CHAPTER III

PLAN AND PROCEDURE OF THE STUDY

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PLAN AND PROCEDURE OF THE STUDY

This chapter deals with details of the procedure used in this study, which include design adopted for the study, the sample, variables considered for the study, tools and techniques adopted for collection of data and techniques adopted for finalising the data.

3.1 Design of the study

Research design is the blueprint of the procedure that enables a searcher to test hypothesis by reaching valid conclusions about relationships between independent and dependent variables; (Best, 1981). The present investigation aims at finding out the strategies adopted by the children in acquiring different science concepts and also, which type of strategy is more effective in acquiring different science concepts. The present study also seeks to determine the relation between information - processing strategies and concept - attainment in science. True experimental design was difficult to be used in a normal classroom situation due to various limitations. However, quasi - experimental design is the most suitable one for present study. The pre-test-post-test Parallel Group Quasi Experimental Design (Campbell & Stanley, 1963, P.217) with purposive sample in the form of intact sections of class VII of the same school, was therefore used for the problem under investigation. The basic design of parallel-group experimentation might be represented as follows :
Gain in achievement was assessed by taking the difference between pretest and post-test achievement scores in Biology and also in simultaneous and successive processing (K-ABC). Pupils socio-cultural status were also determined.

3.2 The Sample

Sampling is the process by which a relatively small number of individuals or measures of individuals, objects, or events is selected and analysed in order to find out something about the entire population from which it was selected.

Several methods have been laid down for selecting a sample in such a way that it is really representative of the population at large. Broadly, methods adopted in selecting a sample are :

(a) Non-Probability Sampling or Purposive Sampling Method

(b) Probability Sampling or Random Sampling Method

Purposive Sampling: According to this method the members selected in a sample are chosen purposely either to serve a particular object or because it is felt that they possess all the characteristics of the parent population.
Random Sampling: The members selected in a sample are chosen in such a way that each item has an equal chance of being selected. Random sampling can be classified into three kinds i.e. stratified sampling, cluster sampling and systematic sampling.

Purposive sampling was used for the present investigation. Central School, INA Colony, New Delhi was selected for the purpose. The subjects were both males as well as females. Two sections of seventh class from the school were taken. These were divided into one experimental and one control group having 25 students in each group. The two groups were as similar as the availability permitted; they were natural and highly comparable in respect of size, average age and specially in their past achievement in science. Thus, the two groups were comparable within approximinity on experimental measures at pre-experimental stage. The investigator used K-ABC (Kaufman Assessment Battery for Children) for measuring information processing strategies adopted by children in the acquisition of science concepts.

As the Kaufman Assessment Battery for children is an individual test and has eight mental processing subtests for 12 year old pupils, the investigator kept the sample restricted to only 50 students.

No doubt, the sample is small for the results of the study to be generalisable but availability of a large sample and feasibility of carrying out such an experimental study with large samples is beyond the control of an investigator. Even earlier investigators conducting such studies through experimental designs have used small samples: Talengaonkar (1984) had taken 34 class IX students for his study, Sushma Kumari (1987) had taken
78 students as her sample for the study, Pande (1986) included 86 students in his sample while Chitrive (1983) had taken three intact sections of class XI for his study with 35 students in each section as his sample. Baveja (1988) took 63 students in her experimental group and 36 students in control group making a total sample of 99 students. Singh and others (1986, 1987, 1988) had taken samples of nearly 45 teacher educators each time. Rai and others (1989) utilised a sample of 50 class X students and Kaul (1986) worked with a sample of 50 students whereas Jemini (1990) has worked on two sections of chemistry classes in a school. Passi and Sansanwal while reviewing research in teaching in Buch’s Fourth Survey of Research in Education, 1991, p. 1023, have justified the use of small samples in such experimental researches due to deeper inquest of these studies and available methodological facilities. It is accepted that almost all studies of the nature, as the present one, have worked on small samples only.

3.3 Variables

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes. Different kinds of variables used in the study are as follows.

3.3.1 Independent Variables: The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his or her attempt to ascertain their relationship to observed phenomena. There are two types of independent variables: treatment and organismic or attribute variables.
(i) Treatment variables are those factors that the experimenter manipulates and to which he or she assigns subjects. In the present study, method of instructions or teaching strategies were used as treatment variables. The treatment variables used in the study are concept attainment model and traditional method of teaching. These were the variables that were manipulated to study the effectiveness.

(ii) Attribute or organismic variables: These attribute variables could not be altered by the experimenter though they had already been determined by the investigator. Socio-cultural status of the pupils was considered as the attribute variable in the present study.

3.3.2 Dependent Variables: The dependent variables are the conditions or characteristics that appear, disappear, or change as the experimenter introduces, removes, or changes independent variables. The dependent variables are the measured changes in pupil performance attributable to the influence of the independent variables. The dependent variables or the criterion of the study were pupils achievement in Biology and the information-processing strategies adopted by pupils. The students were scored on these variables before and after the treatment in both the groups.

3.3.3 Intervening Variables: Many variables are beyond the control of an investigator or could not be controlled due to many constraints though they might have an effect on the criterion variables. Some of these variables are fatigue, time table schedule, absence of some students during experiment, time gap within the treatments, motivation, anxiety, interest
of the students, home environment, previous exposure to type of teaching, present teaching in other subjects, reading habits, academic ability of the subjects, enthusiasm and the like. These remained uncontrolled during the experiment.

