CHAPTER I

INTRODUCTION

All human learning, and especially learning at school, by its very nature influences and get influenced by a multiplicity of factors which depend upon details pertaining to the teacher, the student and the environment. Most people, educationists or otherwise, are very much concerned about what is happening in the schools and its cumulative effect on the younger generation who will be responsible for the nation building in future. There is a great demand for a more quality based education, especially science education, which requires effective teaching learning practices. Teacher, being one of the most important variable in any educational process, it becomes very important for us to examine and re-examine the various practices adopted by him/her from time to time.

Most educators and professional psychologists agree on the fact that findings in psychology of learning form a handy tool in crystallising the objectives of school learning. Yet, many teachers rely on traditional prescriptions available and on precepts and examples of their own teachers and older colleagues instead of taking

help from the findings in psychology of learning. It is true that some of the traditional rules of teaching have withstood the test of time and are probably valid. But the traditions and objectives change. Hence in any case not even the most venerable rules can be followed blindly; they must always be re-examined in the light of changing conditions. Psychological principles not only suggest many new techniques of teaching and instruction but also eliminate many unproductive practices from consideration.

From 1800s to the early 1950s, instruction and teaching were considered to be art forms (Highet, 1950). Today they are considered to be more a series of techniques, methods and processes which are potentially unifiable into a theory of instruction (Gage 1964, Hadden 1970, Bugelski 1971). Although a strong undercurrent of change is apparent from the published literatures, the actual progress towards a unified theory of instruction has been very slow. To get a clear picture of the theoretical situation today, we may have to look at the contributions from learning theories in a historical perspective.

1.1 Learning Theories

From 1900 to 1950s a formidable literature on learning developed from the perspective of associative

learning (Thorndike, 1903, 1913, 1932; Guthrie, 1935, 1952; Hull, 1943; Skinner, 1938, 1954 and Estes, 1959). The various associative theories were interrelated, yet independent. All shared an associative or connective explanation of learning and shunned appeal to mental events. Within each theory, however, explanations as to how learning occured differed as did the nature of experimental subjects. The cognitive psychologists on the other hand considered the appropriate domain to learning to be phenomenal wholes and non-observable mental events (Boring, 1950; Woodworth and Sheehan, 1964). Theorists adhering to cognitive approaches to learning included Gestaltists (Wertheimer, 1912, 1945; Koffka, 1924, 1935; Kohler, 1925, 1940; Dunker, 1945), structuralists, functionalists, developmentalists, and educational psychologists (Baldwin, 1893, 1915, 1906; Piaget, 1926, 1936, 1947, 1964; Werner, 1948; Bruner 1960; Elkind, 1967; Flavell, 1970). Phenomena of particular concern to these theorists were perception, concept formation, problem solving, creativity and thinking all non-observable mental events that were shunned by the associationists. The nature of assumptions and explanations made, the experimental subjects and the experimental tasks were different from those concern to associationists. Whenever theoretical uncertainty exists, it is inevitable that conflicting schools of thought emerge. School learning, which essentially lies in the intellectual development in young children, has been very much affected by these differing views.

1.2 Intellectual Development

Intellectual development in young children, matter of great concern to any educationist, has been viewed differently by learning theorists, psychologists and educationists. The views expressed by them can be broadly characterised into three groups. Lovell (1980) has characterised two such schools of thought in the intellectual development of children. In the first school, the logical aspects of learning are emphasised. Intellectual development is viewed primarily as the process of building in children's minds the intellectual structures associated with a discipline. The possibilities of age related restrictions on the type of thought-process in which children can engage themselves are disregarded and thinking is seen as being quantitatively different at different ages. The theoretical positions associated with Ausubel (1968), Gagne (1977) and Trabasso (1977) are exemplars of this viewpoint.

