Chapter I

Introduction
Chapter -I

INTRODUCTION

Education is most important tool for development of society and individual. Each human has so many inner qualities in itself. Education makes drawing out of these qualities. Education enables human to learn effectively by his own experience. Education helps in transmission and reorganization of cultural characteristics which makes socialization of human possible. Human has tendency of learning new things and skills from birth. Every individual has more potential and capacity to learn in comparison to other animals. This learning potential transformed human from aggressive animal to civilized resident. Human mind is always in process of searching new thing and incidents. Human mind observes any change in environment very precisely. So every individual has an innate virtue of inquiry.

By this process of inquiry, human has used science to make his living comfortable. Science is an important aspect in development of nation. Inquiry strengthens scientific aptitude. Future of any country is shaped in its classrooms. Classroom should be place where scientific aptitude and attitude should be nourished within students.

Science is key of development of nations. Without science and technology we cannot even imagine a single step movement of country towards progress. Science should not only be present in infrastructure and devices, it should be inside our thinking and behaviour. This internalization of science is feasible through proper teaching in classroom.

Teaching influences learning. Apart of learners’ capacities and qualities to learn, method and style of teaching is also factors in pace and stability of learning.

Humans are always curious to know things and events around them. It is human mind which is always indulging in process of inquiry and imagination to know about natural phenomena. Human gives response to environment by observing it and finding out meaningful patterns and relationships. Humans try to adapt into environment around them. They look for measures to interact with and understand the components of their environment and in this process; they made their own concepts about world and nature. This whole process is science.
Science is ever changing and expanding set of facts which changes with new experiences. This knowledge is generated through scientific method. Although we use scientific method in our daily life often but defining this method is more complex than executing this.

Inquiry is most important factor in this method. Every step should be enquired carefully in order to reach precise conclusion. Even Properly evaluated facts of science are not conceived as universal truth. They are subject to modification through new experience, observation, analysis and evolution of new tools and techniques. Though body of scientific knowledge is always questionable but science gives us most reliable information about world.

Science is not only an individual endeavour of a human to make concepts about world, it is a social endeavour also. Its role in development of nations and society cannot be described in some words as it is so vast to explain. Science gives us theory and use of this theory in making our tasks and living is technology. Transportation, health care, infrastructure, communication, we are using science everywhere. Science is making things and processes easier for us.

Although expansion of scientific knowledge is being criticized due to some threats which are being encountered by human being in modern era. Where scientific knowledge is being used in electricity generation by nuclear power, on the other hand this scientific knowledge is being used in making mass destruction weapons also. Science has been reached so deep in our lives that it is now affecting our daily routine.

But this is use of science which makes it good or bad. A good system for providing good science education trains citizens not only in using scientific method efficiently and making inquiry effectively but also using science and technology only for welfare of society and nation, not for war and destruction.

So science education is mandatory for well being of individual, society and nation. A science teacher teaches students who are future citizens. In a democratic country, people can check out possible aberrations and misuse of science. Science with proper wisdom can lead society on the path of progress. This need of wisdom in science and technology provides us a reason to select best method for science teaching.
In this fast changing world, where the most required skill is flexibility in adapting to new demands and creativity in taking advantage of new opportunities, science education is an important need of society.

1.1 TEACHING AND LEARNING IN SCIENTIFIC WORLD

Teaching and learning are correlated to each other. Goals of transmission and preservation of culture are accomplished through proper strategies of teaching. Not only cultural characteristics, scientific and rational thinking is also developed within students by professionally trained and skilled teachers.

So a good teacher requires (i) knowledge of range of strategies for teaching which are suitable and feasible in the school environment (ii) knowledge of using these strategies effectively and efficiently. (Joyce and Weil, 1972). Goal of teaching is always improving outcomes of learning. (Gagne 1963).

Since science speaks about devices and technologies so strategies for science teaching should be affected from technological advancement. Science has become an important part of our life. So teaching is considered as a mechanical process in this technological era. Theory of instruction helps teacher to make teaching a scientific process. Theory of instruction may help teachers for effective teaching. Instruction technology always directs teaching towards pre assumed learning outcomes. Contents and syllabus of subject are structured and designed according to level and potential of learner. Content is presented in pre decided sequence. All the rewards, cues and feedback are arranged in a proper way. All these principles help instruction technology to making teaching mechanistic.

Methods of teaching are key component for science teaching. Science is not body of facts to be memorised. A student feels and perceives facts of science working in daily life. So teaching method should be child centred. Teaching method should allow students to explore knowledge more and more while at the same time; direction of teaching should not deviate from pre defined learning outcomes.

Teaching is not concerned with achieving cognitive outcomes only. It shapes the perception and attitude of students. Teaching is concerned with affective outcomes also. A good teacher does not know teaching only, he/she knows how to motivate
their students. Whole personality of students is influenced by teachers. Teaching is more than transfer of knowledge.

So teaching requires good method which can nourish capacities and skills present inside students like skill of investigation and skill of inquiry.

