EFFECT OF INQUIRY TRAINING MODEL AND INDUCTIVE THINKING MODEL ON COGNITIVE AND AFFECTIVE OUTCOMES OF NINTH GRADERS IN RELATION TO THEIR LEARNING APPROACHES

SUMMARY OF THE THESIS

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HARNEET BILLING

DEPARTMENT OF EDUCATION
PANJAB UNIVERSITY
CHANDIGARH
SUMMARY

INTRODUCTION

The process of teaching and learning aims at transmission of knowledge, imparting skills and formulation of attitudes, values and behavior. Teaching is a complex activity, which is a cluster of different roles and responsibilities. A teacher has to master multiple roles in order to become more professional. The professional competence can be expanded in two ways i.e. firstly by increasing the range of teaching strategies that are needed to be employed and secondly by becoming increasingly skillful in the case of these strategies (Joyce and Weil, 1972). The purpose of teaching is to maximize learning (Gagne, 1963).

In times of scientific and technological advances, declining interest of students in science courses and careers is a worldwide concern. Even the well educated often know little science (Durant, 1990). As science has invaded our homes, how ordinary people perceive science has attracted growing attention not only from the scientific community, but also from social scientist (Bak, 2001). Once again science education finds itself in the midst of reform. A significant amount of research in science education is devoted to understanding ways we can improve the quality of science education and increase enrolment in science courses. One of the key factors in learning science is student’s attitudes and development of positive attitudes towards science can motivate student interest in science education and science-related careers (George, 2006).

According to the report of the Secondary Education Commission (1952-53) “Even the best curriculum and the most perfect syllabus remain dead unless quickened to life by the right methods of teaching and the right kind of teacher”. It seems that the teaching learning process has become more mechanical than meaningful. Interesting, appealing and repeated encounters are a must for meaningful learning. Suitable instructional strategies are essential for achieving the educational objectives. This led researchers to explore various methods and techniques for the development of cognitive, affective and psychomotor domains. There is no single best way or teaching strategy that can be employed in all situations since the number of teaching goals is large and diverse in nature. The best technique is the one that will
be most effective or reaching a particular goal in a given situation (Eggen, Kauchak and Harder, 1979). This is the philosophy behind the models of teaching. Eggan was of the view that “Teaching models represent prescriptive teaching strategies designed to accomplish particular teaching goals.”

Models of Teaching are built around the mental process as ranging from systems for teaching general problem solving ability to procedures for teaching process. Models of teaching range from simple, direct procedures that get immediate results to complex strategies that students acquire gradually from patient and skillful instruction. They include major philosophical and psychological orientations towards teaching and learning (Mehra 2010, p. 171).

Joyce and Weil (1990) have given three meanings of teaching models. Teaching models are just instructional designs. They describe the process of specifying and producing particular environmental situations which cause the student to interact in such a way that specific change occurs in his behavior. Teaching model is a pattern or plan which can be used to shape a curriculum or course, to select instructional materials and to guide a teacher’s actions. Models are designed to attain specific goals. When a teacher identifies a goal, selects a particular strategy designed to attain that goal, we can say that he is using model approach. A model of teaching consists of guidelines for designing educational activities and environments. It specifies ways of teaching and learning that are intended to attain certain kinds of goals.

Joyce and Weil (1972) developed more than twenty models of teaching, which are grouped on the basis of their chief emphasis. They had organized these models into four families, which are as follows:

(i) Social Interaction Model
(ii) Personal Model
(iii) Behavioral Model
(iv) Information Processing Model

The inquiry training model was developed by Suchman (1962) for developing scientific inquiry training skills in the learners. He created this model to help students learn to organize data, examine facts, reason about cause and effect, build and test theories and become independent learners. (Mehra 2010, p.183). "Inquiry is the active
pursuit of meaning involving thought processes that change experience to bits of knowledge. When we see a strange object, for example, we may be puzzled about what it is, what it is made of, and what it is used for, how it came into being, and so forth. To find answers to questions such as these we might examine the object closely, subject it to certain tests, compare it with other, more familiar objects, or ask people about it, and for a time our searching would be aimed at finding out whether any of these theories made sense. Or we might simply cast about for information that would suggest new theories for us to test. All these activities i.e. observing, theorizing, experimenting, theory testing...are part of inquiry. The purpose of the activity is to gather enough information to put together theories that will make new experiences less strange and more meaningful" (Suchman 1962, p.1).

