A STUDY ON EFFECTIVENESS OF INQUIRY TRAINING MODEL IN TEACHING LIFE SCIENCE ON THE CRITERIA OF CREATIVE INQUIRY, SCIENTIFIC THINKING AND SCHOLASTIC ACHIEVEMENT

THESIS SUBMITTED FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN EDUCATION

By

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PREFACE

The main purpose of the science education is to develop the abilities like creative inquiry, scientific thinking, creativity and achievement in the learner. These aims cannot be fulfilled if science teaching is restricted only to the transmission of facts and concepts. So, it is very important that science education should primarily be concerned with the education of mind rather than mere acquisition of knowledge. Curriculum should help learners to become constructor of knowledge and emphasise active role of teachers in relation to the process of knowledge construction.

Now a day’s more emphasis is given on the development of those educations which promotes or teaches the children to think critically and independently (Sternberg and baron, 1985).

Models of teaching is conceived to connect teacher and students to a variety of well-developed ways of teaching-learning process, to the models that not only has a strong rationale but also lines of research into their working and into what one could expects if they are used. Thus, models of teaching represent a base for professional teaching professional meaning “using research to guide practice”.

Joyce et. al (1992) has suggested that ITM is a prominent model for developing of inquiry mind as well as for teaching of concepts in science at secondary school level.

This study is one such endeavor in this direction, to identify a training strategy to train student-teachers in the use of ITM. It also attempts to find out the readiness of teacher educators to use Models of Teaching. The researcher attempts to find out the effectiveness of Inquiry Training Model, weather it helps in developing scientific thinking ability of the students, creative inquiry and scholastic achievements of students in Life Science.

The report of the study is divided into five chapters. Chapter-I deals with theoretical Bases of Models of Teaching, science education and Inquiry Training Models. Chapter-II pertains to the Review of related Literature on various studies conducted by different authors and researchers. Chapter-III deals with the Research methodology and procedure highlighting the Research Design, Samplings Techniques, Tools used and Data Analysis Techniques. Chapter-IV outlines the Data Analyses and Interpretations of Collected
Data. Chapter-V consists of Results, Findings, Conclusions and Suggestions for further study.

Each chapter is ended with the chapter Reference and the bibliography and appendices in relation to this study have been given in the end.

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<td>American Association for the Advancement of Science</td>
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<td>BSCS</td>
<td>Biological Science Curriculum Studies</td>
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<tr>
<td>ISTS</td>
<td>Inquiry Science Teaching Strategies</td>
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<td>ITM</td>
<td>Inquiry Training Model</td>
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<tr>
<td>NCF</td>
<td>National Curriculum Framework</td>
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<td>NRC</td>
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CHAPTER 1

INTRODUCTION

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CHAPTER 1
INTRODUCTION

Any improvement in education should essentially reflect changes in the process of teaching because the major part of formal education is carried out in the form of classroom teaching. Therefore, research in the area of teaching or teaching behavior has received the major attention to the researchers. During the last three decades, in India, about half-a-century doctoral studies have been conducted in the area of teaching. But, most of these studies are found to be dominated by a few popular teaching techniques, viz., lecture method, demonstration method, problem-solving method, etc. However, hardly any study has been done with a view to designing, testing and developing any innovative model of teaching through experimentation.

Research on teaching has a direct bearing on teacher education programmes. Research evidences in this domain may help teacher-educators directly to decide in what type of teacher behaviors of student-teachers should be trained in order to make them more effective teachers in our present context. Till 1974, most of the studies were related to selection criteria, abilities and qualities of teachers; pre-service and in-service training of teachers; work load, job expectations and difficulties experienced by teachers; procedure and practices of teacher education in India and personality variables of teachers.

There had been stray efforts in introducing and evaluating the efficacy of innovative inputs in teacher education in India. It was only 1974 that the NCERT undertook a research project at the national level in the area of
microteaching and continued conducting experimental field studies on this area and brought out research publications (Das, et.al., 1974, 1979 and 1983). This gave meaningful and innovative inputs in teacher education, which has generated large number of research studies at the institutional and doctoral level during the last decade. In fact, a wave of micro-teaching approach had been created which reinforced the analytic concepts of teaching and behavioral modification approach in teacher training. Thus, the complex task of teaching is analyzed into limited but well-defined components called ‘teaching-skills’ that can be taught, practiced, observed, measured and controlled. This departure in teacher education had thrown new lights on training of teachers. Analytic approach to teacher education is found important and useful for the following reasons:

1. A student-teacher can easily incorporate a behaviorally defined teaching skill into his/her teaching repertoire,

2. Objectives can be defined more easily and more reliable measures of changes in teacher behavior can be thought of using behaviorally defined skills,

3. More meaningful studies can be conducted determining relationship between teacher performance and pupil outcome and

4. Teacher-educators get satisfaction in developing teaching skills among trainees as they are able to get immediate evidence in respect of the intended change.

Nwagbo (2001) noted that teachers shy away from the more effective activity oriented teaching methods in preference for methods that are easy and mostly
inadequate and inappropriate. Teachers are expected to be intellectually and professionally competent as well as dynamic enough to adapt to the dynamics of scientific growth and development and discharge their duties to a much more satisfying level. To buttress this point, it was emphasized that even a good curriculum in a well-stocked laboratory would still not give the desired result in the hands of an incompetent teacher (Ossai, 2004). Though the place of teaching of biology is at the top of hierarchy, other science subjects, researches in this area have been relatively scanty. The teaching of biology generally conforms to the conventional methods and continues to be dominated by the teacher making it as dull and uninspiring as ever before (Kalia, 2005). Various research workers such as Aramide (1985), Ogunsola-Bandele and Lawan (1996), Ango and Sila (1986), Ajayi (1998) and Ajaja and Kpagban (2000) had reported the low percentage passes in biology at Senior Secondary School Certificate Examination (SSCE) were partly due to ineffective methods of teaching.

1.1 A Brief history of Inquiry

Webster’s Third International Dictionary (1986), defines inquiry as “an act or an instance of seeking for truth, information or knowledge; investigation; research; or a question or query”, while the original word inquire means “to ask for information about, to make an investigation or search, to seek information or questioning”. Barman (2002) describes inquiry as a teaching strategy and a set of student skills (i.e., individual process skills). Minstrell (2000) defines inquiry as : encouraging inquisitiveness (habit of the mind), teaching strategy for motivating learning, hands-on and minds-on,
manipulating materials to study particular phenomena, and stimulating questions by students. According to Minstrell, an inquiry is completed when “we should know something we did not know before we started. Even when our investigation fails to find the answer, at least the inquiry should have yielded a greater understanding of factors that are involved in the solution”. It is essential for teachers to know what inquiry is, in both pre-service and in-service situations.

1.1.1 Historical Perspective of Inquiry in Education

John Dewey (1910) as a science teacher recommended the inclusion of inquiry into K–12 science curriculum. Dewey considered that efforts should be given for thinking, an attitude of the mind rather than on the facts of sciences. Dewey encouraged science teachers to use inquiry as a teaching strategy as because at that time the scientific method was rigid. Dewey has developed a model in which the student is actively involved and the teacher acts as a facilitator or a guide. In 1916, Dewey had encouraged that students should be taught so that the students could be adding to their personal knowledge of science. Dewey (1938) stated that the problems, to be studied related to students’ experiences and within their intellectual capability; therefore, the students are to be active learners in their searching for answers.

National Science Foundation (NSF, 1956), USA provided funds for curriculum and professional development for implementing the curriculum, with an emphasis on “thinking like a scientist” (DeBoer, 1991). There was
also an emphasis on science processes as individual skills (i.e., observing, classifying, inferring, controlling variables, etc.).

Joseph Schwab (1966) believed that students should view science as a series of conceptual structures. Schwab (1960) had described two types of inquiry: stable (growing body of knowledge) and fluid (invention of new conceptual structures that revolutionize science). He encouraged science teachers to use the laboratory to assist students in their study of science concepts and also believed that science must be taught in an inquiry format. He also recommended that students could use and read reports or books about research and have discussions about problems, data, the role of technology, the interpretation of data and any conclusions reached by scientists. Schwab called this “enquiry into enquiry” (Duschl & Hamilton, 1998,).

There were four different goal clusters of inquiry developed as - personal needs, societal issues, academic preparation, and career education and awareness. The greatest emphasis (95%) was given on academic preparation. Inquiry (Welch, Klopfer, Aikenhead, & Robinson, 1981). Inquiry was studied from two dimensions - (i) content for teachers and their students and (ii) the strategy used by science teachers to help their students to learn science. It may divide student outcomes for inquiry into three categories - science process skills, nature of scientific inquiry and general inquiry process. Welch, et. al. (1981) identifies the reasons why the teachers do not use inquiry as a method of teaching. It may be due to lack of proper management, time, available materials and lack of support.
1.1.2 Influence of Policy Documents

Benchmarks (AAAS, 1993) developed three strand maps on their interpretation of scientific inquiry. First, evidence and reasoning in inquiry includes two categories – (i) Lines of reasoning and observations and evidence, and (ii) The second includes four further categories of scientific investigations: (a) control and condition, (b) reliability of results, (c) record keeping and (d) kinds of investigations. Furthermore, scientific theories consist of six categories: (i) making sense of evidence, (ii) alternative explanations, (iii) theory modifications, (iv) reliability of results, (v) safeguards, and (vi) expectations and (vii) explanations.

A second policy document, the National Science Education Standards (NSES) developed by National Research Council [NRC, 1996] USA considered inquiry as the overarching goal of scientific literacy. They provided guidance on –

(i) What science students are to know, (ii) how teachers are to teach science, and (iii) how teachers are to assess students? The NSES goes in describing inquiry: First, inquiry is the science content area that is viewed from two perspectives - what students should understand about scientific inquiry and what abilities students can develop based on their experiences with scientific inquiry. Secondly, inquiry may also include the teaching strategies associated with inquiry-oriented science activities.

The long-term initiative of the American Association for the Advancement of Science (AAAS) is to help all become literate in science, mathematics and technology. To achieve that goal, the Project 2061 conducts research and
develops tools and services that educators, researchers and policymakers can use to make critical and lasting improvements in the education system.

*National Research Council (NRC)*

In 1996 the National Research Council of USA published the National Science Education Standards (NSES). This document was the result of a long, collaborative process intended to specify what students should know and what students should be able to do after graduating from high school, what teachers should know about science and be able to do to teach science, and what education systems should know about educating future science teachers and be able to do to ensure students would learn science from these teachers. In conjunction with the AAAS Benchmarks for Science Literacy, the NSES catalyzed conversations among the teachers about what science was being taught, what science should be taught and how teachers would assess the quality and quantity of student learning in science.

The NRC (1996) developed six categories for understanding the meaning of inquiry among students. Those are as follows:

1. Conceptual principles and knowledge that guide scientific inquiries;
2. Investigations undertaken for a wide variety of reasons-to discover new aspects, explain new phenomena, test conclusions of previous investigations or test predictions of theories;
3. Use of technology to enhance the gathering and analysis of data to result in greater accuracy and precision of the data;
4. Use of mathematics and its tools and models for improving the questions, gathering data, constructing explanations and communicating results;

5. Scientific explanations that follow accepted criteria of logically consistent explanation, follow rules of evidence, are open to question and modification, and are based upon historical and current science knowledge; and

6. Different types of investigations and results involving public communication within the science community.

In 2000, NRC published Inquiry and the National Science Education Standards and identified five essential features of inquiry for all grade levels:

1. Scientifically oriented questions that will engage the students;

2. Evidence collected by students that allow them to develop and evaluate their explanations to the scientifically oriented questions;

3. Explanations developed by students from their evidence to address the scientifically oriented questions;

4. Evaluation of their explanations, which can include alternative explanations that reflect scientific understanding; and

5. Communication and justification of their proposed explanations.

They also further recommended that K–12 teachers of science must know that inquiry involves -

(i) the cognitive abilities that their students must develop;
(ii) an understanding of methods used by scientists to search for answers for their research questions; and

(iii) a variety of teaching strategies that help students to learn about scientific inquiry, develop their abilities of inquiry and understand science concepts (Bybee, 2000).

National Research Council (1996) specified the following abilities which are essential for inquiry:

(i) Identify questions and concepts that guide investigations;

(ii) Design and conduct scientific investigations;

(iii) Use appropriate technologies and mathematics to improve investigations and communications;

(iv) Formulate and revise scientific explanations and models using logic and evidence;

(v) Recognize and analyze alternative explanations and models and

(vi) Communicate and defend a scientific argument (students should refine their skills by presenting written and oral presentations that involve responding appropriately to critical comments from peers).

With the help of these six abilities K–12 teachers of science can provide multi-investigation opportunities for students. When students practice inquiry, it helps them developing their critical thinking abilities and scientific reasoning, a deeper understanding of science (NRC, 2000).
The Standards of Science Education

The NSES are a set of guidelines for science education in primary and secondary schools in the United States (as established by the NRC in 1996). These provide a set of goals for teachers to set for their students and for administrators to provide professional development. The NSES influences various states own science learning standards (such as the Massachusetts Frameworks), and worldwide standardized testing. The content of these standards is based heavily on a specific model of learning, i.e., constructivism. The goals of the standards include an outline of what students need to know, understand and be able to do. Targets for scientific literacy at different grade levels are given below:

1. All students demonstrate high levels of performance,
2. Teachers are empowered to make the decisions essential for effective learning,
3. Communities of teachers and students are focused on learning science,
4. Educational programs and systems nurture achievement.

The intended purpose of the standards is to define teaching methods which can be applied to all students, regardless of age, gender, cultural or ethnic background, special needs, aspirations or interest and motivation in sciences, recognizing that different students will achieve understanding in different ways, and some students will achieve different degrees of depth and breadth of understanding depending on interest, ability and context. However, the standards expect that all students can develop the knowledge and skills described in the standards.
The goal of scientific literacy includes inquiry, history and nature of science, personal and social perspectives of science, science and technology in addition to the science domains of life science, physical science and earth and space science. Programs defined according to these standards should be developmentally appropriate, interesting and relevant to students’ lives. The contemporary approach to promote inquiry is given below:

Table No.1.1: Changing Approach to Promote Inquiry

<table>
<thead>
<tr>
<th>Less emphasis on</th>
<th>More emphasis on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities that demonstrate and verify science content</td>
<td>Activities that investigate and analyze science questions</td>
</tr>
<tr>
<td>Investigations confined to one class period</td>
<td>Investigations over extended periods of time</td>
</tr>
<tr>
<td>Process skills out of context</td>
<td>Process skills in context</td>
</tr>
<tr>
<td>Emphasis on individual process skills as observation or inference.</td>
<td>Understanding multiple process skills - manipulation, cognitive, procedural</td>
</tr>
<tr>
<td>Getting an answer</td>
<td>Using evidence and strategies for developing or revising an explanation</td>
</tr>
<tr>
<td>Science as exploration and experiment</td>
<td>Science as argument and explanation</td>
</tr>
<tr>
<td>Providing answers to questions about science content</td>
<td>Communicating science explanation</td>
</tr>
<tr>
<td>Individuals and groups of students analyzing and</td>
<td>Groups of students often analyzing and synthesizing data without defending a conclusion synthesizing data after defending conclusions</td>
</tr>
<tr>
<td>Doing few investigations in order to leave time to cover large amounts of content</td>
<td>Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content</td>
</tr>
</tbody>
</table>
Concluding inquiries with the result of the experiment | Applying the result of experiments to scientific arguments and explanations
---|---
Management of materials and equipment | Management of ideas and information
Private communication of student ideas and conclusions to teacher | Public communication of student ideas and work to classmates.

(Source: National Research Council, 1996.)

Anderson (2002) was associated inquiry with ‘good science teaching and learning’. He also considered that science teacher’s beliefs and values about students, teaching and the purpose of education influence their adoption and implementing of inquiry. He mentioned three important barriers or dilemmas that influenced the implementation of inquiry as envisioned by the NSES (NRC, 1996) were:

1. **Technical Dilemmas** include the ability to teach constructively; the degree of commitment to the textbook; the challenges presented by state assessment; the difficulties of implementing group work; the challenge of the new teacher’s role as a facilitator; the challenge of the new student’s role as an active rather than a passive learner and inadequate professional development.

2. **Political Dilemmas** include short-term or limited professional development programs, parental resistance that science is taught differently than they experienced, unresolved conflicts among science teachers about what and how to teach, lack of available resources and differing views about failures must be addressed at local and state levels because of funding ramifications.

3. **Cultural Dilemmas** include quality of textbooks and support materials, views about purposes of assessment and view of preparation for the next science class.

According to Caprio (2001), the supervisor must also be comfortable with inquiry to be able to help their staff. McIntosh (2001), suggested that science faculty must modify their planning so that the science class has true course
goals of content and inquiry. Siebert (2001) recommended that laboratory experience helps in fostering inquiry, rather than being confirmation. All teachers of science (K–16+) must value inquiry, rather than “talk about it, but don’t practice it.” Chinn and Malhotra (2002) constructed a theoretical framework to compare authentic inquiry done by research scientists with K–12 school-based inquiry. Auls’ (1996) suggested that science methods faculty must provide in-depth study so future teachers of science would become comfortable with abilities, understandings, and effective teaching strategies for inquiry.

Cothron, Giese, and Rezba (1996) develop certain resources which can be used to help future teachers of science to develop an understanding about inquiry through experimental designs. To accomplish this task, Cothron, et. al. (1996) utilized a four-question strategy. These are as follows:

(i) What materials are readily available for conducting experiments on general topic?
(ii) How can I change the set of (general topic) materials to affect action?
(iii) How does it (general topic) act? and
(iv) How can I measure or describe the response of (general topic) change?

This general format may allow students to generate their experimental designs to address the questions.

Lee and Fradd (2001) developed an inquiry matrix consisting of questioning, planning, implementation (carrying out the plan and recording), concluding (analyzing data and drawing conclusions), repeating and applying. If students can develop greater confidence in conducting a scientific inquiry (using the four-question strategy), they will become more responsible for constructing their own knowledge base.

**Biological Science Inquiry Model:**

The term biology is derived from the Greek word ‘βίος’ – bios or life and the suffix – ‘λογία’, -logia, study of. Biological science is a branch of the natural
sciences which deals with the studies of living organisms and how they interact with each other and with environment. Biology is a natural science concerned with the study of life and living organisms including their structures, functions, growth, evolution, distributions and taxonomy. The subject is taught throughout the schooling years in India – primary, upper primary, secondary and higher secondary levels.

The root of the BSCS (Biological Science Curriculum Studies) approach is to make the teaching process for the students to possess information with the help of various techniques as used by the biologists in their research works. BSCS makes emphasis on the content and process. Joseph J. Schwab (1962) said that “the problems created by growing human populations, by depletion of resources, by pollution, by regional developments and like all, require intelligent government or community actions. These are, in part at least, biological, ecological problems and every citizen should have some awareness of their background”.

Schwab (1962) stated that “the essence then of a teaching of science as inquiry, would be to show some of the conclusions of science in the framework of the way they arise and are tested. This would mean to tell the student about the ideas posed and the experiments performed to indicate the data. Thus, to find out and to follow the interpretation by which these data were converted into scientific knowledge”. BSCS applied different techniques for teaching science as inquiry. These are as follows:

(i) *Using Statements*
In this technique the teacher utilizes several statements which tell about the tentative nature of science as follows:

(a) We do not know.
(b) I have not been able to find out how this happens.
(c) The information about this is contradictory.

(ii) *Using Narrative of Inquiry*
In this technique, the teacher discusses the history of biology.
(iii) **Arranging Laboratory Work**

The teacher makes arrangement for laboratory works and asks the students to find out various problems. The teacher creates situations in which the students find the space to participate in the inquiry.

(iv) **Designing Laboratory Programme**

The teacher can arrange the laboratory programmes in several blocks and allow the students to involve in an investigation of a real problem related to biological sciences. At first students may be presented with materials already familiar to scientists and problems whose solutions are already disclosed, but as Schwab (1962) said that “as the series of problems progress they gradually come nearer and nearer to the frontier of knowledge”.

(v) **Using Invitation to Enquiry**

The teachers use “invitation to inquiry” technique and encourage the students to involve there in. Invitation to inquiry induces the students to take active parts in reasoning based on activities of inquiry in laboratory. Reynaldo Martinez (1987) gives students materials and a manual and asks students to figure out equipment on their own, providing safety is preserved. Let students make mistakes and allow research for themselves among alternative resources. For instance, offer a range of options and ask students which is the best one and why.

1.2 **Inquiry Training Model : The Conceptual Frame**

Much of the current interest in inquiry can be traced back to the work of John Dewey (1961). He mentioned that the learner should develop the intellectual track and sensitivity to solve problems through constant inquiry. The system is based on the scientific method of investigation which requires posing a problem, generating hypothesis about the problem, testing the hypothesis and applying the solution (Grambs and Carr, 1979; Brown et al., 1982; Davis, 1976).
The model promotes strategies of inquiry, the values and attitude that are essential to an inquiring mind including the Process skills (Viz., observing, collecting and organizing data, identifying and controlling variables formulating and testing hypothesizing, explaining and inferring).

Table 1.2: Instructional and Nurturant Effects of the ITM

<table>
<thead>
<tr>
<th>Instructional nurturing</th>
<th>Inquiry Training Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Science process skill</td>
<td>iv. Independence for autonomy in learning</td>
</tr>
<tr>
<td>ii. Strategies for creative inquiry</td>
<td>v. Tolerance of ambiguity</td>
</tr>
<tr>
<td>iii. Spirit of creativity</td>
<td>vi. Tentative nature of knowledge</td>
</tr>
</tbody>
</table>

Inquiry model develops most of the domains of educational behavioral objectives. According to Joyce and Weil (1978), the essence of the model is the involvement of the students in a genuine problem of inquiry by confronting them with an area of investigation, helping them identify a conceptual or methodological problem within that area of investigation, and inviting them to design ways of overcoming that problem. At the same time, they gain a healthy respect for knowledge and may learn both the limitations of current knowledge and its dependability.