1.2 TEACHING OF SCIENCE

Science education is not easy to plan for educators of any nation. Science education is an important part of education policy. For successful operation of a democracy, good and true science education is must as water is must to strengthening roots of plant. In this age of rapid change, science is best tool for adaptation and survival too. A true science education revolves around learner, his environment and science for better adjustment and adaptation. Not only in terms of infrastructural development, but also in terms of environmental conservation. In other words, true science education is key to balance between nature and human.

A good science curriculum, needed for achieving goal of this balance should have these types of validity as following-

a) Cognitive validity requires that the content, process, language and teaching methods used in science education are age appropriate, and within the cognitive reach of the child.

b) Content validity requires that the curriculum must present significant and scientifically correct content. Presentation of content in concrete terms, which is often necessary to adapt the content to the cognitive level and capacity of the learner, must not be so complicated as to convey something basically flawed and/or meaningless.

c) Process validity requires that the curriculum must engage the learner in activities that lead to generation and verification of scientific facts, and nurture the natural curiosity to enquire and creativity of the child. Process validity is an important validity since it helps in ‘learning to learn’ science.

d) Historical validity requires that science curriculum must be taught by a historical perspective, acquainting learner of how the concepts of science
evolve with time. It also helps the learner to view science as a social and common effort.

e) Environmental validity requires that science curriculum must be placed in the broad context of the learner’s environment, physical and social, enabling him/her to appreciate the issues at the intersection of science, technology and society, and preparing him/her with the requisite knowledge and skills

f) Ethical validity requires that the science curriculum must promote the values of objectivity, rational thinking, honesty, co-operation, fearlessness and develop in the learner a concern for life and conservation of environment.

Teaching of science is related to transformation of theory and experiment into each other. Sometimes theory directs to process of an experiment while sometimes an experiment gives cue or reveal need of generation of new theories.

Science teaching needs balance between learning of facts and training of skills to experiment. Method should be selected after considering theory and experiment both. Students should know about facts in theory and their validation by experiment.

Method selected for science teaching should be able to train students for inquiry by scientific method. That’s why, science teaching is strictly against rote memorisation and cramming. Exploration of problem is must to learn for students. Analysis of problem and synthesis of all pieces of information available about problem should be learnt by every student.

1.3 MODELS OF TEACHING

Teaching is just not communicating a body of facts; it is transformation of learners’ experiences into concepts. A learner what sees and perceives in his environment, is basic unit of his/her knowledge. A teacher has to build the whole body of knowledge or set of skills by synthesising these units of experiences.

Even the best curriculum and the most perfect syllabus is useless in absence of right methods of teaching and the right kind of teacher. In the age of machines, teaching learning process has also become more mechanical than meaningful. Interesting, appealing and frequent presentation and experiences are necessary for meaningful learning. Proper instructional strategies are essential for achieving the educational
objectives. There is no single best method or teaching plan that can be employed in all conditions and settings since the number of teaching objectives is large and varied in nature. The best technique is the one that is most effective and efficient in achieving a specific goal in a given situation. This is the philosophy behind the models of teaching. Joyce and Weil (1990) have explained the meaning of models of teaching. Teaching models are instructional designs to describe the process of specifying and producing particular environmental settings which cause the student to interact in such a manner that specific variation occurs in his behaviour. Teaching model is a pattern or plan which can be used to develop a curriculum or course, to select instructional materials and to direct a teacher’s actions. Models are designed to achieve specific goals. When a teacher recognizes a goal, chooses a particular strategy designed to achieve that goal, we can say that he is using model of teaching. A model of teaching consists of guidelines for defining educational objectives and designing educational activities and environments. It describes the specific ways of teaching and learning that are required to attain certain kinds of goals. There are many powerful and effective models of teaching designed to bring about particular kinds of learning and to help students to become better learners. Teaching method has a large impact on students’ abilities to educate them. Successful teachers are not simply magician, persuasive and expert presenters. Rather they present powerful cognitive and social activities to their students and teach the students how to make effective use of them. Thus, a major goal of teaching is to create powerful learners.

A model of teaching is a teaching strategy or method for constructing concepts in learners’ mind by designing learners’ experiences. A model of teaching is a set of procedures for construction, sequence or delivery of learning environments and instructional experiences. They provide theoretical or instructional frameworks, plan, patterns, or examples for any number of educational components — curricula, teaching techniques, instructional groupings, classroom management plans, content development, sequencing, delivery, and the development of support materials, presentation methods, etc. Teaching models may even be discipline or student-population specific. In other words, Models of teaching is a model representing whole teaching learning process. Every component of teaching learning process is well defined and planned and then, all components are organised in order to achieve predefined instructional objectives.
Models of teaching include a set of instructions, but they are not just a set of instructions themselves. They work for achieving predefined goals. For teaching a particular topic, the whole teaching process is reflected in a pre-designed model.

It is not just a lesson plan as a model of teaching encompasses reactions and behaviors of students also. What will a student perceive after presentation of instruction material? How will they react to this picture? These and similar questions are within the scope of models of teaching.