The goal of inquiry training model is to develop the cognitive skills of searching and data processing, and the concepts of logic and causality that would enable the individual child to inquire autonomously and productively. Inquiry training model has five phases i.e. Phase one requires that the teacher presents the problem situation and explain the inquiry procedures to the student’s (the objectives and procedure of yes/no question). Phase two, verification, is the process whereby students gather information about the event they see or experience. In experimentation, phase three, students introduce new elements into the situation to see if the event happens differently. In phase four the teacher calls the students to organize the data and to formulate an explanation. Finally in phase five, the students are asked to analyze their pattern inquiry. Although the inquiry training model can be quite highly structured, with the social system controlled largely by the teacher, the intellectual environment is open to all relevant ideas; teacher and students participate as equals where ideas are concerned. The most important reactions of the teacher take place during the second and third phase. The optimal support is a set of confronting materials, a teacher who understands the intellectual processes and strategies of inquiry, and resource materials bearing on the problem.

Taba (1967), a curriculum theorist based on her works gave the inductive thinking model which provided backbone to the social sciences curriculum. Taba analyzes thinking from psychological and logical points of view and concludes: While the processes of thought are psychological and hence subject to psychological analysis, the product and the content of thought must be assessed by logical criteria.
and evaluated by the rules of logic. Taba concluded that thinking skills should be taught using specific teaching strategies designed for those thinking skills. Furthermore, these strategies need to be used sequentially because one thinking skill builds on the other (Taba 1966, p.36).

The main focus of the model is to develop the mental abilities and give emphasis on concept formation. This stage involves (a) identifying and enumerating the data that are relevant to a problem; (b) grouping those items according to some basis of similarity; and (c) developing categories and labels for the groups. In all the nine phases, the classroom climate is conducive to learning and is cooperative. Taba provides the teacher with clear guidelines for reacting and responding within each phase. Teacher’s job is to help the students in dealing with more complex data and information. Teacher has to encourage the student in processing data.

The learning outcomes approach reflects a conceptual shift towards making learning more meaningful and effective. For a variety of understandable reasons many students approach education as “alienated intellectual labor,” rather than something that is good for them, learning that enhances their lives. Making education more meaningful for these students requires that they acquire a sense of the educational project as enabling them to lead a richer and more empowered life rather than a task done primarily to satisfy the demands of others. By explicitly building educational experiences based on what students should be able to do with their knowledge, the learning outcomes approach helps the educational community understand the point of the activity. Learning outcomes are broad goals that that describe what the learners are supposed to know or be able to do and may be based upon the needs of the learner, the needs of society, what the learner should know about a particular subject. Learning outcomes are generally classified into three domains as cognitive, affective and psychomotor.

Achievement means the amount of knowledge gained by the student in different subjects of study. Knowledge of an individual’s achievement helps the teacher to know the effectiveness of teaching methods and also encourages the students to work hard and learn more. Achievement in the present study will be studied at the categories of Bloom’s taxonomy of the cognitive domain, viz., knowledge, comprehension and application.
Retention of knowledge means recalling or remembering pieces of knowledge, processes, or skills that were learned earlier in time (Semb and Ellis, 1994). However, as per Klausmier and Goodwin (1996) as cited in Narli (2011) retention can occur only if something has been acquired initially and transfer of acquired outcomes to a new situation can occur only if the outcomes have been retained. Two factors are cited more frequently as affecting memory of new material: (a) Whether the new information is consistent with or can be related to prior knowledge, and (b) How the new information is processed.

Achievement motivation is based on reaching success and achieving all of our aspirations in life. Achievement goals can affect the way a person performs a task and represent a desire to show competence (Harackiewicz, Barron, Carter, Lehto & Elliot, 1997). A number of factors have been linked with achievement motivation. The five most commonly mentioned characteristics associated with student achievement are an emphasis on teaching basic skills, high expectations for student achievement, frequent evaluation of student progress, a safe and orderly school climate, and educational leadership (Reynolds, Bollen, Creemers, Hopkins, Lagerweij & Stoll, 1996). Goodenow (1993) established that a sense of belonging and support was strongly associated with motivation and academic achievement.