According to Lippitt, et. al. (1969), a number of models for teaching the disciplines as the processes of inquiry exist, all built around the concepts and methods of the particular disciplines. In biological sciences, it is designed to teach the processes of research biology to affect the ways that students process information and to nurture a commitment to scientific inquiry. It probably also nurtures open mindedness and an ability to suspend judgment and balance alternatives. Through its emphasis on the community of scholars, it also nurtures a spirit of cooperation and an ability to work with others in scientific inquiry.
1.2.1 Insight into Inquiry-Based Teaching

The world of inquiry, curiosity and wonder should be alive in classrooms everywhere. It is a world where children's minds come alive with possibilities and where students learn through experience, investigation and hands-on activities that engage their minds and foster their interest. An inquiry-based teaching is a perfect complement to a child's natural curiosity about the world and how it works. Whether it is the elementary student's wonder that is prompted by a story about hibernating animals, the middle school student's predictions about the relationship between circumference and diameter that arise from an exploration of different-sized spheres or the high school student's questions that are provoked by a local environmental issue, students become actively engaged in the learning process when given the opportunity to hypothesize and investigate.

Inquiry is central to both mathematics and sciences. For example, inquiry-oriented instruction in science engages students in the investigative nature of the world around them and inquiry-based strategies involve activities and skills that focus on the active search for knowledge or understanding. Mathematics is much more than arithmetic and algorithms. It involves data, measurements and recognition of patterns.

An inquiry-based classroom recognizes the diverse needs of students and employs the research-based strategies that help to keep all students engaged in learning. It is a community of inquiry where students and teachers share responsibility for learning and where they collaborate on constructing new knowledge areas.

Students have significant input into just about every aspect of their learning—how their classroom is set up, how time is structured, which resources are used, which topics are explored, how investigations will proceed and how findings are reported.
Strategies used by exemplary mathematics and science teachers ensure that activities are set up to allow students to be physically and mentally involved in the academic subjects. Activities are based on the use of materials to investigate questions and solve problems. Evidence is mounting that indicates inquiry-based instruction improves student attitude and achievement, facilitates student understanding, fosters critical thinking skills and facilitates mathematical discovery.

Inquiry Strategies for Science and Mathematics Learning also provide guidelines for creating an inquiry-based classroom that provides students with the time, space, resources and safety necessary for learning.

1.2.2 Basic Structure of Inquiry

It deals with following three basic questions:

(i) What do we know?
(ii) What do we need to know?
(iii) How can we find it out?

The essential steps to follow are:

(i) Identifying / Presenting the Problem we are attempting to solve.

(ii) Formulating Hypotheses: tentative solutions to the problem that can be verified with data.

(iii) Data gathering- This may include:
   a. Observation notes
   b. Pictures
   c. Drawings and diagrams
   d. Recordings (audio or video)

(iv) Data analysis

(v) Generalizing & Closure
1.2.3. Inquiry Training Model (ITM)

The Syntax of ITM is consisted of five Phases. These are given below:

Table 1.3: Summary Chart of the ITM

<table>
<thead>
<tr>
<th>PHASE – I</th>
<th>a. Confrontation with the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b. Explain inquiry procedures</td>
</tr>
<tr>
<td></td>
<td>c. Present discrepant event</td>
</tr>
<tr>
<td>PHASE – II</td>
<td>d. Data gathering-verification</td>
</tr>
<tr>
<td></td>
<td>e. Verify the nature of objects and conditions</td>
</tr>
<tr>
<td></td>
<td>f. Verify the occurrence of the problem situation</td>
</tr>
<tr>
<td>PHASE – III</td>
<td>g. Data gathering-Experimentation</td>
</tr>
<tr>
<td></td>
<td>h. Isolate relevant variables</td>
</tr>
<tr>
<td></td>
<td>i. Hypothesis (and test) casual relationships</td>
</tr>
<tr>
<td>PHASE-IV</td>
<td>j. Organizing, formulating and explanations</td>
</tr>
<tr>
<td></td>
<td>k. Formulate rules or explanations</td>
</tr>
<tr>
<td>PHASE – V</td>
<td>l. Analysis of the inquiry process</td>
</tr>
<tr>
<td></td>
<td>m. Analysis inquiry strategy and develop more effective ones</td>
</tr>
</tbody>
</table>

1.2.4 The Suchman’s Inquiry Technique

In the classroom, occasions frequently arise in which students come across unusual phenomena. Each of these occasions and many others like them, provide the teacher with rich opportunities to encourage students to carefully analyze the situation and to hypothesize and test explanations. These situations may make it difficult for students to remain indifferent - they demand explanations and want to know why.

Robert Suchman developed a strategy, similar to the game of twenty questions, to teach students a process for investigating and explaining unexpected and surprising events.
1.2.5 Overview of the Inquiry Strategy

The key features of the Inquiry Strategy in the classroom situation:

(i) Students are confronted with a puzzling situation. It is important that the explanation of the event should be based on ideas with which the students already have some familiarity - the explanation of the situation should be discoverable.

(ii) Students formulate hypotheses. The number of hypotheses should be small enough so that students can see to which hypothesis their data are related.

(iii) Data gathering: These must be of a form which can be answered by a ‘yes’ or a ‘no’. For example, a student may not ask "What is inside the radiometer?" but may ask, "Is there air inside the radiometer?". If a question isn’t answerable by ‘yes’ or ‘no’, the students are asked to rephrase it. Moreover, the questions must be worded so that the answer could be obtained through observation alone. The strategy eliminates all open ended questions and forces students to focus their ideas and to develop questions which are, in effect, limited hypotheses. With practice, students should be encouraged to structure their inquiry output so that they ask questions to analyze the situation they have observed - trying to find out what things are made of, what actually happened, before they consider relationships between the variables involved in the situation.

(iv) Assessing hypotheses: It is important that in this stage, the teacher and the students remember that even after lengthy questioning, a number of satisfactory explanations may be possible and that students should be encouraged to explore a range of alternative hypotheses.

(v) Generalizations: Reflection and analysis of the process. The final stage of the strategy involves students examining the process they have
worked through - considering the stages of the process and the effectiveness of the different questions which have been asked.

Finally, there should not be too much emphasis on "getting the right answer" - rather students should be encouraged to see that there are a number of satisfactory explanations in many situations.

1.3 Inquiry Training as a Model of Teaching

The Inquiry Training Model of teaching (ITM) is based on ‘Invitation to Inquiry’ in the area of Biological Sciences. This model of teaching consists of several steps which are as follows:

(i) Focus: The focus is the central aspect of teaching Model, objectives of teaching

(ii) Syntax: The syntax consists of four phases -
   Phase I: Posing Investigation Area
   Phase II: Structuring the problem
   Phase III: Identifying problems in investigation
   Phase IV: Speculating on ways for solving problems

(iii) Social System

(iv) Principles of Reaction

(v) Support system

(vi) Application

(vii) Instructional and Nurturant Effect

Syntax:

Phase I: Posing Investigation Area

The teacher presents an area of investigation to his/her students and explains the methodology of research which is suitable for conducting investigation. There are several types of research methodology such as historical research, survey research and experimental research.
**Phase II: Structuring the problem**

In this phase the students are encouraged to construct the structure of a problem. The students try to find out the difficulties in the formation of the problem. The teacher tries to help the students and becomes supportive in this direction for the sake of constructing the problem in the right form. The teacher helps in removing the difficulties faced by the students such as the difficulties of data interpretation, data generation, the control of experiments and making inferences etc.

**Phase III: Identifying Problems in Investigation**

The students are induced to speculate about the problem, so that they could be able to identify the difficulty involved in the inquiry.

**Phase IV: Speculating on ways for solving problem**

The students are then motivated and asked to speculate on ways of clearing up the difficult; either by redesigning the experiment, organizing data in different ways generating data, developing constructs and so on.

(iii) **Social System**

In this model conducive, cooperative and rigorous teaching is expected. The students are induced to come into a community of investigators who apply the best techniques of science. The social climate consists of boldness as well as humility at a specific level. The students are expected to make hypotheses rigorously, take challenge of evidence, make criticism of research design etc. As Joyce and Weil (1980) said, “In addition to the necessity for rigor, the students must also recognize the tentative and emergent nature of their own knowledge as well as that of the discipline and in doings so develop certain humility with respect to their approach to the well developed scientific disciplines”.

(iv) **Principles of Reaction**

The most important work of teacher is to make the development of inquiry. The teacher gives due importance to the inquiry in the area of biological sciences. The students are expected to make reactions on the activities of inquiry. As Joyce and Weil (1980) said, “The instructor’s task is to turn the students toward the generation of hypotheses, interpretation of data and the development of constructs, which are seen as emergent ways of interpreting reality”.

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(v) Support System

In the ITM of teaching the teachers act as a flexible instructor and he should be well equipped with effective skills in the process of inquiry. The teacher has to provide sufficient areas of investigation with their problems. The essential information sources must be provided for conducting inquiry which would be very helpful for the students.

**Purposes of Inquiry Training Model:**

The purposes of the ITM are as follows:

1. To deal with the learner’s emotional areas;
2. To develop problem-solving skills;
3. To increase critical thinking level;
4. To develop understanding level;
5. To apply inquiry into human behavior and
6. To increase interaction level.

**Instructional and Nurturant Effect of ITM**

The following figure shows the Instructional and Nurturant effects of the ITM:

---Instructional

---Nurturant

![Diagram of Instructional and Nurturant Effects of the ITM](image)

Figure 1.1: Instructional and Nurturant Effects of the Biological Science Inquiry Model
1.4 Essential Conditions to Create Inquiry

Suchman and his associates (1962) find out the conditions which are essential to create inquiry. They are as follows:

1. The children need to have some kind of problem or stimulus, although not necessarily. One that is discrepant to the schemata or conceptual systems of the child.

Piaget (1964) also believed that students come to class with the schemata which allow them to understand and cope with events to which they are committed to various degrees. The new sets of ideas, when presented and if they are similar to the existing schema, will be assimilated. If the new ideas are contradictory or opposing, then there will be ‘disequilibrium’ (Piaget, 1964), ‘cognitive dissonance’ (Festinger 1957) in the context of attitude and beliefs, ‘conceptual conflict’ (Berlyne, 1963) in the context of Teaching. Piaget (1964), Ausubel (1978) and Novok (1977) told that human beings have an innate need to reduce dissonance, conflict between two cognitions. Ausubel (1978) and Novok (1977) further advocated inducing ‘cognitive dissonance’ in school setting in order to arouse motivation and attention to create the need for accommodation.

2. Children need the condition of freedom. Suchman (1962) has broken down freedom into two parts, one of which is a kind of external freedom, i.e, physical freedom to reach out for desired data and information and to acquire it at any rate in any sequence the child wishes. The internal freedom is something that follows as a consequence. Suchman has found out that when children are given external freedom, they are inhibited for a time and do not avail themselves of it because they have been conditioned to follow the teacher’s lead and to confirm. But eventually, as they explore and find that external freedom does exist, they begin to build up autonomy in their operations. They make decisions and try to satisfy their own cognitive needs by gathering the kinds of information they want. They
also exercise freedom in trying out ideas. For collecting data independently and processing the information, two kinds of scanning are used: Scanning the field for data and scanning the store of ideas for conceptual models. These comprise two parts of the inquiry cycle. A child absorbs a percept and he/she tries to find a usable model to assimilate it. Then, providing assimilation is incomplete, he performs some action to generate new data. At the same time when he acquires new data, he scans for new models on which to test the data. He endeavors to match the data coming in with the models being tried out. At some points the match between the data and a model is made.

3. The third condition is what Moore (1964) calls the ‘response environment’. The child needs to have an environment where when he/she reaches out for data, procures something. She/he does not return with empty hands.

In the inquiry process the child just shifts back and forth from high cognitive control to impulsivity. If the child never leaves the data, then he will not be in a position to construct theory. This ability is related to a third factor which Suchman has identified as autonomy. If the child is high on cognitive control, impulsivity and autonomy, they have found him to be a more effective inquirer than a child who is low on any of the three.

Hence, Suchman concentrated on developing a model which facilitates inquiry. The model should give the children a free atmosphere (freedom) wherein they actively involved in the inquiry process to become effective inquirers.

1.5 Goals of Inquiry Training Model:

1. To help students to develop intellectual discipline, necessary to search out data and process them in a systematic way;
2. To help students to inquire independently in a systematic way;
3. To try to develop a way of thinking in students to question why events happen as they do and to develop intellectual strategies that they can use to determine causal relationships among phenomena;

4. To give the child a new approach of learning by which he could build up concepts through the analysis of concrete episodes and the discovery of relationships between variables;

5. To capitalize on two intrinsic motivations, the rewarding experience of discovery and the excitement inherent in autonomous searching and data processing.

1.6 Assumptions about Inquiry Training:

1. Inquiry training starts with a puzzling events or problem. The underlying assumption here is that the individuals when puzzled or confronted with a problem get intrinsically motivated to search relevant data for the solution of the problem and when the individual solves the problem or puzzle he gets excited by the reward of satisfaction and it helps in building confidence for further autonomous searching.

2. The conscious and awareness of the process and strategies of inquiry should be essential aspect of autonomous inquiry and this helps the student in better analysis and in improving his way of thinking. Frequent reflection on the process of inquiry is very essential.

3. The students should develop an attitude that all knowledge is tentative. Scholars generate theories and explanations and years later, the theories may be disproved and a new theory may originate in the knowledge generation process. Hence, the students should be prepared to accept that all knowledge is tentative and dynamic nature of the world should be realized.

4. Suchman believes that individuals have a natural motivation to inquire.
1.7 The Salient features of the Inquiry Training Model:

The emphasis in this model is clearly on becoming aware of and mastering with the inquiry process, not on the content and exploration of any particular problem situation. Although the model should also be enormously appealing and effective as a mode of acquiring and using information, the teacher cannot be too concerned with the subject matter (content) coverage, i.e., this require an open classroom with emergent content and strict adherence to a prescribed curriculum is not possible.

The teacher, here in this model, has greater responsibility in planning and providing structural environment and facilitating and channelizing inquiry.

Although inquiry training was originally developed in the context of natural science, its procedures have wide applicability in all subject areas. Any topic that can be formulated as a puzzling situation is suitable for inquiry training. Throughout the inquiry process, process evaluation will be continuously going on. Later at the end of each unit or a set of units, evaluation may be done according to the previously formulated specifications.

Self-discipline on the part of the students is emphasized. The spirit of inquiry training could be made use of in combination with any model for efficient learning.

1.8 Implementing Inquiry Training Model:

The global trend in science education is towards science as a basic for all students and in recent years a major movement for the reform of science teaching had developed in many countries. In America, the Physical Science Study Committee (PSSC) has been engaged in fundamental reappraisal of science teaching since 1950’s.

In essence, the aim of this approach is to present the sciences as systems of inquiry rather than simply as bodies of knowledge. To this end, the Biological
Science Curriculum Study (BSCS), Schwab, (1965) precluded curricular and instructional patterns for use in secondary school biology. The essence of the BSCS Approach is to teach students to process information using techniques similar to those of research biologists, by identifying problems and using a particular method to solve them. BSCS emphasizes content and process. To help the students to understand the nature of science, the strategies developed by the BSCS committee introduce students to the methods of biology at the same time that they introduce them to the ideas and facts (Schwab, 1965).

This kind of exposition (the statement of conclusions) has long been the standard rhetoric of textbooks even at higher level. It has many advantages, not the least of which is simplicity and economy of space. Nevertheless, there are serious objections to it. Both by omission and commission, it gives a false and misleading picture of the nature of science (Schwab, 1965). By commission, rhetoric of conclusions has two unfortunate effects on the students. It gives the impression that science consists of unalterable, fixed truth. Yet, this is not the case. The accelerated pace of knowledge in recent years has made it abundantly clear that scientific knowledge is reversionary. It is a temporary codex, continuously restructured as new data are related to old.

Rhetoric of conclusions also tends to convey the impression that science is complete. Here, the fact that scientific investigation still goes on, and at an ever accelerated pace, is left unaccounted to the students. The sin of omission by rhetoric of conclusions can be stated thus. It fails to show that scientific knowledge is more than a simple report of things observed, that it is a body of knowledge forged slowly and tentatively from raw materials. It does not show that these raw materials, data, spring from planned observations and experiments. It does not show that plans for experiments and observation arise from problems posed and that these problems, in turns, arise from concepts which summarize our earlier knowledge.
Inquiry Training Model and Scientific Thinking:

According to Gafoor (2010), teachers often assume that students performance levels are based on their intelligence, effort and motivation. Theories of intellectual style are new entrants into the traditional family of theories of student development. Three most frequently used terms in this connection are cognitive style, learning style and thinking styles. These styles although different are having one feature in common; they are individuals preferred ways of processing information and using abilities that they have. The research in differences in the ways of thinking of individuals has crystallized in terms of thinking styles. A thinking style is the preferred way of thinking and managing activities. Sternberg (1997) defines thinking style as a personality attributes to utilization of abilities.

In actual instructional practice, schools and other institutions value certain ways of thinking over others. Students whose thinking styles do not match those valued by the institution are usually penalized. For example, among the university students, even after age, gender and academic discipline were controlled particular thinking style predisposed students to particular teaching style (Zhang, 2002). It is necessary that schools taken into account students style and consider the chances of the fit between the ways of teaching a subject and the ways of the students think. Science is more like a way of investigation and thinking than a body of knowledge. The process aspect of science concentrates on the way of thinking. The awareness of style of thinking is useful in perceiving the students as they are shoring is to teach students how to think than teaching them what to think (Clemen and Lochhead, 1979). Since educational institutions give high priority to academic achievement the contributions of thinking style to achievement demands research attention.

Corinne Zimmerman (2007) defined scientific thinking as the application of the methods or principles of scientific inquiry to reasoning or problem-solving situations and involves the skills implicated in generating, testing and revising
theories and in the case of fully developed skills to reflect on the process of knowledge acquisition and change (Kostowski, 1996; Kuhn and Franklin, 2006; Wilkeniz and Sodian, 2005). Participants engage in some or all of the components of scientific inquiry, such as designing, experiment evaluating evidence and making inferences in the service of forming and / or revising theories about the phenomenon under investigation.

Some definitions of scientific thinking are as follows -

a. Scientific thinking as knowledge seeking (Kuhn, 1993).

b. Scientific thinking as scientific understanding.

c. Knowledge seeking as the intentional coordination of theory and evidence-transforms implicit theory revision into scientific thinking.

The three central components of scientific thinking and critical thinking are as follows:

(i) Empiricism: Empirical evidence is the evidence which one can see, hear, touch, taste or smell. It is susceptible to one’s senses. Scientists and critical thinkers take vital decisions and reach sound conclusions on the basis of these empirical evidences. The common alternative of empirical evidence is authoritarian evidence, in what authorities (books, television, people, etc) tell us to believe. Evidences are reliable if the authority is reliable but is very essential that we must check the reliability of the authority before we accept the evidence. But finally we must check our own authority and use our own power of critical thinking to know what we believe is reliably true. Teachers, instructors and professors are generally considered to be reliable and trustworthy authorities.

Empirical evidence is also called as natural evidence: the evidence found in nature. Naturalism is the philosophy that says that “Reality and Existence (i.e. the universe, cosmos, or nature) can be described and explained solely in terms of natural evidence, natural processes and
natural laws”. Science is the only method that successfully discovers and formulates reliable knowledge.

(ii) Rationalism: Scientist and critical thinkers always use logical reasoning. Logic allows us to reason correctly. Logical thinking can be learnt by studying logic and reasoning in a philosophy class. Logic is not an ability that is born with or one that will gradually develop and improve on its own, but is a skill or discipline that must be learned within a formal educational environment.

(iii) Skepticism: The final key idea in science and critical thinking is skepticism, the constant questioning of our own beliefs and conclusions. Eminent scientists and critical thinkers constantly examine the evidence, arguments and reasons for their beliefs. Skeptics have open minds, but not believe anything for the first time without adequate evidence or reason.

The Scientific Method in Practice:
The scientific method used in scientific thinking and critical thinking are as follows:
(i) One must identify a significant problem or be able to state the problem or question in such a way that it is conceivably possible to answer.

(ii) Scientist must choose the correct problem and decide the fix time to complete it or solve it because problems are often influenced by cultural, social, political and economic factors. Scientists live and work within a culture that often shapes their approaches to problems, they work within theories that often shape their current understanding of nature, they work within a society that often decides what scientific topics will be financially supported and which will not and they work within a political system that often determines which topics are permitted and financially rewarded and which are not. Science is a
social and cultural construct, that scientific knowledge inevitably changes as societies and facilitates cultural change.

(iv) One must gather relevant information to attempt to answer the question or solve the problem by making observations. Observations must be obtained from library or from our own experiences or from our past experiences. These observations must be sensible, measurable and repeatable, so that others can make the same observations.

(v) In science, the solution or answer of a problem is called as scientific hypothesis. A scientific hypothesis is an informed, testable and predictive solution to a scientific problem that explains a natural phenomenon, process or an event but in critical thinking, as in science the proposed answer or solution must be testable, otherwise it would be essentially useful for further investigation.

(vi) Hypothesis must be tested before it is corroborated and given any real validity. It can be done by two ways-

   a. One can conduct an experiment.
   b. Hypothesis can be tested by making further observations.

Hypothesis can be tested by natural processes, natural events and natural laws. If hypothesis fails then it must be modified and tested again. A corroborated hypothesis is one that has passed its tests, i.e., one whose predictions have been verified and other scientists test the hypothesis.

The final step of the scientific method is to construct, support or cast doubt on a scientific theory.

1.10 Inquiry Training Model and Critical thinking:

Critical thinking skills are skills that are essential for both children and adults to solve their own problems. It includes analyzing and evaluating information that is provided, whether that information is through observation, experience or communication. The core of critical thinking is being responsive to
information and not just accepting it. The most important part of critical thinking is proper questioning. It is a part of scientific, mathematical, historical, economical and philosophical thinking, all of which are essential for the future development of our society.

Important steps of critical thinking are as follows:

(i) *Compare and contrast items and topics:* This allows children to tell the ways things are similar and different and help them analyze and categorize information.

