CONCLUSIONS AND SUGGESTIONS

Study in Retrospect

Major Findings

Major Conclusions of the Study

Contributions of the Study

Recommendations

Suggestions

Implications of the Study

Suggestions for Further Research
CHAPTER VI

CONCLUSIONS AND SUGGESTIONS

This chapter is meant for presenting a brief summary of the study (Objectives, Hypotheses, Tools and Techniques, Sample, Experimental Design and Statistical Techniques) and the conclusions and suggestions derived from the study. The chapter concludes with the recommendations based on the findings of the study, implications of the study and suggestions for further research.

6.1 STUDY IN RETROSPECT

The present investigation is intended to study the effectiveness of an Instructional Material in Biological Science based on Discovery Learning Model for fostering science process skills, scientific creativity and science curiosity in higher secondary students. The study under investigation is entitled as "EFFECTIVENESS OF AN INSTRUCTIONAL MATERIAL IN BIOLOGICAL SCIENCE BASED ON DISCOVERY LEARNING MODEL FOR FOSTERING SCIENCE PROCESS SKILLS, SCIENTIFIC CREATIVITY AND SCIENCE CURIOSITY IN HIGHER SECONDARY STUDENTS".

6.1.1 Variables of the Study

In the experimental study, the Instructional Material in Biological Science based on Discovery Learning Model must be tested for its effectiveness. Since the variable is subjected to testing, it remains independent variable in experiment. The instructional material in Discovery Learning Model has not been tested so far for the development of science process skills, scientific creativity and science curiosity of the
Conclusions and Suggestions

higher secondary school students. So, in this experiment, when the sample is treated with independent variable, does the latter make change in the existing science process skills, scientific creativity and science curiosity? This has to be experimentally determined.

So in this experiment, science process skills, scientific creativity and science curiosity are considered as the dependent variables. Still this change has to be compared with another group of students who are taught using the Lecture Method of Teaching. So the experimental variable is treated at two levels as Discovery Learning Model and Lecture Method. In this experiment, academic achievement is also considered as the dependent variable.

6.1.2 Hypotheses

The present study is likely to give information regarding the effectiveness of the Instructional Material in Biological Science based on Discovery Learning Model for fostering science process skills, scientific creativity and science curiosity in Higher Secondary School Students. So based on the theoretical background and assumptions, the following hypotheses were formulated:

1. There is no significant difference between the experimental group (DLM) and the control group (LM) in terms of science process skills, scientific creativity and science curiosity with regard to pre-test scores.

2. Instructional Material in Biological Science based on Discovery Learning Model will not foster the science process skills of higher secondary students (for the total test scores and for the seven major process skill tests, viz.
Conclusions and Suggestions

Initiation, Hypothesising, Manipulation, Processing Data, Conceptualization, Generalization and Open-endedness).

3. Instructional Material in Biological Science based on Discovery Learning Model will not foster the scientific creativity of higher secondary students (for the total test scores and for the five component tests viz., Fluency, Flexibility, Originality, Sensitivity to Problem and Elaboration and redefinition).

4. Instructional Material in Biological Science based on Discovery Learning Model will not foster the science curiosity of higher secondary students.

5. There is no significant difference between Instructional Material in Biological Science based on Discovery Learning Model teaching and Lecture Method of Biological Science teaching in Pre-test and Post-test with regard to academic achievement of higher secondary students.

6.1.3 Objectives of the Study

The major objectives of the study are:

1. To prepare an Instructional Material in Biological Science based on Discovery Learning Model on the topic “Phylum Mollusca” at higher secondary level.

2. To find out the difference between the experimental and the control group (Pre-test) in terms of science process skills, scientific creativity and science curiosity of higher secondary students.

3. To study the effectiveness of the Instructional Material in Biological Science based on the Discovery Learning Model for fostering science process skills of higher secondary students with respect to the total test scores and for the seven
major process skill tests viz. Initiation, Hypothesising, Manipulation, Processing Data, Conceptualization, Generalization and Open-endedness.

4. To study the effectiveness of the Instructional Material in Biological Science based on the Discovery Learning Model for fostering scientific creativity of higher secondary students with respect to the total test scores and for the five component tests viz. Fluency, Flexibility, Originality, Sensitivity to Problem and Elaboration and redefinition.

5. To study the effectiveness of the Instructional Material in Biological Science based on Discovery Learning Model for fostering science curiosity in higher secondary students.

6. To compare the effectiveness of the Instructional Material in Biological Science based on Discovery Learning Model teaching and the Lecture Method on the achievement of higher secondary students.

7. To give some possible suggestions for fostering science process skills, scientific creativity and science curiosity.

6.1.4 Methodology

Method Adopted

The investigator adopted Experimental method for the present study.