Attitude is the end product of the socialization process which significantly influences man’s responses to cultural products, to other person’s and to group of persons. If the attitude of a given person towards a given object is known it can be used in conjunction with situational and other disposition variables to predict and explain reactions of the persons to the class of objects.

The studies by Marton and Saljo (1976, a & b) on how students perceived a particular reading task and then went about learning it, introduced the idea of “approach to learning”. Students’ approaches to learning describe whether they engage in learning environment with learning matters (Spencer, 2003). The educational area describes two fundamental approaches to learning: deep and surface. The deep approach is characterized by student’s interest in learning and his/her connection with previous or new ideas, events and conclusions. Deep learners try to understand the real meaning of concepts. The surface approach is characterized by student’s lack of interest in the subject matter and memorization of exam knowledge.
That approach regard learning as an external state (Spencer, 2003; Byrne, Flood & Willis, 2001).

There is a critical need to restructure the methodology of teaching science. The traditional way of teaching is through reading from the textbook and doing problems through rote memory of formula and facts. School systems must recognize that traditional methods of teaching and learning are unsuccessful for many students. Using alternative to the unsuccessful traditional methods of teaching and learning is the need of the hour. Robinson (1992) states a change from traditional curriculum and instruction models and adoption of a new method will require major restructuring of how the schools are organized and how teachers are prepared and empowered. School systems have the task of defining success, determine what it requires to be successful in the twenty-first century, and then evaluating research, outcomes, and discussions of which method would best be implemented to meet each individual's needs. Research findings have found teaching method among other factors has been responsible for the poor state of science achievement. Given the possible link between science achievement and teaching strategies it behooves on science teachers and science educators to device teaching methods among other factors, as the centre piece of improving science outcomes, reversing the current negative trend in science achievement through instructional strategies is a major objective of this research effort.

STATEMENT OF THE PROBLEM

**EFFECT OF INQUIRY TRAINING MODEL AND INDUCTIVE THINKING MODEL ON COGNITIVE AND AFFECTIVE OUTCOMES OF NINTH GRADERS IN RELATION TO THEIR LEARNING APPROACHES**

**OPERATIONAL DEFINITION OF THE VARIABLES**

- **Inquiry Training Model:** Inquiry is the active pursuit of meaning involving thought processes that change experience to bits of knowledge.
- **Inductive Thinking Model:** Inductive thinking model is an instructional strategy to teach thinking skills.
- **Traditional Teaching Model:** Traditional instructional strategy involves traditional technique of delivering lectures to impart instructions.
• **Achievement:** Achievement lists how well students have mastered the subject matter in a course of instruction. In the present study achievement refers to the scores of students on achievement test in science.

• **Retention:** Retention of knowledge means recalling or remembering pieces of knowledge, processes, or skills that were learned earlier in time.

• **Attitude:** Attitude as simply a degree to which students like science. In present context attitude of students is measured by the scores of students on attitude towards science scale.

• **Achievement Motivation:** Achievement motivation is a social form of motivation involving a competitive drive to meet the standard of excellence. In the present study achievement motivation has been measured by scores on Deo Mohan’s Achievement Motivation Scale.

**DELIMITATIONS**

The study was delimited with respect to the following

(i) The study was delimited to ninth grade science students of English medium schools of Chandigarh affiliated to Central Board of Secondary Education, New Delhi only.

(ii) Twenty five lessons based on inquiry training model, inductive thinking model and traditional teaching model were developed on topics as Atoms and Molecules, Structure of Atoms, Motion, Force and Law of Motion, Gravitation, Work and Energy and Natural Resources from the prescribed Science syllabus of class ninth by National Council of Education Research and Training, New Delhi.

(iii) The experimental treatment was delimited to about 50 days of the academic session.

(iv) The study was delimited to investigate the effect of inquiry training model and inductive thinking model on cognitive outcomes viz. achievement and retention in science.

