ABSTRACT

Education is required for development of society and country. Education nourishes qualities and virtues inside human and makes him/her a responsible citizen. Education teaches each human how to be an integral part of social system.

Science is indicator of progress in society. Use of science and technology in daily life makes life of human comfortable and progressive. Science is key factor in development of any nation.

As science and education, both are important for society, how science education can be ignored. Science education should be on priority of education policy makers. Science should be taught as it can arouse interest among students towards itself. So method for teaching science is a subject to continuous research.

Inquiry is natural quality of human. If human makes a confrontation with any unknown objects, he/she starts inquiry or investigation for knowing about that unknown object. So method of teaching science should be of such type so that it can make students indulge into inquiry about concepts to be taught.

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.

J. Richard Suchman (1962) developed 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 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: Data 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.

Teaching material was developed on following topics of science syllabus of class IX as per assumptions of Inquiry Training Model.
<table>
<thead>
<tr>
<th>Unit</th>
<th>Lesson</th>
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<tbody>
<tr>
<td><strong>Motion</strong></td>
<td>1. Speed</td>
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<td>2. Displacement</td>
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<td>3. Velocity</td>
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<td>4. Addition of velocities</td>
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<td>5. Acceleration</td>
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<td>6. Distance Time Graph</td>
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<td></td>
<td>7. Speed Time Graph</td>
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<tr>
<td><strong>Force</strong></td>
<td>1. Newton’s first law of motion</td>
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<td></td>
<td>2. Newton’s second law of motion</td>
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<td></td>
<td>3. Newton’s third law of motion</td>
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<td></td>
<td>4. Conservation of momentum</td>
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<tr>
<td><strong>Gravitation</strong></td>
<td>1. Gravitation</td>
</tr>
<tr>
<td></td>
<td>2. Gravitational Acceleration</td>
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<td></td>
<td>3. Archimedes principle</td>
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**Justification:**

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. 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. 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.

**Significance:**

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.

**Statement of the Research Problem :**

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

**Operational Definition of the Variables:**

**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.
Conventional methods of teaching: tradition 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.

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

Objectives:

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.

**Hypotheses:**

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.

**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.

**Delimitations:**

1. The study was delimited to 9th grade science students of Hindi medium schools of Aligarh affiliated to U.P. 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 were studied, i.e. Science.

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

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

**Population:** Population for this study consisted of IX grade students of Hindi medium schools (affiliated to U.P. Board of Secondary education) in Aligarh city.

**Sample:** A sample of 202 students was drawn from IX grade students of Hindi medium schools (affiliated to U.P. Board of Secondary education) in Aligarh city.

**Design:** This research study was an experimental study. For investigation of effect of 2 different teaching strategies, whole sample was divided into two groups which were experimental group and control group. Equivalence of this group was an important
matter for validity of conclusions of this study. For this purpose, randomization was used. Participants were assigned to these 2 groups randomly. So randomised equivalent pre test post test control group design was used for this experimental study. This research design is a true experimental research design.

**Tools** : 6 sets of science achievement test and 14 lesson plans based on inquiry training model were used for data collection in this study.

**Findings** :

1. There was no significant difference in science achievement scores of class IX students in experimental group and control group at pre test stage. Both groups were equivalent at pre test stage.

2. There was significant difference in science achievement scores of class IX students in control group at pre test stage and post test stage. Students of control group were taught through conventional method of teaching and they improved their science achievement scores significantly at post stage with respect to their science achievement scores at pre test stage.

3. There was significant difference in science achievement scores of class IX students in experimental group at pre test stage and post test stage. Students of experimental group were taught through inquiry training model of teaching and they improved their science achievement scores significantly at post stage with respect to their science achievement scores at pre test stage.

4. There was significant difference in science achievement scores of class IX students in experimental group and control group at pre test stage. Students of experimental group performed better than students of control group at post test stage. So Inquiry Training Model was found to be more effective than conventional method of teaching.

5. There was significant difference in science achievement scores of male students of class IX in experimental group and control group at post test stage. Male Students of experimental group were much better than male students of control group at post test stage of science achievement test.
6. There was significant difference in science achievement scores of female students of class IX in experimental group and control group at post test stage. Female Students of experimental group performed better than female students of control group at post test stage.

7. There was significant difference in science achievement scores of rural students of class IX in experimental group and control group at post test stage. Rural Students of experimental group achieved more score than rural students of control group at post test stage of science achievement test.

8. There was significant difference in science achievement scores of urban students of class IX in experimental group and control group at post test stage. Urban Students of experimental group achieved more score than urban students of control group at post test stage of science achievement test.

Conclusions:

1. Inquiry training model was found to have better effect on science achievement of secondary school students when it was compared with conventional method of teaching. Inquiry training model is an innovative teaching strategy and it was found successful. So this study concluded that inquiry training model should be employed for teaching of science in classrooms.