(ii) *Discuss and analyze stories:* Have children "retell" a story you have read in their own words. This encourages them to summarize the main ideas of the story instead of just responding to specific questions with facts. They retell and try to find out the co-relation of the story with their own life.

(iii) *Learn cooperatively:* This providing cooperative learning opportunity will help in developing critical thinking skills among children, so that they can share their ideas and learn from each another.

(iv) *Questioning:* Two approaches are -

(a) *Provide stories without conclusions*

Telling a story without an ending and asking the children to finish the story is another way to encourage critical thinking skills such as synthesis. The children must take the information from the story and creatively compile it, draw conclusions and come up with their own ending.

(b) *Practice the Socratic method*

Socrates was famous for teaching critical thinking through questioning. As children are curious in nature and always ask questions, so turn the tables a little and question them back. Take an opposite position and try to get them to defend or established their opinions on a topic by asking pointed questions.
Critical thinking involves the use of a group of interconnected skills to analyze, creatively integrate and evaluate what we read and hear. To become a critical thinker we must be able to decide whether an author’s opinions are true or false, whether he or she has adequately defended those ideas, whether certain recommendations are practical, as well as whether particular solutions will be effective.

(i) Critical Thinking Dispositions
A disposition is a tendency to act or think in a certain way. Review the list of dispositions that are characteristic of critical thinkers. Critical thinking also involves certain dispositions.

(ii) Critical Thinking Skills
To learn how to think critically, one must learn skills how to learn or think critically, that build upon each other. Only by concentrating on or practicing these basic skills can mastery of critical thinking. Three basic characteristics of the skills required to think critically are - interconnected and they build on each other, and they are goal-oriented in that we can constantly apply them to situations in everyday life.

(iii) Characteristics of Critical Thinking
Critical thinking involves the use of a kind of thinking called reasoning, in which we construct or evaluate reasons to support beliefs. Critical thinking also involves reflection, the examination and evaluation of our own and others’ thoughts and ideas. Finally critical thinking is practical. Actions are more rational if they are based on beliefs that we take to be justified. Critical thinking then, is the careful, deliberate determination of whether we should accept, reject or suspend judgment about the truth of a claim or a recommendation to act in a certain way.

Critical Thinking Dispositions:
Critical thinkers are those who were:-

1. Curious about the whole world.
2. Creative questioners.
3. Frequently asking "why?" and seeking reasons to defend it.
4. Interested only in reliable sources of information.
5. Able to handle the total situation or context when interpreting something.
6. Relevant thinkers are those who stick to the main point.
7. Always looking for alternative explanations or arguments.
8. Open-minded and who seriously consider points of view other than their own.
9. Willing to change a position when the evidence is sufficient to make them do so.
10. Able to withhold judgment when the evidence is insufficient.
11. Able to arrange the materials in such a way that he/she is able to distinguish one idea from another or deal in an orderly manner.
12. Able to apply critical thinking abilities to a wide variety of subjects.
13. Critical thinkers are able to segregate the material into its components.
14. Critical thinkers able to establish how one idea relates to another.
15. Critical thinkers are able to categorize information received.
16. Critical thinkers are able to set up comparisons among things.

Thus, to be a Critical Thinker, one should develop his/her both Hemispheres of the brain by practicing divergent thinking.

1.11 Conclusion:

In this chapter, In-spite of traditional methods of teaching science, there is a need to introduce new techniques or innovations in teaching science. As the human beings are curious in nature so there is a need of introduce new techniques or innovations in this field. A list of innovative techniques has been presented in this chapter. One of the important innovations in the field of education is Inquiry Training Model of Teaching (ITM). It seems to be very useful in improving classroom teaching-learning process.
In order to know the models properly, proper training on model is required or essential; the present study is thus concerned with satisfying the training needs of student-teacher for preparing them to be effective science teachers. This chapter also describes the relevance of ITM in science education programme. The first chapter will help the student-teacher in identifying the different steps and procedure for using the model properly.

References


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CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Reviews on Inquiry Training Model

2.2 Reviews on Thinking Style

2.3 Reviews on Critical Thinking

2.4 Emergence of the problem

2.5 Research Questions

2.6 Objectives

2.7 Hypotheses

2.8 Delimitations of the study

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References
CHAPTER 2
REVIEW OF RELATED LITERATURE

Review of related literature is an essential aspect that helps the researcher to have an idea regarding the scope of the study and also helps in formulating specific and testable hypotheses. It also gives an excellent overview of the nature of work done in the present field and provides the background for further investigation. This is an attempt to make the study and findings and results more reliable, authentic and more substanticable. In the present study, researcher has reviewed the related journals, educational reviews, theses, abstracts, books etc. to reveal the various research works on the topic areas of relevant theories instruction, instructional strategies developed and different models of teachings.

In India, most of the studies are dominated by a few popular teaching models, methods and techniques of teaching. Very few studies are found on the analytical concepts of teaching and behavioral modification approaches in teacher training. Efforts are also made to identify various teaching skills for teaching different topics in different subjects. Many researchers tried to find out the different teaching patterns for developing cognitive and affective behavior of the students. More emphasis was given on the development of the cognitive domain. Models of teaching have the greater potentiality for achieving the goal, i.e., all round development of the personality (cognitive, affective and psychomotor domains) of the students.

2.1 Reviews on Inquiry Training Model

Joyce and Weil (1980) developed more than 23 models and they have classified those into four families. Reviews of Literatures on the Inquiry Training Model are given below:

Eggen, Kauchak and Harder (1979) have discussed six Information Processing Models- Advance Organiser Model, Concept Attainment Model, General
Inductive Model, General Deductive Model, Inquiry Training Model (ITM) and Taba Model.

Joseph Schwab (1965) engaged students in scientific inquiry; the work of Biological Science Study Committee (BSSC, 1963) considered it as Scientific Inquiry Model. In this model the students are brought into scientific process and helped to collect and analyze data, check out hypotheses and theories, and reflect on the nature of knowledge construction.

Joss (1980) in his survey provided adequate evidence to show that the goals and dynamics of Information Processing can be applied with appropriate modification to instructional situations, so that the efficacy of instruction can be increased several fold. Lazarowitz (1976) in his study proved that teachers who used different new innovative programs like BSCS (Biological Science Curriculum Studies), PSSC (Physical Science Study Committee), CHEM study etc. in their teaching activities have showed more favorable attitude towards inquiry strategies than those who does not use these programmes.

Many researches (Chitriv, 1983; Ghosh, 1981; Paul, 1995 and Budhi Sagar, 1990) proved that the models can promote the thinking abilities of students in a better way rather than the conventional method. Students can think independently in a meaningful and purposeful way, and can generate hypotheses with the help of the teachers.

The Inquiry Training Model was first developed by Richard Suchman (1962) and it was different from the other Inquiry Models. This model was basically a question-answer approach. It is both inductive as well as deductive. This model was designed in such a way that students could directly be engaged with the scientific process through exercises that compress the scientific process into small period of time. Schlenker (1976) reported that the inquiry training increased the power of better understanding of science. Later, Ivany (1969) and Collins (1969) reported that Inquiry Training Model works best when confrontations are adequate and strong enough to arouse genuine
puzzlement, when the materials, the students use to discover or explore the topics under consideration are especially instructional.

Voss (1982) reported that both primary and secondary students can profit from the Model. Later, Elephant (1980) successfully uses this model on deaf children and suggested that the model can be enough powerful with the students who have severe sensory impairments.


Passi, Sansanwal, Singh (1988) conducted a study and proved that the training in the model of Teaching was effective in bringing about dynamic and positive changes in student-teacher with regard to some specific instructional effects. These help the student-teacher to explore the use of the best suitable methods for different topics in different subjects in different classes.

Kumar, Amrit and Kaur, Harbinder (1998) conducted their study to find out the Effectiveness of Inquiry Training Model in the development of process skill in Geography in relation to cognitive style and personality style. Major findings of their study were -

(i) The experimental group differed significantly better and the ITM was found more effective for developing process skill in geography than the conventional method.

(ii) The experimental and control group did not differ with respect to cognitive styles and personality on the development of process skill in geography.

(iii) The teaching technique and cognitive style did not have any interaction effect on the development of process skill in Geography and the same was true with personality type.
Rathore and Verma, (2000) conducted their study on “Comparison of integrated Teaching Strategy using CAM and ITM with conventional teaching in terms of Inductive Reasoning”. It was found that (i) Integrated teaching strategy improved the inductive reasoning of student and (ii) Integrated teaching strategy increased student’s inductive reasoning significantly as compared to conventional method.

Kalia, (2005) conducted his study on “Effectiveness of Mastery Learning Strategy and Inquiry Training Model on Pupil’s Achievement in Science”. The objectives of his study were to compare the effect of Mastery Learning strategies and ITM of Teaching on Achievement in Science. It was found that- (i) The subjects exposed to Mastery Learning model of teaching achieved significantly higher mean level of achievement in comparison to students taught through ITM and (ii) Subjects exposed to Mastery learning Model were found significantly higher in comparison to subject exposed to traditional method of teaching.

Alam, (1997) studied on the effectiveness of inductive thinking and inquiry training models for teaching biology to the students of secondary schools and the objectives of his study were i) to study the effectiveness of inductive thinking model, ITM and conventional method in developing the concepts in biology among the students of class ix, ii) to explore the comparative effectiveness of inductive thinking model, ITM and conventional method of teaching in terms of concepts attainment in biology among the students of class IX.

The major findings of his study were-

(i) For concept learning and retention in biology inductive thinking model and ITM were more effective than conventional teaching method.

Vanaja (1998) studied on “A study of the inquiry training model in science teacher education programme”.

The major findings of her study were-
(i) The overall responses of the teachers to the willingness scale was positive,

(ii) Both men and women teacher-educators had shown a similar response pattern to the willingness scores,

(iii) Teacher-educators with M.Phil, Ph.D; obtain a higher mean in willingness scale than those with only P.G. Degree

(iv) The teaching experience of the teacher-educator did not influence the trend of opinions expressed.

(v) The teacher-educator who handled method courses obtain a higher mean in the willingness scale than those teaching foundation courses,

(vi) Teacher-educators who attended in–service programmes obtained a higher mean than those who did not attend,

(vii) There were no significant difference between the large and small groups in their theoretical understanding,

(viii) Only ten percent of the student-teachers had secured low scores on the theory checkup,

(ix) There was no significant difference between the large and small groups in their reaction scores. Only nine percent of the students had shown negative reaction,

(x) There was no significant difference between the large and small groups in their willingness scores,

(xi) Ninety five percent of the student-teachers had shown willingness to use the model of teaching.


The major findings of the study were -

(i) Inquiry training model of teaching science was more effective than the conventional method in developing science process skills, fostering fluency and originality components of creativity and in boosting curiosity.

(ii) Inquiry training model of teaching science was more effective than the conventional method in developing science process skill for students belonging to above average and average groups.

(iii) The students sustained science process skill developed through inquiry training model of teaching science.

(iv) The students sustained fluency and originality components of creativity fostered through inquiry training model of teaching science.

(v) The student’s sustained curiosity boosted through inquiry training model of teaching science.

Naik and Pathy (1997) studied on the “A study of the attitude of secondary school teachers towards teaching of science”.

It was found that-

(i) Science teachers possess positive attitude towards teaching of science.

(ii) Urban secondary school science teachers have more favorable attitude towards teaching of science than rural secondary school science teachers.

(iii) The female science teachers had significantly positive attitude towards teaching of science than their male counterparts.

2.2 Review on Thinking Style:

According to Gafoor (2010) teachers often assume that students’ performance levels are based on their intelligence, effort and motivation. Theories of
intellectual style are new entrants into the traditional family of theories of student development. Three most frequently used terms in this connection are cognitive style, learning style and thinking styles. These styles although different are having one feature in common; they are individuals’ preferred ways of processing information and using abilities that they have. The research in differences in the ways of thinking of individuals has crystallized in terms of thinking styles. A thinking style is the preferred way of thinking and managing activities. Sternberg (1997) defines thinking style as a personality attributes to utilization of abilities.

In actual instructional practices, schools and other institutions value certain ways of thinking over others. Students whose thinking styles do not match those valued by the institution are usually penalized. For example, among the university students, even after age, gender and academic discipline were controlled particular thinking style predisposed students to particular teaching style (Zhang, 2002). It is necessary that schools taken into account, students style and consider the chances of the fit between the ways of teaching a subject and the ways of the students think. Science is more like a way of investigation and thinking than a body of knowledge. The process aspect of science concentrates on the way of thinking. The awareness of style of thinking is useful in perceiving the students as they are shoring is to teach students how to think than teaching them what to think (Clemen and Lochhead, 1979). Since educational institutions give high priority to academic achievement, the contributions of thinking style to achievement demands for research attention.

Corinne Zimmerman (2007) define scientific thinking as the application of the methods or principles of scientific inquiry to reasoning or problem-solving situations and involves the skills implicated in generating, testing and revising theories and in the case of fully developed skills, to reflect on the process of knowledge acquisition and change (Kostowski, 1996; Kuhn and Franklin, 2006; Wilkeniz and Sodian, 2005). Participants engage in some or all of the components of scientific inquiry, such as designing, experiment evaluating
evidence and making inferences in the service of forming and / or revising theories about the phenomenon under investigation.

Some definitions of scientific thinking are as follows-

- Scientific thinking as knowledge seeking (Kuhn, 1993).
- Scientific thinking and scientific understanding.
- Knowledge seeking as the intentional coordination of theory and evidence- Transforms implicit theory revision into scientific thinking.

Ability refers to what one can do, whereas a style refers to how one prefers to use one’s abilities. Major researches on theorization of cognitive styles have been summarized in a few recent works (e.g., Jonassen & Grabowski, 1993; Riding & Cheema, 1991; Riding & Rayner, 1998; Sternberg & Zhang, 2001a).

Thinking styles of Sternberg (1997) defines this style mostly as a preference in the usage of the talent that the individual has rather than preferred kind of something or ability (Sternberg and Zhang, 2001). “Theory of Mental Self-Government” that is put forth by Sternberg (1988, 1990, 1994, 1997) states people thinking styles. Thinking styles can be used at home, in school, at work, in society in many situations. This theory asserts that all people manage the whole daily activities live managing a society. The individuals have their own thinking styles and everybody has his or her own way that he/she feels at ease when dealing with the events happening. Thinking styles can be shaped by the conditions that people are in and charge depending on the necessities of the situation. This change is closely in relation to social environment depending on culture, time and situation.

Research on thinking styles within the educational context has yielded several findings. First, students’ thinking styles vary as a function of their personal characteristics and their learning environment. Second, the thinking styles of teachers, as manifested in teaching, differ depending on their personal characteristics, their teaching experiences and the school environment. Third,
students tend to achieve better academic results when their thinking styles match the thinking styles of their teachers. Finally, students’ thinking styles contribute to their academic achievement beyond what can be explained by their abilities. The Journal of Genetic Psychology assessed by both self-rating and performance tests (Grigorenko & Sternberg, 1997; Sternberg & Grigorenko, 1995; Zhang, 1999 b, 2001 a, 2001 b; Zhang & Sternberg, 1998).

Researchers have examined the nature of thinking styles described in the theory of mental self-government by testing the thinking styles against a number of constructs that are believed to be associated with the thinking style construct. For example, studies have been conducted to examine the relationships of thinking styles to (i) learning approaches, as proposed by Biggs (1987, 1992); (ii) personality types, as proposed by Holland (1973, 1994); and (iii) self-esteem, as measured by the Self-Esteem Inventory–Adult Form (Coopersmith, 1981).

Similar to Piaget’s (1952) theory of cognitive development, Perry’s (1970, 1981) theory focuses on how students think but not what they think. Perry argued that a student’s form of reasoning transcends content. In this study, he dealt with two content areas: education and interpersonal relationships.

Research and application of Perry’s (1970, 1981) theory have been well documented in the literature. Researchers have shown that, in general, Perry’s theory is valid and that cognitive development as described in the theory plays an important role in students’ academic performance (e.g., Ryan, 1984a, 1984b; Schommer, 1990, 1993; Schommer, Calvert, Gariglietti, & Bajaj, 1997; Schommer, Crouse, & Rhodes, 1992). Furthermore, researchers of cross-cultural studies (e.g., Durham, Hays, & Martinez, 1994; Zhang, 1999a) have also suggested the validity of Perry’s theory, although cross-cultural differences were identified in these studies, as would be expected, given that cultural factors have been proven to have a strong impact on cognitive development (e.g., Mwamwenda, 1992; Rogoff & Chavajay, 1995; Slone, Dixon, & Bokhorst, 1993). Unlike Piaget’s (1952) theory, however, Perry’s (1970, 1981) theory of cognitive development has not been tested against a
theoretical model that takes an individual differences approach, such as Sternberg’s (1988, 1997) theory of mental self-government.

The Scientific Method in Practice:
The scientific method used in scientific thinking and critical thinking are as follows-

(i) One must identify a significant problem or one should be able to state the problem or question in such a way that it is conceivably possible to answer.

(ii) Scientist must choose the correct problem and decide the time to complete it or solve it because problems are often influenced by cultural, social, political and economic factors. Scientists live and work within a culture that often shapes their approaches to problems, they work within theories that often shape their current understanding of nature, they work within a society that often decides what scientific topics will be financially supported and which will not and they work within a political system that often determines which topics are permitted and financially rewarded and which are not. Science is a social and cultural construct, that scientific knowledge inevitably changes as societies and cultures change.

(iii) One must gather relevant information to attempts to answer the question or solve the problem by making observations. Observations must be obtained from library or from our own experience or from our past experiences. These observations must be sensible, measurable and repeatable, so that others can make the same observations.

(iv) In science, the solution or answer of a problem is called as scientific hypothesis. A scientific hypothesis is an informed, testable and predictive solution to a scientific problem that explains a natural phenomenon, process or an event but in critical thinking, as in science the proposed answer or solution must be testable, otherwise it is essentially usefully for further investigation.
Hypothesis must be tested before it is corroborated and given any real validity and it can be done by two ways:

(vi) One can conduct an experiment.

(vii) Hypothesis can be tested by making further observations.

Hypothesis can be tested by natural processes, natural events and natural laws. If a hypothesis fails, it must be modified and tested again. A corroborated hypothesis is one that has passed its tests, i.e., one whose predictions have been verified and other scientists test the hypothesis.

The final step of the scientific method is to construct, support or cast doubt on a scientific theory.

### 2.3 Review on Critical Thinking

Menvin (1970) and Gross (1972), studied a number of research reviews concerning methods of inquiry in social studies. Wiley (1977) reported that:

- A large proportion of the effectiveness of the research conducted in social studies falls under the heading of research on instructional methods labeled 'critical thinking', 'inquiry' and the like and the research show no significant differences between critical thinking methods and traditional methods.

Massialas (1966) also mentioned that inquiry methods showed greater efficacy over traditional methods.

Schlenker (1970) in his study proved that students of inquiry oriented teaching showed a greater fluency in inquiry and critical thinking but showed no difference in content mastery and information retention.

Analysis of research conducted by Martorella (1978) reported that there is no significant difference between the critical thinking method and traditional method in teaching Social Studies.
Tyrell (1982) reviewed on comparisons between traditional lecture and discussion methods and noted that 51% favored the lecture method and 49% favored the discussion method. He founded that there was very little difference in achievement scores between either methods. Tyrell also emphasized the following results, which may assist the teacher in making higher choice of strategies:

1. If properly used, the lecture and inquiry discussion methods both were relatively equal in providing knowledge acquisition opportunities.

2. In one study, the lecture-recitation method was found to be superior to inquiry and public issue discussion method. The effectiveness of the approach completely depended upon student ability and performance.

3. Different strategies must be used for different abilities.

Hillocks and Johannessen (1983) discussed about prewriting activities approaches, which emphasized on task analysis and inquiry activities in a very useful theory and research into practice (NCTE).

Johnson (1991) reported that the application of the Inquiry Approach in middle school Science activities resulted in the following outcomes:

(i) It helped in developing science concepts.

(ii) Developing quantitative thinking.

(iii) Helped to integrate science subjects.

(iv) Helped in experiencing success.

Germann (1991) reported that the Inquiry Approach is effective in learning science process skills and scientific problem-solving. Concept mapping, advance organizers diagrams, the theme approach and focusing were used to help students to develop science process skills.

Warren (1991) reported an innovative instructional intervention model that represented a promising approach to the language education of minority students. The Cheche Komen (search for knowledge) model used a collaborative inquiry approach to science in which students posed their own questions, planned and implemented research, collected and analyzed data,
built and revised theories, drew conclusions and made decisions. The main purpose of using the model was to develop student’s way of thinking, talking and acting.

Wolf (1993) compared two instructional approaches to the same Geography lesson. The result concluded that the Inquiry Approach provided more opportunities for students to apply intellectual skills than expository instruction.

Maor (1994) in his study focused on student’s development of inquiry skills in a computerized learning environment and stated that Inquiry Approach is found to be effective in developing the inquiry skills.

Green wood (1995) reported the Science Education Program and Leadership (SEPAL): project, a model science program for elementary teachers and students, designed to improve the teaching of science at the K-8 level. The program was founded on experimental learning for teachers and it promoted an inquiry-oriented approach, which was proved to be an effective method for science teaching.

King (1995) presented an Inquiry-based Approach to promote critical thinking in psychology which helping the students to ask thoughtful questions and the result proved that questioning techniques enhance critical thinking of the students. Later Demastes (1995) also reported that the Inquiry Approach proved to be effective in imparting science education.

Dr. Richard Facione defines critical thinking as, “We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological or contextual considerations upon which that judgment is based. Critical Thinking is essential as a tool of inquiry”.
Effective ways of teaching critical thinking is extremely important. By teaching critical thinking effectively, a deliberate methodology that incorporates tangible outcomes can be employed. Friedel, Irani, Rudd, Gallo, Eckhardt and Ricketts (2008) studied the outcomes of students that were taught critical thinking skills overtly. This study demonstrated that, those students that were taught critical thinking overtly demonstrated significantly higher levels of critical thinking.