(v) The study was delimited to investigate the effect of inquiry training model and inductive thinking model on affective outcomes viz. attitude towards science and achievement motivation.
OBJECTIVES

The study was designed to attain the following objectives:

1. To develop instructional material for teaching science to the students of class ninth as per inquiry training model and inductive thinking model.

2. To compare the effectiveness of inquiry training model, inductive thinking model and traditional model of teaching in respect of affective outcomes viz. achievement motivation and attitude towards science.

3. To compare the effectiveness of inquiry training model, inductive thinking model and traditional model of teaching in respect of affective outcomes viz. achievement motivation and attitude towards science of learners with deep and surface learning approach.

4. To study the interaction effect of instructional strategies and learning approach in respect of affective outcomes viz. achievement motivation and attitude towards science.

5. To compare the effectiveness of inquiry training model, inductive thinking model and traditional model of teaching in respect of cognitive outcomes viz. achievement and retention in science.

6. To compare the effectiveness of inquiry training model, inductive thinking model and traditional model of teaching in respect of cognitive outcomes viz. achievement and retention in science of learners with deep and surface learning approach.

7. To compare the effectiveness of inquiry training model, inductive thinking model and traditional model of teaching in respect of cognitive outcomes viz. achievement and retention in science at knowledge, comprehension and application categories of objectives.

8. To study the interaction effect of instructional strategies and learning approach in respect of cognitive outcomes viz. achievement and retention in science.

9. To study the interaction effect of instructional strategies and categories of objectives in respect of cognitive outcomes viz. achievement and retention in science.
10. To study the interaction effect of learning approach and categories of objectives in respect of cognitive outcomes viz. achievement and retention in science.

11. To study the interaction effect of instructional strategies, learning approach and categories of objectives in respect of cognitive outcomes viz. achievement and retention in science.

HYPOTHESES

H$_{10}$: There will be no significant difference of the pre-test scores on attitude towards science with respect to
   (i) learners of the three treatment groups.
   (ii) surface learners of the three treatment groups.
   (iii) deep learners of the three treatment groups.

H$_{20}$: The three instructional treatments will not yield significant mean gain scores on attitude towards science with respect to
   (i) learners of the three treatment groups.
   (ii) learning approach of the three treatment groups.
   (iii) interaction effect of instructional strategy and learning approach.

H$_{30}$: There will be no significant difference of the pre-test scores on achievement motivation with respect to
   (i) learners of the three treatment groups.
   (ii) surface learners of the three treatment groups.
   (iii) deep learners of the three treatment groups.

H$_{40}$: The three instructional treatments will not yield significant mean gain scores on achievement motivation with respect to
   (i) learners of the three treatment groups.
   (ii) learning approach of the three treatment groups.
   (iii) interaction effect of instructional strategy and learning approach.

H$_{50}$: There will be no significant difference of the pre-test scores on achievement in science with respect to
   (i) learners of the three treatment groups.
   (ii) surface learners of the three treatment groups.
   (iii) deep learners of the three treatment groups.
H_{0}: The three instructional treatments will not yield significant mean gain scores on achievement in science with respect to

(i) learners of the three treatment groups.
(ii) learning approach.
(iii) categories of objectives.
(iv) interaction effect of instructional strategy and learning approach.
(v) interaction effect of instructional strategy and category of objectives.
(vi) interaction effect of learning approach and category of objectives.
(vii) interaction effect of instructional strategy, learning approach and category of objectives.

H_{1}: The three instructional treatments will not yield significant mean retention gain scores with respect to

(i) learners of the three treatment groups.
(ii) learning approach of the three treatment groups.
(iii) category of objectives.
(iv) interaction effect of instructional strategy and learning approach.
(v) interaction effect of instructional strategy and category of objectives.
(vi) interaction effect of learning approach and category of objectives.
(vii) interaction effect of instructional strategy, learning approach and category of objectives.

SAMPLE

Sampling is an important aspect of life in general and enquiry in particular. The adequacy of sample i.e. the lack of bias depends on our knowledge of the population as well as method used for drawing the sample. Population refers to all cases under investigation and a sample is an actual subset of observation drawn from population.