Models of teaching and learning are critical miniature or blueprint to instructional planning and delivery because they help educators to:

1) Develop highly precise and diverse professional repertoires;
2) Allow them to reach a larger number of students more effectively;
3) Create either more uniform, or varied, or effective instructional events, guided by targeted subjects, content, or processes;
4) Understand curricular goals or targets better, especially as different models can be matched specifically to both learning outcomes and/or targeted learning populations;
5) Get needed insights into why some methods work with some learners, while others do not;
6) Redesign radically existing methods of teaching and instructional delivery so that emerging or altered instructional techniques may better meet the needs of today’s students.

Models of teaching have the following features:

1. A predefined purpose or area of concentration like inquiry training model concentrates upon the development of skill to enquire.
2. Underlying and predefined explicit and implicit assumptions about the traits of learners and about the teaching-learning process and environment of the classroom. (These are directly concerned to guidelines of the different divisions of educational psychology and theories of learning. For instance in Behavioural
Models students are seen as being generally passive but able to respond and to be motivated through different forms of directed stimulation.

3. Guidelines for developing specific educational experiences and environment

4. Pre defined patterns and requirements for each instructional event

5. A body of knowledge of research surrounding their development and implementation, or an evaluation of their effectiveness.

1.3.1 Components of models of teaching

Components of a model of teaching are as following:

1. **Focus** is the central core or intent of the model. Focal components describe the main objective of the model. It is the focus of the model which directs to design learning event to encourage learning by manipulating thought or types of thinking; growth in learning through external stimuli or rewards; social learning, or social and emotional growth through interaction; or increased levels of self-achievement and personal growth through personally directed choices. All these decisions are made on the basis of focus of model. Models are usually developed with a focus, an predefined end of learning event, or specific intention. For example – in cooperative learning model the focus is on the importance of spirit of social interchange and peer support in learning new things. Therefore models differ one from the other in terms of their primary objective or focal point of their intended or predefined outcomes.

2. **Syntax** describes the model’s structure and includes the sequence of steps involved in the organization and development of the model. It encompasses the major components and the phases of presentation, or the sequence of steps, and describes how the teaching learning process advances according to model. Obviously the syntax can be quite different for each model.

3. **Principles of Reaction** tell the teacher how to behave with learner and how to respond to activities of learner during the use of the model. Often responses in using a designated model should be appropriate, pre assumed and specific. This element includes teacher’s reactions to the students’ responses. This component of the model tells the teacher for how to react to the responses of the students. It
is here that the teacher knows whether the learners have been actively involved in the model’s processes and steps. For example in inquiry training model, teacher reacts by saying only yes or no.

4. **The Social System** describes the interactions between students and teacher as each model is seemed to be a mini society. Since each teaching model is different, each model will have its own social system and rules interaction. This portion includes the interactive roles and relationships between the teacher and the student, expected norms of behaviours, and which student behaviours should be rewarded. These may be overtly described or simply inferred. Depending on the philosophical orientation of the model, in some models the role of the teachers is main and dominant, while in others his or her role is passive or supporting. In some models the social system emphasizes on the teacher, and in others the concentration is on the students. There are still other models whereby teachers and students share roles equally. In this segment both motivational strategies and tactics for engaging students could be discussed too.

5. **Support system** defines the supporting conditions and materials required to implement the model successfully. ‘Support’ refers to any additional requirements, beyond the general human skills and capabilities that are needed to implementation of the model. This component concerns to any additional requirements beyond those generally possessed by teachers or found in schools. What requirements are needed to make the model effective? Are special skills or knowledge needed; or is there special equipment, aids, media, or learning setting requirements that need to be accessed in using this model? This support would also include special books, films, laboratory kits, reference materials, permissions, facilities, etc.

1.3.2 Families of models of teaching

Conventionally, models of teaching are categorised by a broad array of teaching systems, each system containing a different philosophical foundation, or theory of learning base, with related teaching methodologies. Most models can be loosely categorised into one of four or five distinct families of educational psychology – social; information-processing; personal; behavioural systems are the traditional ones, with constructivist added latter. Models falling into the first four categories
have strong background of research, development, and usage as most have been both refined and verified in the field. Plus, each of these divisions, to include constructivism, has a distinctive theory of learning orientation.

**Personal:** This group of models recognises the uniqueness of each learner. Methods in this category emphasize the importance of individuals in creating, directing, and structuring personal meaning. Also models in this area are often targeted to develop things like self-esteem, self-efficacy, emotional and personal understanding and acceptance. Carl Roger’s *Non-directive Teaching Model* would be a good example for this group.

**Social interaction:** This group of methods aims at building learning communities to develop effective and productive ways of interacting in a democratic setting. These models also emphasize that human learning occurs in social settings and through modelled behaviours and social interaction. The Schafel’s *Role Playing Model* is one of the most popular models in this group. Donald Oliver’s *The Jurisprudence Model* is also an example of form of social learning.

**Information processing:** This is the largest group of models aimed at mastering in cognitive skills like learning specific information and of acquiring and organizing data, solving problems, and developing concepts and language. As the category title implies, models in this category deal with intellectual development, powers of reasoning and logic, mastering students in organizing and retaining information, and in improving their metacognitive functions. Primary examples in this area are David Ausubel’s *Advanced Organizers*, Jerome Bruner’s *Concept Attainment* model, or Richard suchman’s *inquiry training model*.

