Chapter-VI

INTERPRETATION OF THE RESULTS AND DISCUSSION
CHAPTER VI

INTERPRETATION OF THE RESULTS AND DISCUSSION

6.1 INTRODUCTION

In the preceding chapter V we have discussed about the analysis of the collected data in respect of the concerned variables like Reasoning Ability, Scientific Creativity, Attitude Towards Science and Achievement in Science. In this chapter the analyzed data is interpreted for the testing of objectives formulated for the study and the various hypotheses as stated in Section 1.7 and Section 1.8 respectively. Inferences have been drawn from each analysis and the result of the analysis is summarized as the acceptance or rejection of the hypotheses along with the discussion. These finding are discussed here under the following heads:

- Acquisition of objectives
- Improvement of Achievement in Science of IX class Students
- Development of Reasoning Ability
- Development of Scientific Creativity
- Development of favorable Attitude Towards Science

6.2 ACQUISITION OF OBJECTIVES

All the objectives framed under Section 1.7 of this study have been explained in the following manner.

1. To prepare the lessons based on Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching on some topics of Science in IX class.
This objective was fulfilled by developing lesson plans for the experimental groups A, B and a control group C using Concept Attainment Model of teaching, Inductive Thinking Model of teaching, and Traditional Method of teaching respectively based on selected contents of the study in Science at class IX stage (Appendix A, B and C). These lesson plans were used for treatment on the respective groups.

2. To study the effectiveness of Concept Attainment Model of teaching on students' Achievement in IX Science.

For achieving this objective the experimental group A was taught some topics of Science in IX class through Concept Attainment Model of teaching. The Achievement Test prepared by the researcher herself based on the content of IX Science was administered on the students of IX class for recording the score of the students on Achievement in Science. This objective has been achieved by testing the hypothesis $H_012$.

3. To study the effectiveness of Inductive Thinking Model of teaching on students' Achievement in Science of IX class.

For achieving this objective the experimental group B was taught some topics of Science in IX class through Inductive Thinking Model of teaching. Achievement Test based on the content of IX Science was administered on the students of IX class for recording the score of the students on Achievement in Science. This objective has been achieved by testing the hypothesis $H_013$.

4. To study the effectiveness of Traditional Method of teaching on students' Achievement in Science of IX class.

For achieving this objective the control group C was taught some topics of Science in IX class through Traditional Method of teaching. Achievement Test based on the content of IX Science was administered on the students of IX class for recording the score of the students on Achievement in Science. This objective has been achieved by testing the hypotheses $H_012$ and $H_013$. 
5. To study the effectiveness of teaching through Concept Attainment Model of teaching on development of Reasoning Ability of students.

\[ t\text{-value was computed for mean difference of the post-test scores of experimental group A taught through Concept Attainment Model of teaching with its pre-test scores in terms of Reasoning Ability of students. This objective has been achieved by testing the hypothesis } H_{o1}. \]

6. To study the effectiveness of teaching through Concept Attainment Model of teaching on development of students Scientific Creativity.

This objective was studied by comparing mean difference of the post-test scores of experimental group A taught through Concept Attainment Model of teaching with its pre-test scores, using t-test in terms of the variable Scientific Creativity of students. This objective has been achieved by testing the hypothesis \( H_{o2} \).

7. To study the effectiveness of teaching through Concept Attainment Model of teaching on development of favourable Attitude of the students Towards Science.

\[ t\text{-value was computed for mean difference of the post-test scores of experimental group A taught through Concept Attainment Model of teaching with its pre-test scores, in terms of students Attitude Towards Science. This objective has been achieved by testing the hypothesis } H_{o3}. \]

8. To study the effectiveness of teaching through Inductive Thinking Model on development of Reasoning Ability of students.

This objective was studied by comparing mean difference of the post-test scores of experimental group B taught through Inductive Thinking Model of teaching with its pre-test scores, using t-test in terms of Reasoning Ability of students. This objective has been achieved by testing the hypothesis \( H_{o4} \).

9. To study the effectiveness of teaching through Inductive Thinking Model on fostering of students Scientific Creativity.
t-value was computed for mean difference of the post-test scores of experimental group B taught through Inductive Thinking Model of teaching with its pre-test scores in terms of Scientific Creativity of students. This objective has been achieved by testing the hypothesis $H_{05}$.

10. To study the effectiveness of teaching through Inductive Thinking Model on development of favourable Attitude of the students Towards Science.

This objective was studied by comparing mean difference of the post-test scores of experimental group B taught through Inductive Thinking Model of teaching with its pre-test scores, using $t$ - test in terms of students Attitude Towards Science. This objective has been achieved by testing the hypothesis $H_{06}$.

11. To study the effectiveness of teaching through Traditional Method on development of Reasoning Ability of students.

$t$-value was computed for mean difference of the post-test scores of control group C taught through Traditional Method of teaching with its pre-test scores in terms of Reasoning Ability of students. This objective has been achieved by testing the hypothesis $H_{07}$.

12. To study the effectiveness of teaching through Traditional Method on development of students Scientific Creativity.

This objective was studied by comparing mean difference of the post-test scores of control group C taught through Traditional Method of teaching with its pre-test scores, using $t$ - test in terms of Scientific Creativity of students. This objective has been achieved by testing the hypothesis $H_{08}$.

13. To study the effectiveness of teaching through Traditional Method on development of favourable Attitude of the students Towards Science.

$t$-value was computed for mean difference of the post-test scores of control group C taught through Traditional Method of teaching with its pre-test scores in terms of students Attitude Towards Science. This objective has been achieved by testing the hypothesis $H_{09}$.
14. To study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching on students' Achievement in Science.