The sample can thus be described by a distribution of proportions propelling the probability distribution of function. The sampling distribution can be thought of as the result of repeating a sampling operation many times. Distribution can be thought of as the result of repeating a sampling operation many times with a fixed sample size, and calculating a statistic like from each sample. At the same time, the sampling distribution of statistics gives us a way of relating the sample estimate to the population parameter. It provides a way of determining the significance level of a
given result under the null hypothesis. The sample in the present study was drawn at two levels i.e. school sample and student sample.

5.7.1 THE SCHOOL SAMPLE

The sample was drawn from representative secondary schools of Chandigarh who were affiliated to Central Board of Secondary Education, New Delhi. A list of the schools under the administration of Union Territory of Chandigarh was procured from director public instructions (school) through the district education officer. The schools were compared with regards to the criteria that school has almost same class climate, physical facilities, teacher taught ratio, sex ratio etc. The names of schools were written down in separated sheets of papers of equal sizes. The names were folded into six symmetrical equal parts and put in an enclosed carton box. The lid was then sealed and the box was shaken up many a times for easy shuffling to take place. Satisfied the investigator carefully made a slit, in which the hand could easily slide through in and out without hindrance. Again after shuffling was done by hand as in the form of lottery. Satisfied, the investigator drew out the first three cards one by one bearing the names of each school which represented the population under investigation:

(i) Jawahar Navodya Vidyalaya, Sector 25, Chandigarh
(ii) Government Senior Secondary School, Sector 47, Chandigarh
(iii) Government Senior Secondary School, Sector 37, Chandigarh

5.7.2 THE STUDENT SAMPLE

The study was initiated on 150 9th grade secondary school students studying in the Union Territory of Chandigarh. These were English medium, co-educational schools affiliated to Central Board of Secondary Education, New Delhi. Most of these students belonged to middle class families. A list of school was collected from Director Public Instruction (Secondary), Chandigarh. Out of total schools of Chandigarh, three schools were selected only. After selecting the schools the student sample was drawn randomly.
DESIGN

The present study was designed to study ‘Effect of inquiry training model and inductive thinking model on cognitive and affective outcomes of ninth grades in relation to their learning approaches’. The present study employed an experimental method with $2 \times 3 \times 3$ factorial design for cognitive outcomes and $2 \times 3$ factorial design for affective outcomes. In factorial design instructional strategies and learning approach were the independent variables. The variable of instructional strategy was studied at three levels viz inquiry training model, inductive thinking model and traditional model of teaching. The variable learning approach was studied at two levels viz. deep learning approach and surface learning approach. Cognitive outcomes viz. achievement and retention in science and affective outcomes i.e. achievement motivation and attitude toward science were the dependent variable.

TOOLS USED

Tools are the techniques which are appropriate for the collection of certain types of evidence or information for conducting the research. The tools used for the present study are given below:

(i) Revised two factor Study Process Questionnaire (R-SPQ-2F) developed and standardized by Biggs, Kember & Leung (2001) to identify deep and surface learning approach.

(ii) Deo Mohan’s Achievement Motivation Scale (1985).

(iii) Attitude towards Science Scale was developed by the investigator herself.

(iv) Achievement Test in Science was developed by the investigator herself.

(v) Instructional Material in Science was developed based on Inquiry Training Model, Inductive Thinking Model and Traditional Model of Teaching by the investigator herself.

PROCEDURE

The experiment was conducted in three stages as follows:

STAGE I: SELECTION OF THE SAMPLE

Revised two factor Study Process Questionnaire (R-SPQ-2F) was administered to 300 class IX students from representative English medium secondary schools of Chandigarh and two sub groups were formed (75 deep and 75 surface learners). The students were assigned to three groups i.e. experimental group I, experimental Group II and control group.
STAGE II: CONDUCT OF THE EXPERIMENT

**Firstly, Pre-Testing:** This phase involved the administration of the following tests to the students of the experimental and control groups’ viz achievement test in science, achievement motivation scale, scale of attitude towards science. The students were given 45 minutes to complete the test. The answer sheets were scored as per the answer key to obtain knowledge about threshold values of learners on the variables under study.