Mazer, Hunt, and Kuznekoff (2007) conducted a study in a basic communication course that demonstrated critical thinking fostered through student interaction. This study concluded that an effective strategy was for the instructor to teach critical thinking strategies and then let the students engage in interactive learning approaches that enabled the students to become a part of their own education.

Schamber and Mahoney (2006) conducted a similar study in which students were taught to cultivate critical thinking skills through collaborative groups. They also found that group work enhanced critical thinking skills and provided opportunities for students to assess their thought processes and ideas.

Yang (2007) conducted a study to determine whether critical thinking skills could be cultivated in large classrooms? He found that critical thinking skills can also be taught in large classrooms. Also, well-developed Socratic dialogues have been demonstrated as a tool that promotes critical thinking skills. Yang, Newby and Bill (2005) also found a similar growth in critical thinking skill through the use of Socratic questioning in instruction.

Astleitner (2002) conducted a study to determine the effectiveness of teaching critical thinking skills online. He found that there was no difference in critical thinking outcomes from either a traditional or online instruction.

Ernst and Monroe (2006) in their study prove that critical thinking skills can be inculcated through the use of proper environment. Stedman and Andenoro
(2007) also found that by engaging students through critical thinking focused exercises helps develop critical thinking dispositions.

Facione (1988) noted that effective critical thinking instruction motivates as well as incorporates critical thinking skills and dispositions.

**Teaching Critical Thinking**

When it comes to teaching critical thinking, we need to examine the abilities of teachers and how well they understand critical thinking. Teachers should understand what critical thinking is and how they can best teach it. Also, they need to be able to recognize critical thinking, especially since the ultimate goal of teaching critical thinking should be in seeing it applied or infused within student outcomes.

Genc (2008) conducted a study looking at critical thinking dispositions between male and female teacher candidates and found that females demonstrated a higher aptitude toward critical thinking, while their male counterparts demonstrated a greater capability toward analytical thinking.

Solon (2007) in his study applied critical thinking to an introductory Psychology course. He found that there was no statistical difference in the psychology tests but there was an increase in the critical thinking test scores that were taken by the students.

Sungar and Tekkaya (2006) also conducted research on problem-based learning and its application to critical thinking. They found that students were able to perform at high order thinking levels, were more collaborative in learning and that their critical thinking skills benefitted from the problem-based learning approach.

**Summary of Critical Thinking Research**

Critical thinking is a widely-used term with a very ambiguous meaning. However, some researchers have thoroughly studied critical thinking and developed some useable definitions. While it would be too laborious to discuss
the various definitions, one researcher, Peter Facione (2010), developed a set of cognitive skills that can be applied to teaching, utilizing and assessing critical thinking skills. These cognitive skills are interpretation, analysis, evaluation, inference, explanation and self-regulation. Based on these cognitive skills, reviews may focus on effective teaching of critical thinking, domain-specific application of critical thinking and applying critical thinking to intelligence analysis. Overall, teaching critical thinking in a deliberate and structured manner has produced tremendous results in the critical thinking abilities of students. However, teaching critical thinking in a domain-specific manner has a greater impact on student’s ability to apply critical thinking skills (McKown, 1997). Lastly, critical thinking taught using problem-solving, hands-on exercises or asynchronous group projects typically produces the best critical thinkers.

Bodi (1998) claims that information literacy instruction in higher education can be used to encourage and reinforce critical thinking skills.

**The Research Gap**

There is a significant awareness among the educationists to adopt inquiry method of teaching in order to increase student’s active participation in the classroom situation, to promote their creative thinking as a result to enable them to master the content effectively. Many studies show that inquiry method in superior than traditional method in developing or improving students questioning ability, inquiry habit, science process skills, verbal creativity and achievement.

Some studies proved that student-teachers are found to be having positive attitude towards model of teaching and were willing to implement the models. Some of the studies had tried to find out the theoretical understanding, attitudes and willingness of student-teachers towards inquiry training models.

Some of the other studies were conducted to test the teachers’ competence of student-teachers after giving them training in ITM using microteaching
approach. Some study tries to find out the effectiveness of three training strategies in advance organizer model. Some studied on the post-test effects of training strategies, which had variation in feedback procedures.

The main purpose of science education is to develop certain abilities like inquiries, questioning, creativity and achievement in the learners. These aims cannot be fulfilled if science teaching is restricted only to the transmission of facts and concepts. So, it is very important that science education should primarily be concerned with the education of mind rather than acquisition of knowledge. The National Curriculum Framework (NCF 2005) also recommended that curriculum should help learners to become constructors of knowledge and emphasizes “active role of teachers in relation to the process of knowledge construction”.

Nowadays, more emphasis is given on those education which promotes or teaches children to think critically and independently (Sternberg & Baron 1985)

Joyce et. al (1999) had suggested that the Inquiry Training Model is a prominent model for developing of inquiry mind as well as for teaching of concepts in science at secondary school level.

2.4 Emergence of the Problem

The researcher goes through various literature reviews, surveys, journals, etc. on models of teaching and the researcher found that so many works have been done on different models of teaching and the researcher also observed that maximum numbers of research works are done on comparison between different models. Many of them compare one model or two models with traditional/ conventional method. Very few works have been done on any single modular studies of the effectiveness of any one model. So the researcher decided to work on a single model and find out its effectiveness in
respect /or to raise creative inquiry, scientific thinking and scholastic achievement in Life Science.

Most of the studies made comparison between the ITM and another models such as CAM or AOM, which show the effectiveness of ITM over traditional method. But rarely any work is done on the study which shows the effectiveness of ITM in developing creative thinking, scientific thinking style and achievement in Life Science among the children and on the basis of these study the investigator try to investigate some questions.

2.5 Research Questions

From the above discussions, the researcher has identified the following research questions for the present study:

1. Are the Student-teachers of the Teacher Education programme ready with positive Attitude and Willingness to implement the ITM?

2. Is there any effect of Thinking Style of students of different Sex, Locality and Medium of instruction on teaching through ITM for developing Creative Inquiry, Scientific Thinking and Scholastic Achievement in Life Science?

3. Is there any relationship between the readiness of student-teachers and impact of their classroom teaching through ITM on Creative Inquiry, Scientific Thinking and Scholastic Achievement in Life Science?

2.6 Objectives

On the basis of above three research questions following objectives were identified:

1. To orient the students-teachers with ITM based teaching in Life science and to find out their theoretical knowledge, attitude towards the ITM and Willingness to implement the model of teaching;
2. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education of the secondary students on the criterion of Creative Inquiry.

3. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education on the criterion of Scientific Thinking.

4. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education on the criterion of Scholastic Achievement.

5. To study the relationship between the readiness of student-teachers and impact of their classroom teaching through ITM on Creative Inquiry, Scientific thinking and Scholastic Achievement.

2.7 Hypotheses

\[ H_1 \]: There is no significant mean difference between the gains in pre-test and post-test scores on attitude towards the ITM through the orientation of male and female student-teachers.

\[ H_2 \]: There is no significant mean difference between the gains in pre-test and post-test scores on willingness to implement ITM through the orientation of male and female student-teachers.

\[ H_3 \]: There is no significant mean difference between the gains in pre-test and post-test scores on theoretical knowledge of the ITM through the orientation of student-teachers.

\[ H_4 \]: There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Creative Inquiry.

\[ H_5 \]: There is no impact of ITM of Teaching between the Urban and Rural students on the criterion of Creative Inquiry.
$H_0$: There is no impact of ITM of Teaching between the students of Bengali and English Medium schools on the criterion of Creative Inquiry.

$H_7$: There is no impact of ITM of Teaching between the students of WBBSE and Other (CBSE & ICSE) Boards on the criterion of Creative Inquiry.

$H_8$: There is no impact of ITM of Teaching between Boy and Girl students on the criteria of Thinking Style.

$H_9$: There is no impact of ITM of Teaching between Urban and Rural students on the criteria of Thinking Style.

$H_{10}$: There is no impact of ITM of Teaching between the students of Bengali and English Medium schools on the criterion of Thinking Style.

$H_{11}$: There is no impact of ITM of Teaching between the students of WBBSE and Other Boards on the criterion of Thinking Style.

$H_{12}$: There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Scholastic Achievement.

$H_{13}$: There is no impact of ITM of Teaching between Urban and Rural students on the criterion of Scholastic Achievement.

$H_{14}$: There is no impact of ITM of Teaching between the students of Bengali and English Medium schools on the criterion of Scholastic Achievement.

$H_{15}$: There is no impact of ITM of Teaching among the students of WBBSE and Others (CBSE & ICSE) Boards on the criterion of Scholastic Achievement.
2.8 Delimitations of the Study

The limitations of the study are those characteristics of design that may have impact or influence the interpretation of the findings in the ongoing research. They are the constraints on generalizability, applications to practice, and/or utility of findings keeping all these in the mind, the researcher initially designs in such a way that the study and/or the method used to establish internal and external validity. Those are mainly:

1. The investigator chooses a simple method of quasi-experimental design to study the effects of training strategies.

2. The adapted English and Bengali translations of the tools are used to assess the student-teacher response to the training imparted.

3. The investigation is confined to student-teachers and students only. The implementation of ITM during practice teaching by student-teachers after undergoing training on ITM was not included in the preview of the study.

4. The investigator cannot control other variables except the categorical variables (age, sex and locality) viz; Intellectual level, social-economic factor, aspiration level etc. which may also affect the trait to some extent, though those were equally distributed according to the study design.

5. Chance of differences between samples may also disturb the result.

6. Practice effect of the group on measuring tool can also affect the result.

7. Intervening variables which are out of the preview of the present form quasi-experiment may also affect the independent variables. Thus, a margin of error is always possible to occur.
2.9 Operational Definition of Terms

1. **Effectiveness:** The degrees to which objectives are achieved and the extent to which targeted problems are solved. In contrast to efficiency, effectiveness is determined without reference to costs and, whereas efficiency means ‘doing the thing right’, ‘effectiveness means ‘doing the right thing’.

2. **Inquiry Training Model:** This model is designed by Richard Suchman to teach students to engage in casual reasoning and to become more fluent and precise in asking questions, building concepts and hypotheses and testing them.

3. **Life Science:** Any of several branches of science as microbiology, zoology, botany or ecology that deals with living organisms and their organization, life processes and relationships to each other and their environment.

4. **Creative Inquiry:** The Creative Inquiry, Interdisciplinary Arts program creates a space for students to use their art as a tool of inquiry- personal, political, spiritual, etc. Inquiry takes us to the heart of our own wildness and wilderness.

5. **Scientific Thinking:** Scientific thinking is that mode of thinking- about any Scientific subject, content or problem- in which the thinker improves the quality of his /her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them.

6. **Scholastic Achievement:** Scholastic Achievement is the achievement related with the cognitive domain of the learners, viz.: knowledge, understanding, application, analysis, synthesis and evaluation.
References


Buch, M.B., (Ed.) 1979- Fourth Survey of Research in Education, New Delhi, NCERT.


Yang, Y. C. (2007). “A catalyst for teaching critical thinking in a large university class in Taiwan: asynchronous online discussions with the facilitation of teaching assistants”. Education Technology Research and Development. 56, 241-264.

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CHAPTER 3

METHODS AND PROCEDURE

3.1 Introduction

3.2 Methodology of the study

3.2.1 Design of the Study

3.2.2 Sample

3.2.3 Variables

3.2.4 Tools

3.2.4.1 Teaching-Learning Tool

3.2.4.2 Measuring Tools

3.2.5 The Study Design

3.3 Procedure

3.3.1 Experimentation

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References
CHAPTER 3

METHODS AND PROCEDURE

3.1 Introduction
Research is a systematic attempt to obtain answers to meaningful questions about phenomena or events through the application of scientific procedures. It is an objective, impartial, empirical and logical analysis and recording of controlled observations that may lead to the development of generalizations, principles or theories, resulting to some extent in prediction and control of events that may be consequences or causes of specific phenomenon. Research is scientific and as much, is not satisfied with isolated facts, both seek to integrate and systematize its findings. It is concerned with the objective verification which requires the logical analysis of problems and devising of appropriate methodologies for obtaining evidence.

Research methods have out most importance in a research process. They describe the various steps of the plan to be adapted in solving a research problem, such as the manner in which the problems are formulated, the terms are defined, the choice of sample for investigation; the validation of data and its analysis and interpretation along with the processes of inference and generalization.

3.2 Methods of the Study
3.2.1: Design of the Study
The present study comprises Quasi-experimental type of research. The investigator assumed that student-teachers have general theoretical knowledge to models of teaching. The study was quasi-experimental to the extent that an attempt was to make to manipulate the response of student-teachers by providing training. An attempt was also made to establish a logical association between training strategies and observed respondent effects.

3.2.2: The Sample
Two types of Sampling Units were studied-
A. Student-Teachers B. Students
A. **Sampling of Student-Teachers**

Student-teachers of West Bengal are taken as the populations of the present study. Out of 20 districts, one district has been selected at random as the location of the study. Hence, out of the 200 student-teachers of ten Teacher Education Institutes are selected at random and 20 student-teachers are selected at random from each of the Teacher Education Institutes.

All student-teachers were subjected to assess Theory Check-up on ITM, Attitude towards ITM and Willingness to Implement the ITM.

**Student-Teachers**

Distribution of student-teachers as sample according to sex and locality.

Table: 3.1: Distribution of Student-teacher sample according to Sex and Locality (N=200)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>CATEGORY</th>
<th>SAMPLE SIZE(200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GENDER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MALE</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>FEMALE</td>
<td>96</td>
</tr>
<tr>
<td>2</td>
<td>LOCALITY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>URBAN</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>RURAL</td>
<td>99</td>
</tr>
</tbody>
</table>
B. Sampling of Students:
A total of 600 students of class IX were selected at random from the 12 schools selected under four categories, namely, Urban, Rural and Bengali medium and English medium respectively for the selected north 24 Parganas District.

Tables: 3.2: Distribution of Student Sample (N=600)

<table>
<thead>
<tr>
<th>GENDER</th>
<th>LOCALITY</th>
<th>MEDIUM OF INSTRUCTION</th>
<th>BOARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL</td>
</tr>
<tr>
<td>BOYS</td>
<td>URBAN</td>
<td>BENGALI</td>
<td>WBBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>196</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td></td>
<td>123</td>
<td>CBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ENGLISH</td>
<td>ICSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>73</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>RURAL</td>
<td>BENGALI</td>
<td>WBBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>179</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td></td>
<td>149</td>
<td>CBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ENGLISH</td>
<td>ICSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>GIRLS</td>
<td>URBAN</td>
<td>BENGALI</td>
<td>WBBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>132</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97</td>
<td>CBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ENGLISH</td>
<td>ICSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>RURAL</td>
<td>BENGALI</td>
<td>WBBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td></td>
<td>71</td>
<td>CBSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ENGLISH</td>
<td>ICSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
<td>7</td>
</tr>
</tbody>
</table>

3.2.3: Variables:

The researcher used two major variables for her study, such as-

A. Independent variables and
B. Dependent variables
Table 3.3: Distribution of Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Independent Variables</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categorical Variables</td>
<td>Treatment Variables</td>
<td></td>
</tr>
<tr>
<td>1. Gender</td>
<td>ITM</td>
<td>1. Creative Inquiry</td>
</tr>
<tr>
<td>2. Locality</td>
<td></td>
<td>2. Thinking Style</td>
</tr>
<tr>
<td>3. Medium of Instruction</td>
<td></td>
<td>3. Scholastic Achievement</td>
</tr>
<tr>
<td>4. Types of Boards</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A: Independent variables-
According to the construct of the study, the researcher divided the Independent variables in two forms-

(i)  *Categorical variables-*

The variables chosen under the Categorical Variables for the study were-

a. Gender of the student (Boys and Girls)

b. Locality of the student (Urban and Rural)

c. Medium of Instruction (Bengali and English)

d. Types of schools (Bengali and English medium-CBSE and ICSE)

(ii)  *Treatment Variables-*

The researcher prepared a detailed learning material about ITM of teaching, which explained the Focus, Syntax, Social System Support System and Institutional output phases of the ITM. The researcher explained all the phases of ITM in detail and after that researcher asked the student-teachers to form various groups and to prepare seven lesson plans following the syntax of the ITM on the topic ‘Respiration’ of class IX.

After preparing one complete lesson plan (for each group) the researcher asked them for group activity which was followed by a group discussion. The researcher asked each group to present their lesson and the other groups
reacted on it. Thus, the lesson plans in both the Bengali and English languages are prepared according to the following phases (Annexure- )

Table 3.4: Syntax of the ITM

<table>
<thead>
<tr>
<th>Phase-I</th>
<th>Confrontation with the Problem</th>
<th>Explain inquiry procedures. Present discrepant event.</th>
</tr>
</thead>
</table>
| Phase-II | Data Gathering-Verification | • Verify the nature of objects and conditions.  
          |                                 | • Verify the occurrence of the problem situation. |
| Phase-III | DataGathering-Experimentation | • Isolate relevant variables.  
                             |                                 | • Hypothesize (and test) causal relationships. |
| Phase-IV | Organizing, Formulating an Explanation | • Formulate rules or explanations. |
| Phase-V | Analysis of the Inquiry Process | • Analyze inquiry strategy and develop more effective ones. |

3.2.4: Tools:
The researcher used two major tools for her study, such as-
I. Teaching-Learning Tool and
II. Measuring Tools

3.2.4.1: Teaching-Learning Tool:

Lesson Plan according to ITM

Educational Unit: Respiration
Subject: Life Science
Class: IX
Duration: 45 minute
Standard competence: Understanding the term of Respiration.
Base Competence: Defining respiration, types of respiration, respiration in
Animals and Plants.

**Indicators:**

**Instructional Goal** is that Students can:

1. Define the term respiration
2. They know about the types of respiration: - aerobic and anaerobic respiration
3. Know about the respiration in different animals:
4. Respiration in Plants

**Instructional lessons:**
Meaning of respiration, aerobic and anaerobic respiration, Respiration in animals i.e. Earthworm, Leech, Cockroach, Bird, Fish, Man and Respiration in Plants.

**Duration:** 7 days X 45 min.

**Instructional Method:**

1. **Model:** Inquiry Model

2. **Method:** Lecture, Discussion, Assignment, Group Work and Question-Answer

**Instructional Steps:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Instructional Steps:</th>
<th>Time</th>
<th>Method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Apperception</td>
<td>5 min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teacher asks if students know the meaning of Respiration</td>
<td></td>
<td>Lecture</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Core Activity</td>
<td>35min.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Students are divided in five groups.
2. Each group is given sheet containing examples of animals and plants.
3. Each group identifies some examples.
4. Each group categorizes the examples into category of aerobic and anaerobic respiration.
5. From the categorizing, each group concludes definition for respiration and its type.

<table>
<thead>
<tr>
<th>C</th>
<th>Closing</th>
<th>5min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students orally respond teacher’s question.</td>
<td>Question-Answer Method / Giving Assignment/Discussion Method</td>
<td>Specimen (living &amp; non-living)/Charts/Microscope/Hand lens/Audio-visual Aids</td>
</tr>
<tr>
<td>2. The teacher gives motivation to students to learn next materials.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The teacher gives an individual task.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2.4.2.1: Three measuring tools were adapted for the student-teachers in the study were:

3.2.4.2.1.1: Theory check up for the student-teachers regarding understanding of ITM. (Annexure- IV)

3.2.4.2.1.2: Attitude scale for the student-teachers towards ITM. (Annexure- V)

3.2.4.2.1.3: Willingness scale for the student-teachers towards ITM. (Annexure- VI)

3.2.4.2.2: The Three tools used for the students in the study were:

3.1.4.2.2.1: Creative Inquiry Scale for students. (Annexure- VII)

3.1.4.2.2.2: Style of Learning and Thinking Scale for students. (Annexure-VIII)

3.1.4.2.2.3: Scholastic Achievement Test for students. (Annexure-IX)

3.2.4.2.1.1: *Theory check-up for the Inquiry Training Model (Bruce Joyce):*

It was developed following Bruce Joyce (1990) and his associates to assess the theoretical knowledge and understanding of the Inquiry Training Model and its phases. It consisted of ten multiple choice items. The researcher used six multiple choice items for her study given in the Annexure –IV.

3.2.4.2.1.2: *Attitude scale on the Inquiry Training Model:*

Passi and Sansanwal (1985) developed the tool to assess the attitude of the subjects towards the Inquiry Training Model and its phases. It had two parts- Part A had 16 statements to be rated on a five-point scale ranging from Strongly Agree (SA) to Strongly Disagree (SD) and Part-B had four open-ended questions related to the practice of the Inquiry Training Model to get free and frank responses of the subjects. The researcher used 16 statements for her study, given in Annexure-V.
3.2.4.2.1.3: Willingness Scale for Implementation of the ITM:

This scale was designed to assess the subjects’ willingness to implement the Inquiry Training Model. For this purpose 23 statements were to be rated on a five-point scale—Strongly Agree (SA) to Strongly Disagree (SD). After giving the opinion, the subjects were required to write at least two reasons for their opinion. The willingness scale consisted of 23 statements on which opinions and reasons were to be given. The researcher used 18 statements for her study. (Annexure- VI)

3.2.4.2.2.1: Creative Inquiry Scale for Students:

The researcher prepared the creative inquiry test herself. For that the researcher went through different tests and scales which are related to creative inquiry in Life Science.

While going through different literatures (Menvin, 1970; Gross, 1972; Wiley, 1977; Schlenker, 1970) the researcher found that the creative inquiry was basically same as scientific thinking. On the basis of that the researcher prepared a blueprint of that test on the basis of educational objectives.

The researcher went through the various topics from WBBSE, CBSE and ICSE Board and prepared a puzzle chart on the basis of various topics of the Biology Text books.

The researcher prepared the puzzle chart and took the opinions of six experts in Life Science/Biological Sciences and then modified the test on the basis of their suggestions.

The researcher, after modifying her test, applied it on a group of 200 students for pilot study. It revealed that Test-Retest reliability was 0.78. The format of puzzle is given in Annexure-VII.

3.2.4.2.2.2: Style of Learning and Thinking (SOLAT) Test

Following the concepts of Venkataraman (1994) on style of Learning and Thinking the SOLAT was adapted.