**Behavioural:** Behavioural techniques are aimed at highly structured outcomes that concentrate on observable objectives such as learning to read, physical skills, behavioural and emotional adaptations and restructuring. These models are highly structured with finite goals toward specific pre-determined terminals. B. F. Skinner is one of the more well know developers of behavioural techniques like his *Operant Conditioning*.

**1.4 INQUIRY TRAINING MODEL**

J. Richard Suchman (1962) developed this inquiry training model of teaching. The foundation of this teaching model lies on methods employed by research personnel,
especially physical scientists. Although it was developed for teaching of the natural sciences, this model has wide applicability in all subject areas. The goals of inquiry training model are to help students develop the cognitive potentials necessary to search out data, process it and apply logic to it. This teaching model attempts for developing scientific inquiry training skills in the learners. He created this model to help students learn to organize and categorize data, verify facts, know reason about cause and effect, build and test hypotheses and become independent learners. Inquiry is the active achievement of meaning involving thought processes that change experience to pieces of knowledge. When we see an unknown object, we may be puzzled about what it is, what it is made of, and what it is its use, how it came into existence, and so on. To find answers to such questions we might start to examine the object closely, apply certain tests on it, compare it with other more known objects, or ask people about it, and for a time our searching would be aimed at finding out whether any of known theories made sense about this unknown object. Or we might simply seek for information that would suggest new theories for us to know about this object. All these activities i.e. observing, building hypotheses, doing experiments, hypotheses verification etc. are part of inquiry. The purpose of the activity of inquiry is to collect enough information to put together theories that will make new piece of knowledge less unknown and more meaningful. Every individual have a natural tendency to inquiry. This model is built upon intellectual encounters to the situation. Suchman believed that it is necessary to convey to students that "all knowledge is tentative". Inquiry training originated in a belief leading to the development of independency of learning; its method requires active participation of learners in scientific inquiry. Children are curious and they have zeal to grow, and inquiry training work on their natural energetic explorations, giving them specific directions so that they explore new fields more forcefully. The general goal of inquiry training is to help learners develop the intellectual discipline and skills necessary to raise questions and search out answers stemming from their curiosity. Suchman was in favour of helping students to inquire independently, but in a systematic manner. The chief purpose of inquiry training is to make children more independent learners. He wanted students to ask question why events are happened and to collect and process data logically, and he wanted them to develop general cognitive strategies that they can use to find out why things are as they are (Joyce, Weil and Calhoun, 2008).
1.4.1 Components of inquiry training model

The inquiry training model was developed by Suchman (1962)

(i) **Focus**: The goal of inquiry training model is to help learners develop the cognitive abilities of searching and processing data, and the concepts of logic and reasoning that would enable the individual learner to inquire autonomously and fruitfully. This model helps the students to build questions about the process, collect data, formulate and test hypotheses. Inquiry training model helps students to develop the intellectual discipline and ability necessary to raise questions and search out answers having roots in their curiosity. Suchman’s model helps students to enquire independently in a disciplined manner. Inquiry training begins by presenting students with puzzling event or phenomenon, and the individual are motivated to solve the puzzle.

(ii) **Syntax**: Inquiry training model has five phases. Phase one requires that the teacher presents the problem situation (discrepant event) and explain the inquiry procedures to the students i.e. which question is to be answered and teacher gives response in only yes or no. Phase two, verification, is the phase whereby students gather information about the events they see or experience explained in the problem and generates possible answers or hypotheses to the problem. In experimentation, phase three, students introduce these new components of the problem i.e. hypotheses generated in previous phase into the situation to see if the problem happens differently. Although verification and experimentation are considered as separate phases of the model, the students thinking and the types of questions they generate usually alternate between these two phases of data gathering. In phase four the teacher calls the students to organize the data and to formulate an explanation based on tested hypotheses in previous step. Finally in phase five, the students are asked to analyze their pattern of inquiry so that they can conceptualize this answer to problem into theory. They may determine the questions that were most effective, the lines of discussion that were productive and those that were not, or the type of data they needed and did not obtain. This phase is essential if we need to make inquiry a conscious one and systematically try to improve it.
(iii) **Social System:** Schuman’s intention was that the social system be cooperative and strictly according to democratic environment. Although the inquiry training model can be rigorously structured, with the social system controlled mostly by the teacher, the intellectual environment is open to all relevant thoughts and ideas; teacher and students participate equally where ideas are concerned. In this model, teacher encourages students to initiate inquiry as much as possible. After a period of teacher structured sessions, the students can undertake inquiry in settings controlled by them. In the initial stages of inquiry the teacher’s role is to choose the problem situation, to referee the inquiry according to inquiry training procedures, to give response to students’ inquiry probes with the necessary information, to help beginning inquirers in focusing on their inquiry, and to make suitable environment for discussion of the problem situation among the students.