3.3.4 Situational Variables: Situational variables like teacher, time, duration of treatment, conditions of instruction, use of teaching aids, subject to be taught, sample size and the like were controlled administratively and through selection of the sample; equating the time, equating the groups through equal treatments and likewise.

Both the experimental as well as control group were taught by the researcher herself. They were taught the same content for the same duration of time.

In order to develop the competence in teaching through concept attainment model the investigator underwent training. She gave demonstration lessons using the concept Attainment Model in the presence of her supervisor. The lessons were taught to the students other than those constituting the sample.

During the treatment, a few lessons on the CAM were also observed by the supervisor in order to ensure effective use of the model. Besides this same teaching aids were used in both the groups.

3.4 Tools

The following tools were selected for the study:-

i) Kaufman Assessment Battery for Children

ii) Socio-cultural status scale by Dabas.
The following tool was developed by the investigator for collecting the requisite data.

iii) Concept-Attainment Test in Biology.

3.4.1 Kaufman Assessment Battery for Children

The Kaufman Assessment Battery for children (K-ABC) is an individually administered measure of intelligence and achievement, standardized on a large representative nationwide sample of normal and exceptional children ages 2½ through 12½ years. The K-ABC covers thoroughly the preschool and elementary school years, and is intended for use in school and clinical settings. Administration time averages about 45 minutes for preschool children and about 70 to 75 minutes for school-age youngsters.

The multi-subtest battery yields standard scores (mean of 100, standard deviation of 15) in four global areas of functioning: sequential processing, simultaneous processing, mental processing composite (sequential plus simultaneous) and achievement.

Intelligence, as measured by the K-ABC, is defined in terms of an individual's style of solving problems and processing information, this definition, which also stresses level of skill in each style of information processing, has a strong theoretical foundation in the domains of both neuropsychology and cognitive psychology. The sequential processing and simultaneous processing scales represent two types of mental functioning that have been identified independently by cerebral specialization researchers (Bogen, 1975; Gazzaniga, 1975; Kinsbourne, 1978), by Luria (1966, 1970, 1973b) and his followers (Das, Kirby & Jarman, 1975, 1979)
and by cognitive psychologists (Neisser, 1967). Sequential Processing places a premium on the serial or temporal order of stimuli when solving problems; in contrast, simultaneous processing demands a gestalt-like, frequently spatial, integration of stimuli to solve problems with maximum efficiency. The K-ABC Mental Processing subtests were deliberately designed to minimize the role of language and verbal skills for successful performance, and to include stimuli that are as fair as possible for boys and girls from diverse backgrounds.

Unlike the theoretically based Mental Processing scales, the K-ABC Achievement scale was derived from only rational and logical considerations. The Achievement scale includes new, generally innovative, measures of skills that are traditionally assessed by tests of global or verbal intelligence (vocabulary, language concepts), tests of school achievements (reading) or both (arithmetic, general information). We see these diverse tasks as united by the demands they place on children to extract and assimilate information from their cultural and school environment. Regardless of more traditional approaches to the definition and measurement of intelligence, the K-ABC is predicated on the distinction between problem-solving and knowledge of facts. The former set of skills is interpreted as intelligence; the latter is defined as achievement. This definition represents a break from other intelligence tests, where a person's acquired factual information and applied skills frequently influence greatly the obtained IQ.

For the K-ABC, tasks were selected that were judged easy to administer by experienced testers. Ease of administration is further aided by using easels, by adopting a highly similar format for each processing task, by
keeping the examiner's verbiage to a minimum, and by employing a single discontinue rule for all subtests.

Regarding scoring, subtests and items were chosen that were judged easy to score objectively by examiners. In addition, tasks that require much subjective judgement, such as tests of design copying or verbal expression, were avoided. To enhance the objectivity of scoring the K-ABC subtests with some subjective aspects, namely the ones requiring brief verbal responses, lists of right and wrong answers were compiled by studying the standardization second forms.

PURPOSES AND USES OF THE K-ABC

The K-ABC is seen as useful for the following purposes: psychological and clinical assessment, psychoeducational evaluation of learning-disabled and other exceptional children, educational planning and placement, minority group assessment, preschool assessment, neuropsychological assessment, and research. When discussing the practical utility of the K-ABC for individual assessment, the focus is always on a multiscale instrument composed of fact-oriented as well as problem-solving tasks. Scores on the sequential and simultaneous processing scales promote understanding of a child's potential in wide range of mental and academic problem-solving activities. The K-ABC Achievement scale provides a pertinent context, namely, the degree to which children have been able to apply their mental processing skills to both everyday life and school-oriented learning situations.
When using the K-ABC for research on mental processing rather than for individual assessment, it is more acceptable to administer only the two processing scales. Nevertheless, even for research purposes the Achievement subtests make a valuable contribution to an in-depth understanding of information processing: virtually all of these factual and academic tasks demand integration of sequential and simultaneous processing for successful performance.

SEQUENTIAL PROCESSING SCALE

Each task in the K-ABC sequential processing scale presents a problem which must be solved by arranging the input in sequential or serial order. Each idea is linearly or temporally related the preceding one. Although short-term memory is an aspect of each subtest, the unifying process is the sequential handling of stimuli, regardless of their content, their method of presentation, or the mode of response.