**Secondly, Instructional Programme Session:** The experimental groups have been taught through inquiry training model and inductive thinking model and control group was taught by traditional model of teaching. Each group was taught topics such the meaning, types and characteristics of atoms and molecules, structure of atoms, motion, force & laws of motion, gravitation, work & energy and natural resources as selected from class ninth curriculum.

**Thirdly, Post–Testing:** After completion of the instructional program, the following tests have been administered to the experimental and the control groups’ viz. achievement test in science, achievement motivation scale and scale of attitude towards science. The students were given 45 minutes to complete the test. The answer sheets were scored with the help of scoring key. Gain scores as the percentage of difference between post- test and pre test scores was calculated and used for comparative study of three groups.

STAGE III: RETENTION-TEST

After a period of 30 days, same achievement test in science have been administered to all the three groups to determine how much they have retained. The answer sheets were scored with the help of scoring key and retention scores were obtained. The percentage of difference in retention-test scores and pre- test scores formed retention scores. These scores were used for analysis and comparison of three groups.
**STATISTICAL TECHNIQUES USED**

The following statistical techniques were employed to analyze the data obtained from the experiment in order to test the hypotheses.

(i) Descriptive Statistics like mean, standard deviation, skewness and kurtosis were used to determine the nature of distribution of the scores.

(ii) Analysis of Variance was employed with respect to
- Factorial design $2 \times 3$ for mean gain scores on attitude towards science.
- Factorial design $2 \times 3$ for mean gain scores on achievement motivation.
- Factorial design $2 \times 3 \times 3$ for mean gain scores on achievement in science.
- Factorial design $2 \times 3 \times 3$ for mean retention scores.

(iii) For the significant F-ratio, the t-test has been used for testing the significance of difference between the mean scores different groups on variables under study.

(iv) Graphical techniques were used for descriptive analysis and visual perception of the data.

**FINDINGS**

The data obtained from the experiment were statistically analyzed and the following results were obtained which are described under following sub-headings:

**ATTITUDE TOWARDS SCIENCE**

(i) The instructional treatment yielded significant mean gain scores on attitude towards science with respect to learners of three treatment groups. It was further found that:

- The mean gain attitude towards science scores of the group through inquiry training model was found to be significantly higher than that of the group taught through traditional model of teaching.

- The mean gain attitude towards science scores of the group through inductive thinking model was found to be significantly higher than that of the group taught through traditional model of teaching.

- The mean gain attitude towards science scores of the group through inquiry training model and inductive thinking model was not significantly different from each other.
(ii) The mean gain attitude towards science scores of deep and surface learners was not significantly different from each other.

(iii) The interaction effect of instructional strategy and learning approach in respect of gain attitude towards science scores was not significant.

**ACHIEVEMENT MOTIVATION**

(i) The instructional treatment yielded significant mean gain scores on attitude towards science with respect to learners of three treatment groups. It was further found that:

- The mean gain achievement motivation scores of inquiry training model group were found to be significantly higher than that of the group taught through traditional model of teaching.
- The mean gain achievement motivation scores of inductive thinking model group were found to be significantly higher than that of the group taught through traditional model of teaching.
- The mean gain achievement motivation scores of the group through inquiry training model and inductive thinking model were not significantly different from each other.

(ii) The mean gain achievement motivation scores of deep and surface learners were not significantly different from each other.

(ii) The interaction effect of instructional strategy and learning approach in respect of gain achievement motivation scores were not significant.

**ACHIEVEMENT IN SCIENCE**

(i) The instructional treatment yielded significant mean gain scores on achievement in science with respect to learners of three treatment groups. It was further found that:

- The gain achievement in science scores of the group taught through inquiry training model were found to be significantly higher than that of the group taught through traditional model of teaching.
- The gain achievement in science scores of the group through inductive thinking model were found to be significantly higher than that of the group taught through traditional model of teaching.
• The gain achievement in science scores of the group through inquiry training model and inductive thinking model were not significantly different from each other.