The objective was achieved by testing various hypotheses formulated for the study of relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching through computation of F-ratio and t-value of mean difference of post test scores of group pairs on students' Achievement in Science. This objective has been realized by testing hypotheses numbers H₀10, H₀11, H₀12 and H₀13.

15. To study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching on development of Reasoning Ability of students.

The objective was achieved by testing various hypotheses formulated for study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model of teaching and Traditional Method of teaching through computation of F-ratio and t-value of mean difference of post-test scores on development of Reasoning Ability of students. This objective has been realized by testing hypotheses numbers H₀14, H₀15, H₀16 and H₀17.

16. To study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method on fostering of students Scientific Creativity.

The objective was achieved by testing various hypotheses formulated for the study of relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model of teaching and Traditional Method of teaching through computation of F-ratio and t-value of mean difference of post test scores on Verbal Test of Scientific Creativity on the students of IX class. This objective has been realized by testing hypotheses numbers H₀18, H₀19, H₀20 and H₀21.

17. To study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method on development of favourable Attitude of the students Towards Science.
The objective was achieved by testing various hypotheses formulated for the study the relative effectiveness of teaching through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching through computation of F-ratio and t-value of mean difference of post test scores on Science Attitude Scale to measure the development of favourable Attitude of the students Towards Science. This objective has been realized by testing hypotheses numbers $H_022$, $H_023$, $H_024$ and $H_025$.

6.3 IMPROVEMENT OF ACHIEVEMENT IN SCIENCE OF IX CLASS STUDENTS

The finding in this section indicates that the experimental groups A and B perform better than that of control group C in improving Achievement of IX class students in Science. Where the experimental groups A and B were taught through Concept Attainment Model of teaching and Inductive Thinking Model of teaching respectively. The control group C was taught through Traditional Method of teaching. To study the differential effectiveness of these groups on improving Achievement of IX class students in Science, hypotheses $H_010$, $H_011$, $H_012$ and $H_013$ are tested as follows:

$H_010$: There is no significant difference between the mean score of Achievement of IX class students in Science taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This hypothesis when tested by calculated F-ratio through ANOVA in the section 5.6 (Table-5.10), which is 17.6. This value of F-ratio was found significant at 0.05 and 0.01 levels of significance for 2/374 degrees of freedom. Due to this significant F-value, the hypothesis $H_010$ is there by rejected. Thus the treatment had differential effects in these three groups on criterion variables, i.e. improvement of Achievement of IX class students in Science at the end of the experiment. It could be inferred that there is a significant difference between the mean score of these three groups of IX class students in Science taught through Concept Attainment Model, Inductive Thinking Model of teaching and Traditional Method of teaching.
As all these treatments had differential effect on the variable, pair wise differential effects are further investigated through t-values by testing hypotheses \( H_{011}, H_{012} \) and \( H_{013} \).

\( H_{011} \): There is no significant difference between the mean score of Achievement of IX class students in Science taught through Concept Attainment Model and Inductive Thinking Model of teaching.

As seen in section 5.6.1-I (Table-5.11), the t-value of Achievement Test in Science for mean difference of experimental groups A and B taught through Concept Attainment Model and Inductive Thinking Model of teaching respectively is 0.52. This t-value is non-significant at 0.05 and 0.01 levels of significance for 249 degrees of freedom, thus the hypothesis \( H_{011} \) was therefore accepted.

Hence it could be inferred that these two groups did not differ significantly on improvement of IX class students in Science after the treatment. Since there is no significant difference in the mean scores, the two experimental groups A and B can be said to have performed equally well on Achievement in Science of IX class students even as a result of differential treatments.

Hence the acceptance of the hypothesis \( H_{011} \) evident that the Concept Attainment Model and Inductive Thinking Model performed equally on students' Achievement in Science.

\( H_{012} \): There is no significant difference between the mean score of Achievement of IX class students in Science taught through Concept Attainment Model and Traditional Method of teaching.

The t-value for mean difference of experimental group A and the control group C is 5.95 as given in Section 5.6.1-II (Table-5.11). This t-value is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom, which show that the hypothesis \( H_{012} \) is there by rejected. Thus there is a significant difference between the mean score of Achievement of IX class students in Science taught through Concept Attainment Model and Traditional Method of teaching. Hence it could be inferred that group A performed better on improvement of IX class students in Science as a result of treatment as compared to group C, which were
taught through Concept Attainment Model of teaching and the Traditional Method of teaching respectively. Hence, the rejection of the hypothesis $H_{012}$ and gain in the mean score of the group A implies that the Concept Attainment Model performed better than the Traditional Method of teaching on students' Achievement in Science.

$H_{013}$: There is no significant difference between the mean score of Achievement of IX class students in Science taught through Inductive Thinking Model and Traditional Method of teaching.

Section 5.6.1-III (Table-5.11) shows that the t-value for mean difference of experimental group B and control group C is 4.98. Since this t-value is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom, hypothesis $H_{013}$ is thereby rejected. Thus there is a significant difference between the mean score of Achievement of IX class students in Science taught through Inductive Thinking Model and Traditional Method of teaching. This difference of mean is in favour of group B (greater mean score), it could be inferred that group B performed better on Achievement of IX class students in Science as a result of treatment as compared to group C. Where group B was taught through Inductive Thinking Model of teaching and the group C was taught through the Traditional Method of teaching. Hence the rejection of the hypothesis $H_{013}$ and gain in the mean score of the group B implies that the Inductive Thinking Model performed well than the Traditional Method of teaching on students' Achievement in Science.