The second school of thought emphasises the psychological aspect of learning processes. Here the theoretical focus is on internal restrictions on the child's thinking and the qualitative changes in this thinking as cognitive growth occurs. Differences in the intellectual

structures associated with different disciplines and fields of study are ignored and an attempt is made to build content free intellectual structures which transcend discipline boundaries. This school of thought encompasses the Piagetian (Inhelder and Piaget, 1958) and neo-Piagetian paradigms and information processing views on cognitive development. (e.g., Klahr and Wallace, 1976). The psychological theorists of this school see the internal cognitive processing capacities of pupils as the main focus of teaching and learning. Subject matter is important only in so far as it must be matched to these capacities and any analysis of this subject matter must be approached from the child's perspective rather than that of a discipline specialist. Piaget's work provides an exemplar for this viewpoint which has been particularly influential in the field of science education. Children are thought to assimilate knowledge from their environment and pass through four major developmental stages in an invariant sequence, each stage being characterised by the emergence of intellectual abilities. The teacher's task is to firstly assess the level of development of the learner and then select and sequence learning experiences in such a way as to facilitate progress. Though the enormous flow of Piagetian literature had a great impact on science curriculum development, Flavell (1963),

Brainerd (1978) and Brown and Desforges (1979) draw our attention to some of the limitations of Piaget's Model. Whereas theory is both powerful and parsimonious, in many respects it is untestable. Even where the theory is expressed in testable terms, it turns out to be a poor predictor of pupil behaviours (Lawson et al, 1978).

We can consider a third school of thought which tries to take into consideration both logical as well as psychological approaches for the study of learning. The works of Bruner (1960) and Schwab (1964) are examples for the same. They were the first major congnitive theorists to recognise the importance of both the child and the structure of a discipline as important factors in the learning process. The studies by Driver (1982) and Osborne (1983) emphasise the importance of ideas which children bring to the classroom and the content and the context of a task as factors to be considered in studying the learning process. The work of Fensham et al (1981) describes the study carried out on logical analysis of intellectual structures of specific science curriculum topics in terms of 'intended cognitions' and have then used in variety of psychological interview techniques to probe the intellectual structures possessed by the individual students, thus assessing the

extent to which they match the 'intended cognitions'. As an emerging school of thought many more studies are required in this direction to establish the arguments.

It is true that there are epistemological and other differences between theorists within each of these broad schools of thought. Nonetheless, Lovell (1980) points out that these differences are of a lower order of magnitude than the between group differences which have been outlined. An extensive study carried out by Hacker (1984), suggests that the internalization of new facts concepts, principles and models are more frequently achieved by direct instruction as suggested by Gagne rather than by cognitive restructuring process favoured by Piaget (1964) and Bruner (1966).

The logical theorists in the first school of thought mentioned earlier believed in altering the observable behaviours. This naturally brings to focus the subject-matter to be dealt with a particular set of students. These set of theorists seeks to focus attention on some form of task analysis which makes subject-matter more digestible for the learner, Gagne's work providing a well known example of this approach. A key element

in Gagne's approach is the development of a student learning hierarchy. This is achieved by placing a target intellectual ability at the apex of a pyramid and then undertaking a logical analysis of the topic to identify pre-requisite intellectual abilities and thus fill in the body of the pyramid. The science teacher must then develop diagnostic pretests and post tests for each intellectual ability incorporated into the pyramid and performances on these tests reveal the full and partial intellectual structures acquired by the learner. In this way the diagnostic tests determine precisely what has to be learned to work towards the apex of the pyramid. As Case (1975) points out, this theory takes no account of the possibility of age related restrictions on types of intellectual abilities which children can acquire. It is possible that Gagne's earlier work with U.S. Airforce Pilot Training Programmes may go some way towards accounting his perspective on learning. Working with able, mature, adultminds would naturally focus attention towards the need for a task analysis as the major limiting factor in the learning process. Certainly, the bulk of research work based on logical theories of intellectual development has been carried out with secondary or senior secondary level students, such students being regarded by psychological theorists as having completed their basic

intellectual development. Case (1974) further points out that Gagne's theory takes account of the structural changes which occur in development by proposing that learning is cumulative and hierarchical. Complicated skills can be acquired only, once the lower order component skills have been mastered; further, more lower order skills are learned by processes which are qualitatively different from those by which higher order skills are learned.

Learning must be planned rather than haphazard so that each person will come closer to the goals of optimal use of his talents. This requires carefully planned and systematic instruction, taking fully into account the learning conditions that need to be established to facilitate purposeful learning.