(ii) The three instructional treatments yielded significant difference in mean gain achievement scores with respect to learning approach of three treatment groups. It was further found that the gain achievement in science scores for deep learners were significantly higher than those of surface learners.

(iii) The three instructional treatments yielded significant differences in mean gain achievement scores with respect to learning approach of three treatment groups. It was further found that the mean gain achievement scores were significantly higher on comprehension category of objectives than on knowledge and application category of objectives.

(iv) The interaction effect of instructional strategy and learning approach in respect of mean gain achievement in science scores was not significant.

(v) The interaction effect of instructional strategy and category of objectives in respect of mean gain achievement in science scores was significant. Further analysis revealed that

• The mean achievement gain scores for group imparted instruction through inquiry training model were significantly higher for comprehension category of objective than that of knowledge and application categories of objectives.

• The mean achievement gain scores for group imparted instruction through inductive thinking model were significantly higher for comprehension category of objective than that of knowledge and application categories of objectives.

• The mean gain achievement scores for group imparted instruction through traditional instructional model were significantly higher on comprehension category of objective than on knowledge and application categories of objectives.

• The mean gain achievement scores on knowledge category of objectives for group imparted instruction through inquiry training model was significantly
higher than mean gain achievement in application category of objectives for group imparted instruction through traditional model of teaching.

- The mean gain achievement in comprehension and application categories of objectives for group imparted instruction through inductive thinking model was significantly higher than mean gain achievement in knowledge category of objective for group imparted instruction through inquiry training model.

- The mean gain achievement in comprehension for group imparted instruction through traditional model was significantly higher than mean gain achievement in knowledge category of objective for group imparted instruction through inquiry training model.

- The mean gain achievement in comprehension category of objectives for group imparted instruction through inquiry training model was significantly higher than mean gain achievement in knowledge and application categories of objectives for group imparted instruction through inductive thinking model.

- The mean gain achievement in comprehension category of objectives for group imparted instruction through inquiry training model was significantly higher than mean gain achievement in knowledge, comprehension and application category of objectives for group imparted instruction through traditional model of teaching.

- The mean gain achievement in application category of objectives for group imparted instruction through inquiry training model was significantly higher than mean gain achievement in knowledge category of objective for group imparted instruction through inductive thinking model.

- The mean gain achievement in application category of objectives for group imparted instruction through inquiry training model was significantly higher than mean gain achievement in knowledge, comprehension and application category of objectives for group imparted instruction through traditional model of teaching.

- The mean gain achievement in knowledge category of objectives for group imparted instruction through inductive thinking model was significantly higher...
than mean gain achievement in application category of objectives for group imparted instruction through traditional model of teaching.

- The mean gain achievement in comprehension and application categories of objectives for group imparted instruction through inductive thinking model was significantly higher than mean gain achievement in knowledge, comprehension and application category of objectives for group imparted instruction through traditional model of teaching.

(vi) The interaction effect of instructional strategy and category of objectives in respect of gain achievement in science scores was significant. Further analysis revealed that

- Surface learners exhibited significantly higher mean achievement gain scores on comprehension category of objectives than mean achievement gain on knowledge and application categories of objectives.

- Deep learners exhibited significantly higher mean achievement gain scores on comprehension and application category of objectives than on knowledge categories of objectives of surface learners.

- Surface learners exhibited significantly higher mean achievement gain scores on comprehension category of objectives than mean achievement gain on knowledge and application category of objectives for deep learners.

- Deep learners exhibited significantly higher mean achievement gain scores on comprehension category of objectives than mean achievement gain on knowledge and application category of objectives by surface learners.

- Deep learners exhibited significantly higher mean achievement gain scores on application category of objectives than mean achievement gain on knowledge category of objectives by surface learners.

Rest of the combinations did not yield significant differences in mean gain achievement scores.

(vii) The interaction effect of instructional strategy, category of objectives and learning approach in respect of achievement in science scores was not significant.
RETENTION IN SCIENCE

The attainment data obtained after an interval of 30 days revealed the following findings:

(i) The instructional treatment yielded significant mean retention scores with respect to learners of three treatment groups. It was further found that

- The group imparted instruction through inquiry training model showed significantly higher retention than traditional model of teaching.
- The group imparted instruction through inductive thinking model showed significantly higher retention than traditional model of teaching.