Sample for the Study

The study was based on a sample of 322 XI Standard students selected from Holy Angels H. S. S., Govt. Girls Higher Secondary School, Pattom and St. Joseph’s H. S. S. Palayam in Trivandrum Revenue district.
Tools Used

1. Instructional Material in Biological Science based on Discovery Learning Model.

2. Test of Process Skills in Biological Science.

3. Test of Creativity in Biological Science

4. Science Curiosity Inventory.

5. Achievement Test in Biological Science.

Procedure

Experimental Method was adopted for conducting the study. The effectiveness of the Instructional Material in Biological Science based on Discovery Learning Model was tested by experimental method by selecting a sample of 322 students (162 students in the experimental group and 160 students in the control group). The topic “Phylum Mollusca” of standard XI was selected for the study. The control group was taught by the Lecture Method and the experimental group was taught using the Discovery Learning Model. An achievement test based on the topic was administered to both the groups. Standardised test of science curiosity, standardized test of science process skills and standardised test of scientific creativity were administered to the DLM and LM groups. The pre-test and post-test scores obtained were compared to determine the effectiveness of an Instructional Material in Biological Science based on Discovery Learning Model over the Lecture Method of teaching for the fostering of science process skills; scientific creativity and science curiosity in higher secondary students.
Statistical Techniques Applied

The following statistical techniques were used for analysis.

1. Test of significance of difference between means.
2. Analysis of Variance and Covariance

6.2 MAJOR FINDINGS

The important findings of the study are summarised under four sections.

SECTION I

6.2.1 COMPARISON OF PRE-TEST SCORES OF SCIENCE PROCESS SKILLS, SCIENTIFIC CREATIVITY AND SCIENCE CURIOSITY: DLM AND LM (TOTAL SAMPLE)

(a) COMPARISON OF PRE-TEST SCORES OF SCIENCE PROCESS SKILLS : DLM AND LM (TOTAL SAMPLE)

Comparison of the mean scores (Total sample) of the treatment groups (DLM and LM) on Pre-test Science Process Skills revealed that, there is no significant difference between DLM and LM groups with regard to the pre-test Science process skills.

\[ M (DLM) = 10.81; \quad M (LM) = 10.86 \]

\[ CR = 0.132; \quad p > 0.05 \]

(b) COMPARISON OF PRE-TEST SCORES OF SCIENTIFIC CREATIVITY: DLM AND LM (TOTAL SAMPLE)

Comparison of the mean scores (Total sample) of the treatment groups (DLM and LM) on Pre-test Scientific Creativity revealed that, there is significant
Conclusions and Suggestions

difference between DLM and LM. The difference is in favour of Lecture Method or Control group.

\[ M \text{ (DLM)} = 13.81; \quad M \text{ (LM)} = 15.93 \]

\[ CR = 4.251; \quad p < 0.01 \]

(c) COMPARISON OF PRE-TEST SCORES OF SCIENCE CURIOSITY:

DLM AND LM (TOTAL SAMPLE)

Comparison of the mean scores (Total sample) of the treatment groups (DLM and LM) on Pre-test Science Curiosity revealed that, there is no significant difference between DLM and LM groups with regard to pre-test science curiosity.

\[ M \text{ (DLM)} = 14.825; \quad M \text{ (LM)} = 13.74 \]

\[ CR = 1.493; \quad p > 0.05 \]

6.2.2 COMPARISON OF PRE-TEST ACHIEVEMENT SCORES OF DISCOVERY LEARNING MODEL AND LECTURE METHOD (TOTAL SAMPLE)

Comparison of the overall mean scores of the treatment groups (Discovery Learning Model and Lecture Method on pre-test Achievement scores obtained on Achievement Test in Biological Science before experimental teaching) revealed that there is no significant difference between the two groups in terms of pre-test achievement in Biological Science.

\[ M \text{ (DLM)} = 11.01 \quad M \text{ (LM)} = 11.30 \]

\[ CR = 0.690; \quad p > 0.05 \]
SECTION II

6.2.3 COMPARISON OF POST-TEST SCORES OF SCIENCE PROCESS SKILLS, SCIENTIFIC CREATIVITY AND SCIENCE CURIOSITY: DLM AND LM (TOTAL SAMPLE)

(a) COMPARISON OF POST-TEST SCORES OF SCIENCE PROCESS SKILLS: DLM AND LM (TOTAL SAMPLE)

Comparison of means of post-test Science Process Skills scores of DLM and LM showed that there is significant difference between the post-test science process skill scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M \text{ (DLM)} = 17.98 \quad M \text{ (LM)} = 11.86 \]
\[ C.R. = 16.513; \quad p < 0.01 \]

(b) COMPARISON OF POST-TEST SCORES OF SCIENTIFIC CREATIVITY: DLM AND LM (TOTAL SAMPLE)

Comparison of means of post-test Scientific Creativity scores of DLM and LM showed that there is significant difference between the post-test Scientific Creativity scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M \text{ (DLM)} = 26.81; \quad M \text{ (LM)} = 16.65 \]
\[ C.R. = -18.283; \quad p < 0.01 \]
Conclusions and Suggestions

(c) COMPARISON OF POST-TEST SCORES OF SCIENCE CURiosity : DLM AND LM (TOTAL SAMPLE)