The ability to process or solve problems sequentially is closely related to a variety of everyday, school-oriented skills. These include memorization of number facts, of lists of spelling words, and of associations between letters and the sounds they make. Sequential processing also may affect learning grammatical relationships and rules, understanding the chronology of historical events, using an appropriate sequence of steps to invoke the scientific method, and applying the correct stepwise procedures for various mathematical skills such as "borrowing". Children who have poor word attack skills, who cannot break down complex science or arithmetic problems into their component parts, or who have difficulty in systematically interpreting the various parts and features of a design or drawing may
be deficient in sequential processing ability; the same disability may be at the root of more socially oriented problem areas such as failure to understand the rules of many games and inability to comprehend and follow the oral instructions of parents and teachers. Indeed, the noted neurologist Lashley (1951) indicated that successive synthesis was intrinsic "in the more general domain of the serial order of behaviour itself" (Jarman, 1980, p. 157).

SIMULTANEOUS PROCESSING SCALE

The problems presented in the Simultaneous Processing Scale are spatial, analogic, or organizational in nature, simultaneous or holistic problem solving is accomplished by processing many stimuli at once, rather than stimulus-by-stimulus (or feature-by-feature) as is characteristic of sequential problem solving. The ability to form gestalts facilitates tasks that are primarily at the perceptual level, such as learning the shapes of letters and numbers or deriving meaning from pictures and other visual stimuli; however, simultaneous processing is also closely related to many higher-level intellectual functions because it is the capacity to integrate information from diverse sources and obtain overviews of seemingly disparate stimuli.

Thus, children with well developed simultaneous problem-solving skills not only have an advantage in rapidly learning the shapes of letters and spatial configurations of words during the early stages of reading, but they possess the type of good processing ability that is necessary for understanding the main ideas of stories and comprehending the meaning of difficult paragraphs. Analogously, excellent simultaneous processing assists children in learning basic arithmetic concepts by use of concrete materials and
other visual stimuli, and also in understanding more complex mathematical principles by grasping the underlying meaning of the numerical relationships involved. Creative problem solving is also most likely dependent to a large degree on good simultaneous skills, as is the ability to make full use of diagrams and flow charts in learning complicated materials in any academic or nonacademic discipline.

DESCRIPTION OF THE SUBTESTS

The K-ABC comprises 16 subtests, although a maximum of 13 is administered to any particular child. Some tasks span the full 2½ through 12½ year range but, in general, the subtests for different age groups were selected with the different interests, behaviours, and skills of preschool and elementary school children very much in focus. In keeping with the developmental needs of children, the K-ABC is shorter for younger children, in terms of both the number of subtests administered and the overall testing time.

Descriptions of the 16 subtests, and the age range for each, follow. The K-ABC Easel - Kits and Individual Test Record are organized to facilitate easy determination of the subtests administered at each age level. However, the investigator herself prepared the Individual Test Record keeping in view the requirements of the present study.

SEQUENTIAL PROCESSING SCALE

Hand Movements  (ages 2-6 through 12-5) - Performing a series of hand movements in the same sequence as the examiner performed them.
Number Recall (ages 2-6 through 12-5) - Repeating a series of digits in the same sequence as the examiner said them.

Word Order (ages 4-0 through 12-5) - Touching a series of silhouettes of common objects in the same sequence as the examiner said the names of the objects. (More difficult items include an interference task between the stimulus and response).

SIMULTANEOUS PROCESSING SCALE

Magic Window (ages 2-6 through 4-11) - Identifying a picture which the examiner exposed by slowly moving it behind a narrow window, making the picture only partially visible at any one time.

Face Recognition (ages 2-6 through 4-11) - Selecting from a group photograph the one or two faces that were exposed briefly on the proceeding page.

Gestalt Closure (age 2-6 through 12-5) - Naming an object or scene pictured in a partially completed "inkblot" drawing.

Triangles (ages 4-0 through 12-5) - Assembling several identical triangles into an abstract pattern to match a model.

Matrix Analogies (ages 5-0 through 12-5) - Selecting the meaningful picture or abstract design which best completes a visual analogy.

Spatial Memory (ages 5-0 through 12-5) - Recalling the placement of pictures on a page that was exposed briefly.
Photo Series (ages 6-0 through 12-5) - Placing Photographs of an event in chronological order.

ACHIEVEMENT SCALE

Expressive Vocabulary (ages 2-6 through 4-11) - Naming the object pictured in a photograph.

Faces & Places (ages 2-6 through 12-5) - Naming the well known person, fictional character, or place pictured in a photograph or drawing.

Arithmetic (ages 3-0 through 12-5) - Demonstrating knowledge of numbers and mathematical concepts, counting and computational skills, and other school related arithmetic abilities.

Riddles (ages 3-0 through 12-5) - Inferring the name of a concrete or abstract concept when given a list of its characteristics.

Reading/Decoding (ages 5-0 through 12-5) - Identifying letters and reading words.

Reading/Understanding (ages 7-0 through 12-5) - Demonstrating reading comprehension by following commands that are given in sentences.

GOALS IN DEVELOPING THE K-ABC

The primary goals of K-ABC were:

1. To measure intelligence from a strong theoretical and research basis.

2. To separate acquired factual knowledge from the ability to solve unfamiliar problems.
3. To yield scores that translate to educational intervention.
4. To include novel tasks.
5. To be easy to administer and objective to score.

