, properties, conditions and events.

An object type of question is one which verifies and tests the nature or identity of objects. The question—what the object is—tells us the identity of the object. The question—what the object is made of—tells us the nature of the object.

An event question is one which verifies and tests the occurrence and nature of an action. Condition questions are those which verify or test the state of objects or events a particular time. When a question seeks to find out—what the generalised behaviour of an object is under specified conditions, it is called a property question.
2.5.2 Level of Theory Building

Suchman identified four levels of theory building:

1. Simple linear causation
2. Theories of properties
3. Analogies
4. Application of a generalisation or principle

Like Bruner and Ausubel, Suchman believes that students can become more and more aware of the process of inquiry and that this process can be taught to them directly. In his opinion the conscious awareness of the process and the strategies of inquiry is an essential aspect of autonomous inquiry. Through this awareness of the process of inquiry students become conscious of their own thinking strategies and learn to analyse them.

During phase Three of the model, the teacher guides the students to ask questions which will tell them what would happen to the situation if the element is added or removed or if elements are rearranged in it. In this phase experimentation is the process whereby students gather information about an event they see or experience.

Experiments serve two functions:

Exploration and direct testing: Exploration—changing things to see what will happen.
Direct testing occurs when students try out a theory or hypothesis.

In phase Four, the teacher calls on the students to organise the data and to formulate an explanation.
Finally, in phase Five, the students are asked to analyse their patterns of inquiry. This phase is essential if we are to make the inquiry process a conscious one and systematically try to improve it.

Support System

It refers to all the specific conditions required for the smooth running of the phases of the model which include books, films, poster and apparatus required for experiment.

Fig. 2.5 Effects of Inquiry Training Model