Comparison of means of post-test Science Curiosity scores of DLM and LM showed that there is significant difference between the post-test science curiosity scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M \text{ (DLM)} = 22.52 \quad M \text{ (LM)} = 14.01 \]

\[ CR = 11.230; \quad p < 0.01 \]

6.2.4 COMPARISON OF POST-TEST ACHIEVEMENT SCORES OF DISCOVERY LEARNING MODEL AND LECTURE METHOD (TOTAL SAMPLE)

Comparison of means of post-test Achievement scores of DLM and LM showed that there is significant difference between the post-test achievement scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M \text{ (DLM)} = 34.83; \quad M \text{ (LM)} = 21.44 \]

\[ C.R. = 18.416; \quad p < 0.01 \]
SECTION III

6.2.5 COMPARISON OF GAIN SCORES OF DLM GROUP (TOTAL SAMPLE) IN TERMS OF SCIENCE PROCESS SKILLS, SCIENTIFIC CREATIVITY AND SCIENCE CURIOSITY.

(a) COMPARISON OF GAIN SCORES OF DLM GROUP AND LM GROUP WITH REGARD TO SCIENCE PROCESS SKILLS

Comparison of means of gain Science Process Skills scores of DLM and LM showed that there is significant difference between the gain scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

M (DLM) = 7.17;  M (LM) = 1.01
C.R. = 25.039;  p < 0.01

(b) COMPARISON OF GAIN SCORES OF DLM GROUP AND LM GROUP WITH REGARD TO SCIENTIFIC CREATIVITY

Comparison of means of gain Scientific Creativity scores of DLM and LM showed that there is significant difference between the gain scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

M (DLM) = 12.99;  M (LM) = 0.62
C.R. = 29.520;  p < 0.01
Conclusions and Suggestions

(c) COMPARISON OF GAIN SCORES OF DLM GROUP AND LM GROUP WITH REGARD TO SCIENCE CURIOXY

Comparison of means of gain Science Curiosity scores of DLM and LM showed that there is significant difference between the gain scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M_{\text{DLM}} = 7.67 \quad M_{\text{LM}} = 0.26 \]

C.R. = 17.585; \( p < 0.01 \)

6.2.6 COMPARISON OF GAIN ACHIEVEMENT SCORES OF DLM AND LM (TOTAL SAMPLE)

Comparison of means of gain Achievement scores of DLM and LM showed that there is significant difference between the gain scores of DLM and LM. The difference is in favour of the instructional material in Biological Science based on Discovery Learning Method.

\[ M_{\text{DLM}} = 23.82; \quad M_{\text{LM}} = 10.14 \]

C.R. = 20.997; \( p < 0.01 \)

SECTION IV

6.2.7 COMPARISON OF PRE-TEST SCIENCE PROCESS SKILLS AND POST-TEST SCIENCE PROCESS SKILLS SCORES OF DLM AND LM (TOTAL SAMPLE)

Comparison of the pre-test and post-test scores of students in the Experimental and Control groups with respect to the Science Process Skills showed that the experimental group gained higher scores for the total test and all the seven
process skill tests than that of the control group. It indicates that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the science process skills of students in Biological Science (for the total test and the major process skill wise tests) compared to that of Lecture Method.

1. **Findings Related to the Test of Science Process Skills (Total)**

   a) The F value obtained from the Analysis of Covariance of the pre-test and post-test scores of students with respect to the science process skills tests in Biological Science was significant ($F_{y,x}$ for $df$ 1/319 = 810.65; $p < 0.01$) (Vide Table 5.14).

   b) When the difference between adjusted means of the post-test scores of students in the experimental and control groups was tested for significance for $df$, 319, the ‘t’ value obtained was significant ($t = 29.27; p < 0.01$). The adjusted means of post-test scores shows that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the science process skills of students in Biological Science compared to that of Lecture Method. (Vide Table 5.15).

2. **Findings related to the Science Process Skills tests of seven major Science Process Skills**

1. **(a) Science Process Skills Test with respect to ‘Initiation’**

   The F value obtained from the Analysis of Covariance of the pre-test and the post-test scores of students in the Experimental and Control groups for the process skill ‘Initiation’ was significant.
Conclusions and Suggestions

(Fy.x for df 1/319 = 79.64; p < 0.01)

(Vide Table 5.17)

b. When the difference between adjusted means of post-test scores of students in the Experimental and Control groups for the component ‘Initiation’ was tested for significance of df 319, the ‘t’ value obtained was significant ( t= 8.96; p < 0.01). The adjusted means of post-test scores shows that the instructional material in Biological Science based on Discovery Learning Model is effective for fostering the Process Skill ‘Initiation’ in Biological Science than the Lecture Method (Vide Table 5.18).

II Science Process Skills Test with respect to “Hypothesising”

a. The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the Experimental and Control groups for the process skill ‘Hypothesising’ was significant.