RELIABILITY & VALIDITY

The reliability and validity has been calculated based on the data collected on more than 4100 separate K-ABC administrations or about 1500 more than the number tested as part of the standardization.

RELIABILITY

Different kinds of reliability coefficients have been calculated in age wise for each of the subtest. The technique adopted for calculating the reliability include Split - Half and Test-Retest.

The split-half reliability coefficients varies from .71 for Gestalt closure to .85 for Matrix Analogies for children of school age level.

Overall, the obtained split-half reliability coefficients showed very good internal consistency for the K-ABC subtests across the entire age range, as mean value of .80 and above were obtained for 12 of 16 subtests.

The split-half reliability coefficient value for K-ABC subtest for the age group 12 years 6 months is given ahead

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>Hand Movement</th>
<th>Gestalt Closure</th>
<th>Number Recall</th>
<th>Triangles</th>
<th>Word Order</th>
<th>Matrix Analogies</th>
<th>Spatial Memory</th>
<th>Photo Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.0-12.6</td>
<td>100</td>
<td>.70</td>
<td>.67</td>
<td>.83</td>
<td>.79</td>
<td>.76</td>
<td>.88</td>
<td>.79</td>
<td>.86</td>
</tr>
</tbody>
</table>
The other technique adopted for finding the reliability coefficient is test-retest method. The K-ABC was administered twice with two to four weeks interval. The test was administered on 70 children of the age group 9-12½ yrs.

Table : Test - Retest Reliability coefficients for the K-ABC.

<table>
<thead>
<tr>
<th>K-ABC Scale</th>
<th>( r^a )</th>
<th>First Testing</th>
<th>Second Testing</th>
<th>Gain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential Processing</td>
<td>.88</td>
<td>99.8</td>
<td>102.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Simultaneous Processing</td>
<td>.91</td>
<td>101.9</td>
<td>107.6</td>
<td>5.7</td>
</tr>
</tbody>
</table>

The coefficient of correlation varied from 0.59 in case of hand movements to 0.86 in case of gestalt closure. The Reliability coefficient calculated using test retest method for the K-ABC subtests is given ahead.

<table>
<thead>
<tr>
<th>K-ABC Subtest</th>
<th>Ages 9-0 through 12-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>( r )</td>
</tr>
<tr>
<td>Hand Movements</td>
<td>70</td>
</tr>
<tr>
<td>Gestalt Closure</td>
<td>70</td>
</tr>
<tr>
<td>Number Recall</td>
<td>70</td>
</tr>
<tr>
<td>Triangles</td>
<td>70</td>
</tr>
<tr>
<td>Word Order</td>
<td>70</td>
</tr>
<tr>
<td>Matrix Analogies</td>
<td>70</td>
</tr>
<tr>
<td>Spatial Memory</td>
<td>70</td>
</tr>
<tr>
<td>Photo Series</td>
<td>70</td>
</tr>
</tbody>
</table>
Despite relatively unimpressive split-half coefficients of Gestalt closure (mean of .72), this subtest was quite stable, especially for School-age children. The good test-retest results for Gestalt closure suggest that the several component skills measured by this subtest are stable over time.

VALIDITY

The techniques adopted for determining the validity of the test include construct, predictive and concurrent validity.

Construct Validity - According to Anastasi (1982, pp. 144-152), there are five major areas which contribute to a test's construct validation: developmental changes, internal consistency, factor analysis, convergent and discriminant validation, and correlations with other tests.

(a) Developmental changes - Higher relationships were obtained for subtests spanning wide age ranges: about .65 to .75 for Matrix Analogies Spatial Memory, Photo series, and the three Sequential Processing subtests, and about .80 to .90 for Gestalt Closure and Triangles.

(b) Internal Consistency - At the school age level there was more variability in the correlations of each subtest with the Mental Processing Composite. Gestalt Closure correlated only .49 with total score, with the other subtests producing coefficients in the .57 to .68 range. The best measures of total processing for school age children were Photo Series, Triangles and Matrix Analogies.

(c) Factor Analysis - Two different approaches used to factor analyze the K-ABC are principal factor analysis and confirmatory factor
analysis. Principal factor analyses of the K-ABC offer strong support for the construct validity. The Simultaneous Processing standard score correlated .84 to .96 with the simultaneous factor and Sequential Processing standard score correlated .78 to .95 with the Sequential factor score.

For confirmatory analysis, the two-factor solutions were analyzed for the Mental Processing subtests and three-factor solutions for all K-ABC subtests combined. Large, highly significant values of chi-square were obtained for all analyses, and substantial factor loadings (usually in excess of .55) were found for the subtests on each factor.

The confirmatory and exploratory analyses both attest to the construct validity of the K-ABC.

(d) Convergent and Discrimination Validation - This type of validity was explored for the K-ABC by correlating the Sequential and Simultaneous Processing variables with Das, Kirby and Jarman’s (1975, 1979) successive-simultaneous battery. The Sequential Processing correlated highly, as predicted, with the successive factor (.69), and poorly with the simultaneous factor (.27), similarly Simultaneous Processing correlated .47 with the Das-Kirby-Jarman factor of the same name, but correlated negligibly (−.11) with the successive factor. The results confirm to predictions and therefore support the construct validity of the K-ABC.