(ii) The instructional treatment did not yield significant mean retention scores with respect to learning approach of three treatment groups.

(iii) The instructional treatment yielded significant mean retention scores with respect to categories of objectives. It was further found that

- The mean retention was significantly higher on comprehension category of objectives than on knowledge and application categories of objectives.
- The mean retention was significantly higher on application category of objectives than on knowledge category of objective.

(iv) The instructional treatment yielded significant differences in mean retention scores with respect to interaction effect of instructional strategy and learning approach. It was further found that

- For group imparted instruction through inquiry training model mean retention was significantly higher for deep learners than surface learners.
- Deep learners of the group imparted instruction through inquiry training model showed significantly higher retention than that of deep and surface learners of traditional model of teaching.
- Deep learners of the group imparted instruction through inductive thinking model exhibited significantly higher retention than the surface learners of group imparted instruction through inquiry training model.
- Surface learners of the group imparted instruction through inquiry training model showed significantly higher retention than that of deep and surface learners of traditional model of teaching.
• Deep learners of the group imparted instruction through inductive thinking model exhibited significantly higher retention than deep and surface learners of traditional model of teaching.

• Surface learners of the group imparted instruction through inductive thinking model exhibited significantly higher retention than deep and surface learners of traditional model of teaching.

• Deep learners of the group imparted instruction through traditional model of teaching exhibited significantly higher retention than surface learners of the same group.

(v) The instructional treatment did not yield significant differences in mean retention scores with respect to interaction effect of instructional strategy and categories of objective.

(vi) The interaction effect of learning approach and category of objectives for mean retention was not significant.

(viii) The interaction among instructional strategy, learning approach and category of objectives for mean retention was not significant.

EDUCATIONAL IMPLICATIONS OF THE FINDINGS

In the present days, with rapidly changing educational scenario, the role of teacher and teaching are changing fast wherein he is enshrined with the responsibility of promoting fruitful learning and stimulating the students by adopting different strategies. Science education is spreading its roots deeper and deeper in the name of scientific literacy, encroaching into the whole educational system and touching all disciplines. Thus, the present study has following educational implications.

(i) The study will enable teachers to make optimum use of inquiry training model and inductive thinking model of teaching as effective strategies to make learning science interesting and lively activity.

(ii) It will enable teachers, guidance workers and parents to make optimum use of models of teachings as teaching strategies to shape the attitudes of learners and develop achievement motives in the learners.
(iii) In light of the results of the study, curriculum developers will seek to develop an enriched curriculum for deep learners.

(iv) As deep learners exhibited higher achievement gains, the study will guide the teachers and parents to adopt strategies to develop deep learning approach among the students.

(v) The study will be of use for students to make optimum use of inquiry training model and inductive thinking model of teaching as effective strategies to attain desirable objectives of learning.

(vi) In light of the results of the study, schools will seek to shift their emphasis from passive answer absorbing to active answer seeking, from rigid daily programmes to active flexible schedules, from teacher dominated classroom to child directed and group activities and from memorizing to problem awareness and problem solving.

(vii) As evident from the results that learners respond differently to different or a variety of educational environments, contents remaining the same, teachers will be able to realize their role as an organizer and responsibility for an order in social system.

(viii) The study will be of use for all those who want to keep pace with the scientific race having interest in research and innovations in the field of teaching science.

SUGGESTIONS FOR FURTHER STUDY

(i) The original learning and retention components were examines in this research. Transfer of learning is another component of learning that deserves consideration. The future researches can be conducted to check the effectiveness of models of teaching in causing transfer of learning.

(ii) The researches can be conducted on a wider sample for more valid generalizations. Also the researches can be conducted for subjects other than science, to have a comprehensive picture.

(iii) Further studies using same approach for other models may be attempted.
(iv) Studies indented to measure the effectiveness of strategies in terms of competence of teachers and student teachers to implement the models in classroom situations also can be studied.

(v) Studies to validate techniques of preparation of self-instructional materials and lesson plan writing need to be taken to avoid the use of only Herbartian approach.