(Fy.x for df 1/319 = 132.16; p < 0.01)

(Vide Table 5.20)

b. When the difference between adjusted means of post-test scores of students in the Experimental and Control Groups for the component ‘Hypothesising’ was tested for significance for df 319, the ‘t’ value obtained was significant (t = 11.57; p < 0.01). The adjusted means of post-test scores shows that the instructional material in Biological Science based on Discovery Learning Model is effective for fostering the Process skill ‘Hypothesising’ than the Lecture Method (Vide Table 5.21).
III. **Science Process Skills test with respect to ‘Manipulation’**

a) The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the experimental and control groups for the Process Skill ‘Manipulation’ was significant.

\[
(F_{yx} = 121.74 \text{ for } df = 1/319; \ p < 0.01)
\]

(Vide Table 5.23)

b) The difference in the adjusted means for pre-test scores of students in the Experimental and Control group for the Process Skill ‘Manipulation’ was significant.

\[
(M_{1yx} = 2.7; \ M_{2yx} = 1.9, \ t = 11.04, \ p < 0.01)
\]

This shows that the instructional material in Biological Science based on Discovery Learning Model is more effective in improving the Process Skill ‘Manipulation’ of students than the Lecture Method.

(Vide Table 5.24)

IV. **Science Process Skills test with respect to ‘Processing data’**

a) The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the experimental and control groups for the Process Skill ‘Processing data’ was significant.

\[
(F_{yx} = 96.23 \text{ for } df = 1/319; \ p < 0.01)
\]

(Vide Table 5.26)

b) The differences in the adjusted means for post-test scores of students in the experimental and control group for the Process Skill ‘Processing data’ was significant.

\[
(M_{1yx} = 1.9; \ M_{2yx} = 1.2; \ t = 9.81; \ p < 0.01)
\]
This shows that the Instructional material in Biological Science based on Discovery Learning Model is more effective in improving the Process Skill ‘Processing data’ scores of students in Biological Science than the Lecture Method (Vide Table 5.27).

V. Science Process Skill Test with respect to ‘Conceptualization’

a. The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the Experimental and Control groups for the process skill, ‘Conceptualization’ was significant.

\[ F_{y.x} = 166.31 \text{ for } df = 1/319; \ p < 0.01 \] (Vide Table 5.29)

b. When the difference between adjusted means of post-test scores of students in the Experimental and Control groups for the process skill ‘Conceptualization’ was tested for significance for df 319, the ‘t’ value obtained was significant \( t = 12.91, \ p < 0.01 \). The adjusted means of post-test scores show that the instructional material in Biological Science based on Discovery Learning Model is effective for fostering the Process Skill ‘Conceptualization’ in Biological Science than the Lecture Method. (Vide Table 5.30)

VI. Science Process Skills Test with respect to ‘Generalization’

a) The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the experimental and control groups for the Process Skill ‘Generalization’ was significant.

\[ F_{y.x} = 143.91 \text{ for } df 1/319; \ p < 0.01 \]

(Vide Table 5.32)
b) The differences in the adjusted means for post-test scores of students in the experimental and control group for the Process Skill ‘Generalization’ was significant.

\[(M_{1yx} = 3.2, M_{2yx} = 2.2; t = 12.01; p < 0.01)\]

This shows that the instructional material in Biological Science based on Discovery Learning Model is more effective in improving the Process Skill ‘Generalization’ scores of students than the Lecture Method (Vide Table 5.33).

VII. Science Process Skills Test with respect to ‘Open-endedness’

a) The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the Experimental and Control groups for the Process Skill, ‘Open-endedness’ was significant.

\[(F_{y.x} = 139.52 \text{ for df 1/319; } p < 0.01)\]

(Vide Table 5.35)

b) When the difference between adjusted means of post-test scores of students in the Experimental and Control groups for the Process Skill ‘Open-endedness’ was tested for significance for df 319, the ‘t’ value obtained was significant \((t = 11.98, p < 0.01)\). The adjusted means of post-test scores show that the instructional material in Biological Science based on Discovery Learning Model of teaching is effective for fostering the Process Skill ‘Open-endedness’ in Biological Science than the Lecture Method.

(Vide Table 5.36)
The hypothesis formulated in this context viz. Hypothesis 2, ‘instructional material in Biological Science based on Discovery Learning Model will not foster the Science Process Skills of higher secondary students (for the total test scores and for the seven process skills tests viz. Initiation, Hypothesizing, Manipulation, Processing data, Conceptualization, Generalization and Open-endedness)’ is not substantiated.

6.2.8 COMPARISON OF PRE-TEST AND POST-TEST SCIENTIFIC CREATIVITY SCORES OF DLM AND LM (TOTAL SAMPLE)

Comparison of the pre-test and post-test scores of students in the Experimental and Control groups with respect to the Scientific Creativity showed that the Experimental group gained high scores for the total test and all the five component tests than that of the control group. It indicates that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the scientific creativity (for the total test and the component tests), compared to that of the Lecture Method.