(e) Correlation with other tests-Since most K-ABC achievements subtests resemble closely the verbal tasks in the Stanford-Binet and in
Wechsler's Verbal Scales, the Binet, WISC-R, and WPPSI IQs serve as meaningful criteria for the entire K-ABC, not just the intelligence scales. The highest correlates of Binet IQ on the Mental Processing subtests were Matrix Analogies, Number Recall, and Word Order. Using Binet IQ as the criterion, support is offered for the construct validity of all K-ABC subtests except Gestalt Closure.

**Predictive Validity**—At the school age level, there was a tendency for Simultaneous Processing to correlate more highly than Sequential Processing with mathematics, and for the reverse pattern to hold true for spelling. In general, predictive validity coefficients for the Nonverbal Scale were of the same magnitude as the values for Simultaneous Processing.

**Concurrent Validity**—Tests of school achievement are the best criteria of concurrent validity for all K-ABC scales. Studies using individually administered tests like KeyMath Diagnostic Arithmetic Test (complete battery), Stanford-Diagnosis Reading Test validate the K-ABC. The sequential and Simultaneous Processing scales generally correlated well with diverse areas of school achievement, and they emerged as equally valid correlates of group achievement scores. In addition, Mental processing composite invariably correlated more highly with achievement criteria than did either processing scale by itself; this finding suggests that both styles of information processing make unique contributions to the concurrent "prediction" of school achievement.
SCORING

Every item on the K-ABC is dichotomous: correct responses are scored 1, and incorrect responses are scored 0. No partial credit or bonus points for quick performance are given. Total raw score on each K-ABC subtest is simply the number of items answered correctly. Children who start a subtest beyond item 1 are given credit for the earlier items not administered as long as they pass at least one item in the first unit administered. Failure of all items in the first unit requires the examiner to return to item 1 and administer the items preceding the starting point.

Children sometimes give two or more responses to a single item. If the child intended the last response to replace earlier responses, then score only the last response and ignore the earlier ones, whether the last response is correct or incorrect.

3.4.2 Development of Achievement Test in Biology

There are a number of Achievement Tests in Biology available but the investigator felt a need to develop a new test for the purpose of assessing the achievement in concepts of ‘Photosynthesis’ in Biology of VII grade pupils who constituted the sample of the study.

It is absolutely true that a good test does not happen, but it results from careful planning because achievement test is not just a collection of items, but it is a tool designed to measure knowledge, comprehension, application and skills in the discipline. Vaughn gave a clear idea about the operations encompassed in test planning. In his words, test planning encompasses all of the many and varied operations that go into producing a test. Not
only does it involve the preparation of an outline or a table specifying the content or operations to be covered by the test, but it must also involve careful attention to item difficulty, to types of items, to directions to the examiners, to the arrangements for layouts, to the problems of test reproduction and to the provision for expert review (Vaughn 1963, P-159).

Keeping in view the importance of analysis of the subject content in the construction of Achievement Test and in order to identify the syllabus content, the investigator went through the text book syllabus of class VII. The teacher's guides prepared by the NCERT were also referred.

**List of Subconcepts Considered in the Development of Concept Attainment Test**

1. Properties of living cells
4. Experiment showing sunlight is necessary for photosynthesis.
5. Experiment showing carbon dioxide is necessary for photosynthesis
6. Experiment showing chlorophyll is necessary for photosynthesis.
7. Experiment showing oxygen is released during photosynthesis.
8. Food for all - food chain - Herbivores - Carnivores
9. Plants purify the atmosphere
10. Importance of plants to animals
11. Balance of nature - effects of deforestation
12. Interdependence of plants and animals


Novak pointed out that, "the structure of a science may be viewed as a system of major generalisation or concepts together with process by which these concepts are obtained and enlarged," (Novak, 1968, P-122). According to Gagne, the term "Concept" has several meanings but the fundamental meaning of the term concept is of two kinds. The first one 'Concept by observation' are exhibited in individual responses to object qualities such as colour, shape, etc. or by common objects such as cats, chair, etc. These concepts are also known as concrete concept. The second referred to as "concept by definition" - are the abstract concepts involving relations which can be described by definition such as concepts of mass, temperature (Gagne, 1977, P-111). The world as experienced and understood by human beings is largely organised by means of concepts and the acquisition of concepts is what makes instruction possible. We read in terms of concepts. We communicate with concepts, we think with concepts (Ibid pp. 120-121). The mastery of concepts makes the individual ready to learn any amount of knowledge that is virtually without limit (Ibid P-124). So, concept learning is obviously of tremendous importance of most kinds of intellectual activity engaged in human beings (Ibid P-120). Again as pointed out by Voelker, "Without the analysis of concepts prior to their inclusion in the curriculum and organising for instruction, there is no basis for establishing, or confirming a learning hierarchy consistent with the child's development. Without concept analysis, there can be no means of gathering organised data to serve as a basis of making decisions about the context of science.
curriculum. Concept analysis becomes a mean of gathering and checking off relevant data and provides a vehicle for making decision about what is to be expected of a child, cutting down adult impositions on younger learners" (Voelker 1972, P-129). Gagne states that "there needs to be planning in terms of student capabilities." What are the specific prerequisites for learning and what will be able to learn next — the planning that proceeds effective design for learning is a matter of specifying with some care what may be called the "learning structure" subject must be analysed in terms of the types of learning involved in it (Gagne, 1965, PP. 24-25).