Discussion:

It can be derived from these results that Concept Attainment Model and Inductive Thinking Model of teaching have greater opportunities for improvement of Achievement as students respond to the active learning, encourages by the inductive process by the concept formation and Concept Attainment Model. Both of these models are an excellent evaluation tools when teachers want to determine whether important ideas introduce earlier have been mastered and they facilitate child centered approach to teaching and they stress active involvement of learners in teaching learning process.

Concept Attainment Model provides a way of delivering and clarifying concepts and train students to become more effective at developing
concepts, it engage students into formulating concepts through the use of examples. It quickly reveals the depth of the students understanding and reinforces their previous knowledge. Though these two information models of teaching referred here lead to improvement in Achievement of IX class students in Science.

From the result presented through caption 5.6, 5.6.1 (I, II and III) it has been observed that Concept Attainment Model and Inductive Thinking Model of teaching are more effective significantly in terms of improving the Achievement in Science of IX class students than Traditional Method of teaching.


Thus from the present findings it is also clear that Concept Attainment Model and Inductive Thinking Model of teaching are equally effective in improving Achievement in Science among IX class students and both of these models are more effective than Traditional Method of teaching.

6.4 DEVELOPMENT OF REASONING ABILITY

In this section the findings and hypotheses relating to development of Reasoning Ability in reference of individual effectiveness and relative effectiveness in case of Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching are discussed. The findings in this sections indicate that Concept Attainment Model and Inductive Thinking Model of teaching are quite effective in developing the Reasoning Ability among students of experimental groups A and B than the students of control group C taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching respectively.

6.4.1 Individual Effectiveness

Individual effectiveness has been tested through the t-value of the difference of mean scores between the pre-test and post-test in each group on the variable Reasoning Ability.
H₀₁. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model of teaching.

The section 5.4.1(i) (Table-5.1) presents t-value (9.12) for the difference between mean score on Reasoning Ability at pre-test and post-test stage on group A taught through Concept Attainment Model. This t-value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom and thus the hypothesis H₀₁ is thereby rejected. Thus there is a significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model of teaching.

This inferred that the Concept Attainment Model of teaching is effective in developing Reasoning Ability among the students of group A as established by the significant standard error of mean difference. The gain in scores between pre-test and post-test stage also supports the above inference for effective teaching through Concept Attainment Model of teaching.

H₀₄. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Inductive Thinking Model of teaching.

The t-value for mean difference of pre-test and post-test scores of experimental group B on Reasoning Ability is 7.42 as given in section 5.4.2(i) (Table-5.3). This t-value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom therefore the hypothesis H₀₄ is rejected. Thus there is a significant difference between the mean score of IX class students in developing Reasoning Ability taught through Inductive Thinking Model of teaching.

This shows that the group B taught through Inductive Thinking Model of teaching perform better in developing Reasoning Ability among the students as established by the significant standard error of mean difference between pre-test and post-test scores. The gain in mean scores between pre-test and post-test stage also shows that there is a gain in scores of the students of group B on Reasoning Ability as a result of treatment through Inductive Thinking Model of teaching.
H₀⁷. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Traditional Method of teaching.

The section 5.4.3(i) (Table-5.5) shows that the t-value for the mean difference of pre-test and post-test scores of control group C on Reasoning Ability is 2.26, which is non-significant at 0.01 level of significance for 126 degrees of freedom hence the hypothesis H₀⁷ is there by accepted. Thus there is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Traditional Method of teaching. This inferred that the group C taught through Traditional Method of teaching was not effective in developing Reasoning Ability among the students as established by the non-significant standard error of mean difference. The gain in the mean scores between pre-test and post-test stage also supports this inference that the Traditional Method of teaching is not effective.

6.4.2 Relative Effectiveness

Relative effectiveness has been determined by t-value of the difference of mean scores between the post-test scores of the group pairs AB, AC and BC on the criterion variable Reasoning Ability.

H₀¹⁴. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This hypothesis when tested by calculated F-ratio through ANOVA in section 5.7 (Table-5.12), which is 10.88. This value of F-ratio was found significant at 0.01 and 0.05 levels of significance for 2/374 degrees of freedom. Due to this significant F-value, the hypothesis H₀¹⁴ was, therefore, rejected. Thus there is a significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model, Inductive Thinking Model, and Traditional Method of teaching.

This is further supported by the significant F-ratio at 0.01 and 0.05 levels of significance for 2/374 degrees of freedom (Table-5.13), which is 11.67 through the ANOVA of gain scores of experimental groups A, B and a control
group C taught through above models respectively on Reasoning Ability. This shows that the treatment had differential effects in these three groups on development in Reasoning Ability of the students at post-test stage as well as in gain scores.

As all these treatments had differential effect on the variable Reasoning Ability, pair wise differential effects are further investigated through the t-values by testing hypotheses H₀15, H₀16 and H₀17.

H₀15. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model and Inductive Thinking Model of teaching.

The t-value for mean difference of post-test scores of experimental groups A and B taught through Concept Attainment Model and Inductive Thinking Model of teaching, respectively on Reasoning Ability is 0.56 as shown in Section 5.7.1-I (Table-5.14). Due to this non-significant t-value at 0.01 and 0.05 levels of significance for 249 degrees of freedom the hypothesis H₀15 is there by accepted. Thus there is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model and Inductive Thinking Model. Hence it could be inferred that these groups did not differ significantly on development in Reasoning Ability of the students after the treatment. Thus the two groups A and B can be said to have performed equally on Reasoning Ability before and after the treatments.