Findings Related to the Total Test of Scientific Creativity

1. The F value obtained from the analysis of covariance of the pre-test and post-test scores of students with respect to the Scientific Creativity Test in Biological Science was significant.

\[(F_{y.x} \text{ for df 1/319} = 810.65; \quad p < 0.01)\]

(Vide Table 5.38)

2. When the difference between adjusted means of the post-test scores of students in the Experimental and Control groups was tested for significance for df 319; the ‘t’
value obtained was significant \( t = 29.27; \ p < 0.01 \). The adjusted means of post-test scores indicates that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the Scientific Creativity of students in Biological Science, compared to that of the Lecture Method.

(Vide Table 5.39)

**Findings related to the Component Tests of Scientific Creativity**

I. **Component test with respect to ‘Fluency’**

(a) The F value obtained from the analysis of covariance of the pre-test and post-test scores of students in the Experimental and Control groups for the component ‘Fluency’ was significant.

\( (F_{y.x} \text{ for } \text{df } 1/139 = 415.96; \ p < 0.01) \)

(Vide Table 5.41)

(b) When the difference between adjusted means of the post-test scores of students in the Experimental and Control groups was tested for significance for \( \text{df } 319 \), the ‘t’ value obtained was significant \( t = 20.56; \ p < 0.01 \). The adjusted means of post-test scores show that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the Scientific Creativity Component ‘Fluency’ in Biological Science compared to that of the Lecture Method.

(Vide Table 5.42)
II. Component Test with respect to ‘Flexibility’

(a) The F value obtained from the analysis of covariance of the pre-test and post-test scores of students in the Experimental and Control groups for the component ‘Flexibility’ was significant.

\[(F_{y.x} \text{ for } df 1/319 = 190.03; \ p < 0.01)\] (Vide Table 5.44)

(b) When the difference between adjusted means of post-test scores of students in the Experimental and Control groups for the component ‘Flexibility’ was tested for significance for df 319, the ‘t’ value obtained was significant \((t = 14.48; \ p < 0.01)\). The adjusted means of post-test scores show that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering ‘Flexibility’ than that of Lecture Method of teaching. (Vide Table 5.45)

III. Component Test with Respect to ‘Originality’

a. The F value obtained from the analysis of covariance of the pre-test and the post-test scores of students in the Experimental and Control groups for the component ‘Originality’ was significant.

\[(F_{y.x} \text{ for } df 1/319 = 268.23; \ p < 0.01)\]

(Vide Table 5.47)

b. The difference in the adjusted means for post-test scores of students in the Experimental and Control groups for the component ‘Originality’ was significant \((M_1yx = 6.5; M_2yx = 3.7; \ t = 16.96; \ p < 0.01)\). This shows that the instructional material in Biological Science based on Discovery Learning
Model is more effective in improving scientific creativity component ‘Originality’ in Biological Science than that of Lecture Method.

(Vide Table 5.48)

IV. **Component Test with Respect to ‘Sensitivity to Problem’**

a. The F value obtained from the analysis of covariance of the pre-test and post-test scores of students with respect to the scientific creativity component ‘Sensitivity to problem’ was significant. The experimental group is superior to control group.

(F_{y.x} \text{ for } df 1/319 = 171.70; p < 0.01)

(Vide Table 5.50)

b. When the difference between adjusted means of the post-test scores of students in the Experimental and Control groups was tested for significance for df 319, the ‘t’ value obtained was significant (t=13.45; p < 0.01). The adjusted means of post-test scores show that the instructional material in Biological Science based on Discovery Learning Model is more effective for fostering the scientific creativity component ‘Sensitivity to problem’ than the Lecture Method of teaching.

(Vide Table 5.51)

V. **Component test with Respect to ‘Elaboration and Redefinition’**

a. The F value obtained was significant showing that the post test scientific creativity component ‘Elaboration and redefinition’ scores of students in the Experimental and Control groups differ significantly after they have been adjusted for the difference in the pre-test ‘Elaboration and redefinition’ scores.

(F_{y.x} = 375.27; p < 0.01) (Vide Table 5.53)
b. When the difference between the adjusted means of the post-test Scientific Creativity scores was tested for significance for df 1/319, the ‘t’ value obtained is 19.46, which is found to be significant at 0.01 level showing that the instructional material in Biological Science based on Discovery Learning Model is effective for fostering scientific creativity component ‘Elaboration and redefinition’ compared to that of Lecture Method. (Vide Table 5.54)

The hypothesis formulated in this context viz. Hypothesis 3 ‘Instructional material in Biological Science based on Discovery Learning Model will not foster the scientific creativity of higher secondary students (for the total test scores and for the five components tests viz. Fluency, Flexibility, Originality, Sensitivity to problem and Elaboration and Redefinition)’ is not substantiated.

6.2.9 COMPARISON OF PRE-TEST SCIENCE CURIOSITY SCORES AND POST-TEST SCIENCE CURIOSITY SCORES OF DLM AND LM (TOTAL SAMPLE)

(a) The analysis of covariance in pre-test and post-test Science Curiosity scores of students in the Experimental and Control groups showed significant difference between the two groups.

\[(F_{y,x} \text{ for df } 1/319 = 337.46; \ p < 0.01)\]

(Vide Table 5.56)

(b) The adjusted means for the post-test scores were tested for significance for df 1/319. The ‘t’ value obtained was significant at 0.01 level (t = 18.43; \( p < 0.01 \)). This significant ‘t’ value confirms that the two means differ considerably. The conclusion is that the Experimental group is better than the
Control group in their performance of Science Curiosity. So the Instructional Material in Biological Science based on Discovery Learning Model is a better teaching method for fostering Science Curiosity than the Lecture Method.