The right and left hemisphere preferences for information processing for the concepts selected were identified as indicated in the literature available and in
the studies by others in the area and these preferences accepted as applicable for the study is listed in the figure 3.4 given below:

Figure 3.1: Whole Brain Thinking Model

Source: Herrmann International 1986-2010

Description of SOLAT

The initial version of style of learning and thinking (SOLAT) tool was intended for school children from eighth standard and up to college students, and consisted of 100 items based upon accumulated research findings concerning the specialized functions of the left and right hemispheres. Each item provided the respondent with three choices - one representing a specialized function of the left cerebral hemisphere, the second representing a parallel specialized function of the right hemisphere and the third is checking of both the items representing the integration of right and left hemisphere functions. The researcher asked the students to indicate which of the three specific styles of thinking and/or learning best described about their own typical behavior.
Construction of style of learning and thinking:

For the construction of SOLAT tool, D.Venkataraman (1994) had gone through the literature dealing with hemispheric functions connected with education. After reviewing the related literature and consulting medical books, psychology books and journals, the functions of right hemisphere and left hemisphere were listed. After listing the hemispheric functions, characteristic and activities of creative students, the items were prepared based on these lists. The hemisphere functioning in two different areas such as learning style and thinking style was considered for identification of opinions, consisting of twenty professors and ten doctors who were working in the field of psychology.

Some items were modified and finally 50 items in Learning Style and Thinking Style were retained. It was then administered to the students of private and government schools to two hundred higher secondary students. The main purpose of this pilot study was to ensure comprehensibility elucidated and difficult sentence were altered and modified into easy language of understanding and thus the tool was finalized.

Reliability of the tool:

The reliability of the tool was measured by test-retest method. One month after the first test, retest was conducted to 300 students of which 150 boys and 150 girls. The reliability coefficient of correlation for the right hemisphere function was found to be .89. For the left hemisphere function the coefficient of correlation was found to be .65. The coefficient of correlation for the integrated score was .71. These coefficients suggest that the SOLAT possesses reliability to a significant level.

Validity:

(i) Content Validity Evidence

A compilation of findings was made from an extensive survey of literature on specialized cerebral functions of the hemisphere (Venkataraman 1989). The items were constructed by attempting to translate research findings on hemisphericity into a multiple choice format, without representing particularly right hemisphere functioning or left hemisphere functioning.
The original inventory consisted of 62 items, and out of them 12 items were deleted on the basis of pilot study and opinion from the experts. The items were finally selected for inclusion based on the sustained experts.

(ii) **Construct Validity Evidence**

The initial construct validity study was conducted by the researcher. The SOLAT as tested with 50 students from a variety of academic disciplines. As part of the course, each student took several tests of creativity which provided to construct validity evidence. Creative problem solving and creative thinking call for both left and right-hemisphere functions. Considerable evidence suggests that the essence of creative behavior calls for right-hemisphere functions and judgment, evaluation and elaboration require left-hemisphere functions.

(iii) **Concurrent Validity**

The SOLAT tool was constructed and validated with the help of standardized SOLAT tool constructed by Paul Torrance. To find out the validity of the tool, both the SOLAT tools, (i.e. Tool prepared by Paul Torrance and tool adapted by the researcher) were administered to 300 subjects. The correlation between the two tests scores was .842 for the right hemisphere part; .621 for the left hemisphere part and .678 for the integrated part. The correlation coefficients reveal that the SOLAT tool possesses reasonable level of concurrent validity. The researcher used the same SOLAT test for her study (Annexure-VIII).

**3.2.4.2.2.3: Scholastic Achievement Test for Students:**

The researcher developed the test items on the basis of behavioral objectives of the learning, topic ‘Respiration’ of class IX. The test consisted of 25 (twenty five) items of 25 marks. The items are multiple choice types. Each correct answer carries one mark. The reliability and validity of the test applied on a sample of 500 students were found 0.82 and 0.81 respectively. For this referred to Annexure-IX.
3.2.5: The Study Design

The comprehensive Study design is given below:

**Table: 3.5** The Schematic Study Design

<table>
<thead>
<tr>
<th>Sample</th>
<th>Categorical Variables</th>
<th>Treatment Variables</th>
<th>Dependent Variables</th>
<th>Qualitative Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-teachers</td>
<td>1. Gender</td>
<td>Orientation</td>
<td>1. Knowledge of ITM</td>
<td>RELATION</td>
</tr>
<tr>
<td></td>
<td>2. Locality</td>
<td>with ITM</td>
<td>2. Attitude towards ITM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Willingness to implement ITM</td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>1. Gender</td>
<td>Teaching-learning</td>
<td>1. Creative Inquiry</td>
<td>CONNECTION</td>
</tr>
<tr>
<td></td>
<td>2. Locality</td>
<td>with ITM</td>
<td>2. SOLAT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Medium of Instruction</td>
<td></td>
<td>3. Scholastic Achievement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Types of Boards</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Observation:
After completion of the orientation programme of student-teachers of different gender and locality in various phases of ITM, it was observed that the student-teachers gain the complete knowledge of ITM, which was checked by using Theory Check-up Scale and in order to find out their attitude towards ITM, Attitude towards ITM Scale was used and in order to know their willingness towards ITM Willingness towards ITM Scale was used.

It was well known that a trained teacher can utilize his/her maximum efforts in classroom teaching by using various teaching-learning techniques, for make their teaching more effective.

The researcher observed that, those teachers who were oriented with ITM can able to develop the inquiry mind of the students/learners better than others. They know/learn the techniques how to arouse curiosity among students/learners by asking different types of questions. The teachers who were oriented in ITM can easily bring out the thinking capacities/ abilities of the students/learners and also utilize them in developing Inquiry habits.

It is found that the student-teachers who are well oriented with ITM, they can develop better teaching-learning environment according to the ITM of teaching, viz.; Confrontation with the problem, Data gathering-verification, Data gathering- Experimentation, Organizing, formulating and explanations and Analysis of the inquiry process.

The better orientation to the ITM may help the students to develop their Creative Inquiry, Scientific thinking and Scholastic achievement on the topic of learning.

3.3: Procedure
According to the Study Design the following procedure was followed for data collection:
**Flow Diagram of the Procedural Steps**

Step – I: Student-Teachers  
(N=200)  
↓  
Orientation with ITM  
↓  
Administration of Theory Check-up, Attitude towards ITM and Willingness to implement ITM Tools  
↓  
Step – II: Students  
(N=600)  
↓  
Experimentation  
↓  
Administration of (i) Creative Inquiry, (ii) Style of Learning & Thinking Test, (iii) Scholastic Achievement Test  
↓  
Data Collection & Tabulation

**3.3.1: Experimentation:**
The experiment was conducted in three phases:  
(i) Pre-testing; (ii) Experimental treatment; and (iii) Post-testing.

**Phase I: Pre-Testing**
In the pre-test stage, achievement test was administered to the students to assess the entry level of the students.

**Phase II: Experimental Treatment**
Inquiry training model by Suchman (1962) was followed to provide instruction to all the students. Seven Lesson Plans based on the five phases of Inquiry Training Model was prepared on the unit ‘Respiration’ of class IX. All the students were taught by the investigator to avoid teacher variance. Same topic was taught to the entire sample for seven days.
Phase III: Post-Test
After completion of the instructional treatment through ITM, Creative Inquiry, SOLAT and Scholastic Tests were administered as post-test to students.

3.3.2: Data Collection:
The researcher collected all data after the administration of the three tests namely (i) Creative Inquiry, (ii) SOLAT and (iii) Scholastic Achievement. Data were cleaned and tabulated for further analysis.

References


CHAPTER 4

ANALYSIS OF DATA

4.1 Descriptive Statistics

4.2 Inferential Statistics

4.3 Hypothesis Testing

4.4 The Mixed Approach
CHAPTER 4

ANALYSIS OF DATA

This chapter deals with statistical analysis of data. It consists of two parts-

(i) Descriptive statistics and
(ii) Inferential statistics.

It is a brief descriptive statistical coefficients that summarize the given data set, which can be either a representation of the entire population or a sample of it. Descriptive statistics deals with central tendency and speed of the frequency distribution. Measures of central tendency include the mean, median, mode and measure of variability, the standard deviation.

Descriptive statistics, in short, help to describe and understand the general features of a specific data set, by giving short summaries about the sample and measures of the data. The most recognized types of descriptive statistics are the mean and standard deviation which are used at almost all levels of statistical analysis.

Inferential statistics makes inference about populations using data drawn from the population. Instead of using the entire population to gather the data, generally, the researcher collect a sample or samples from the population of the study and make inferences about the entire population using the sample.

4.1 Descriptive Statistics

Descriptive statistics is the term given to the analysis of data that helps to describe, show or summarize data in a meaningful way such that, for example, patterns might emerge from the data. Descriptive statistics do not, however, allow us to make conclusions beyond the data we have analyzed or reach conclusions regarding any hypotheses we might have made. They are simply a way to describe our data.
Descriptive statistics are very important because if we simply present our raw data it would be hard to visualize what the data are showing, especially if there is a lot of it. Descriptive statistics, therefore, enables us to present the data in a more meaningful way, which allows simpler interpretation of the data. For example, if we had the results of 100 coursework of students, coursework, we may be interested in the overall performance of those students. We would also be interested in the distribution or spread of the marks. Descriptive statistics allow us to do this. How to properly describe data through statistics and graphs is an important aspect. Typically, there are two general types of statistics that are used to describe data- Mean and Standard Deviation.

**Mean:**
The statistical mean refers to the mean or average that is used to derive the central tendency of the data in question. It is determined by adding all the data points in a population and then dividing the total by the number of points. The resulting number is known as the mean or the average.

Statistical mean is the most common terms for calculating the mean of a statistical distribution. It has a wide range of applicability in various types of experimentation. 

This type of calculation eliminates random errors and helps to derive a more accurate result than a result described from a single experiment.

The statistical mean is popular because it includes every item in the data set and it can easily be used with other statistical measure. Statistical mean gives important information about a data set and provides insight into the experiment and nature of the data.

**Standard Deviation:**
In statistics, the standard deviation (SD, also represented by the Greek letter sigma ‘σ’ or the Latin letter s) is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean (also called the
expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.

Standard deviation is the measure of dispersion of a set of data from its mean. It measures the absolute variability of a distribution; the higher the dispersion or variability, the greater is the standard deviation and greater will be the magnitude of the deviation of the value from their mean.

The standard deviation of a random variable, statistical population, data set, or probability distribution is the square root of its variance. A useful property of the standard deviation is that, unlike the variance, it is expressed in the same units as the data. It may be worth noting in passing that the mean error is mathematically distinct from the standard deviation.
Table 4.1: Distribution of N, M and SD on the basis of Gender, Locality Medium of Instruction and Board

<table>
<thead>
<tr>
<th>GENDER</th>
<th>BOYS</th>
<th></th>
<th>GIRLS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>375</td>
<td>20.37</td>
<td>2</td>
<td>225</td>
<td>20.57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCALITY</th>
<th>URBAN</th>
<th>RURAL</th>
<th>LOCALITY</th>
<th>URBAN</th>
<th>RURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>196</td>
<td>20.78</td>
<td>1.93</td>
<td>179</td>
<td>19.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEDIUM OF INSTRUCTION</th>
<th>BENGALI</th>
<th>ENGLISH</th>
<th>BENGALI</th>
<th>ENGLISH</th>
<th>BENGALI</th>
<th>ENGLISH</th>
<th>BENGALI</th>
<th>ENGLISH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>123</td>
<td>21.09</td>
<td>2.11</td>
<td>73</td>
<td>20.58</td>
<td>1.77</td>
<td>149</td>
<td>19.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WBBSE BOARD</th>
<th>URBAN</th>
<th>RURAL</th>
<th>OTHER BOARD</th>
<th>URBAN</th>
<th>RURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>220</td>
<td>20.79</td>
<td>2.26</td>
<td>220</td>
<td>19.59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CBSE</th>
<th>ICSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>15</td>
<td>18.8</td>
</tr>
<tr>
<td>7</td>
<td>21.2</td>
</tr>
</tbody>
</table>
4.2 Inferential Statistics:

Inferential statistics, is one of the two main branches of statistics is used in a random or correlated sample of data drawn from a population to describe and make inferences about the population or we can say that the inferential statistics predicts and infers about a much larger data or population.

Inferential statistics makes inferences about populations using data drawn from the population. Instead of using the entire population to gather the data, the statistician collects a sample or samples from the millions of residents and makes inferences about the entire population using the sample.

Inferential statistics provide ways of testing the reliability of the findings of a study and ‘inferring’ characteristics from a small group of participants or people (as for example, the present sample) onto much larger groups of people (the population). Descriptive statistics just describe the data, but inferential let us say what the data mean.

*Hypothesis wise Inferential Statistics of the Study.*

$H_0$: There is no significant mean difference between the gains in pre-test and post-test scores on attitude towards the ITM through the orientation of male and female student-teachers.

Table 4.2: t-value between gains in pre-test and post-test scores on attitude on the orientation with the ITM of male and female student-teachers

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>t'-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>104</td>
<td>35.5</td>
<td>3.31</td>
<td>2.00</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
<td>34.5</td>
<td>3.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here, t-value is less than the table value at 0.05 level of significance for df 198. It is found that there is significant difference between the gains in pre-test
and post-test scores on attitude on the orientation with the ITM of male and female student-teachers. So, the null hypothesis $H_0$ is rejected. Hence, it may be interpreted that there is a difference in gains in Attitude towards ITM between the male and female student teachers.

*Item wise analysis of Attitude towards ITM Scale:*

The null hypothesis being true and since there was no difference in preference, the expected frequency $[f_e]$ under each category would be the same. Under the assumption of equal probability each category of item has the equal chances. The observed frequencies $[f_o]$ and the expected frequencies $[f_e]$ are tabulated in the following table and the calculated value of $X^2$ with its level of significance is shown in the Table 4.3 below:

Table: 4.3: Item wise Chi-square Analysis of Attitude towards ITM Scale

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Statements</th>
<th>Responses</th>
<th>Chi-Square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F  N  U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>It provides opportunity to think independently.</td>
<td>58  3  5</td>
<td>88.43</td>
<td>$P &lt; 0.01$</td>
</tr>
<tr>
<td>2</td>
<td>I get frustrated when my hypothesis gets rejected.</td>
<td>28  18  20</td>
<td>2.53</td>
<td>$P &lt; 0.05$</td>
</tr>
<tr>
<td>3</td>
<td>It helps in developing independent study habit.</td>
<td>60  4  2</td>
<td>98.53</td>
<td>$P &lt; 0.01$</td>
</tr>
<tr>
<td>4</td>
<td>I get motivated when I see others asking questions.</td>
<td>59  7  -</td>
<td>72.44</td>
<td>$P &lt; 0.01$</td>
</tr>
<tr>
<td>5</td>
<td>It does not provide freedom for thinking</td>
<td>4  10  52</td>
<td>62.16</td>
<td>$P &lt; 0.01$</td>
</tr>
<tr>
<td>6</td>
<td>Others subjects It does not provide freedom for thinking should also be taught by this method.</td>
<td>49  8  9</td>
<td>49.71</td>
<td>$P &lt; 0.01$</td>
</tr>
<tr>
<td>S. No.</td>
<td>Statements</td>
<td>Responses</td>
<td>Chi-Square</td>
<td>Significance</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------</td>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>7</td>
<td>It does not help in developing self-confidence</td>
<td>5</td>
<td>7</td>
<td>54</td>
</tr>
<tr>
<td>8</td>
<td>I remain active while teaching through this model.</td>
<td>45</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>It is not conducive to developing scientific process skill.</td>
<td>9</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>I can develop a new hypothesis on the basis of other ideas</td>
<td>49</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>I fell exhausted quickly during teaching through this model.</td>
<td>18</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>12</td>
<td>It is time consuming yet no through understanding of the subject.</td>
<td>29</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>This model is good for learning how to ask pin-pointed.</td>
<td>51</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>It does not help in developing analytical ability.</td>
<td>6</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>15</td>
<td>It is difficult to maintain discipline during teaching.</td>
<td>21</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>16</td>
<td>Without any hesitation I can ask questions.</td>
<td>58</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
For df 2, table value of Chi-square at 0.05 level is 3.18 and 0.01 level is 5.84. Since the observed ratio is greater than the table value, hence the marked divergence is found significant. Thus, it may be concluded that both the male and female student-teachers really favor the proposition. From the Table: 4.3, it is also clear that Chi-square values for all the 16 items are found differing significantly.

Hence, it may be interpreted that there is an impact of the orientation programme for developing attitude towards ITM, and that impact was equally effective for both the male and female student-teachers.

$H_2^0$: There is no significant mean difference between the gains in pre-test and post-test scores on willingness to implement the ITM through the orientation of student-teachers.

Mean differences in respect to Gender (between Male and Female) and Locality (between Urban and Rural) are analyzed through t-tests under the hypothesis $H_2^0$.

Table 4.4: t-value between the male and female student-teachers on the gains of willingness to implement the ITM scores

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number (200)</th>
<th>Mean</th>
<th>SD</th>
<th>t'-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>104</td>
<td>36.3</td>
<td>4.94</td>
<td>1.74</td>
<td>$P &gt; 0.05$</td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
<td>35.1</td>
<td>4.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of data (Table 4.4) shows that there is no significant mean difference between the gain in scores of male and female student-teachers on the criterion of willingness to implement ITM. For df 198, table value of ‘t’ at 0.05 level is 1.97. Thus, the null hypothesis $H_2^0$ is partly accepted. It may be interpreted that both the male and female student-teachers were equally effective in terms of willingness to implement the ITM.
Table 4.5: t-value between the urban and rural student-teachers on the gains of willingness to implement the ITM scores

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number (200)</th>
<th>Mean</th>
<th>SD</th>
<th>t'-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>101</td>
<td>35.4</td>
<td>5.26</td>
<td>1.19</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Rural</td>
<td>99</td>
<td>36.2</td>
<td>4.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here, there is no significant mean difference between the gains in scores of Urban and Rural student-teachers on the criterion of willingness to implement ITM. Thus, the null hypothesis $H_2$ is also partly accepted. Hence, the urban and rural student-teachers are found equally effective in terms of their willingness to implement the ITM.

In terms of t-values from Tables 4.4 and 4.5, no significant mean differences between male and female as well as between urban and rural student-teachers are found. Hence, the $H_2$ is retained.

$H_3$: There is no significant mean difference between the gains in pre-test and post-test scores on Theoretical Knowledge of the ITM through the orientation of student-teachers.

The hypothesis $H_3$ is also tested in terms of Gender and Locality through t-tests.

Table 4.6: t-value between the male and female student-teachers on the gains of theoretical knowledge of the ITM scores

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>104</td>
<td>36.3</td>
<td>4.94</td>
<td>1.74</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
<td>35.1</td>
<td>4.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of data (Table 4.6) shows that there is no significant mean difference between the gain in scores of male and female student-teachers on the criterion of theoretical knowledge of ITM. For df 198, table value of ‘t’ at 0.05 level is 1.97. Thus, the null hypothesis $H_3$ is partly accepted. It may be
interpreted that both the male and female student-teachers were equally effective in terms of theoretical knowledge of the ITM.

Table 4.7: t-value between the urban and rural student-teachers on the gains of theoretical knowledge of the ITM scores

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>101</td>
<td>35.4</td>
<td>5.26</td>
<td>1.19</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Rural</td>
<td>99</td>
<td>36.2</td>
<td>4.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of data (Table 4.7) shows that there is no significant mean difference between the gain in scores of Urban and Rural student-teachers on the criterion of willingness to implement ITM. For df 198, table value of ‗t‘ at 0.05 level is 1.97. Thus, the null hypothesis $H_3$ is also partly accepted. It may be interpreted that both the Urban and Rural student-teachers were equally effective in terms of willingness to implement the ITM.

In terms of t-values from Tables 4.6 and 4.7, no significant mean differences between male and female as well as between urban and rural student-teachers are found. Hence, the $H_3$ is retained.

According to the study design, after the orientation of the student-teachers with ITM, the researcher herself and the oriented student-teachers taught the 600 students of class IX from different schools. At the end, the impact of the ITM was studied on the basis of the hypotheses below and tested as follows:

$H_4$: There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Creative Inquiry.

Table 4.8: t-value between the boy and girl students on the criterion of Creative Inquiry

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>375</td>
<td>20.37</td>
<td>2.00</td>
<td>1.17</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Girls</td>
<td>225</td>
<td>20.57</td>
<td>2.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the above Table No. 4.8, it is found that the‘t’ value (1.17) is less than the table value of 1.96 for df 598, at 0.05 level of significance. It indicates that
there is no significant difference between the mean scores of Boys and Girls, on the criterion of creative Inquiry, as the impact of ITM. Thus, the null hypothesis $^0H_4$ is retained. Hence, the ITM is found equally effective for both the Boys and Girls students in terms of developing creative inquiry.

$^0H_5$: There is no impact of ITM of Teaching between the Urban and Rural students on the criterion of Creative Inquiry.

Table 4.9: t-value between the urban rural students on the criterion of Creative Inquiry

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>328</td>
<td>20.8</td>
<td>1.97</td>
<td>6.35</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Rural</td>
<td>272</td>
<td>19.9</td>
<td>2.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table: 4.9 shows that the t-value (6.35) is found more than the table value 2.59 at 0.01 level of significance indicates that there is a significant difference between the Urban and Rural students, in terms of the impact of ITM on the criterion of creative Inquiry. So, the null hypothesis $^0H_5$ is rejected. It is also found that Urban students are better than the Rural students in terms of creative Inquiry.

$^0H_6$: There is no impact of ITM of Teaching between the students of Bengali and English Medium schools on the criterion of Creative Inquiry.