This can be further supported by non-significant t-value (1.04) in gain scores of these two groups (Table-5.15) on Reasoning Ability as a result of treatments. Thus Concept Attainment Model and Inductive Thinking Model of teaching are equally effective on development in Reasoning Ability of the students of IX class.

H₀16. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model and Traditional Method of teaching.

Section 5.7.1-II (Table-5.14) presents the t-value (4.34) for the mean difference of post-test scores of experimental group A and control group C on
Reasoning Ability, which is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom and thus the hypothesis $H_0.16$ was, therefore, rejected. Thus there is a significant difference between the mean score of IX class students in developing Reasoning Ability taught through Concept Attainment Model and Traditional Method of teaching. It could be inferred that group A taught through Concept Attainment Model performed better on development in Reasoning Ability of the students as a result of treatment as compared to group C taught through the Traditional Method of teaching.

This is further evidenced by significant t-value (4.55) between the mean gain scores on Reasoning Ability of these two groups (Table-5.15) as a result of treatment. Thus Concept Attainment Model of teaching is more effective in developing the Reasoning Ability among the students of IX class than the Traditional Method of teaching.

$H_0.17$. There is no significant difference between the mean score of IX class students in developing Reasoning Ability taught through Inductive Thinking Model and Traditional Method of teaching.

The t-value for mean difference of post-test scores of experimental group B and control group C taught through Inductive Thinking Model and Traditional Method of teaching, respectively on Reasoning Ability is 3.81 as shown Section 5.7.1-III (Table-5.14). This t-value is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom, Hypothesis $H_0.17$ was therefore, rejected. Thus there is a significant difference between the mean score of IX class students in developing Reasoning Ability taught through Inductive Thinking Model and Traditional Method of teaching. It could be inferred that experimental group B performed better on development in Reasoning Ability of the students as a result of treatment as compared to control group C.

This is further confirmed by significant t-value (3.56) between the gain scores of these two groups on Reasoning Ability (Table-5.15) as a result of treatment. Thus Inductive Thinking Model of teaching is more effective in developing the Reasoning Ability among the students of IX class than the Traditional Method of teaching.
Discussion:

It can be derived from these results that Concept Attainment Model and Inductive Thinking Model of teaching have greater opportunities for development of Reasoning Ability of the students, as students respond to the active learning, encourages by the inductive process by the concept formation and concept attainment method. Also Reasoning Ability may be inductive or deductive. Concept Attainment Model and Inductive Thinking Model of teaching provides practice in inductive reasoning and opportunities for altering and improving students concept-building strategy. Concept Attainment Model is well suited to classroom use because all thinking abilities can be challenged throughout the activity with experience, children becomes skilled at identifying relationship in the words or the situations and Inductive Thinking Model of teaching helps in developing the mental abilities and emphasizing concept formation involving cognitive task. The process skills developed through these models of teaching are the factors contributing to the development of Reasoning Ability among the students.

The significantly higher outcomes on the Reasoning Ability enhancement and significantly higher outcomes on its difference in effectiveness seen in group pairs AC and BC may be because of specific instructional effects of these models and effects nurtured by teaching-learning environment created by them. There seem to be great resemblance in these models as compared to Traditional Method of teaching and the effects nurtured by them with respect to the traits needed for this variable development through scientific methodology of tasks developed for teaching activity and a number of specific objectives. Though these two information models of teaching referred to here lead to development in Reasoning Ability of the students.

From the result presented through caption 5.4.1(i), 5.4.2(i), 5.4.3(i), 5.7, 5.7.1 (I, II and III) it has been observed that Concept Attainment Model and Inductive Thinking Model of teaching are effective significantly in developing the Reasoning Ability among the students of IX class than the Traditional Method of teaching.

These finding are supported by Bhaveja (1989), Singh (1990), Sood (1990), Martis (1990), Kaur (1991), Jaimini (1991), Gupta (1992) etc.
From the present findings it is clear that Concept Attainment Model and Inductive Thinking Model of teaching are effective in developing the Reasoning Ability among the students. Both of these models are equally effective in developing the Reasoning Ability among the students and has greater efficacy than Traditional Method of teaching in developing the Reasoning Ability.

6.5 DEVELOPMENT OF SCIENTIFIC CREATIVITY

The findings in sections indicate that Concept Attainment Model and Inductive Thinking Model of teaching are quite effective in fostering Scientific Creativity among students as established by the significant standard error of mean difference than the Traditional Method of teaching. The findings and hypotheses relating to fostering Scientific Creativity in reference of individual effectiveness and relative effectiveness in case of Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching are discussed.

6.5.1 Individual Effectiveness

Individual effectiveness has been tested through the t-value of the difference of mean scores between the pre-test and post-test in each group on the variable Scientific Creativity.

H₀2. There is no significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Concept Attainment Model of teaching.

The section 5.4.1(ii) (Table-5.2) presents t-value (8.51) for the difference between mean score on Scientific Creativity at pre-test and post-test stage on group A taught through Concept Attainment Model. This t-value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom and thus the hypothesis H₀2 is thereby rejected. Thus there is a significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Concept Attainment Model of teaching. This inferred that the Concept Attainment Model of teaching was effective in developing Scientific Creativity among the students of group A as established by the significant standard error of mean difference.
The gain in mean scores between pre-test and post-test stage also supports the above inference for effective teaching through Concept Attainment Model of teaching.

$H_{05}$: There is no significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Inductive Thinking Model of teaching.