(Vide Table 5.57)

The hypothesis formulated in this context, Hypothesis 4, ‘Instructional material in Biological Science based on Discovery Learning Model will not foster the Science Curiosity of higher secondary students’ is not substantiated.

6.2.10 COMPARISON OF PRE-TEST ACHIEVEMENT AND POST-TEST ACHIEVEMENT SCORES OF DLM AND LM (TOTAL SAMPLE)

(a) The Analysis of covariance in pre-test achievement and post-test Achievement scores of students in the Experimental and Control groups showed significant difference between the two groups (Fy.x for df 1/319 = 442.47; p < 0.01)

(Vide Table 5.59)

(b) The adjusted means for the post-test scores were tested for significance for df 1/319. The ‘t’ value obtained was significant at 0.01 level (t = 21.05; p < 0.01). This significant ‘t’ value confirms that the two means differ considerably. The conclusion is that the Experimental group is better than the Control group in their Academic Achievement. So the instructional material in Biological Science based on Discovery Learning Model is a better teaching methodology than the Lecture Method. (Vide Table 5.60)

The hypothesis formulated in this context viz. Hypothesis 5 ‘There is no significant difference between the instructional material in Biological Science based
Conclusions and Suggestions

on Discovery Learning Model and Lecture Method in pre-test and post-test with regard to academic achievement of higher secondary students’ is not substantiated.

TENABILITY OF THE HYPOTHESES

The findings emerged from the study indicates that the Hypothesis 1 is partially substantiated and the Hypotheses 2, 3, 4 and 5 are not substantiated.

6.3 MAJOR CONCLUSIONS OF THE STUDY

SECTION – I

The analysis of this section indicates that the pre-test science process skill and science curiosity scores of experimental and control groups showed no significant difference in their initial performance. This means that the two groups are more or less equal. The analysis of pre-test scientific creativity scores of experimental and control group showed significant difference in their initial performance on scientific creativity, the difference being in favour of the control group.

The pre-test academic achievement scores of pupils with regard to the experimental and control group are not significant. It can be concluded that the experimental and control groups are more or less equal with regard to pre-test achievement.

SECTION – II

After introducing the instructional material in Biological Science based on Discovery Learning Model (independent variable) to the experimental group and allowing the control group to carry on with the Lecture Method, it was found that, with respect to post-test science process skills, scientific creativity and science curiosity scores the experimental group was better than the control group. The
analysis of post-test achievement scores of experimental and control group showed
significant difference in their final performance in achievement. The difference being
in favour of the Experimental (DLM) group.

SECTION – III

The gain scores of pupils with regard to the experimental and control groups
are significant. The difference being in favour of the experimental group. Hence it is
tentatively concluded that the instructional material in Biological Science based on
Discovery Learning Model developed was more effective than the Lecture Method for
fostering Science Process Skill, Scientific Creativity and Science Curiosity.
Comparison of means of gain achievement scores of Discovery Learning Model and
Lecture Method showed that there is significant difference between the gain of scores
of Discovery Learning Method and Lecture Method groups. The difference is in
favour of the instructional material in Biological Science based on Discovery
Learning Model.

SECTION – IV

The analysis of covariance showed that there is significant difference in the
adjusted mean scores of experimental and control groups which also is in favour of
the experimental group. It clearly indicates that the instructional material in
Biological Science based on Discovery Learning Model foster the science process
skills (total test scores and for the seven major process skills tests viz. Initiation,
Hypothesising, Manipulation, Processing data, Conceptualization, Generalization and
Open-endedness), Scientific Creativity (with respect to the total test scores and for the
five component tests viz. Fluency, Flexibility, Originality, Sensitivity to problem and Elaboration and redefinition) and Science Curiosity of the higher secondary students.

The Analysis of Covariance (ANCOVA) also showed that there is significant difference in the adjusted mean scores of experimental and control groups which also is in favour of the Experimental group. It indicates that the instructional material in Biological Science based on Discovery Learning Model improves achievement of higher secondary students.