Table 4.10: t-value between the Bengali medium and English medium schools on the criterion of Creative Inquiry

<table>
<thead>
<tr>
<th>Medium of Instruction</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali Medium</td>
<td>440</td>
<td>20.1</td>
<td>2.30</td>
<td>1.08</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>English Medium</td>
<td>160</td>
<td>20.6</td>
<td>2.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.10 shows that the ‘t’ value is less than the table value of 1.96 at 0.05 level of significance for df 598. So, the null hypothesis $^0H_6$ is retained. It is
found that there is no significant mean difference between the students of Bengali medium and English medium secondary schools due to impact of ITM in terms of creative Inquiry scores. Thus, the impact of ITM between the Bengali medium and English Medium schools on the criterion of creative Inquiry are found equal.

$H_7^0$: There is no impact of ITM of teaching between the students of WBBSE and Other (CBSE & ICSE) Boards on the criterion of Creative Inquiry.

Table 4.11: t-value between the Urban Students of West Bengal Board of Secondary Education and other Boards on the criterion of Creative Inquiry

<table>
<thead>
<tr>
<th>Board (Urban)</th>
<th>Number (328)</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>220</td>
<td>20.79</td>
<td>2.26</td>
<td>2.4</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>OTHER</td>
<td>108</td>
<td>20.55</td>
<td>1.79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.12: t-value between the Rural Students of West Bengal Board of Secondary Education and other Boards on the criterion of Creative Inquiry

<table>
<thead>
<tr>
<th>Board (Rural)</th>
<th>Number (272)</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>220</td>
<td>19.59</td>
<td>2.28</td>
<td>7.18</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>OTHER</td>
<td>52</td>
<td>20.38</td>
<td>2.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to find out the impact of ITM of Teaching among the students of WBBSE and Other (CBSE & ICSE) Boards on the criterion of Creative Inquiry, From the Table 4.11 & 4.12 it is revealed that there is a significant difference between the mean scores of creative inquiry of WBBSE and other Boards. Hence, the hypothesis $H_7^0$ is rejected. Hence, the teaching the students of different Boards through ITM has an impact of developing creative inquiry and students of WBBSE are found better on the criterion of Creative Inquiry.
\( H_0 \): There is no impact of ITM of Teaching between Boy and Girl students on the criteria of Thinking Style.

According to the nature of the scale, the non-parametric testing technique of Chi-square with equal probability assumption was used between boy and girl students for each of the three groups, namely, Low, Low-Average and High-average under Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles:

**Right Hemisphere Thinking Style:**

Table: 4.13: Chi-square Analysis between Low Group of Boys and Girl Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Low Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>((\text{Fo-Fe})^2)</th>
<th>((\text{Fo-Fe})^2/\text{Fe})</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>58</td>
<td>44</td>
<td>14</td>
<td>196</td>
<td>4.45</td>
<td>39.01</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Girls</td>
<td>5</td>
<td>44</td>
<td>39</td>
<td>1521</td>
<td>34.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.13, it may be interpreted that there exists a significant difference between Low group of Boy and Girl students on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. Low group Girls are found better on the criterion of Right Hemisphere Thinking style.

Table: 4.14: Chi-square Analysis between Low-Average Group of Boy and Girl Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Low Average Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>((\text{Fo-Fe})^2)</th>
<th>((\text{Fo-Fe})^2/\text{Fe})</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>223</td>
<td>185</td>
<td>38</td>
<td>1444</td>
<td>7.81</td>
<td>24.16</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Girls</td>
<td>130</td>
<td>185</td>
<td>55</td>
<td>3025</td>
<td>16.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.14 indicates that there exists significant difference between Low-Average group of Boy and Girl students on the criterion of Right Hemisphere
Thinking Style at 0.01 level of significance. Low-average group of Girls are found better on the criterion of Right Hemisphere Thinking Style.

Table 4.15: Chi-square Analysis between High-Average Group of Boys and Girls on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th></th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)^2 / Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>79</td>
<td>185</td>
<td>106</td>
<td>11236</td>
<td>60.73</td>
<td>119.19</td>
</tr>
<tr>
<td>Girls</td>
<td>81</td>
<td>185</td>
<td>104</td>
<td>10816</td>
<td>58.45</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.15 indicates that there exists significant difference between High-Average group of Boy and Girl students on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. Here the High-average group Boys are found better on the criterion of Right Hemisphere Thinking Style.

*Left Hemisphere Thinking Style*

Table 4.16: Chi-square Analysis between Low group of Boy and Girl students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th></th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)^2 / Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>74</td>
<td>44</td>
<td>30</td>
<td>900</td>
<td>20.25</td>
<td>24.29</td>
</tr>
<tr>
<td>Girls</td>
<td>31</td>
<td>44</td>
<td>13</td>
<td>169</td>
<td>3.84</td>
<td></td>
</tr>
</tbody>
</table>

From the Table 4.16, of Boy and Girl students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low group Boys are found better than Girls on the criterion of Left Hemisphere Thinking Style.
Table: 4.17: Chi-square Analysis between Low-Average group of Boy and Girl students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Low-Average Group</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>179</td>
<td>185</td>
<td>6</td>
<td>36</td>
<td>0.19</td>
<td>2.8</td>
</tr>
<tr>
<td>Girls</td>
<td>163</td>
<td>185</td>
<td>22</td>
<td>484</td>
<td>2.61</td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.17, it may be interpreted that there exists significant difference between Low-Average group of Boy and Girl students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low-average group of Girls are found better on the criterion of Left Hemisphere Thinking Style

Table: 4.18: Chi-square Analysis between High-Average group of Boy and Girl students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>High Average Group</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>196</td>
<td>185</td>
<td>11</td>
<td>121</td>
<td>0.65</td>
<td>90.6</td>
</tr>
<tr>
<td>Girls</td>
<td>56</td>
<td>185</td>
<td>129</td>
<td>16641</td>
<td>89.95</td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.18, it may be interpreted that there exists significant difference between High-Average group of Boy and Girl students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. High-average group Girls are found better on the criterion of Left Hemisphere Thinking Style
**Whole Brain Thinking Style**

Table: 4.19: Chi-square Analysis between Low group of Boy and Girl students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Low Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>73</td>
<td>44</td>
<td>29</td>
<td>841</td>
<td>19.11</td>
<td>22.38</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Girls</td>
<td>32</td>
<td>44</td>
<td>12</td>
<td>144</td>
<td>3.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.19 reveals that there exists significant difference between Low group of Boy and Girl students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low group Boys are found significantly better than the Girls on the criterion of Whole Brain Thinking Style.

Table: 4.20: Chi-square Analysis between Low-Average group of Boy and Girl students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Low-Average Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>159</td>
<td>185</td>
<td>26</td>
<td>676</td>
<td>3.65</td>
<td>3.91</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>Girls</td>
<td>178</td>
<td>185</td>
<td>7</td>
<td>49</td>
<td>0.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.20, it may be interpreted that there exists significant difference between Low-Average group of Boy and Girl students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low-average group Boys are found better than Girls on the criterion of Whole Brain Thinking Style.

Table: 4.21: Chi-square Analysis between High-Average group of Boy and Girl students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>High Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>59</td>
<td>44</td>
<td>15</td>
<td>225</td>
<td>5.11</td>
<td>24.22</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Girls</td>
<td>15</td>
<td>44</td>
<td>29</td>
<td>841</td>
<td>19.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.21 indicates that there exists significant difference between High-Average group of Boy and Girl students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. High-average group Girls are found better on the criterion of Whole Brain Thinking Style.

According to the Tables 4.13 to 4.21 presented above, the significant differences are revealed through Chi-square analyses on all the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of Boy and Girl students. Thus, the null hypothesis $^0H_9$ is rejected.

$^0H_9$: There is no impact of ITM of Teaching between Urban and Rural students on the criteria of Thinking Style.

Similarly, according to the nature of the scale, the non-parametric testing technique of Chi-square with equal probability assumption was used between Urban and rural students of the three groups, namely, Low, Low-Average and High-average under Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles.

**Right Hemisphere Thinking Style:**

Table 4.22: Chi-square Analysis between Low Group of Urban and Rural Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Low Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>$(\text{Fo-Fe})^2$</th>
<th>$(\text{Fo-Fe})^2/\text{Fe}$</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>51</td>
<td>44</td>
<td>7</td>
<td>49</td>
<td>1.11</td>
<td>1.47</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Rural</td>
<td>40</td>
<td>44</td>
<td>4</td>
<td>16</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.22, it may be interpreted that there exists no significant difference between Low group of Urban and Rural students on the criterion of Right Hemisphere. Thinking Style even at 0.05 level of significance.
Table 4.23: Chi-square Analysis between Low-Average Group of Urban and Rural Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>181</td>
<td>185</td>
<td>4</td>
<td>16</td>
<td>0.086</td>
<td>4.026</td>
</tr>
<tr>
<td>Rural</td>
<td>158</td>
<td>185</td>
<td>27</td>
<td>729</td>
<td>3.940</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.23 indicates that there exists significant difference between Low-Average group of Urban and Rural students on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. Low group Rural students are found better on the criterion of Right Hemisphere Thinking Style.

Table 4.24: Chi-square Analysis between High-Average Group of Urban and Rural Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>96</td>
<td>185</td>
<td>89</td>
<td>7921</td>
<td>42.82</td>
<td>109.42</td>
</tr>
<tr>
<td>Rural</td>
<td>74</td>
<td>185</td>
<td>111</td>
<td>12321</td>
<td>66.6</td>
<td></td>
</tr>
</tbody>
</table>

From Table 4.24, it indicates that there exists significant difference between High-Average group of Urban and Rural students on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. High-average group Rural students are found better on the criterion of Right Hemisphere Thinking Style.

*Left Hemisphere Thinking Style:*

Similarly, for the Thinking Style of Left Hemisphere was measured through the SOLAT as a non-parametric measure and the Chi-square tests are used:.
Table 4.25: Chi-square Analysis between Low group of Urban and Rural Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>51</td>
<td>44</td>
<td>7</td>
<td>49</td>
<td>1.11</td>
<td>1.47</td>
<td>P&lt; 0.01</td>
</tr>
<tr>
<td>Rural</td>
<td>40</td>
<td>44</td>
<td>4</td>
<td>16</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.25, it may be interpreted that there exists significant difference between Low group of Urban and Rural students on the criterion of Left Hemisphere Thinking Style even at 0.01 level of significance. Low group of Urban students are found better on the criterion of Left Hemisphere Thinking Style.

Table 4.26: Chi-square Analysis between Low-Average group of Urban and Rural Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>179</td>
<td>185</td>
<td>6</td>
<td>36</td>
<td>0.19</td>
<td>1.57</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Rural</td>
<td>169</td>
<td>185</td>
<td>16</td>
<td>256</td>
<td>1.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.26, it may be interpreted that there exists significant difference between Low-Average group of Boy and Girl students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low-average group Rural students are found better on the criterion of Left Hemisphere Thinking Style.

Table: 4.27: Chi-square Analysis between High-Average group of Urban and Rural Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>149</td>
<td>185</td>
<td>36</td>
<td>1296</td>
<td>7</td>
<td>43.34</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Rural</td>
<td>103</td>
<td>185</td>
<td>82</td>
<td>6724</td>
<td>36.34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From the Table: 4.27, it may be interpreted that there exists significant difference between High-Average group of Urban and Rural students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. High-average group Rural students are found better on the criterion of Left Hemisphere Thinking Style.

**Whole Brain Thinking Style:**

Table 4.28: Chi-square Analysis between Low group of Urban and Rural students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>53</td>
<td>44</td>
<td>9</td>
<td>81</td>
<td>1.84</td>
<td>19.66</td>
</tr>
<tr>
<td>Rural</td>
<td>72</td>
<td>44</td>
<td>28</td>
<td>784</td>
<td>17.82</td>
<td></td>
</tr>
</tbody>
</table>

Table: 4.28 reveals that there exists significant difference between Low group of Urban and Rural students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low group of Rural students are found better on the criterion of Whole Brain Thinking Style.

Table 4.29: Chi-square Analysis between Low-Average group of Urban and Rural Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>197</td>
<td>185</td>
<td>12</td>
<td>144</td>
<td>0.77</td>
<td>4.42</td>
</tr>
<tr>
<td>Rural</td>
<td>159</td>
<td>185</td>
<td>26</td>
<td>676</td>
<td>3.65</td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.29, it may be interpreted that there exists significant difference between Low-Average group of Urban and Rural students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low Average group of Rural students are found better on the criterion Whole Brain Thinking Style.
Table: 4.30: Chi-square Analysis between High-Average group of Urban and Rural Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Locality</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>78</td>
<td>44</td>
<td>34</td>
<td>1156</td>
<td>26.27</td>
<td>26.47</td>
</tr>
<tr>
<td>Rural</td>
<td>41</td>
<td>44</td>
<td>3</td>
<td>9</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.30 indicates that there exists significant difference between High-Average group of Urban and rural students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. High-average group of Urban students are found better on the criterion Whole Brain Thinking Style.

According to the Tables 4.22 to 4.30 presented above, the significant differences are revealed through Chi-square analyses on all the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of Urban and Rural students. Only the exception was found between Low group of Urban and Rural students on the criterion of Right Hemisphere Thinking Style. Thus, the hypothesis $^0H_0$ is rejected.

$^0H_0$: There is no impact of ITM of Teaching between the Bengali and English Medium students on the criterion of Thinking Style.

*Left Hemisphere Thinking Style:*

Table: 4.31: Chi-square Analysis between Low group of Bengali and English medium Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>50</td>
<td>44</td>
<td>6</td>
<td>36</td>
<td>0.81</td>
<td>2.26</td>
</tr>
<tr>
<td>English</td>
<td>36</td>
<td>44</td>
<td>8</td>
<td>64</td>
<td>1.45</td>
<td></td>
</tr>
</tbody>
</table>
From the Table: 4.31, it may be interpreted that there exists significant difference between Low group of Bengali and English medium students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low group of English medium students are found better in comparison with Bengali medium students on the criterion of Left Hemisphere Thinking Style.

Table: 4.32: Chi-square Analysis between Low-Average group of Bengali and English medium Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>175</td>
<td>185</td>
<td>10</td>
<td>100</td>
<td>0.54</td>
<td>4.77</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>157</td>
<td>185</td>
<td>28</td>
<td>784</td>
<td>4.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.32, it is revealed that there is significant difference between Low-average group of Bengali and English medium students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low-average group of English medium students are found better in comparison with Bengali medium students on the criterion of Left Hemisphere Thinking Style.

Table: 4.33: Chi-square Analysis between High-Average group of Bengali and English medium Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>97</td>
<td>185</td>
<td>88</td>
<td>7744</td>
<td>41.85</td>
<td>94.82</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>86</td>
<td>185</td>
<td>99</td>
<td>9801</td>
<td>52.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.33, it is revealed that there is significant difference between High-average group of Bengali and English medium students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. High average
group of English medium students are found better in comparison with Bengali medium students on the criterion of Left Hemisphere Thinking Style.

**Right Hemisphere Thinking Style:**

Table: 4.34: Chi-square Analysis between Low group of Bengali and English medium Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>72</td>
<td>44</td>
<td>28</td>
<td>784</td>
<td>17.81</td>
<td>22.26</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>30</td>
<td>44</td>
<td>14</td>
<td>196</td>
<td>4.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.34, it is revealed that there is significant difference between Low group of Bengali and English medium students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low group of Bengali medium students are found better in comparison with English medium students on the criterion of Right Hemisphere Thinking Style.

Table: 4.35: Chi-square Analysis between Low Average group of Bengali and English medium Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>168</td>
<td>185</td>
<td>17</td>
<td>289</td>
<td>1.56</td>
<td>163.33</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>12</td>
<td>185</td>
<td>173</td>
<td>29929</td>
<td>161.77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.35, it is revealed that there is a significant difference between Low-average group of Bengali and English medium students on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low-average group of English medium students are found better in comparison with Bengali medium students on the criterion of Right Hemisphere Thinking Style.
Table 4.36: Chi-square Analysis between High-Average group of Bengali and English medium Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>104</td>
<td>185</td>
<td>81</td>
<td>6561</td>
<td>35.46</td>
<td>82.21</td>
</tr>
<tr>
<td>English</td>
<td>92</td>
<td>185</td>
<td>93</td>
<td>8649</td>
<td>46.75</td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.36, it is revealed that there is a significant difference between High-average group of Bengali and English medium students on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. High-average group of English medium students are found better in comparison with Bengali medium students on the criterion of Right Hemisphere Thinking Style.

Whole Brain Thinking Style:

Table 4.37: Chi-square Analysis between Low group of Bengali and English medium Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>71</td>
<td>44</td>
<td>28</td>
<td>784</td>
<td>17.82</td>
<td>59.84</td>
</tr>
<tr>
<td>English</td>
<td>1</td>
<td>44</td>
<td>43</td>
<td>1849</td>
<td>42.02</td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.37, it is revealed that there is significant difference between Low group of Bengali and English medium students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low group of English medium students are found better in comparison with Bengali medium students on the criterion of Whole Brain Thinking Style.
Table: 4.38: Chi-square Analysis between Low-Average group of Bengali and English medium Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>159</td>
<td>185</td>
<td>26</td>
<td>676</td>
<td>3.65</td>
<td>58.79</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>84</td>
<td>185</td>
<td>101</td>
<td>10201</td>
<td>55.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.38, it is revealed that there is a significant difference between Low-average group of Bengali and English medium students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low-average group of English medium students are found better in comparison with Bengali medium students on the criterion of Whole Brain Thinking Style.

Table: 4.39: Chi-square Analysis between High-Average group of Bengali and English medium Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Medium</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>41</td>
<td>44</td>
<td>3</td>
<td>9</td>
<td>0.20</td>
<td>15.56</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>English</td>
<td>18</td>
<td>44</td>
<td>26</td>
<td>676</td>
<td>15.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table: 4.39, it is revealed that there is a significant difference between High-average group of Bengali and English medium students on the criterion of Whole Brain Thinking Style at 0.01 level of significance. High-average group of English medium students are found better in comparison with Bengali medium students on the criterion of Whole Brain Thinking Style.

According to the Tables 4.31 to 4.39 presented above, the significant differences are revealed through Chi-square analyses on all the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of Bengali and English Medium students. Hence, the hypothesis $H_{10}$ is rejected.
\( H_{11} \): There is no impact of ITM of Teaching between the students of different Boards on the criterion of Thinking Style.

**Left Hemisphere Thinking Style**

Table: 4.40: Chi-square Analysis between Low group of WBBSE and Other Board Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>13</td>
<td>44</td>
<td>31</td>
<td>961</td>
<td>21.84</td>
<td>36.04</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>19</td>
<td>44</td>
<td>25</td>
<td>625</td>
<td>14.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.40 reveals that there is a significant difference between Low group of students of WBBSE and Other Board on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low group of WBBSE students are found better in comparison with Other (ICSE/ CBSC) Boards on the criterion of Left Hemisphere Thinking Style.

Table: 4.41: Chi-square Analysis between Low-Average group of WBBSE and Other Board Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)²</th>
<th>(Fo-Fe)²/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>153</td>
<td>185</td>
<td>32</td>
<td>1024</td>
<td>5.54</td>
<td>122.34</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>38</td>
<td>185</td>
<td>147</td>
<td>21609</td>
<td>116.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.41 reveals that there is a significant difference between Low-average group of students of WBBSE and Other Board on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. Low-average group of Other (ICSE/ CBSC) students are found better in comparison with WBBSE Boards on the criterion of Left Hemisphere Thinking Style.
Table 4.42: Chi-square Analysis between High Average group of WBBSE and Other Board Students on their Left Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>73</td>
<td>185</td>
<td>112</td>
<td>12544</td>
<td>67.80</td>
<td>164.85</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>51</td>
<td>185</td>
<td>134</td>
<td>17956</td>
<td>97.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.42 reveals that there is a significant difference between High-average students of WBBSE and Other Board on the criterion of Left Hemisphere Thinking Style at 0.01 level of significance. High-average group of Other (ICSE/ CBSC) students are found better in comparison with WBBSE Boards on the criterion of Left Hemisphere Thinking Style.

Table 4.43: Chi-square Analysis between Low group of WBBSE and Other Board Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>35</td>
<td>44</td>
<td>9</td>
<td>81</td>
<td>1.84</td>
<td>17.20</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>44</td>
<td>26</td>
<td>676</td>
<td>15.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.43 reveals that there is a significant difference between Low group of students of WBBSE and Other Board on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. Low group of Other (ICSE/ CBSC) students are found better in comparison with WBBSE Boards on the criterion of Right Hemisphere Thinking Style.

Table 4.44: Chi-square Analysis between Low-Average group of WBBSE and Other Board Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Low Average Group</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>165</td>
<td>185</td>
<td>20</td>
<td>400</td>
<td>2.16</td>
<td>60.62</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>81</td>
<td>185</td>
<td>104</td>
<td>10816</td>
<td>58.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.44 reveals that there is a significant difference between Low-average group of students of WBBSE and Other Board on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. Low-average group of Other (ICSE/ CBSC) students are found better in comparison to WBBSE Boards on the criterion of Right Hemisphere Thinking Style.

Table: 4.45: Chi-square Analysis between High Average group of WBBSE and Other Board Students on their Right Hemisphere Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>79</td>
<td>185</td>
<td>106</td>
<td>11236</td>
<td>60.73</td>
<td>206.11</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
<td>185</td>
<td>164</td>
<td>26896</td>
<td>145.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.45 reveals that there is a significant difference between High Average group of students of WBBSE and Other Board on the criterion of Right Hemisphere Thinking Style at 0.01 level of significance. High-average group of Other (ICSE/ CBSC) students are found better in comparison with WBBSE Boards on the criterion of Right Hemisphere Thinking Style.

Table: 4.46: Chi-square Analysis between Low group of WBBSE and Other Board Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>14</td>
<td>44</td>
<td>30</td>
<td>900</td>
<td>20.45</td>
<td>34.65</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>19</td>
<td>44</td>
<td>25</td>
<td>625</td>
<td>14.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.46 reveals that there is a significant difference between Low group of students of WBBSE and Other Board on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Low group of WBBSE students are found better in comparison with Other (ICSE/ CBSC) Boards on the criterion of Whole Brain Thinking Style.
Table 4.47: Chi-square Analysis between Average group of WBBSE and Other Board Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>150</td>
<td>185</td>
<td>35</td>
<td>1225</td>
<td>6.62</td>
<td>144.99</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>185</td>
<td>160</td>
<td>25600</td>
<td>138.37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.47 reveals that there is a significant difference between Low group of students of WBBSE and Other Board on the criterion of Whole Brain Thinking Style at 0.01 level of significance. Average group of Other (ICSE/ CBSC) students are found better in comparison with WBBSE Boards on the criterion of Whole Brain Thinking Style.