The investigator concerned herself with the end products of learning while constructing the achievement test... entailing identification of instructional objectives as learning outcomes towards which pupils were expected to progress. These were the end results stated in terms of changes in the pupil behaviour (Gronlund, 1976, P-29). In other words, in defining objectives as learning outcomes it was essential to indicate the types of performance students are expected to demonstrate when they have successfully completed a course of instruction (Gronlund, 1978, P-4).

Bloom et. al. (1956) developed one of the most helpful guide for identifying and defining instructional objectives known as Taxonomy of Educational Objectives. Amongst the three domains of Taxonomy - the cognitive domain includes objectives, such as knowledge, intellectual abilities and skills like comprehension, application, analysis, synthesis and evaluation. Each of these major categories was assumed to include behaviour of the lower level, e.g. comprehension include the behaviour at the knowledge
Showing Nature and Hierarchy of Concepts Related to Photosynthesis

Nature

Conservation of life
Balance of nature

CONVERSION AND RECYCLING

Combination of Ashes Manure elements C.H.O

Organic
Inorganic

Production of Sugar (Carbohydrates)

Leaf Primary Producer of food

Herbivore
Carnivore

Consumers of food

Food for All

LEAF

LEAF AS A STRUCTURAL UNIT

Vascular
Palisade
Epidermis

Xylam
Phloem
Chloroplast
Stomata

Sun

PHOTOSYNTHESIS

CONDITIONS NECESSARY FOR PHOTOSYNTHESIS

Water
CO₂ (AIR)

Roots

Absorption of water by Capillary Action

O₂

Minerals

Knowledge of MINERALS AND FERTILIZERS

Knowldge of BIND SOIL AND PREVENTS EROSION

PURIFY AIR

Water

Food

Chlorophyll

Chlorophyll → Leaf

Leaf

Leaf a factory

- LEAF

Leaf Plant
level, application included the behaviour of both the knowledge and comprehension levels and so on (Ibid pp. 26-27).

Knowledge - the lowest level of learning outcomes was defined as remembering of the previously learned material which may involve recall of a wide range of material from specific facts to complete theories but all that was required, was bringing to mind the appropriate information. The next level comprehension was defined as ability to group the meaning of the material. This may be expressed by translating material from one form to another (words to number), by interpreting material (explaining or summarising) and by estimating future trends (predicting consequences or effects). The higher level of understanding than that of comprehension was application which referred to the ability to use learned material in new and concrete situation. This may include the application of such things as rules, materials, concepts, principles, laws and theories (Gronlund, 1976, P-28).

For stating objectives as learning outcomes, Gronlund suggested some steps which were considered appropriate for the present investigation. According to him, each general instructional objective had to be stated as expected learning outcome with a verb, e.g. knows common terms, interprets diagrams, demonstrates correct usage of the method, etc. Next, the list of specific learning outcomes under each general instructional objective that described the terminal behaviour that the students were to demonstrate after achieving the objective had to be tested. This could be done by beginning each specific learning outcome with a verb that specified definite observable behaviour. For example, "known common terms" could be inferred by observable behaviour such as - defines,
identifies, outlines, etc. Sufficient number of specific learning outcomes under each objective had to be listed in order to describe adequately the behaviour of the students who achieved the objective (Gronlund, 1978, P-18).

The percentage of the number of test items to be constructed in each nodal concept and its pre-requisites were decided tentatively to represent the pre-requisite of each nodal concept with regard to three objectives - knowledge, comprehension and application of cognitive domain.

The next step in the construction of achievement test was to decide the type of test items. It was decided by the present investigator to construct a test with objective type items which provide for an objective count of correct responses that could be conveniently used for the purposes of investigation. The test included multiple-choice, true-false and incomplete sentences test-items.

Multiple-choice type of items was chosen because of its effectiveness in measuring simple as well as complex outcomes in knowledge comprehension and objective. As Gronlund puts it, "The multiple choice item is generally recognised as the most widely applicable and useful type of objective test item. It can more effectively measure many of the simple learning outcomes measured by the short-answer item and the matching exercise. In addition, it can be measure a variety of more complex outcomes in knowledge understanding and application areas. This flexibility plus the higher quality of items usually attained with the multiple-choice form, has led to its extensive use in achievement testing" (Gronlund, 1976, P-188)
BLUE PRINT OF THE TEST

The test was based on the course content given in the NCERT text book of Biology for class VII. The objectives of the test were taken from the Bloom's taxonomy of educational objectives in cognitive domain i.e. knowledge, understanding and application.

The medium of the test was English. The test include three types of items i.e. true-false, multiple-choice and incomplete sentences. A blue print for the pre-tryout test given ahead.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Concept</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>True</td>
<td>Multiple</td>
<td>Incomplete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>False</td>
<td>Choice</td>
<td>sentences</td>
</tr>
<tr>
<td>1.</td>
<td>Photosynthesis</td>
<td>8</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>26</td>
<td>24</td>
</tr>
</tbody>
</table>

TRY OUT OF THE TEST

The draft of the test consisted of 75 multiple-choice items. It was tried out on a sample of 150 students of class seventh of a school other than the school selected for the experiment.

To obtain score of students, each correct answer was given one mark and wrong answer was given zero.

ITEM ANALYSIS

Item analysis is an essential part of test construction. Various techniques are used for the purpose of item analysis. Kelley (1939) has suggested
a method of considering 27 percent above and 27 per cent below groups only in the continuum of performance. Kelley argued that there was no need of conducting analysis with whole of the sample. The 27 percent highest and 27 percent lowest performance in the group can help to determine the representative difficulty and discrimination value for the whole test.