6.4 CONTRIBUTIONS OF THE STUDY

The concept of Discovery Learning Model in teaching, as accepted in modern education, owes much to the theoretical postulations of the pioneering researches in the field of science education. Discovery Learning Model requires self-activity of the pupil. It provides him the joy of self-achievement which further boosts his tendency for self efforts. In this method pupils are prompted to acquire essential content knowledge on their own. They are expected to record the points and subpoints of generalizations, principles, rules, cause-effect relationship included in the learning material to search in the generalizations, principles and cause-effect relationships and to learn on their own. Successful use of Discovery Learning Model of teaching improves academic achievement of different subjects at different levels of students. Most of the research studies have been confined to the comparison of Discovery Learning Model with other model of teaching, while only few researches have studied the effectiveness of Discovery Learning Model of the selected basic science process skills (Shiney, 2000). The present study has helped to find out the effectiveness of an instructional material in Biological Science based on Discovery Learning Model for
fostering Science Process Skills, Scientific Creativity and Science Curiosity in higher secondary students. This study also investigated the effectiveness of an instructional material in Biological Science based on Discovery Learning Model in academic achievement. The findings of the present study provide a broader frame work for understanding the instructional material in Biological Science based on Discovery Learning Model of teaching and its role in the development of Science Process Skills, Scientific Creativity and Science Curiosity. Moreover, emphasis was placed in the fostering of Science Process Skills (for total test scores and for all the seven major process skills test viz; Initiation, Hypothesising, Manipulation, Processing data, Conceptualization, Generalization and Open-endedness). This study also emphasizes effectiveness of an instructional material in Biological Science based on Discovery Learning Model for fostering Scientific Creativity (Total test scores and for all the components of Scientific Creativity viz; Fluency, Flexibility, Originality, Sensitivity to Problem and Elaboration and Redefinitions).

The studies conducted on the comparison of Discovery Learning Model with other models (Gurumurthy, Andrews, 1984; Bhalwankar, 1988; Selim and Shrigley, 1983; Raghavendra Rao, 1988) concentrated on the improvement of academic achievement only. Most of the research studies in the area of Discovery Learning Model of teaching have been conducted only in Testing and Preparation of Discovery Learning Model at various levels, viz; Primary, Upper Primary, High School and Higher Secondary classes in various subjects. (Mulapo and Fowler, 1987; Nair, 1995; Ambili, 1997, Beena, 1998; Xavier, 2000; George, 2002; Nayar, 2003).
In the present study, effectiveness of an instructional material in Biological Science based on Discovery Learning Model for fostering Science Process Skills, Scientific Creativity and Science Curiosity was studied.

The major findings in this study supported the instructional material in Biological Science based on Discovery Learning Model. This study proves that the instructional material in Biological Science based on Discovery Learning Model provides a creative and logical thinking process which enhances the scientific creativity of students. This study was an attempt to encourage scientific creativity of pupils.

From this study, the investigator found that the instructional material in Biological Science based on Discovery Learning Model helps students to develop conceptual understanding of science content and the relevant Science Process Skills. So the Instructional material in Biological Science based on Discovery Learning Model is effective for fostering science process skills. The investigator also found that Discovery Learning Model creates a positive state of mind for learning and participation in Discovery Learning activities encourages students to pose questions, propose hypotheses, make predictions, use tools together and analyse data, general inferences in light of empirical evidence, construct arguments, communicate their findings, and to use a broad array of reasoning strategies that involve critical, creative and logical thinking. This make improvement in academic achievement of students. This study also found that the instructional material in Biological Science based on Discovery Learning Model is a creative, reflective, effectively organized, active and highly motivated learning strategy. So it results in optimal learning.
The present study has been conducted on 322 Higher Secondary Biology Students in Trivandrum Revenue District. The study found that the instructional material in Biological Science based on Discovery Learning Model is effective for fostering Science Process Skills, Scientific Creativity and Science Curiosity. In general, the study was an attempt to find out the effectiveness of an instructional material in Biological Science based on Discovery Learning Model for fostering Science Process Skills, Scientific Creativity and Science Curiosity in Higher Secondary students.

6.5 RECOMMENDATIONS

1. The study revealed (based on the analysis of science process skill scores) that DLM is significantly superior to LM with regard to post-test performance of Science Process Skill (Total scores) (Tables – 5.5, 5.9, 5.13, 5.14 and 5.15). It is therefore recommended that the instructional material in Biological Science based on Discovery Learning Model can be used as an effective method for fostering Science Process Skills of Higher Secondary Students.

2. The study also revealed (Tables 5.16 to 5.36) the superiority of an instructional material in Biological Science based on Discovery Learning Model over Lecture Method for fostering seven major Science Process Skills such as Initiation, Hypothesising, Manipulation, Processing data, Conceptualization, Generalization and Open-endedness. Hence teachers should be encouraged to adopt the instructional material in Biological Science based on Discovery Learning Model for teaching Biological Science at Higher Secondary Level, for the fostering of Science Process Skills.
3. The findings based on the analysis of scientific creativity scores revealed the superiority of an instructional material in Biological Science based on Discovery Learning Model over Lecture Method with regard to post-test Scientific Creativity scores. Hence teachers should be encouraged to adopt the instructional material in Biological Science based on Discovery Learning Model for fostering Scientific Creativity of Higher Secondary Students. (Tables 5.6, 5.10, 5.37, 5.38 and 5.39).