The t-value for mean difference of pre-test and post-test scores of experimental group B on Scientific Creativity is 7.55 as given in section 5.4.2(ii), (Table-5.4). This value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom; therefore the hypothesis $H_{05}$ is rejected. Thus there is a significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Inductive Thinking Model of teaching. This shows that the group B taught through Inductive Thinking Model of teaching perform better in developing Scientific Creativity among the students as established by the significant standard error of mean difference between pre-test and post-test scores.

The gain in mean scores between pre-test and post-test stage also shows that there is a gain in scores of the students of group B on Scientific Creativity.

$H_{08}$: There is no significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Traditional Method of teaching.

The section 5.4.3(ii) (Table-5.6) shows that the t-value for the mean difference of pre-test and post-test scores of control group C on Scientific Creativity is 2.33, which is non-significant at 0.01 level of significance for 126 degrees of freedom, hence the hypothesis $H_{08}$ is there by accepted. Thus there is no significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Traditional Method of teaching. This inferred that group C taught through Traditional Method of teaching was not effective in fostering Scientific Creativity among the students as established by the non-significant standard error of mean difference.
The gain in the mean scores between pre-test and post-test stage also supports this inference that the Traditional Method of teaching is not effective in fostering Scientific Creativity among the students.

6.5.2 Relative Effectiveness

Relative effectiveness has been determined by t-value of the difference of mean scores between the post-test scores of the group pairs AB, AC and BC on the variable Scientific Creativity.

$H_{018}$. There is no significant difference between the mean score of IX class students in terms of fostering Scientific Creativity taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This hypothesis when tested by calculated F-ratio through ANOVA in section 5.8 (Table-5.16), which is 10.14. This value of F-ratio was found to be significant at 0.01 and 0.05 levels of significance for 2/374 degrees of freedom. Due to this significant F-value, the hypothesis $H_{018}$ was, thereby rejected. Thus there is a significant difference between the mean score of IX class students in terms of fostering Scientific Creativity taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This is further supported by the significant F-ratio (Table-5.17), which is 9.85 through the ANOVA of gain scores of experimental groups A, B and a control group C taught through above models on fostering the Scientific Creativity. This shows that the treatment had differential effects in these three groups on development in Scientific Creativity of the students at post-test stage as well as in gain scores.

As all these treatments had differential effect on the variable Scientific Creativity, pair wise differential effects are further investigated through computation of the t-values by testing hypotheses $H_{019}$, $H_{020}$ and $H_{021}$.

$H_{019}$. There is no significant difference between the mean score of IX class students in terms of fostering Scientific Creativity taught through Concept Attainment Model and Inductive Thinking Model of teaching.
The t-value for mean difference of post-test scores of experimental groups A and B taught through Concept Attainment Model and Inductive Thinking Model of teaching, respectively on Scientific Creativity is 0.28 as shown in Section 5.8.1-1 (Table-5.18). Due to this non-significant t-value at 0.01 and 0.05 levels of significance for 249 degrees of freedom, the hypothesis $H_019$ is there by accepted. Thus there is no significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Concept Attainment Model and Inductive Thinking Model. Hence it could be inferred that these groups did not differ significantly on development in Scientific Creativity of the students after the treatment. Thus the two groups A and B can be said to have performed equally on Scientific Creativity before and after the treatments.

This can be further supported by non-significant t-value (0.45) in gain scores of these two groups on Scientific Creativity (Table-5.19) as a result of treatments. Thus it can be said that the Concept Attainment Model and Inductive Thinking Model of teaching are equally effective on development in Scientific Creativity among the students of IX class. $H_020$. There is no significant difference between the mean score of IX class students in terms of fostering Scientific Creativity taught through Concept Attainment Model and Traditional Method of teaching.

Section 5.8.1-1 II (Table-5.18) presents the t-value (4.11) for the mean difference of post-test scores of experimental group A and control group C on Scientific Creativity, which is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom and thus the hypothesis $H_020$ was, therefore, rejected. Thus there is a significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Concept Attainment Model and Traditional Method of teaching. It could be inferred that experimental group A taught through Concept Attainment Model performed better on development in Scientific Creativity of the students as a result of treatment as compared to control group C taught through the Traditional Method of teaching.

This is further evidenced by significant t-value (3.97) between the mean gain scores on Scientific Creativity of these two groups (Table-5.19) as a result
of treatment. Thus Concept Attainment Model of teaching is more effective in fostering the Scientific Creativity among the students of IX class than the Traditional Method of teaching.

H₀21. There is no significant difference between the mean score of IX class students in terms of fostering Scientific Creativity taught through Inductive Thinking Model and Traditional Method of teaching.

The t-value for mean difference of post-test scores of experimental group B and control group C taught through Inductive Thinking Model and Traditional Method of teaching, respectively on Scientific Creativity is 3.78 as shown Section 5.8.1-III (Table-5.18). This t-value is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom. Hypothesis H₀21 was therefore rejected. Thus there is a significant difference between the mean score of IX class students in fostering Scientific Creativity taught through Inductive Thinking Model and Traditional Method of teaching. It could be inferred that experimental group B performed better on development in Scientific Creativity of the students as a result of treatment as compared to control group C.

This is further confirmed by significant t-value (3.54) between the gain scores of these two groups (Table-5.19) on Scientific Creativity as a result of treatment. Thus Inductive Thinking Model of teaching is more effective in fostering the Scientific Creativity among the students of IX class than the Traditional Method of teaching.