(iv) **Principle of Reaction:** The most important reactions concerning to teacher take place during the second and third phase. During the second phase the teacher’s duty is to help the students to inquire but not to do the inquiry for them. In case the students ask a question which may not be answered in yes/no, the teacher must tell the students to rephrase the question so that their attempt to collect data and relate them to problem situation may be continuous. The teacher can, if required, keep the inquiry continuous by making new information available to the group and by focusing on more relevant events or by raising questions. During the last phase, the teachers’ task is to keep the inquiry directed towards the process of inquiry itself.

(v) **Support System:** The optimal support is a set of demonstration materials, a teacher who knows about the intellectual processes and strategies of inquiry, and resource materials pertaining to problem.

(vi) **Application:** Although inquiry training was initially developed for the natural sciences, its procedures are usable in all subject areas. Like other models, especially information processing models, inquiry training can be taught in a teacher controlled setting or incorporated into more self-directed, learning centred environments. Discrepant events can be presented through print, film, or audio means. Task cards directing students to inquire according to the model
can be developed. The inquiry can be made over a period of several days, and
the inferences of other students’ inquiries can be shared. Students should have
access to proper resources, and they can work together in groups. Students may
also develop discrepant events and conduct inquiry sessions in their peer group
(Joyce, Weil and Calhoun, 2008).

(vii) **Instructional and Nurturing Effects** : The model promotes strategies of
inquiry and the values and attitudes that are required to an inquiring mind,
including; • Processing Skills (observing, collecting, and organizing data;
identifying and controlling variables; generating and verifying hypotheses and
explanations; making conclusions) • Active, autonomous learning • Verbal
expressiveness • Tolerance of difference; consistency • Logical thinking •
Attitude that all knowledge is tentative.

### 1.4.2 Phases of Inquiry training model

Inquiry training model has 5 phases-

**Phase I : Encounter with the Problem.**
- explain inquiry procedure
- present discrepant event

**Phase II : Data Gathering - Verification**
- verify the nature of objects, events time and properties

**Phase III: Date Gathering - Experimentation**
- isolate relevant variables
- testing hypotheses
- find causal relationships

**Phase IV: Formulation of an Explanation**
- Simple linear causation
- theory of properties
- analogy
- application

**Phase V : Analysis of the Inquiry Process**
- Recapitulation of the steps of the model analysis of the strategies of inquiry.
1.4.3 Rules for teaching with inquiry training model

The inquiry begins with a problematic situation and students inquire to find its solution. It is necessary that teachers concern themselves primarily with adding inquiry into classroom climate. To creating this climate for inquiry, suchman formulated six rules for conducting the inquiry session.

Rule I: The questions should be asked in such a way that they can be answered in 'yes' or 'no' only. This rule helps teacher to induce more precise thinking on the part of students, and it prevents them from putting the load of unnecessary thinking on the teacher through open-ended questions.

Rule II: Once called upon, there should be no limitation of asking questions for students. Creative thinking requires time and persistency. Students should not feel pressure by other students willing to inquire.

Rule III: The teacher does not answer 'yes' or 'no' to statements of formulas/theory or to questions that is intended to obtain the teacher's approval of a theory. Theories are only initial points for inquiries; the teacher should encourage students to extend their theories to experiment and test them. There are no final conclusions. Scholars and scientists are always searching for better explanations.

Rule IV: "Any student can test any theory at any time". Students should argue the pros and cons of one another's theories and feel free to test all theories that have been proposed in process of inquiry.

Rule V: "Any time the students feel a need to discuss with one another without the teacher's presence they should be free to call a conference on problem to be solved". Conferences should be brief and in short time, about four minutes. Their aim is to help students who are reluctant or shy to expose their ideas to a teacher, and to facilitate the cross fertilization (interexchange) of ideas.

Rule VI: "Inquirers should be trained to work with experimental kits, idea books, or resource books or materials at any time they feel".

The teacher directs the students to a strategy whereby their early questions are limited to data gathering stage; they ask questions about events, objects, conditions and properties related to problem. Through this information they attempt to find out the
nature and identity of the objects, the events, the characteristics and conditions surrounding the problem. Thus the students are taught through experience which they gain in searching out data for solving problem. As the students become aware of the properties and characteristics of the data, hypotheses should come to mind in the form of attempt to solve problem and guide further inquiry. Using their knowledge about behaviour and properties of the objects, students can modify answer of their questions into the relationships among the variables in the situation. They can conduct verbal or real experiment to test these casual relationships among variables, using selection of new data or organising the present data in new way to see what will happen if things are altered or done differently. By introducing a new situation or altering an existing one, students isolate variables and perceive how they are affected by one another. Finally, students try to develop hypotheses that will explain properly what happened actually in the problematic situation. Even after lengthy and dense chain of verification and experimentation activities, many hypotheses may be available to final explanation of situation. Students express these theories or the final explanation with different levels of preciseness and specificity in solution of puzzle. Inquiry cannot be planned in advance, and the range of productive inquiry strategies is large. The model promotes development of strategies of inquiry in mind of learner, and the values and attitudes that are essential to an inquirer mind. The model splendidly integrates several process skills like observation, data collection and organization of data into a single, meaningful unit of experience. The format of the model promotes active participation of students and autonomous learning as the students formulate questions and test ideas themselves. It gives students courage to ask questions, but it is hoped that this type of risk taking will become only a derivative to the students. They will also become more confident in expression of their ideas and thought and they can listen and grasp of ideas of others.