Table 4.48: Chi-square Analysis between High Average group of WBBSE and Other Board Students on their Whole Brain Thinking Style

<table>
<thead>
<tr>
<th>Board</th>
<th>Fo</th>
<th>Fe</th>
<th>Fo-Fe</th>
<th>(Fo-Fe)^2</th>
<th>(Fo-Fe)^2/Fe</th>
<th>Chi-square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>17</td>
<td>44</td>
<td>27</td>
<td>729</td>
<td>16.56</td>
<td>21.75</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>44</td>
<td>31</td>
<td>961</td>
<td>5.19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.48 reveals that there is a significant difference between High Average group of students of WBBSE and Other Board on the criterion of Whole Brain Thinking Style at 0.01 level of significance. High Average group of WBBSE students are found better in comparison with Other (ICSE/ CBSC) Boards on the criterion of Whole Brain Thinking Style.

According to the Tables 4.40 to 4.48 presented above, the significant differences are revealed through Chi-square analyses on all the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of WBBSE and Other Board students. Thus, the hypothesis ⁰H₁₁ is rejected.

⁰H₁₂: There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Scholastic Achievement in Life Science.
According to the nature of the Scholastic Achievement Test was computed to find out the significant mean differences

Table: 4.49: Significant Mean Difference between Boys and Girls on Scholastic Achievement in Life Science

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>328</td>
<td>21.09</td>
<td>2.1</td>
<td>1.59</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>Girls</td>
<td>272</td>
<td>20.58</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the above Table 4.49, it is found that the ‘t’ value (1.59) is found less than 2.07 at 0.05 level of significance for the df 198, indicates that there is no significant difference between the mean scores of boys and girls, on the criterion of Scholastic Achievement in Life Science, as the impact of ITM. Thus, the null hypothesis $H_{12}$ is retained.

$H_{13}$: There is no impact of ITM of Teaching between Urban and Rural students on the criterion of Scholastic Achievement in Life Science.

Table 4.50: Significant Mean Difference between Urban and Rural students on Scholastic Achievement in Life Science

<table>
<thead>
<tr>
<th>Locality</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>20.6</td>
<td>2.17</td>
<td>5.27</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Rural</td>
<td>19.7</td>
<td>2.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the Table 4.50, it may be interpreted that there exists significant difference between Urban and Rural students on the criteria of Scholastic Achievement in Life Science at 0.01 level of significance. So, there was an impact of ITM on scholastic Achievement in Life Science. Therefore, there is a significant difference between the means of these two groups on the criteria of Scholastic Achievement, as the impact of ITM. Thus, the $H_{13}$ is rejected.

$H_{14}$: There is no impact of ITM of Teaching between the students of Bengali and English Medium students on the criterion of Scholastic Achievement in Life Science.
Table 4.51: Significant Mean Difference between Boys and Girls student on Scholastic Achievement in Life Science

<table>
<thead>
<tr>
<th>Medium</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengali</td>
<td>375</td>
<td>20.29</td>
<td>2.24</td>
<td>0.72</td>
<td>P &gt; 0.05</td>
</tr>
<tr>
<td>English</td>
<td>225</td>
<td>20.16</td>
<td>2.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here ‘t’ value is less than table value at 0.05 level of significance. It reveals that there is no significant difference between the mean scores of students of Bengali and English medium on the criterion of Scholastic Achievement in Life Science, as the impact of ITM. Thus, the null hypothesis \( H_{14} \) is retained.

\( H_{15} \): There is no impact of ITM of Teaching among the students of WBBSE and Other Board (CBSE and ICSE) on the criterion of Scholastic Achievement.

Table 4.52: Significant Mean Difference between Schools of WBBSE and Other Boards on Scholastic Achievement in Life science

<table>
<thead>
<tr>
<th>Urban Students</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>‘t’-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBBSE</td>
<td>220</td>
<td>20.79</td>
<td>2.26</td>
<td>2.4</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>OTHERS</td>
<td>108</td>
<td>20.55</td>
<td>1.97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the above Table 4.52, it is found that the ‘t’ value (2.4) is found significant at 0.05 level of significance, indicates that there is a significant difference between the means scores of WBBSE and Other (CBSE & ICSE) Board on the criterion of Scholastic Achievement in Life Science, as the impact of ITM. Thus, the null hypothesis \( H_{15} \) is rejected.

4.3: Hypothesis Testing

The results of hypotheses testing accord the study design, nature of tools and statistical analyses have been summarized in the following Table 4.53.
<table>
<thead>
<tr>
<th>Number</th>
<th>Hypothesis</th>
<th>Retained / Rejected</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁</td>
<td>There is no significant mean difference between the gains in pre-test and post-test scores on attitude towards the ITM through the orientation of male and female student-teachers.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₂</td>
<td>There is no significant mean difference between the gains in pre-test and post-test scores on willingness to implement the ITM through the orientation of student-teachers.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₃</td>
<td>There is no significant mean difference between the gains in pre-test and post-test scores on willingness to implement the ITM through the orientation of student-teachers.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₄</td>
<td>There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Creative Inquiry.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₅</td>
<td>There is no impact of ITM of Teaching between the Urban and Rural students on the criterion of Creative Inquiry.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₆</td>
<td>There is no impact of ITM of Teaching between the students of Bengali and English Medium schools on the criterion of Creative Inquiry.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₇</td>
<td>There is no impact of ITM of teaching between the students of WBBSE and Other (CBSE &amp; ICSE) Boards on the criterion of Creative Inquiry.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₈</td>
<td>There is no impact of ITM of Teaching</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Hypothesis</td>
<td>Retained / Rejected</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>between Boy and Girl students on the criteria of Thinking Style.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₉</td>
<td>There is no impact of ITM of Teaching between Urban and Rural students on the criteria of Thinking Style.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₁₀</td>
<td>There is no impact of ITM of Teaching between the Bengali and English Medium students on the criterion of Thinking Style.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₁₁</td>
<td>There is no impact of ITM of Teaching between the students of different Boards on the criterion of Thinking Style.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₁₂</td>
<td>There is no impact of ITM of Teaching between Boy and Girl students on the criterion of Scholastic Achievement in Life Science.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₁₃</td>
<td>There is no impact of ITM of Teaching between Urban and Rural students on the criterion of Scholastic Achievement in Life Science.</td>
<td>Rejected</td>
</tr>
<tr>
<td>H₁₄</td>
<td>There is no impact of ITM of Teaching between the students of Bengali and English Medium students on the criterion of Scholastic Achievement in Life Science.</td>
<td>Retained</td>
</tr>
<tr>
<td>H₁₅</td>
<td>There is no impact of ITM of Teaching among the students of WBBSE and Other Board (CBSE and ICSE) on the criterion of Scholastic Achievement.</td>
<td>Rejected</td>
</tr>
</tbody>
</table>
4.4: The Mixed Approach

As a part of the analysis of study both the technique of Mixed approach, viz., Qualitative and Quantitative Analyses was used.

After completion of orientation programme of sampled students-teachers of Life Science through various phases of ITM, the student-teachers are requested to prepare lesson plans on the topic of study. Then, the student-teachers administered those lesson plans in their respective classrooms. The researcher takes the permissions of the head of the institutions and observed the teaching of those student-teachers who were oriented with ITM, in their respective classrooms of different schools.

After completion of their teaching a particular topic, the researcher asked about their views regarding the use of such a new ITM of Teaching technique in their classrooms. Every student was said that the new teaching model, a time taking, but very effective for students. During class teaching it is also observed that each and every student in the classroom is active. Everyone was found curious to know what new things going to happen in the classroom. The researcher also observed that every student in the classroom was busy in observing and writing. All the students take active participation.

The researcher also collected the views of different students regarding this new technique of teaching. Maximum students were found very much satisfied with this technique of teaching as well as they also suggested the researcher if all the teachers of their schools would use this technique then results of the students will be much better than before and the level of understanding of a particular subject will also improved.

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CHAPTER-V

DISCUSSIONS

5.1 Concerns of the Study
5.2 Objectives of the Study
5.3 The Findings of the Study
5.4 Limitations of the Study
5.5 Suggestion for Further Research
5.6 Conclusion

References
CHAPTER 5
DISCUSSIONS

The prime objective of the teacher education programme is to motivate student-teachers towards implementation of innovations in the academic discipline of teacher education. They must have a positive outlook towards the new models or strategies and to implement that in the real classroom situations. For achieving such a goal, training in models of teaching may be focused seriously.

The Inquiry Training Model as developed by Suchman is classified under the information processing models of teaching by Joyce and Weil (1992). They have done immense works in the field of models of teaching. Models are highly specific teaching strategies designed to accomplish certain goals. Models of teachings are based on the empirical works, theories and researches of various scholars who worked in different fields of the teacher education. More than twenty models of teaching are grouped into four families based on their prime emphases and the way they approach educational means and goals. Suchman assumes that human beings are basically curious and problem solvers by nature. Suchman and his associates (1962) tried to analyze the methods employed by creative research personnel, especially in the scientists. They identified elements of basic inquiry process, devised the Inquiry Training Model (ITM).

The main purpose of the present study was aimed to determine how the ITM is related to critical thinking dispositions and creative measures of the students as learning outputs in education.

5.1 Concerns of the Study
The important research questions that were raised in the present study were:
1. Are the Student-teachers of the Teacher Education programme ready with positive Attitude and Willingness to implement the ITM?
2. Is there any effect of Thinking Style of students of different Sex, Locality, Medium of instruction and Board of studies on teaching through ITM for
developing Creative Inquiry, Scientific Thinking and Scholastic Achievement in Life Science?

3. Is there any relationship between the readiness of student-teachers and impact of their classroom teaching through ITM on Creative Inquiry, Scientific Thinking and Scholastic Achievement in Life Science?

The present study was undertaken to evolve training strategies to train student-teachers to use ITM. The relative effectiveness of different training strategies was analyzed in terms of three dependent variables:

1. Theoretical understanding of ITM.
2. Willingness to implement ITM.
3. Attitude towards ITM.

The present study was also undertaken to analyze the effectiveness of ITM on students (thinking style, creative inquiry capacities and their scholastic achievement). The effectiveness of dependent variables on students was studied by using other three dependent variables.

1. Thinking Style
2. Creative Inquiry
3. Scholastic Achievement

5.2 Objectives of the Study

On the basis of above three research questions following objectives were identified:

1. To orient the students-teachers with ITM based teaching in Life science and to find out their theoretical knowledge, attitude towards the ITM and Willingness to implement the model of teaching;

2. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education of the secondary students on the criterion of Creative Inquiry.

3. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education on the criterion of Scientific Thinking.
4. To study the impact of ITM of Teaching among the Gender, Locality, Medium of Instruction and Boards of Education on the criterion of Scholastic Achievement.

5. To study the relationship between the readiness of student-teachers and impact of their classroom teaching through ITM on Creative Inquiry, Scientific thinking and Scholastic Achievement.

5.3: The Findings of the Study

On analysis of Hypotheses Testing (Table: 4.3), following inferences can be drawn:

1. The impact of Orientation towards the ITM towards the development of Attitude towards the ITM was found better for the male student teachers.

2. The impact of Orientation towards the development of Willingness to Implement the ITM was found equal between the male and female student-teachers.

3. The impact of Orientation towards the development of Theoretical knowledge of the ITM was also found equal between the male and female student-teachers.

4. The impact of teaching through ITM on the criterion of developing Creative Inquiry, no difference was revealed. Thus, both the Boy and Girl students are found equally effective in terms of Creative Inquiry.

5. The impact of teaching through ITM on the criterion of developing Creative Inquiry was found that the Urban students were better.

6. The impact of teaching through ITM on the criterion of Creative Inquiry between the students of Bengali and English Medium are found equally effective.

7. The significant impact of teaching through ITM on the criterion of Creative Inquiry between the students of WBBSE and Other (ICSE & CBSE) Board was revealed and students of WBBSE were found better.
8. The significant impact of teaching through ITM on the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of Boy and Girl students were found. Mostly the Girl students are better than the Boys.

9. No impact of teaching through ITM on the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of Urban and Rural students were found. The Bengali and English medium students are found equally effective.

10. The significant impact of teaching through ITM on the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups between Bengali and English Medium students were found. Mostly the English medium students were found better.

11. The significant impact of teaching through ITM are revealed on all the criteria of Right Hemisphere, Left Hemisphere and Whole Brain Thinking Styles of Low, Low-average and High-Average groups of WBBSE and Other (ICSC/ CBSC) Board students. The Other Boards are found better in respect to their Thinking Style.

12. No significant impact of teaching through ITM between the boy and girl students was found on the criterion of Scholastic Achievement in Life Science. Thus, both the boys and girls were found equally effective.

13. Significant impact between Urban and Rural students on the criteria of Scholastic Achievement in Life Science was revealed as an impact of teaching through ITM on scholastic Achievement in Life Science. Urban students were found better.

14. No significant impact teaching through ITM was found between the students of Bengali and English medium on the criterion of Scholastic Achievement in Life Science. Thus, equal impact was found between the Bengali and English medium students on Scholastic Achievement.
15. Significant impact between the mean scores of WBBSE and Other (CBSE & ICSE) Board on the criterion of Scholastic Achievement in Life Science, as the impact of teaching through ITM. It was found that WBBSE students were found better than the Other Boards.

5.4 Limitations of the Study

The limitations of the study are those characteristics of design or methodology that impacted or influenced the interpretation of the findings from your research. They are the constraints on generalizability, applications to practice, and/or utility of findings that are the result of the ways in which you initially chose to design the study and/or the method used to establish internal and external validity.

1. The colleges of education was very co-operative and receptive but the roster of teacher education programme was so tightly scheduled that the investigator found it difficult to implement a well planned experimental design.
2. The investigator chose a simple methods experimenter design to study the effects of training strategies.
3. English and Bengali translations of the tools were used to assess the student-teacher response to the training imported.
4. The investigation was confined to student-teachers and students only. The implementation of ITM during practice teaching by student-teachers after undergoing training in ITM was not included in their prescribed curriculum format.
5. The administrative and time constraints placed a limitation on the study.
6. The investigator cannot improve his tool any time in the middle of the study. She will have to bank on the same tool that she used in the beginning.
7. The investigator cannot control other variables except age, sex, and locality eg. Intellectual level, social-economic factor, aspiration level etc. may also affect the trait to some extent.
8. Chance of differences between samples may also disturb the result in both directions.
9. Practice effect of the group on measuring tool can also affect the result.
10. Intervening variables which are out of the preview of the experiment also affect the independent variables. Thus, a margin of error is always possible to occur.

5.5 Suggestion for Further Research

The present study may have various implications for all those who are interested in research and innovation in the field of science teaching in particular, and teaching in general. So, it can be said that it has implications for teachers, student-teachers, administrators and research workers. Some suggestions for implication in future research are listed below:

1. Models of teaching need to be introduced for teaching of science as they have significant effect on bringing about desirable changes in the students along with better learning.
2. Teachers need to be trained in the Models of Teaching, especially with the Inquiry Training Model, so that they are able to develop tasks in their subjects according to this model.
3. The models of teaching are easily applicable in Indian classroom because they are based on no other technology except the technology of developing instructional materials so it can easily be used in our classrooms as well as in our schools curriculum structure.
4. In a homogenous/mixed class, consisting of all the students with different thinking styles, scientific inquiry (creative) and scholastic achievement, Inquiry Training Model may preferably be employed for teaching science lessons.
5. The model of teaching as theory-cum-practice programme could be integrated into method of teaching various subjects at training courses.
6. Student-Teacher Education programme in India should incorporate training for Varity of models of teaching so that tomorrow’s student-teachers would be more rational and flexible in selection and use of a
teaching strategy suitable to students and their needs. The implement
ability of the model of teaching is experimentally tried and field tested.
7. In the Indian context further researches are needed to find out the
relationship between orientations to the model of teaching with the
gains in learning output of the school students.

5.6 Conclusion
Training in the Inquiry Training Model in the form of different teaching
methods such as-lecture, demonstration, discussion and group practice and the
obtained feedback enhanced the student-teachers understanding of the
theoretical aspects of ITM. Training in ITM mostly did bring about favorable
reactions of the student-teachers towards ITM. The student-teachers showed a
positive attitude towards implementation of ITM.
A good academic programme supports critical thinking and it takes into
consideration different cognitive styles are the disposition or the preference of
the individuals inclination to use his/her abilities and skills while taking the
new information (Fan and Ye 2007;Zhang, 2006). Different individuals use
different thinking styles in order to gain new information.
Thinking styles of Sternberg (1997) defines this style mostly as a preference in
the usage of the talent that the individual has rather than preferred kind of
something or ability (Sternberg and Zhang, 2001, p.198). “Theory of Mental
states people thinking styles. Thinking styles can be used at home, in school,
at work, in society in many situations. This theory asserts that all people
manage the whole daily activities live managing a society. The individuals
have their own thinking styles and everybody has his or her own way that
he/she feels at ease when dealing with the events happening. Thinking styles
can be shaped by the conditions that people are in and charge depending on
the necessities of the situation. This change is closely in relation to social
environment depending on culture, time and situation.
Paul (1995) who is known for his studies on critical thinking defines critical
thinking as the thinking about it when the person is achieving the act of
thinking in order to develop the person’s self thinking. Critical thinking is not
only thinking, but it is also thinking of which things are effective for self-
development. The self-development is related to the ability of the individual that he/she will use the standards when he/she is thinking. Facione et al. (1995) has defined critical thinking disposition as consistent internal motivation which provides to decide by thinking and to solve the problem.

There are two important similarities between thinking style and critical thinking disposition.

Firstly, as it is defined before, thinking style states the preferred way of the usage of the abilities. Similarly, critical thinking disposition states to the tendency of critical thinking. Therefore, both of the structures underline the person’s thinking habit (habit of the mind).

Secondly, both of the structures are wide in their each own ways. While thinking style structure includes the style qualities of the three traditions in mental style studies, critical thinking disposition structure includes the definitions of objective disciplined claim, ideal critical thinker, generalization in the different environment and situations” (Facione, Facione and Giancarlo, 1998, p.2).

Finally, importance of the findings in relation to the relationship between Thinking Styles and Critical thinking (inquiry) disposition not only contributing to the different fields, but also it is vital for education-teaching, learning and evaluations and for the development of future programmes. If the students were given the opportunities to use their own thinking styles especially in order to develop students critical thinking abilities. It was also found that if the teachers use various teaching methods and techniques in the students’ education and if they evaluate the students’ success from different points of views the students who have different thinking styles can be more benefited from these types of teaching.

The researcher in her study found that the student-teachers shows positive attitude towards ITM and also they show positive response towards willingness to implement that in their classroom and which shows similarities with the studies of Passi, Sansanwal and Singh (1992) and Vanaja, (1998).

The researcher in her study also observed that the ITM of teaching science was more effective and it can helps in boosting curiosity among the students which shows similarity with Swamy’s (1995) study.
The researcher also realized that the inquiry oriented teaching can create or develop interest and curiosity among the students regarding science teaching and as well as it also helps in increasing the achievement level of the students in science and this was already proved by Schlenker (1970), Katiyal (1985), Dubey (1986), Sivakumar and Prema (1997), Alam (1997) and Dwivedi (2014).

The researcher during her study observed that apart from students achievement, Inquiry Approach in Science activities also helps in developing science concepts (Johnson, 1991) and this approach is also found to be effective in developing the inquiry skills (Moar, 1994; Demastes, 1995). During her study the researcher also feels that inquiry-based science programs can develop students attitudes towards science and interest in science which shows some similarity with the Gibson (1998) study.

Marsh (1975) indicated that the inquiry method is superior in terms of recall, transfer and retention of data and in developing specific skills in questioning and concept building, Olmo (1978) reported that the inquiry techniques are successful in providing examples, clarifying themes; arouse interest, encouraging Synthesis and application of concepts.

The researcher feels that those students were taught critical thinking overtly, demonstrated significantly higher levels of critical thinking as Friedel, Irani, Rudd, Gallo, Eckhardt, and Ricketts (2008) also proved in their studied. Most of the research highlights the value of utilizing critical thinking in instruction. Students have been found to benefit from domain-specific applications of critical thinking and problem-based applications. Proper environment is also essential for proper development of critical thinking. It is necessary to cultivate classrooms and environments that help to promote the critical thinking skills.

References


Teachers’ Thinking Styles to Critical Thinking Dispositions (Istanbul-Fatih Sample) 347


Yang, Y. C. (2007). “A catalyst for teaching critical thinking in a large university class in Taiwan: asynchronous online discussions with the facilitation of teaching assistants”. *Education Technology Research and Development. 56*, pp.241-264.
ANNEXURE – I

Model Lesson
Standard: IX  Subject: Life Science
Topic: Respiration

The teacher will prepare the environment of the classroom that the lightning and the temperature of the classroom are comfortable for the students. The teacher asks the students to sit closely and divide them into different groups. During the demonstration of the materials or any audio-visual aids, make sure that each and every student is able to see the materials as well as the aid.

PHASE –I: Encounter the Learning Situation
(The teacher keeps all the necessary Instructional materials or aids on the table and great the students.)