Discussion:

Concept Attainment Model and Inductive Thinking Model helps students of all grades to become independent learners and critical and creative thinkers. Both of these Models are concern with acquisition and retention of concept. Concept Attainment Model provides a way of delivering and clarifying concepts and training students to become more effective at developing concepts. It helps students in developing observational and analytical abilities, and engages them into formulating concepts through the use of various examples. It also helps to make connections between what students know and why will be learning. Students also learn how to examine a concept, how to sort out relevant information and extend their
knowledge of concept by classifying more than one example. Inductive Thinking Model helps the students to develop scientific temper in them.

It can be derived from these results that Concept Attainment Model and Inductive Thinking Model of teaching have greater opportunities for development of Scientific Creativity among the students and in turn for developing thinking and logic. Though these two information-processing models of teaching referred here lead to development of Scientific Creativity in the students.

The significantly higher outcomes on fostering Scientific Creativity enhancement and significantly higher outcomes on its difference in effectiveness seen in group pairs AC and BC may be because of specific instructional effects of these models and effects nurtured by teaching-learning environment created by them. There seem to be great resemblance in these models (Concept Attainment Model and Inductive Thinking Model) as compared to Traditional Method of teaching on Scientific Creativity among the students of IX class.

From the result presented through caption 5.4.1(ii), 5.4.2(ii), 5.4.3(ii), 5.8, 5.8.1 (I, II and III) it has been observed that Concept Attainment Model and Inductive Thinking Model of teaching are effective significantly in fostering Scientific Creativity among the students than the Traditional Method of teaching.


From the present findings it is clear that Concept Attainment Model and Inductive Thinking Model of teaching are effective in developing the Scientific Creativity among the students. Both these models are equally effective in fostering Scientific Creativity among the students but more effective than Traditional Method of teaching in fostering the Scientific Creativity.
6.6 DEVELOPMENT OF FAVORABLE ATTITUDE TOWARDS SCIENCE

This part deals with the analysis of findings and hypotheses relating to development of favorable Attitude Towards Science, which have been discussed in relation to individual effectiveness and relative effectiveness of all the three models (selecting two models at a time / pairwise groups) through ANOVA and t-test. The quantification of the variable in terms of scores of subjects is used in testing the hypotheses and arriving at the results.

The finding in section indicate that the Concept Attainment Model and Inductive Thinking Model of teaching are significantly effective in developing favorable Attitude of the students Towards Science where as Traditional Method of teaching is not effective.

6.6.1 Individual Effectiveness

Individual effectiveness has been tested through the t-value of the difference of mean scores between the pre-test and post-test in each group on the variable Attitude Towards Science.

Hₐ3. There is no significant difference between the mean score of IX class students in developing favourable Attitude of Students Towards Science taught through Concept Attainment Model of teaching.

The section 5.5.1 (Table-5.7) presents t-value (10.97) for the difference between mean score on Attitude Towards Science at pre-test and post-test stage on group A taught through Concept Attainment Model. This t-value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom and thus the hypothesis Hₐ3 is thereby rejected. Thus there is a significant difference between the mean score of IX class students in developing favourable Attitude of students Towards Science taught through Concept Attainment Model of teaching. This inferred that the Concept Attainment Model of teaching was effective in developing Attitude Towards Science among the students of group A as established by the significant standard error of mean difference. The gain in scores between pre-test and post-test stage also supports
the above inference for effective teaching through Concept Attainment Model of teaching.

H₀6. There is no significant difference between the mean score of IX class students in developing favourable Attitude of students Towards Science taught through Inductive Thinking Model of teaching.

The t-value for mean difference of pre-test and post-test scores of experimental group B on Attitude Towards Science is 10.77 as given in section 5.5.2 (Table-5.8). This t-value is significant at 0.01 and 0.05 levels of significance for 124 degrees of freedom therefore the hypothesis H₀6 is rejected. Thus there is a significant difference between the mean score of IX class students in developing favourable Attitude of students Towards Science taught through Inductive Thinking Model of teaching.

This shows that group B taught through Inductive Thinking Model of teaching performed better in developing Attitude Towards Science among the students as established by the significant standard error of mean difference between pre-test and post-test scores. The gain in mean scores between pre-test and post-test stage also shows that there is a gain in scores of the students of experimental group B on Attitude Towards Science.

H₀9. There is no significant difference between the mean score of IX class students in developing favourable Attitude of students Towards Science taught through Traditional Method of teaching.

The section 5.5.3 (Table-5.9) shows that the t-value for the mean difference of pre-test and post-test scores of control group C on Reasoning Ability is 1.5, which is non-significant at 0.01 and 0.05 level of significance for 126 degrees of freedom hence the hypothesis H₀9 is there by accepted. Thus there is no significant difference between the mean score of IX class students in developing favourable Attitude of students Towards Science taught through Traditional Method of teaching.

This inferred that the group C taught through Traditional Method of teaching was not effective in developing Attitude Towards Science among the students as established by the non-significant standard error of mean difference. The
gain in the mean scores between pre-test and post-test stage also supports this inference that the Traditional Method of teaching is not effective in developing the Attitude of students Towards Science.

6.6.2 Relative Effectiveness

Relative effectiveness has been determined by t-value of the difference of mean scores between the post-test scores of the group pairs AB, AC and BC on the criterion variable Attitude Towards Science.

H₀²². There is no significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This hypothesis when tested by calculated F-ratio through ANOVA in section 5.9 (Table-5.20), which is 27.54. This value of F-ratio was found significant at 0.01 and 0.05 levels of significance for 2/374 degrees of freedom. Due to this significant F-value, the hypothesis H₀²² was, therefore, rejected. Thus there is a significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching.