1.3 Instructional Design

A psychologist or for that matter an educationist must set himself to the task of selecting those aspects of psychology of learning which will help in designing better instruction. The psychologists need to ask the following kinds of questions: "What item of knowledge and skill must a person have in order to do a job?", "How do these items of knowledge and skill depend on one another in such a way

that certain ones should be learned before others?", "Into what components can these items be analysed?", and "How are they in turn organised?". All learning theories had their contribution to instructional design and a number of educational psychologists gave increased attention to simplifying some of the basic principles of learning, drawn from various branches and schools of thought, for the application to education. Notable efforts were made by Skinner (1954, 1970), Holland (1961), Gage (1964), Bugelski (1964), Gagne (1965, 1970, 1974, 1977),Keller (1969), Hadden (1970), Travers (1972), Snelbecker (1974), Bloom (1971, 1981), Merril (1977, 1979), Case (1978), Reigeluth (1979, 1980) and a few others. Though the task was really a most difficult one and most of them did a commendable work, Gagne developed most widely recognised applications of learning theory to instruction. Gagne roughly categorizes instruction as being "pre-designed in which procedures are planned and tested before being used in classroom. He depicts instruction as mainly involving the arrangement of those conditions which facilitate learning. Learning must be linked to the design of instruction through consideration of different types of capabilities that are being learned. The strategy which Gagne adopted is to assume that these are several different types of learning, some of which

are subordinate to and components of other, more complex types. Gagne has drawn eclectically from many diverse and sometimes possibly imcompatible theories in his search for a comprehensive taxonomy of learning types. Hilgard and Bower (1966) suggests that Gagne's taxonomic arrangement depicts "the beginning of a unified theory of learning".

According to Gagne instruction can be successful in improving performances on complicated developmental tasks, only if it is based on a learning hierarchy analysis which breaks the criterion tasks into component tasks and which trains each of these separately, working up from the simplest components to the most complex ones. Gagne sees complex rules as being built up from simple rules which in turn built up from simple concepts and so on, down to the most basic building blocks which are S-R connections. For Gagne the process of development is largely one of cumulative learning. More recently Resnick and her colleagues (Resnick, Wang and Kaplan 1973; Resnick and Fork 1981) have found that learning hierarchies are useful in prescribing and assessing sequences of instruction when the to be learned material can be specified as behaviours. By the nature of science all learning theories cannot influence its method of instruction. Science mainly consists of concepts rules and problem solving. The true nature of sciences goes very well with

Gagne's approach to the subject-matter. His views had tremendous impact on science instructiom in many countries in particular U.S.A. and U.K. "Science - A Process Approach" in U.S.A. and "Schools Council Integrated Science Project" (SCISP) in U.K. are well known examples for the same. Its influence on science instruction has been very much accepted by researchers and educationists throughout the world.

1.4 Science Instruction

Tremendous progress has been taking place in the field of science instruction in most of the Western countries. Especially, learning theory based instruction is gaining its roots slowly, though most projects were adopting eclectic approaches. The schools Council Integrated Science Project (SCISP) developed in U.K. (1974-77) is one such programme developed based on an explicit learning model of the Gagne. The explicitness, says Mike Lyth (1977), of the model is one of its strengths, in the sense that its operation can be monitored and criticized and its usefulness evaluated at all stages. The published literatures, these days, show a great concern for science instruction and the need for improving the same. Unfortunately, the research

the research in this field in India is very less and science education research is one of the most neglected fields. Though there has been some studies in related fields in India (Patel, 1967; Pandya, 1974; Vaidya, 1974; Sonar, 1975; Dave, 1975; Praksh, 1976; Patel, 1976; Singh, 1977; Arunkumar, 1978; Pillai, 1980; Pandey, 1981; Vaidya, 1982; Ravindranath, 1982; Vardhini, 1983; Pillai, 1985), in most cases science instruction was incidental and learning theory based research on science instruction was almost nil.