For this, responses of students about each item were analysed. Each item is best described by two indices: difficulty value of item and discrimination index. For getting difficulty value, response of top 27% students and bottom 27% students were noted and arranged in descending order. Difficulty value and discrimination index for each item was calculated. Only those items were selected which were in the range of 30% to 70% for difficulty value and 25% to 75% for discrimination index. Selected items constituted the final form of the test.

FINAL FORM OF THE TEST

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Concept</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiple</td>
<td>Multiple</td>
<td>Multiple</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incomplete</td>
<td>Incomplete</td>
<td>Incomplete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sentences</td>
<td>sentences</td>
<td>sentences</td>
</tr>
<tr>
<td>1.</td>
<td>Photosynthesis</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The final form of the test consisted of 40 multiple-choice items. The duration of the test was 1½ hrs. The language of the test was reviewed thoroughly and items were arranged in a logical sequence. The test was also discussed with the experts. The reliability and validity of the test
was determined. A copy of the Achievement Test developed by the investigator may be seen in Appendix XV.

RELIABILITY

The reliability of a test relates to the accuracy with which skills and knowledge are measured. Items were arranged according to their difficulty level. The reliability was measured by split half method, putting all the odd numbered test items into one half and all the even numbered test items into another half. Care was taken to put the highly comparable items into two halves, scores obtained on two halves were correlated and then correction was applied by Spearman Brown formula. The reliability of the test was found to be 0.89.

VALIDITY

A test is valid when it measures what it purports to measure. Content validity and predictive validity of the test were assessed.

(a) Content validity - Opinions of the experts from the Department of Measurement and Evaluation Survey and Data Processing, NCERT, New Delhi, Institute of Advanced Studies in Education, Jamia Millia Islamia, New Delhi, and Biology teachers of three schools of Delhi were collected. Content validity was established in terms of consistency of test items with objective and content.

(b) Predictive Validity - This was measured by correlating the scores of 150 students (sample used in tryout) on the constructed test with their achievement scores in the school examination. The coefficient of correlation between two sets of scores was found to be 0.91.
The same test was used as pre-test as well as post-test.

3.4.3 Socio-Cultural Status Scale

The tool selected for identifying the socio-cultural status of pupils was the scale constructed by Dabas (1979) viz. Socio-Cultural Status scale. This scale was later used by Dabas (1982). The following aspects or specifications for this cultural status scale were used in the investigation:

(a) Income
(b) Education
(c) Occupation
(d) Material and Cultural Possession and
(e) Style of living of the family.

These aspects of home environment or cultural status were considered to be symbols of an intangible aspects of the home and just as items in an intelligence test may be regarded as shafts to send down to tap the stones of mental energy. So these items are best regarded as shafts sent down to tap the socio-cultural environment (Campbell, 1962).

For the purpose of the investigation, it was presumed that cultural status of an individual's statement depends upon income, education and occupation of parents as well as the degree of possession and style of living in the family. The student having more favourable home environment or cultural status scale would be one whose parents, guardians have adequate income, education and occupation as well as sufficient material and cultural possessions and style of living at home.
Thus, the scale consisted of three parts viz.

(1) Socio-economic status which included income, education and occupation of the parents/guardians with whom the child was living during the period of her study, being treated as indicators of socio-economic status

(2) Material and cultural possessions at home, and finally

(3) Style of living of the family being treated as indicators of socio-cultural environment at home.

All the three were combined into a single scale.

For the first part of the scale, Dabas (1979) adopted the Kuppuswamy's socio-economic status scale (Urban) with necessary modifications in scale values for income. In the second part of the scale, items such as T.V., telephone, refrigerator, scooter, car, electric appliances, newspapers, etc were included. The third part of the scale covered the style of living of the family, e.g. eating habits of the family, treatment with friends, help given in study at home, place of study for the child, future plan for the child, etc. (Appendix XIV).

**SCORING**

Scores were allotted for all the four groups i.e. Income, Education. Occupation, Material and Cultural Possession, and Style of Living of the family.
Income: For income level, the Kuppuswamy scale was revised to give the following groups:

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs. 8000 and above per month</td>
<td>12</td>
</tr>
<tr>
<td>Rs. 5000 - 7999 per month</td>
<td>10</td>
</tr>
<tr>
<td>Rs. 4000 - 4999 per month</td>
<td>6</td>
</tr>
<tr>
<td>Rs. 3000 - 3999 per month</td>
<td>4</td>
</tr>
<tr>
<td>Rs. 2000 - 2999 per month</td>
<td>3</td>
</tr>
<tr>
<td>Rs. 1000 - 1999 per month</td>
<td>2</td>
</tr>
<tr>
<td>below Rs. 1000 per month</td>
<td>1</td>
</tr>
</tbody>
</table>

Education: For educational level, the score and group given by Kuppuswamy were considered

1. Professional Degree, Masters Degree and above - 7
2. B.A., B.Sc. - 6
3. Intermediate, Post high school - 5
4. High school or equivalent - 4
5. Elementary or middle - 3
6. Literate - 2
7. Illiterate - 1

Occupation: For occupational level also, the scores and group given by Kuppuswamy were considered:

1. High Profession—Engineering, Medical, Law, Administration - 10
2. Semi Profession—Lecturers, Research Inspector, High School Teachers - 6
3. Clerk, Shopkeeper, Farm-owner 5

4. Skilled worker—Mason, Carpenter, Mechanic, Drivers or Telephone Operators 4

5. Semi Skilled Worker—Library Assistant, Labourers in a factory or workshop 3

6. Unskilled Worker—Domestic Servant, Farm Labourers, Casual Labourers. 2

7. Unemployed, Dependent—Beggars, etc. 1

For material possession—Account of one for each item possessed at home.