This is further supported by the significant F-ratio (38.86) through the ANOVA (Table 5.21) of gain scores of experimental groups A, B and a control group C taught through above models respectively on Attitude Towards Science. This shows that the treatment had differential effects in these three groups on development in Attitude of the students Towards Science at post-test stage as well as in gain scores.

As all these treatments had differential effect on the variable Attitude Towards Science, pair wise differential effects are further investigated through the t-values by testing hypotheses H₀²³, H₀²⁴ and H₀²⁵.

H₀²³. There is no significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught
through Concept Attainment Model and Inductive Thinking Model of teaching.

The t-value for mean difference of post-test scores of experimental groups A and B taught through Concept Attainment Model and Inductive Thinking Model of teaching, respectively on Attitude Towards Science is 0.26 as shown in Section 5.9.1-I (Table-5.22). Due to this non-significant t-value at 0.01 and 0.05 levels of significance for 249 degrees of freedom, the hypothesis $H_0$ is there by accepted. Thus there is no significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Concept Attainment Model and Inductive Thinking Model. Hence it could be inferred that these groups did not differ significantly on development in Attitude of the students Towards Science after the treatment. Thus the two groups A and B can be said to have performed equally on Attitude Towards Science before and after the treatments.

This can be further supported by non-significant t-value (0.59) in gain scores of these two groups (Table-5.23) as a result of treatments. Thus Concept Attainment Model and Inductive Thinking Model of teaching are equally effective on development in Attitude of the students of IX class Towards Science.

$H_0^{24}$. There is no significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Concept Attainment Model and Traditional Method of teaching.

Section 5.9.1-II (Table-5.22) presents the t-value (6.29) for the mean difference of post-test scores of experimental group A and control group C on Attitude Towards Science, which is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom and thus the hypothesis $H_0^{24}$ was, therefore, rejected. Thus there is a significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Concept Attainment Model andTraditional Method of teaching. It could be inferred that group A taught through Concept Attainment Model performed better on development in Attitude of the students Towards Science as a result of treatment as compared to group C taught through the Traditional Method of teaching.
This is further evidenced by significant t-value (8.14) between the mean gain scores on Attitude Towards Science of these two groups (Table-5.23) as a result of treatment. Thus Concept Attainment Model of teaching is more effective in developing the Attitude Towards Science among the students of IX class than the Traditional Method of teaching.

\[ H_0: \text{There is no significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Inductive Thinking Model and Traditional Method of teaching.} \]

The t-value for mean difference of post-test scores of experimental group B and control group C taught through Inductive Thinking Model and Traditional Method of teaching, respectively on Attitude Towards Science is 6.06 as shown Section 5.9.1-III (Table-5.22). This t-value is significant at 0.01 and 0.05 levels of significance for 251 degrees of freedom. Hypothesis \( H_0 \) was therefore rejected. Thus there is a significant difference between the mean score of IX class students in developing favourable Attitude of the students Towards Science taught through Inductive Thinking Model of teaching and Traditional Method of teaching. It could be inferred that experimental group B performed better on development in Attitude of the students Towards Science as a result of treatment as compared to control group C.

This is further confirmed by significant t-value (7.53) between the gain scores on Attitude Towards Science of these two groups (Table-5.23) as a result of treatment. Thus Inductive Thinking Model of teaching is more effective in developing the Attitude Towards Science among the students of IX class than the Traditional Method of teaching.

**Discussion:**

It can be derived from these results that Concept Attainment Model and Inductive Thinking Model of teaching have greater opportunities for development of Attitude Towards Science among the students as these models facilitate child center approach to teaching and they stress active involvement of learners in teaching-learning process. Inductive Thinking Model requires the students to predict consequences, explain unfamiliar data, or hypothesize, interprets data, apply principle
and then attempts to creating inductive. This model also helps to develop the scientific attitude or temper among the students. Due to deductive and inductive approach of these models in teaching-learning process concept formation, generalization, skills, and presentation increases among the students. Though these two information models of teaching referred to here lead to development of Attitude Towards Science among the students.

The significantly higher outcomes on developing favourable Attitude of the students Toward Science enhancement and significantly higher outcomes on its difference in effectiveness seen in group pairs AC and BC may be because of specific instructional effects of these models and effects nurtured by teaching-learning environment created by them.

There seem to be great resemblance in these models as compared to Traditional Method of teaching and the effects nurtured by them with respect to the traits needed for this variable development through scientific methodology of tasks developed for teaching activity and a number of specific objectives. The process skills developed through these models of teaching are the factors contributing to the development of Attitude Towards Science among the students.

For these results one agreed with Bloom that one’s Attitude or Interest has been developed Towards a Subject, it is fairly resistant to change. He further states “It should be remembered that a short term study of a few months of learning would not be likely to have profound consequences on the students affective characteristics”.

From the result presented through caption 5.5, 5.9, 5.9.1 (I, II and III) it has been observed that Concept Attainment Model and Inductive Thinking Model of teaching are effective significantly favourable Attitude of the students Towards Science.

From the present findings it is clear that Concept Attainment Model and Inductive Thinking Model of teaching are effective to promote a favourable Attitude of the students Towards Science. The Concept Attainment Model and Inductive Thinking Model of teaching are equally effective to promote a favourable Attitude of the students Towards Science. Both of these models are more effective than traditional method of teaching to promote a favourable Attitude of the students Towards Science.