1.5 JUSTIFICATION OF THE PROBLEM

Students of modern world need to understand and appreciate the importance of science in a modern society. Changes in the social structure have been brought about by the inventions and discoveries of science and technology. The teaching of science for better level of living should become a major objective. Students may gain scientific knowledge and perhaps possess desirable scientific attitude, but fail to preserve and use this attitude and knowledge outside the class. So, it has become
necessary to bring about changes in the methods of teaching science with change in traditional classroom environment.

Research and experiments are required for innovative strategies in classroom teaching and to develop a science of behaviour and teacher student interaction applicable for educational institutes. Many past research studies have revealed the new approaches of programmes that reflect much better ways of making teacher-pupil interaction more interactive inferring in enhanced achievement on the part of the pupil.

Teachers have a key position in the field of education by playing the role of facilitator for learning by organizing the instructional activities and required learning circumstances. They can't play this significant role effectively if methods of teaching especially in science education have not proper directives for providing facility for organization of learning environment. Therefore, for the effective improvement of education pattern, innovative and effective methods of teaching science should be located through research and are to be tried out in real classroom settings. The amount and the direction of research on teaching styles show vigorous changes during the past decades resulting in the development of general patterns or styles that have broad utility as well as the possibility of synthesizing specific patterns suitable for particular children in specific situations.

In spite of this continuous endeavour for searching and applying innovative methods of teaching, the instructional procedures in science are not giving maximum targeted returns or learning outcomes. This suggests that effectiveness in teaching learning process depend on the methodologies of teaching and learning; instructional practices used; learning environment provided or learning activities organized. More and more research studies are required to locate and discover the effective methods of teaching. Therefore, it is high time for teachers to implement effective methods of Teaching, which are supported by research and which can strengthen learning potential of learners. A teacher needs such teaching strategies which are logical, systematically planned and designed and which provide for their outcomes with very few limitations. Models of teaching implement such strategies. There are various models of teaching and they adequately serve for achieving a wide range of objectives. Each model has its own aim, theoretical prepositions, principle and major concept underlying it. Some models are designed and planned for very specific objectives while others are
designed to have general applicability. As a consequence, the researcher felt the need for determining the most effective models for teaching concepts of science in high school classroom settings. It was clearly noted by the researcher that even among the few studies done on models of teaching, comparisons had been made between models of teaching and conventional or traditional methods of teaching for a short period of time or for a small number of topics.

Several teaching methods and strategies are being evaluated here in terms of prevalent variables. It is, however, observed that there is a requirement for more detailed and in-depth studies in the same area. Research on teaching methods at this stage is still in its infant condition, because previous research on classroom teaching has brought educationists only marginally closer to an understanding of teaching - learning process. In this era of technology, Time is now right to scientifically investigate for new and alternative strategies that can be easily and effectively implemented. One of the important facts in education, which every educator need to know, is that improvement in teaching and learning can be achieved by research when it is directed by proper philosophy of education. (Best, W John 1978) states that, "research is one method by which one finds the solution to educational problems". Every teacher should appreciate the importance of research in teaching and learning process. The common misbelieve that the art of teaching is merely the process of imparting information is gone. The main goal of teaching is to encourage the child to react to his environment in an effective manner. A detailed analysis of teaching and research or experimentation in teaching methods provides for improvement in teaching. The important thing for improving teaching of science is strongly interrupted by lack of changes in teaching methods over many years. Therefore it is right time to use innovative strategies of teaching that foster transformation of thoughts into concepts and evaluation in the process of education. Education in schools has become concentrated on focus, rigid and more related to textbooks than to the life of learners. Hence, it is time to reframe the objectives of education according to the present and future requirements of the individual and society. Any improvement in educational system should essentially modify the process of teaching because the major part of formal education is imparted in the form of classrooms teaching. Focus of research should be on examining the compatibility of educational practices with strategies and techniques of teaching. There are so many validated research studies on models of
teaching in western countries. To what extent do they are compatible into Indian conditions?

There is a need to explore the feasibility and usability of these models of teaching in Indian conditions. There is a prevalent assumption that science teaching in schools has become full of cramming and rote memorization. It does not develop the logical thinking in students and it does not arises the interests of students towards science. Students start to tend to develop negative perception for learning of science. This negative perception leads to low enrolment in science at higher levels of education causing dearth of scientists who can be indulged in research and development. Lack of Creativity in science may be harmful for society. Hence, interest of students in learning of science should be developed at school level itself by adopting a variety of feasible and suitable teaching strategy. Models of teaching are teaching strategy designed to achieve specific objectives. This objective of developing interest in science is possible through models of teaching. Education process is not transmission of information and facts only but is concerned with developing analytical, critical and problem solving abilities as well as the creativity of an individual. Many research studies in this regard on learners’ performance or achievement in learning has been done. However, it is very significant to note that there are so many studies on finding out effectiveness of various teaching strategy. Most of them revolve around comparison of conventional method of teaching with other teaching methods. Studies on models of teaching also follow this trend of comparison. These comparisons are in terms of various variables like achievement, attitude etc.