2. Inquiry training model was equally effective for male and female students. Gender did not affect science achievement in study and gender did not have interaction with teaching strategies. So this study concluded that gender was not linked with effectiveness of teaching method. Same teaching strategies should be applied for both, male and female.

3. Rural and urban students were found to have equal effect of inquiry training model. Living place did not interfere in effect of teaching strategies.

4. Conventional method of teaching was found inferior to an innovative teaching strategy. This reflects that there is a need to change whole system of science education.
5. Students performed well in this study when they got opportunity to construct their own knowledge. This study concluded that there is urgent need of implementation of student centred teaching methods.

6. Methods or strategies of teaching had significant effect on improvement of learners. So this study concluded that teaching method is important aspect of teaching learning process and can not be ignored.

**Educational implications :**

1. The study will enable teachers to make optimum use of inquiry training model of teaching as effective strategy to make learning science interesting and fruitful activity. Students will attain learning experiences resulting into concepts.

2. It will enable teacher, counsellors and parents to make optimum use of models of teachings as teaching strategies to shape the positive attitudes of learners towards learning science and develop achievement motives in the learners.

3. In light of the results of the study, curriculum developers will seek to develop an curriculum including model approach of teaching specially inquiry training model.

4. The study will be of use for students to employ inquiry training model of teaching as effective strategies to grasp and understand some complex concepts of science.

5. In light of the results of the study, schools will seek to shift their emphasis from passive answer absorbing (memorisation of facts ) to active answer seeking (theory construction ), from rigid daily programmes to flexible schedules of learning, from teacher centred classroom to child directed and group activities based classroom.

6. As shown from the results that learners respond differently to different or a variety of educational environments or classroom settings, contents remaining the same, teachers will be able to realize their role as an organizer of activities in classroom and responsibility for creating a model of cooperative social system and arousing interest for innovations in the field of teaching science.
7. The study will be of use for all those who want to keep pace with the scientific progress.

8. This study will be useful to improve aptitude and increase potential for research for students having interest in research and innovations in the field of teaching science.

9. This study shows that innovative methods of teaching are equally effective on rural students. Their background is not a barrier for them.

10. This study will be use for educators for solving problem of limited resources. Inquiry training model guides how to use resources effectively with less number of supporting material.

Recommendations:

1. State level academic bodies should take steps to raise the acknowledgement of educators by exposing them to extensive in-service training, conference or workshops. They should be allowed to attend the workshop, orientation courses, refresher courses, and seminars regularly so that they can be acquainted with innovative teaching methods.

2. Curricular materials based on inquiry training model should be developed. Model approach of teaching should have proper place in curriculum.

3. Inquiry training model should be included in existing curriculum of the pre-service teacher training program so that teachers should be master in using effective strategy.

4. The outcome of research suggested that effectiveness in academic achievement is not influenced by the location of school, background of students and gender. Teaching methods should be irrespective of all these factors.

5. The curriculum should be so designed in such a way that sufficient time is allocated for the individual student in order to attain specific cognitive skills like inquiry and investigation.
6. Teaching material should be designed in light of possible responses by students.

7. Teaching session should give opportunities to students for interacting and building their own concepts. Inquiry training model helps them to verify these concepts.

8. Inquiry training model should not be used as supporting teaching method. Whole content of science syllabus should be taught by using inquiry training model.

9. There should be endeavour for making teaching material based on inquiry training model more interesting.

10. Students should be allowed give suggestions for enhancement of inquiry sessions as responses of students’ lead teaching learning process in inquiry training model.

**Suggestions for further research:**

1. Similar studies can be conducted on mastery of students in various scientific investigation skills by using inquiry training model.

2. The replication of the study on a larger sample is needed to arrive at a more reliable and precise results.

3. Studies can be conducted on the achievement of learners of different age groups, and subjects.

4. Similar study can be conducted for effectiveness of the inquiry training model and traditional method for the students of other levels like primary, Higher Secondary and university.

5. Effects of inquiry training model based teaching material on some other cognitive and personality variables can be tested.

6. Effect of teaching material on Affective and psychomotor aspects can be investigated.
7. Since, this study evaluated the effectiveness of inquiry training model for teaching three chapter of science. It is suggested that teaching material can be prepared in all topics in science and effectiveness can be tested experimentally.

8. Since, this study was conducted for a period; therefore further study would be required to determine what effects of inquiry training model, if used for the entire one semester or for the entire session, would have on students’ achievement.

9. Effect of inquiry training model can be compared with other innovative teaching strategies.

10. A detailed analysis of the practical difficulties likely to be encountered by teachers while using inquiry training model can be conducted.

11. Similar experiment can be done with more variable.