This long-term experimental study may be helpful in investigating the issue related to the models involve in scientific methodology of teaching in respect of individual effect of these two models and relative effectiveness of the pair of models on the concern variables. The present study has shown that individually the models, Concept Attainment Model and Inductive Thinking Model studied here are effective in developing Reasoning Ability, Scientific Creativity, Attitude Towards Science and the Achievement in Science of IX class students but the Traditional Method of teaching is not found effective on these variables.

When all these hypotheses are taken into consideration simultaneously and a holistic approach is followed, it is found that for individual effectiveness hypotheses H01, H02, H03, H04, H05 and H06 are rejected, which shows that the Concept Attainment Model and Inductive Thinking Model of teaching used are effective in development of Reasoning Ability, Scientific Creativity and favourable Attitude Towards Science. On the other hand the hypotheses H07, H08 and H09 are accepted for individual effectiveness, which shows that the Traditional Method of teaching used is not effective in development of Reasoning Ability, Scientific Creativity and favourable Attitude Towards Science.

Similarly for the comparison of relative effectiveness between the three groups A, B and C the hypotheses H010, H014, H018, and H022 are rejected as these three groups are not equally effective in improving Achievement in Science, development of Reasoning Ability, Scientific Creativity and favourable Attitude Towards Science. Further it is also found that hypotheses H012, H013, H016, H017, H020, H021, H024 and H025 are rejected for relative effectiveness between two group pairs (i.e. AC and BC), which shows that there is differential effect between the Concept Attainment Model and Traditional Method of teaching; Inductive Thinking
Model and Traditional Method of teaching studied in improving Achievement in Science, development of Reasoning Ability, Scientific Creativity and favourable Attitude Towards Science. Concept Attainment Model and Inductive Thinking Model of teaching are more effective than Traditional method of teaching as there is a gain the scores of Concept Attainment Model and Inductive Thinking Model. The hypotheses $H_011$, $H_015$, $H_019$ and $H_023$ are accepted for relative effectiveness between two groups A and B, which shows that the Concept Attainment Model and Inductive Thinking Model of teaching studied are equally effective in improving Achievement in Science, development of Reasoning Ability, Scientific Creativity and favourable Attitude Towards Science.

In order to have review of the inferential analysis, outcome from each analysis has been given in Table - 6.1 and Table - 6.2 for convenience of discussion; hypotheses have been classified according to the criterion variables.

Results obtained from these inferential analysis have been formulated in terms of conclusions and educational implications in the next chapter.
### Table 6.1
Summary of the Results on Individual Effectiveness

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Criterion Variable</th>
<th>Group</th>
<th>Teaching Strategy</th>
<th>Hypothesis No.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Developing Reasoning Ability</td>
<td>A</td>
<td>Concept Attainment Model</td>
<td>$H_01$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Inductive Thinking Model</td>
<td>$H_04$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Traditional Method</td>
<td>$H_07$</td>
<td>Accepted*</td>
</tr>
<tr>
<td>2</td>
<td>Fostering Scientific Creativity</td>
<td>A</td>
<td>Concept Attainment Model</td>
<td>$H_02$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Inductive Thinking Model</td>
<td>$H_05$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Traditional Method</td>
<td>$H_08$</td>
<td>Accepted*</td>
</tr>
<tr>
<td>3</td>
<td>Developing Attitude Towards Science</td>
<td>A</td>
<td>Concept Attainment Model</td>
<td>$H_03$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Inductive Thinking Model</td>
<td>$H_06$</td>
<td>Rejected*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Traditional Method</td>
<td>$H_09$</td>
<td>Accepted*</td>
</tr>
</tbody>
</table>

* → at 0.01 and 0.05 levels of significance
Table-6.2
Summary of the Results on Relative Effectiveness

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Criterion Variable</th>
<th>Group Pair</th>
<th>Hypothesis No.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Achievement in Science</td>
<td>A-B-C</td>
<td>$H_0^{10}$</td>
<td>Rejected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B</td>
<td>$H_0^{11}$</td>
<td>Accepted A ~ B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-C</td>
<td>$H_0^{12}$</td>
<td>Rejected A &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B-C</td>
<td>$H_0^{13}$</td>
<td>Rejected B &gt; C</td>
</tr>
<tr>
<td>2.</td>
<td>Developing Reasoning Ability</td>
<td>A-B-C</td>
<td>$H_0^{14}$</td>
<td>Rejected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B</td>
<td>$H_0^{15}$</td>
<td>Accepted A ~ B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-C</td>
<td>$H_0^{16}$</td>
<td>Rejected A &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B-C</td>
<td>$H_0^{17}$</td>
<td>Rejected B &gt; C</td>
</tr>
<tr>
<td>3.</td>
<td>Fostering Scientific Creativity</td>
<td>A-B-C</td>
<td>$H_0^{18}$</td>
<td>Rejected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B</td>
<td>$H_0^{19}$</td>
<td>Accepted A ~ B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-C</td>
<td>$H_0^{20}$</td>
<td>Rejected A &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B-C</td>
<td>$H_0^{21}$</td>
<td>Rejected B &gt; C</td>
</tr>
<tr>
<td>4.</td>
<td>Developing Attitude Towards Science</td>
<td>A-B-C</td>
<td>$H_0^{22}$</td>
<td>Rejected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B</td>
<td>$H_0^{23}$</td>
<td>Accepted A ~ B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-C</td>
<td>$H_0^{24}$</td>
<td>Rejected A &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B-C</td>
<td>$H_0^{25}$</td>
<td>Rejected B &gt; C</td>
</tr>
</tbody>
</table>

' > ' → Significantly perform better than

' ~ ' → Equivalent to