The urgent need of selection of suitable teaching strategy for teaching science motivates investigator to conduct study on models of teaching as these models are found to be very much effective teaching strategy for teaching of science. Science needs development of preciseness, logical and critical thinking and analytical abilities in learners which demands a conceptual, compatible, calibrated and well planned teaching strategy. Models of teaching fulfil these criteria for teaching of science.

Science needs exploration and investigation. Students need to develop skills used by scientists in their experiments. Though potential and abilities of students at secondary level are not sufficient for performing experiment like scientists but they can learn method and procedure used by scientists. Their preciseness and performance may not
be at optimum level of scientists and professional investigators but they can be acquainted of scientific method of inquiry.

Inquiry training model is an instruction strategy which emphasizes on training of learners in scientific inquiry. Skills like problem solving, reasoning and logical argumentation are on focus of this teaching strategy. Students are given environment to think like scientists. So inquiry training model is a step towards innovative teaching of science which creates zeal among students to enquire according to scientific method and investigate like professional researchers.

Inquiry training model should be on preference of researchers searching for pedagogical procedures of teaching science as this model gives students opportunity to think like scientists does. Analysis of various components of problematic situation which is a discrepant event in this model and synthesis of these components after discussion and application of logic gives a direction forming a hypothesis. Hypothesis here is most possible answer for problem to be solved. Then students verify the hypothesis. All these steps put the mind of learners in a scientific framework and they get acquainted of scientific method of inquiry. So investigator choose inquiry model of teaching among models of teaching for research on teaching strategy of science teaching.

There are few studies on inquiry training model in Indian circumstances. Most of them have small number of participants. Even though sample size is proper in any study, generalization of result seems to be difficult because investigators did not include inquiry training model in curriculum of school where participants were given treatment. Inquiry training model was presented in school as a supplement of teaching, not teaching itself.

So investigator decided to select a proper number of participants and gave treatment to them for a whole semester on the regular basis in their school curriculum. In this way, this research problem was selected for study.

1.6 SIGNIFICANCE OF THE STUDY

Pedagogy is an important part of education. Science encompasses a major part of school curriculum. Research on teaching science is always in preference list of educators. This research study signifies importance of contribution of interaction
between teacher and learner. Other teaching methods in teaching of science emphasizes on content ie. Focus on conceptualization of topics or content by memorisation or understanding. But this teaching model focuses on how learners can indulge themselves in making concepts. Here theory is build, not grasped. Skills of scientific experimentation and inquiry are presented to students. Inquiry training model is a solution to problem of achievement of maximum learning outcomes in limited feasible resources as teaching of science demands a big number of resources like scientific equipments, laboratory materials etc.

In Indian circumstances where teaching of science has become full of cramming and rote memorisation, where students have less interest in science and they study science for purpose of passing only then this inquiry training mode of teaching brings students in teaching learning process with full enthusiasm. This study reveals how much innovative methods of teaching are useful in Indian school environment and how much effectively they serve in school curriculum. Educators and teachers may locate the key points in effective and impressive presentation of content.

This research study encourages educators to promote experimentation in real school environment. Educators come to know that students can learn new things and enjoy the process of giving treatment. Inquiry training model of teaching reflects the need of modification of teaching learning according to nature of subject. Students are Participants, not subjects. They should have contribution in presentation of concepts and teacher should not be neglected as teacher is guide of learning process and gives students various cues and hints for reaching valid conclusion.

In this way, this research study has significance in terms of improvement of science education.

1.7 STATEMENT OF THE PROBLEM

“Comparative Study of Effect of Inquiry Training Model and Conventional Method of Teaching on Achievement in Science of Secondary School Students”

1.8 OPERATIONAL DEFINITION OF THE VARIABLES

1.8.1 Inquiry Training Model: Inquiry is the process or mental exercise to find out solution of problem which requires arrangement and classification of pieces of experiences and observation. Inquiry training model is a strategy of teaching which
use this process of inquiry as generating function of knowledge. This teaching strategy changes experience and observation into pieces of knowledge or facts.

1.8.2 Conventional methods of teaching: traditional strategy or method of teaching like lecture and lecture demonstration method are conventional method of teaching. Mostly, these methods are using in classroom for teaching. Lectures are main components in these teaching methods.

1.8.3 Science achievement: Achievement refers to extent of accomplishment of learning outcomes by students. It shows how much students have mastered in subject matter. Science achievement of a student refers to achievement of that student in science. In the present study, science achievement of a student means score of that student in science achievement test.

1.9 OBJECTIVES OF THE STUDY

1. To develop teaching material of class IX to teach Science as per assumptions of inquiry training model.

2. To find out the Significance of difference in science achievement scores of class IX students in experimental group and control group at pre test stage.

3. To find out the effectiveness of conventional method of teaching on science achievement scores of class IX students in control group at pre test stage and post test stage.

4. To find out the effectiveness of inquiry training model on science achievement scores of class IX students in experimental group pre test stage and post test stage.

5. To find out the significance of difference in science achievement scores of class IX students in experimental group and control group at post test stage.