Style of Living

<table>
<thead>
<tr>
<th>Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>x</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>x</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>x</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>x</td>
</tr>
</tbody>
</table>

The scores earned by the pupils are given in the Appendix.

3.5 The Experiment

Before administering the tools, it was necessary to approach the subjects. In this regard, the permission of the Principal of Central School, INA Colony, New Delhi was sought after telling him the plan and purpose of the study.
Then the two sections of class VII of the said sample school were selected and the teacher teaching Biology to these sections was taken into confidence. Her acceptance was also sought after informing her of the purpose and plans of the experiment and the purpose of the study. After this, the sample subjects were interacted with for the course of experiment and rapport established with them. In the mean time, they were oriented to the tests to be used with them and also the methodology of the treatment, the concept Attainment Model of teaching. This permission was sought in the month of September, 1996 and the experimentation was started immediately after that. The regular class periods were also adjusted with teachers and the school authorities for conducting the experiment which was conducted in the natural setting. Structured lesson plans for the treatment were prepared beforehand on the selected contents of the study. The experiment was conducted in a phased manner in the form of pre-test-treatment-post-test. The activities for each phase of the experiment are presented schematically in the following Table.
The Schematic Presentation of Activities Undertaken During the Experiment.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Phase</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pretest</td>
<td>Following tests were administered in control and experimental groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Achievement test in Biology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Kaufman Assessment Battery for Children</td>
</tr>
<tr>
<td>2.</td>
<td>Treatment</td>
<td>The researcher taught the selected content of Biology to the control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>group through traditional method of teaching and to the experimental</td>
</tr>
<tr>
<td></td>
<td></td>
<td>group through concept attainment model of teaching.</td>
</tr>
<tr>
<td>3.</td>
<td>Post-test</td>
<td>After the treatment following tests were administered:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Achievement test in Biology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Kaufman Assessment Battery for Children</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Socio-Cultural status scale.</td>
</tr>
</tbody>
</table>

3.6 Treatment

In the present study, the control group was taught through traditional method of teaching and experimental group through concept attainment model of teaching. Both the groups were taught by the researcher herself. The concept “Photosynthesis” was identified for the experiment. Thirteen subconcepts in relation to Photosynthesis were identified for the purpose.
These subconcepts are listed below:

<table>
<thead>
<tr>
<th>Concept</th>
<th>Subconcepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthesis</td>
<td>Cell</td>
</tr>
<tr>
<td></td>
<td>Plant</td>
</tr>
<tr>
<td></td>
<td>Nutrition</td>
</tr>
<tr>
<td></td>
<td>Food</td>
</tr>
<tr>
<td></td>
<td>Respiration</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
</tr>
<tr>
<td></td>
<td>Growth</td>
</tr>
<tr>
<td></td>
<td>Carbohydrates</td>
</tr>
<tr>
<td></td>
<td>Chlorophyll</td>
</tr>
<tr>
<td></td>
<td>Leaves</td>
</tr>
<tr>
<td></td>
<td>Autotrophs</td>
</tr>
</tbody>
</table>

The next step was the preparation of lesson plans based on the Concept Attainment Model of Teaching. Lesson Planning Guide for concept Attainment Model as suggested by Weil and Joyce (1978) was followed. One lesson plan based on concept Attainment Model is presented in Appendix XI.

The treatment was of four weeks duration for both the groups. The researcher taught the experimental group i.e. section B of Class VII, through Concept Attainment Model and the control group i.e. Section A of Class VII, through traditional method of teaching. Similar schedule was followed for both the groups. This was done to avoid carry over effects of one teaching strategy into other. The time was of one period (40 minutes) duration only so that the schedule of school was not disturbed.
3.7 Collection of Data

In order to study whether there is any relation between information processing strategies and concept-attainment, K-ABC and Achievement test constructed by the investigator were administered in pre-treatment phase to both the groups. Achievement test was given to the students of both the groups on the same day in their respective classrooms. But as stated earlier that the K-ABC is an individual test with eight subtests, therefore the subtests were administered individually and it took almost six weeks. The researcher used a separate room for the administration of K-ABC, in order to avoid any disturbance.

The researcher got the permission of the Principal of the school after explaining the difficulties in the administration the K-ABC and she was allowed to take the student one by one from their class for testing without disturbing their schedule.

After the pre-treatment phase of both the groups, teaching of groups commenced as in treatment phase. Control group was taught through traditional method of teaching and experimental group through concept Attainment Model. The treatment phase lasted for four weeks for both the groups.

Achievement test was again given to both the groups after the completion of treatment. Besides this, socio-cultural status scale was administered next day. Kaufman Assessment Battery for Children (K-ABC) was also administered on the students.
3.8 Techniques for Data Analysis

The statistical techniques to be used for the analysis of data included descriptive and inferential statistics. The descriptive statistics was applied to study the nature of data after computing mean and standard deviation. The inferential statistics included t-test the test of significance of difference and coefficient of correlation.