There is a great need for research into the dimensions of the instructional and nurturant effects of various types of instructional practices in science education today. Competence in teaching stems from the capacity to reach out to differing children and to create a rich and a multidimensional environment for them. This demands that we have to increase our experience with different models of instruction in different classroom settings. Also we must examine diverse range of alternative patterns of instruction upon which teachers may model their behaviour. Each design of instruction prepared, with learning theory underlying procedures, should be validated to see that each child becomes a productive and effective learner. Science education research, then, should direct its attention - (i) to improve the existing procedures for teaching science and

(ii) to establish new and verified procedures for teaching science.

In the contexts mentioned above the investigator felt the need for extensive research for the improvement of science instruction in India, particularly based on established learning theories, fully endorsing Gagne's view that "Most instruction in school subjects is concerned with the learning and use of concepts and rules and with problem solving" and optimum learning takes place when the necessary conditions for the same are established.

1.5 The Title of the Investigation

The present study was to be conducted through instruction in physics at the secondary school level taking fully into consideration, the conditions under which learning occurs as formulated by Gagne. Thus the study was titled :

"AN EXPERIMENTAL STUDY OF GAGNE'S CONDITIONS OF LEARNING FOR INSTRUCTION IN PHYSICS AT SECONDARY LEVEL".

1.6 Objectives of the Study

The main objective of the study was to design an instructional strategy for teaching physics based on

Gagne's conditions of learning and to conduct an investigation into its efficacy. The following objectives were thus formulated :

(1) to design an instructional strategy based on Gagne's conditions of learning.

(2) to experimentally validate the instructional strategy developed.

(3) to examine whether the acquisition of higher order capabilities necessarily include lower order capabilities also.

(4) to determine whether the instructional strategy adopted brings any change in cognitive preferences.

1.7 Hypotheses

Physics, because of the nature of the subject itself, consists of mainly intellectual skills and investigators interest was limited only to concepts, rules and problem solving. No effort was intended to be made to look into the hierarchy aspect between the elements within concepts or rules. The following hypotheses, thus, were proposed to be tested :

1. The instructional strategy designed and developed based on Gagne's conditions of learning can successfully be used in the normal classroom setting.

2. The performance of the experimental group using the instructional strategy based on "Gagne's Conditions of Learning" will be better compared to that of control group following the traditional method.

3. The existence of higher order capability problem solving ensures the presence of lower order capabilities rules and concepts and the acquisition of rule capability depends on the presence of concept capability.

4. The hierarchy in learning does not depend upon the nature of instructional inputs and their sequencing.

5. The learning h hierarchy based on instructional strategy with problem solving at its apex will bring changes in the cognitive preferences of the learners from facts to problems.

1.8 Conclusion

The present study has been designed to be an experimental one conducted in an actual classroom situation with its normal strength, and all constraints of time, teacher and facilities. The outcome of the research should be that it should really help the practitioner with a package which he or she can make use of. This demands that the experiment should be performed in the real classroom environment without any change or special regrouping. These are the days when classrooms are getting more and more overcrowded, reducing the facilities for any individual attention, and the teachers are supposed to deliver the goods to all. As a consequence most science teachers see themselves as more practically oriented. They are interested in techniques and materials that can be used in the present day classrooms. This is what the investigator aimed at and developed.

The introduction chapter has given a complete overview of the study. The second chapter which reviews the related literature, focusses on some of the contributions from various theories towards an instructional design. Contributions from various theories were included to create a background to discuss the Gagne's conditions of learning; giving it more clarity. An instructional design formulated

by drawing its learning principles from the conditions of learning, is discussed towards the end of the chapter. The main interest of this study is in science education and as such our attention is drawn towards the researches in this field in India in the third chapter. The learning material developed, as part of the instructional strategy, is described in chapter IV. The experiment conducted to examine the instructional strategy adopted is explained in chapter V. It also deals with the validation aspect as required under objective No.2, to find out the effectiveness of the instructional strategy with the help of the data obtained as student performances. The sixth chapter gives a study on learning hierarchy, as required for objective No.3, based on the data collected for the study of the second objective. Any good instructional strategy should bring corresponding changes in cognitive preferences of the children and a study conducted to examine the same is reported in Chapter VII as per the requirement of objective No.4. Chapter VIII summarises the whole study reported in the earlier chapters.