6. To find out the significance of difference in science achievement scores of male students of class IX in experimental group and control group at post test stage.

7. To find out the significance of difference in science achievement scores of female students of class IX experimental group and control group at post test stage.
8. To find out the significance of difference in science achievement scores of rural students of class IX in experimental group and control group at post test stage.

9. To find out the significance of difference in science achievement scores of urban students of class IX in experimental group and control group at post test stage.

1.10 HYPOTHESES OF THE STUDY

1. There is no significant difference in science achievement scores of class IX students in experimental group and control group at pre test stage.

2. There is no significant difference in science achievement scores of class IX students in control group at pre test stage and post test stage.

3. There is no significant difference in science achievement scores of class IX students in experimental group at pre test stage and post test stage.

4. There is no significant difference in science achievement scores of class IX students in experimental group and control group at pre test stage.

5. There is no significant difference in science achievement scores of male students of class IX in experimental group and control group at post test stage.

6. There is no significant difference in science achievement scores of female students of class IX experimental group and control group at post test stage.

7. There is no significant difference in science achievement scores of rural students of class IX in experimental group and control group at post test stage.

8. There is no significant difference in science achievement scores of urban students of class IX in experimental group and control group at post test stage.

1.10.1 Sub hypotheses

Hypotheses are formulated to see effect of Inquiry training model and conventional methods of teaching on each unit respectively. These sub hypotheses are as-

1.1 There is no significant difference in science achievement scores in unit – 1 (force) of class IX students in experimental group and control group at pre test stage.
2.1 There is no significant difference in science achievement scores in unit – 1 (force) of class IX students in control group at pre test stage and post test stage.

3.1 There is no significant difference in science achievement scores in unit – 1 (force) of class IX students in experimental group at pre test stage and post test stage.

4.1 There is no significant difference in science achievement scores in unit – 1 (force) of class IX students in experimental group and control group at pre test stage.

5.1 There is no significant difference in science achievement scores in unit – 1 (force) of male students of class IX in experimental group and control group at post test stage.

6.1 There is no significant difference in science achievement scores in unit – 1 (force) of female students of class IX experimental group and control group at post test stage.

7.1 There is no significant difference in science achievement scores in unit – 1 (force) of rural students of class IX in experimental group and control group at post test stage.

8.1 There is no significant difference in science achievement scores in unit – 1 (force) of urban students of class IX in experimental group and control group at post test stage.

1.2 There is no significant difference in science achievement scores in unit -2 (force) of class IX students in experimental group and control group at pre test stage.

2.2 There is no significant difference in science achievement scores in unit -2 (force) of class IX students in control group at pre test stage and post test stage.

3.2 There is no significant difference in science achievement scores in unit -2 (force) of class IX students in experimental group at pre test stage and post test stage.
4.2 There is no significant difference in science achievement scores in unit -2 (force) of class IX students in experimental group and control group at pre test stage.

5.2 There is no significant difference in science achievement scores in unit -2 (force) of male students of class IX in experimental group and control group at post test stage.

6.2 There is no significant difference in science achievement scores in unit -2 (force) of female students of class IX experimental group and control group at post test stage.

7.2 There is no significant difference in science achievement scores in unit -2 (force) of rural students of class IX in experimental group and control group at post test stage.

8.2 There is no significant difference in science achievement scores in unit -2 (force) of urban students of class IX in experimental group and control group at post test stage.

1.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of class IX students in experimental group and control group at pre test stage.

2.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of class IX students in control group at pre test stage and post test stage.

3.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of class IX students in experimental group at pre test stage and post test stage.

4.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of class IX students in experimental group and control group at pre test stage.

5.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of male students of class IX in experimental group and control group at post test stage.
6.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of female students of class IX experimental group and control group at post test stage.

7.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of rural students of class IX in experimental group and control group at post test stage.

8.3 There is no significant difference in science achievement scores in unit -3 (gravitation) of urban students of class IX in experimental group and control group at post test stage.

1.11 DELIMITATIONS OF THE STUDY

1. The study was delimited to 9th grade science students of Hindi medium schools of Aligarh affiliated to Uttar Pradesh Board of Secondary Education, Allahabad only.

2. Fourteen lessons based on inquiry training model were developed on topics as Motion, Force, and Gravitation from the prescribed Science syllabus of class 9th by National Council of Education Research and Training, New Delhi.

3. The experimental treatment was delimited to about 50 days of the academic session.

4. The study was delimited to investigate the effect of inquiry training model on cognitive outcomes viz. achievement.

5. The present study is delimited to District Aligarh in U.P only.

6. Only one subject was studied, i.e. Science.

7. The Teaching material was to teach only 3 units of Science subject.

8. The sample of this study consisted of only those students who were enrolled in class IX of session 2015-16.

1.12 ORGANIZATION OF THE STUDY :

This study has been presented in five chapters. All of them are enlisted hereunder:
Chapter I : Introduction
Chapter II : Review of Related Literature
Chapter III : Methodology and Procedure of the Study
Chapter IV : Statistical Analysis and Interpretation of Data
Chapter V : Summary, Findings and Recommendations