T: (Show some balloons of different size, plastic bottle, thick straw, knife and thread)
   What do you call this object?
S1: Balloon.
T: (call one student) Now the teacher asks the student to blow air into the balloon. Now, what happened to the balloon?
S2: It increase in size / it inflates.
T: Now the teacher asks the student to release the air. What happens to the balloon?
S1: It again comes to its original shape.
S3: Air inside the balloon comes out.
T: Yes, when we blown air into the balloon it increase in size and when we release the air, it again comes to its original shape.
T: The teacher will ask the students if they have any idea what organ might be similar to the balloons and the way it was inflated.
S2: The lungs.
T: Yes.
   (The teacher will present information on the Respiratory System of Different Animals and Plants.)
PHASE –II: Exploration of Relevant
T: Give instructions: The teacher, with the help of students provide the required materials to each group and ask them to observe carefully. And ask them to fill their worksheets properly.
S4: When we breathe in, our lungs fill with air.
T: Yes.
S5: When we breathe out, our lungs release the air.
T: Yes. (The teacher will show the picture of Respiratory System and also provide different pieces of respiratory organ and ask the students to arrange them correctly.
S3: The air first enters our body through our nose.
T: Yes.
S4: From mouth also.
T: Yes, but we must avoid to take air through our mouth. (Explain the reason).
S5: The nose is connected to a long pipe like structure.
S3: Can we call this pipe wind- pipe.
T: Yes, but we must called it trachea. (The trachea is a tube that allows the air to go to the lungs.)

PHASE-III: Formulation of Hypothesis
T: (The teacher provides them with opportunities to formulate the relevant hypothesis. The hypothesis is focused on the relationship between different organs of respiratory system.)
Teacher gives instruction how to prepare a respiratory organ with the help of few common materials like empty bottle, balloons (small & big), Straw, tape and rubber band.
T: The teacher pull the large balloon fitted at the lower cut portion of the bottle and ask the students to observe it carefully.
S1: The small balloon inside the bottle which is connected to the straw inflates.
T: Yes. The teacher asks another student to repeat it again.
T: Call another student and instruct him to push the lower balloon inside. What happens to the small balloon?
S2: The balloon deflates  
(The empty bottles represent the chest cavity, Straw as trachea, small balloon as lungs and large balloon as diaphragm)

PHASE –IV: Experimentation  
S2: (Students perform the experiment as shown by the teacher and the teacher assists.)  
T: What happens when the diaphragm is pulled down?  
S3: The balloon inflates.  
S4: The volume of the cavity increase.  
T: Yes, (call another student and ask him to push the diaphragm inside) what you have observe now?  
S5: It deflates.  
T: Yes, Can anyone tell me why it happens?  
S3: The volume of the cavity decrease.  
T: Yes.  
(The teacher explains as the diaphragm is pulled down, the volume of the cavity increases. This causes the pressure to fall. Air rushes into to equalize the pressure causing the balloon to inflate. As the diaphragm is pushed up, the volume of the cavity decreases, the pressure rises, and the air ruses out of the balloon causing them to deflate.

PHASE-V: Analysis of Result  
The teacher asks the students to present their results. (Based on the experiment performed by the students)  
T: How many lungs we have?  
S1: Two.  
T: Yes, Name the organ through which the air enters our body?  
S3: Mouth.  
S4: Through nose.  
T: Yes through nose. Name the tube which allows the air to go to the lungs?  
S4: Trachea.  
T: Yes, when our lungs inflate.
S5: When we inhale air.
T: Yes
The teacher assists the students in shaping the explanation related to the problem. In this way, the students derive the inference.
The teacher summaries the events in a logical sequence
পর্যবেক্ষন-পত্র:

বিদ্যালয়ের নাম:
ছাত্রের নাম:
শ্রেণী:
প্রথম পর্যায় - সমস্যার সম্পূর্ণ হওয়া -

বিষয়:
সময়:

দ্বিতীয় পর্যায় - যাচাইকরণ -

তৃতীয় পর্যায় - তথ্যসংগ্রহের প্রক্রিয়া -

চতুর্থ পর্যায় - ব্যাখ্যাকরণ (তথ্য প্রতিষ্ঠাকরণ) -

পঞ্চম পর্যায় - অনুসন্ধানের প্রক্রিয়ার বিশ্বেষণ -

xxx
অন্তর্ভুক্ত নাম:
ক্ষেত্র:
প্রথম পার্শ্ব - সমস্যার সম্ভূমিতে
(শিক্ষাকর্মীর একটি বাণ্ডর ত্রিতে একটি চেন্ট বাণ্ডর করে শিক্ষাকর্মীর
pর্যাকারক করে তার সম্ভূম তাদের চিকি প্রশ্ন করার জন্ত উৎসাহিত করবে।)

দ্বিতীয় পার্ষ্ব - বাচাইকরণ

তৃতীয় পার্ষ্ব - তথ্যসংগ্রহের প্রক্রিয়া:

চতুর্থ পার্ষ্ব - বাণ্ডরণ (মথ পতিভাগ করন):

পঞ্চম পার্ষ্ব - অনুসন্ধানের প্রক্রিয়ার বিশ্লেষণ:
ANNEXURE-II-C

পর্যবেক্ষণ-পর্যায়:

বিদ্যালয়ের নাম:
ছাত্র/ছাত্রী নাম:
শ্রেণী:
প্রথম পর্যায়-সমস্যার সম্ভাবনা হওয়া

(শিক্ষক শিক্ষার্থীদের একটি বাবতে পারোক্ষ তাড়িত দেখিয়ে ও
tাকে অল করে পর্যবেক্ষণ করে তাদের সম্পর্কে বিভিন্ন প্রশ্ন
করার জন্য উৎসাহিত করবেন।
)

দ্বিতীয় পর্যায় - বাচাইকরণ

তৃতীয় পর্যায় - তথ্যসংগ্রহের প্রক্রিয়া:

চতুর্থ পর্যায় - ব্যাখ্যাকরণ (টথা প্রতিষ্ঠাকরণ):

পঞ্চম পর্যায় - অনুসন্ধানের প্রক্রিয়ার বিশ্লেষণ:
ANNEXURE-II-D

নির্দেশিত প্রক্রিয়াগুলি পেঞ্জ করুন।

প্রথম পর্যায় - সমস্যার সমুচিত হওয়া
(পিংক পিলাসের একটি উন্ডিবেলে শুকনো অণুমানিক তালিকা এবং অনুমান যথে সাহায্য
প্রতিয়ে নেওয়া যেন কে প্রক্রিয়া করে তার অভ্যন্তর বিভিন্ন প্রতি করার জন্য উৎসাহিত করেন।
)

দ্বিতীয় পর্যায় - যাচাইকরণ

তৃতীয় পর্যায় - তথ্যাণ্ডার প্রক্রিয়া:

চতুর্থ পর্যায় - ব্যাখ্যকরণ (তথ্য পতিতাকরণ):

পঞ্চম পর্যায় - অনুসন্ধানের প্রক্রিয়ার বিবেচনা:
ANNEXURE-III

Respiratory system in a Human being

The lungs and alveoli and their relationship to the diaphragm and capillaries
Respiratory system in an insect

Respiratory system in an Fish

Respiratory system in an Bird

Respiratory system in an Frog

Amphibian lungs are ventral outpocketings of the gut, though they lie dorsal to it
Dear student,

Improving educational standard involves changes in the process of classroom teaching. The need of the hour is to develop new instructional strategies, design ways to implement them and to develop training strategies to train the student-teachers. This questionnaire is to gather your opinion about one such training strategy. The data will be kept confidential and used for research purpose only. Your cooperation is solicited in this academic venture.

Thanking you,

Yours sincerely,

Kabita Dey
(Researcher)

Please fill in the following personal data:
1. Name of Teacher trainee:
2. Sex: Male / Female
3. Locality: Urban / Rural
4. Name of the Institution:

A. Choose the correct answer and mark it by a tick (√).

1. Inquiry means-
   a. To describe an event
   b. To investigate and solve a problem
   c. To listen to teachers instruction
   d. To read out textual matter loudly

2. Inquiry Training Model was designed by-
   a. Ausubel
   b. Skinner
   c. Hilda Taba
   d. Richard Suchman
3. An inquiry training class requires
   a. Explanation to be given by teachers
   b. Passive listening by students.
   c. Active participation by all the students in the classroom
   d. Laboratory work to be performed by students.

4. In Inquiry Training Model students gather data by-
   a. Direct experimentation
   b. Questioning (Yes/No answer type)
   c. Taking teacher’s guidance and using Textbooks
   d. Manipulation of facts

5. The Inquiry Training Model has following stages-
   a. Two
   b. Three
   c. Four
   d. Five

6. An inquiry session ends only after-
   a. Teacher suggests a possible explanation
   b. Analysis of inquiry session is made
   c. Data is gathered by asking Yes/No answer type question
   d. A hypothesis is proposed

7. Which one is an instructional effect of ITM?
   a. Development of creativity
   b. Development of social adjustment
   c. Development of independence of learning
   d. Development of scientific process skills.

B. Match the phases of syntax of ITM with phase number:

   (a) One         1. Analysis of Inquiry process (   )
   (b) Two         2. Encounter with the problem (   )
   (c) Three       3. Data gathering-verification (   )
   (d) Four        4. Data gathering-Experimentation (   )
   (e) Five        5. Formulation of an explanation (   )
## ANNEXURE-V
### Attitude Scale on the ITM

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Statements</th>
<th>Responses</th>
<th>Chi-Square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It provides opportunity to think independently.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I get frustrated when my hypothesis gets rejected.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>It helps in developing independent study habit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I get motivated when I see others asking questions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>It does not provide freedom for thinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Others subjects It does not provide freedom for thinking should also be taught by this method.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>It does not help in developing self-confidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I remain active while teaching through this model.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>It is not conducive to developing scientific process skill.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I can develop a new hypothesis on the basis of other ideas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I fell exhausted quickly during teaching through this model.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>It is time consuming yet no through understanding of the subject.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>This model is good for learning how to ask pinpointed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>It does not help in developing analytical ability.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>It is difficult to maintain discipline during teaching.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Without any hesitation I can ask questions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.NO.</td>
<td>STATEMENTS</td>
<td>RESPONSES</td>
<td>CHI-SQUARE</td>
<td>SIGNIFANT</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>The model of teaching is very difficult to implement.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>My Head of Institution will give academic support for implementing the model of teaching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I don’t understand the theory underlying the models.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>My Head of Institution does not allow any change in the time-table.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I am ready to implement provided my work-load is reduced.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I have lost faith in educational innovations.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>I am ready to implement provided I get additional increment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Models of teaching are more useful in those institutions where hardware facilities are available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I don’t have time for its preparation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>The space facilities required for implement the model of teaching are not available in my institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The institutional materials required for implementing the models of teaching are not available in my institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>The models of teaching need not to be applied as these may not improve teacher training programme.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Students-teachers of my institution will find it difficult to understand even the theoretical part of the model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>The use of the models of teaching in our teacher training institutions is not practicable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Through this practice I could not develop abilities needed for implementing of the models of teaching.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I am sure the models of teaching can improve the quality of teacher training programme.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Through this practice I could not develop abilities needed for implementing of the models of teaching.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>The implementation of the models of teaching will not have any financial burden on my institution</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE-VII

নামঃ

শিক্ষামূর্তি

১) জীবন সময়ে বিদেশে যান

২) ফরাসি ভাষা পার নাম

৩) কিছু শেলে যোগ করে খুশু শেলে

৪) আলগাদের উপকৃতিতে আমি বাছাই হলাম

৫) মিথ্যায় প্রতিষ্ঠিত হয়

৬) এই শিক্ষা বিষয়ে রেকর্ড করে

৭) ব্যাঙ্ক পাত্র - এই ধারণ

৮) প্রতিদিনের যে ধারণ

৯) পরীক্ষণে বা বিশেষ প্রয়োজন

১০) অমিনি - এই অভিযোগে যে কথা হয়

১১) এক ফুলফুলের কথা

১২) পরমাণু এক নামে বয়ে গেল যোগ

১৩) হলো উড়িনের জন্য কিছু প্রতিনিধি

১৪) ব্যাঙ্ক প্রতি যা অনলাইনের ফি

১৫) মূর্ত বদ্ধ মুহুর্তে যারা বেঁধে গেল

১৬) ব্যাঙ্ক প্যাসপোর্ট এর নাম

১৭) বিজ্ঞাপনে রেকর্ড হয়

১৮) ব্যাঙ্কে গোল বিভাগ যা বাঁধন

১৯) ফাঁদার আত্মীয় যাকাত

২০) ফাঁদার ধরণ
ANNEXURE-VIII

SOLAT

NAME:                              AGE:
CLASS:                              SEX:
SCHOOL:                             DATE:

DIRECTIONS

Please read the following statements carefully. Each statement has two parts ‘a’ and ‘b’, followed by boxes in the end. Put a tick mark in the box whichever statement is true for you. You may tick both the statements in a pair if both are true for you or you may leave both the statements if none of them are true for you.

(NOTE: LEAVE BOTH THE STATEMENTS BLANK ONLY IF IT IS IMPOSSIBLE FOR YOU TO DECIDE).

1. I understand clearly the information passed through by actions. a□
   I understand clearly the information passed through by words. b□

2. I have the habit of talking while reading or writing. a□
   I need complete silence while reading or writing. b□

3. I can learn best in the class when the instructor uses Visual presentation. a□
   I can learn best in the class when the instructor uses verbal presentation. b□

4. I like to draw pictures. a□
   I like to write and talk. b□

5. I like to express my feelings through dance, drama, poetry and songs. a□
   I like to express my feelings openly in words. b□

6. I like to learn things by handling light tools and electronic items in a laboratory. a□
   I like to learn things by handling machines in industries. b□

7. I like modifications of lessons without planning for learning apart from syllabus. a□
   I like planned lessons for learning as per syllabus. b□

8. I like to learn lessons by main ideas. a□
   I like to learn lessons by detailed and specific facts. b□

9. I like to write, imaginative stories. a□
   I like to write essays and articles. b□
10. I like to learn through exploration.  
   I like to learn through examination.
11. I get clarity while learning experimentally.  
   I can learn easily through logical reasoning, without experiment.
12. I understand things when a matter is analysed as a whole.  
   I understand things when a matter is analysed in parts.
13. I understand lessons easily when taught through examples.  
   I understand lessons easily when taught through concepts or summary.
14. I take time to understand and follow habits.  
   I easily understand and follow habits.
15. I am not interested in games and sports.  
   I am interested in games and sports.
16. I can give various answers in different forms and ways to a particular question.  
   I can give only one answer to a particular question.
17. I can concentrate on several things at a time.  
   I can concentrate on things one by one.
18. I like to try to be better than other students.  
   I do not like always trying to be better than other students.
19. I like to work by myself.  
   I like to work in a group.
20. I can work by myself, by adjusting with other in the class.  
   I cannot adjust or tolerate in the class which I dislike.
21. I like to invent something new in an imaginative way.  
   I like to improve upon the existing one.
22. I like to solve complex problems smoothly.  
   I like to solve simple problems.
23. I am interested in artistic and aesthetic works.  
   I am interested in worldly affairs.
24. I am interested in knowing activities and characters of men.  
   I am interested in knowing activities and characters of women.
25. I am interested in funny things.
I am not interested in funny things.

26. When I think about a matter I think about it as a whole unit.
   When I think about a matter I think it in segments and its merits and demerits

27. I can remember my friends through faces rather than their names
    I can remember my friends through names rather than their faces.

28. I can remember and recall shapes and figures.
    I can remember and recall languages and numerical figures.

29. I can identify a person through his voice.
    I can identify a person through his speech.

30. I can organize and express the ideas with examples.
    I can organize and express in a sequence as they occur.

31. I can find out theory through facts and examples.
    I can find out facts through theory.

32. I like to solve problems through independent thinking.
    I like to solve problems with the opinion of others.

33. I think deep while leaning down.
    I think deep while sitting erect.

34. I can easily find out directions even in unfamiliar places.
    I can easily find out directions only in familiar places.

35. I like to guess results.
    I am not interested in guessing results.

36. I think creatively to solve problems.
    I think intellectually to solve problems.

37. I like to pre-plan things which I have to do.
    I like to day-dream things which I have to do.

38. I like to solve problems by analyzing the reasons through internal feelings.
    I like to solve problems by analyzing the reasons through intelligence.

39. I judge things through experience and internal inspirations or feelings.
    I judge things through logical reasons.

40. I like to solve problems in a playful way.
    I like to solve problems in a business like approach.
41. I forget things which I have to do.  
   I never forget things which I have to do.
42. I hope that everything will be all right.  
   I feel that everything will be a failure.
43. I do not have the nature of punishing others, when things go bad for me.  
   I have the nature of punishing others, when things go bad for me.
44. I am always peaceful even when facing problems.  
   I get aggressive and angry easily when facing problems.
45. I have strong determination and ambition to be successful in every matter.  
   I hope or feel to be successful in every matter.
46. I have strong memory and remembrance for images and pictures  
   I have strong memory and remembrance for voices.
47. I can do things by imagination.  
   I can do things after knowing and analyzing.
48. I have the ability to tell the characteristic features of an object by touching  
   I have no ability to tell the characteristic features of an object by touching.
49. I can imagine and summarize matters.  
   I can give outline of matters.
50. I can imagine incidents occurred in the past.  
   I can analyze details of incidents occurred in the past.

FOR OFFICE USE ONLY

R Scores □

L Scores □

W Scores □

HEMISPHERECITY □

(Brain Dominance)
ANNEXURE-IX

Achievement - Test

Name- 
Class- 
Name of the school- 

Choose the correct answer-

1. Which one is the main respiratory organ in whale-skin /lungs /gills /trachea

Which organ is the main respiratory organ in a whale?

- Skin
- Lungs
- Gills
- Trachea

Subject-Life science
Total marks-25
Time- 20 min.

2. The respiratory organ in lizard is-skin /nephridia/external gills/ lungs

Which organ is the respiratory organ in a lizard?

- Skin
- Nephridia
- External gills
- Lungs

3. Trachea is a respiratory organ in-cockroach/ fish/ lizard/earthworm

Where is the trachea found in an organism?

- Cockroach
- Fish
- Lizard
- Earthworm

4. The respiratory organ in crocodile is-skin /lungs /gills /trachea

What is the respiratory organ of a crocodile?

- Skin
- Lungs
- Gills
- Trachea

5. The respiratory organ in cockroach is-

What is the respiratory organ of a cockroach?

- Skin
- Lungs
- Gills
- Trachea
skin/lungs/gills/trachea

6. The respiratory organ in grasshopper is -
   lungs/gills/skin/wind pipe

7. The energy released during respiration is -
   heat energy/light energy/static energy/chemical energy

8. The total amount of ATP released during respiration is -
   2 molecule/38 mol./38 mol./50 mol.

9. Aerobic respiration does not take place in -
   earthworm/cockroach/prawn/round worm

10. Kreb's cycle occurs in -
    endoplasmic reticulum/cytoplasm/mitochondria/lysosome

11. Respiration occurs in plants through -
    root/stem/leaves/stomata
12. The process in which glucose is converted into pyruvic acid:

EMP path/TCA cycle/ terminal respiration /Kelvin cycle

13. The process of intake of O₂ and given out CO₂:

photosynthesis/respiration/transpiration/excretion

14. The respiratory organ in butterfly is:

booklung/bookgill / trachea/none

15. The total number of air sac in region is:

9 pairs /10 pairs /only 9 /8 pairs

16. Accessory respiratory organ found in - catla catla/ rohu/anabas/hilsa

আত্মিক শ্রাস্ত আঁধার মাছ হল -
রুই মাছ /কাতলা মাছ /কাই মাছ / ইলিশ মাছ
17. The main respiratory substrate in cell is-
   glucose/ protein/ fat/ water

বেলেরে প্রধান শুসন কোনোটি হল -
   গ্লুকোজ / প্রোটিন / ফ্যাট / জল

18. Alveoli is a part of -
   liver/ lungs/skin/kidney

আলভিউলাস কোন অস পাওয়া যায় -
   ব্যাকুট / প্যাসকুট / ভুক / দুধ

19. ............... is a respiratory pigment.
   haemoglobin/ lymph/ water

-------- একটি শুসস্ত্রু যে।
   হিমোগ্লোবিন / ল্যুম্ব / জল

20. During respiration, the exchange of gases takes place in-
   Bronchi / alveoli / bronchioles / trachea

ক্ষনকুলে - কোন জাগায় গ্লুক আলভিউলাস হয় -
   ব্রোঞ্জিস / আলভিউলাস / এপ্রোগ্লোবিন / সেনলাতলি

21. One of the following organisms can live without Oxygen of air. This organism is -
   Amoeba / yak / yeast / leech

কোন প্রাণীর অজিজেন ছাড়া জীবন পারে -
   অমোব্যা / চামীর গায় (ইয়েক) / ইস্ট / লোক
22. Which of the following increases in the muscle cells when there are lacking oxygen?

Carbon dioxide / Lactose / Lactic acid / Uric acid

অর্জিয়েনের অভাবে পেশির মধ্যে কোনটি বৃদ্ধি পায় -

কার্বনডাইঅক্সাইড / ল্যাকটোস / ল্যাকটিক আসিড / ইউরিক আসিড

23. When air is blown from mouth in to a test-tube containing lime water, the lime water turns milky due to presence of -

oxygen / Carbon dioxide / nitrogen / water vapour

চুনের জলে মুখ দিয়ে ফু দিলে চুনের জল সাদা হয়ে যায় কেন -

অর্জিয়েন / কার্বনডাইঅক্সাইড / নাইট্রাজেন / জলীয় পাপ

24. Which of the following is the correct sequence of air passage during inhaling—

বাস নেওয়ার (প্রক্রিয়া) প্রত্যায় কে ক্রমে সাজাও -

(a)Larynx- Pharynx- Trachea- Lungs

ল্যারিঙ্ক - প্রায়ম - ট্রাক্চিয়া - ল্যাঙ্গ্স

(b)Nasal passage-Trachea-Pharynx-Larynx-Alveoli

শ্বাসনালি - ট্রাক্চিয়া - প্রায়ম - ল্যারিঙ্ক --আলীলিউলাই

(c)Larynx- Nostril-Pharynx-Lungs

ল্যারিঙ্ক - নাসোরাই - প্রায়ম - ল্যাঙ্গ্স

(d)Nostril-Pharynx-Larynx-Trackia-Alveoli
25. Match the following parts -

বিভিন্ন অংশগুলি সতিক ভাবে সাজাও -

1. stomata (রন্ধ্র)

2. Accessory respiratory organs
   (অতিরিক্ত শ্বাসযন্ত্র)

3. Guard cell (রক্ষীকোষ)