4. It is evident from the analysis (Tables 5.40 to 5.54) that the instructional material in Biological Science based on Discovery Learning Model is more effective than Lecture Method in fostering components of Scientific Creativity, like Fluency, Flexibility, Originality, Sensitivity to problem and Elaboration and redefinition. Hence it is recommended that the instructional material in Biological Science based on Discovery Learning Model can be used for teaching Biological Science at higher secondary level for the fostering of the above mentioned components of Scientific Creativity.

5. It is evident from the analysis (Tables 5.7, 5.11, 5.55, 5.56 and 5.57) that the instructional material in Biological Science based on Discovery Learning Model group is superior to the Lecture Method group with regard to post-test science curiosity scores. The difference can be attributed to the influence of DLM. Therefore an instructional material in Biological Science based on Discovery Learning Model can be adopted as an effective method for fostering Science Curiosity of higher secondary students.

6. The study revealed (based on the analysis of achievement scores) that the instructional material in Biological Science based on Discovery Learning Model is
significantly superior to Lecture Method with regard to post-test achievement. It is therefore recommended that the instructional material in Biological Science based on Discovery Learning Model should be adopted for teaching Biological Science at Higher Secondary level. (Tables 5.8, 5.12, 5.58, 5.59 and 5.60).

6.6 SUGGESTIONS

Based on the results of the present study, the following suggestions are given for fostering the science process skills, scientific creativity and science curiosity among students:

1. Developing Science Process Skills, Scientific Creativity and Science Curiosity should be made an important objective of Biological Science instruction and the curriculum should contain plenty of opportunities for creative behaviour.

2. The pupils should be given opportunities to discover facts on their own, as an instructional material in Biological Science based on Discovery Learning Method acts as a catalyst for developing Science Process Skills, Science Curiosity and Scientific Creativity in it. While introducing a new concept, the teachers should provide enough initial instruction, so that the children get a basis for discovering facts.

3. The teacher should have an attitude of encouraging discovery learning. Some of the guiding principles are: be respectful to unusual questions, show the children that their ideas have value, let pupils occasionally do something and encourage and give credit for self-initiated learning.

4. Assignments which call for original work, independent learning, self-initiated projects and experimentation should be given.
5. Instructional Material in Biological Science based on DLM should cover a wide range of scientific activities which call for original work, independent learning, self-initiated projects and experimentation.

6. Instructional strategies in Biological Science based on Discovery Learning Model is a creative, reflective, effectively organized, active and highly motivated learning strategy. So it enhances Science Curiosity, Scientific Creativity and Science Process Skills in the present study.

7. The present study proves that participation in the Instructional Material in Biological Science based on Discovery Learning Model activities encourages students to pose questions, propose hypotheses, make predictions, use tools together and analyse data, generate inferences in light of empirical evidence, construct arguments, communicate their findings and to use a broad array of reasoning strategies that involve critical, creative and logical thinking. So instructional material in Biological Science based on Discovery Learning Model classrooms nourishes Scientific Creativity and develops Science Process Skills and Science Curiosity.

6.7 IMPLICATIONS OF THE STUDY

In the present study, the instructional material in Biological Science based on Discovery Learning Model of Teaching was found more effective than the Lecture Method of teaching for fostering Science Process Skills, Scientific Creativity and Science Curiosity.

While using the instructional material based on Discovery Learning Model, the students are active participants. They have the prime role in the learning process.
Since students are engaging in the discovery learning process, they are active, pleasant and responsible throughout the learning process. They are automatically elevated to high esteem of self-satisfaction because they “discover” construct through investigation the knowledge that they expected to study according to their syllabus.

The findings of the study have wide implications for the improvement of Biological Science teaching in the Higher Secondary Schools of Kerala. These findings provide guidelines to teachers, administrators and curriculum framers regarding the possible ways of fostering Science Process Skills, Scientific Creativity and Science Curiosity.

Instructional material in Biological Science based on Discovery Learning Model carried out in the study for fostering Science Process Skills, Scientific Creativity and Science Curiosity highlighted the fact that provision of appropriate teacher activities and pupil activities, adoption of proper instructional materials will go a long way in improving Science Process Skills, Scientific Creativity and Science Curiosity in Biological Science.

The Discovery Learning Model has great relevance for teachers who intend to improve his/her own instructional method. They should get training in preparing this model which is an important activity of students when they learn through Discovery Learning Model. Also they should develop the habit of leading children to acquire ideas and knowledge through their own curiosity. Now a days in classroom activities, they should get a well arranged training in teaching through instructional materials based on Discovery Learning Model of teaching.
Instructional material in Biological Science based on Discovery Learning Model was found very effective for the development of Science Process Skills, Scientific Creativity, Science Curiosity and higher achievement. The teachers can therefore readily use it in the classroom, but sufficient facilities are a precondition for student investigation.

It is seen that in our country Science Curiosity, Scientific Creativity and Science Process Skill testing have not been properly recognized so far. Teachers are not aware of its importance. So it is desirable that a special orientation programme be conducted for them. With such a programme giving adequate training to teachers for various models of teaching, so as to enable them to teach science by developing Science Curiosity, Scientific Creativity and Science Process Skills in our growing children.

6.8 SUGGESTIONS FOR FURTHER RESEARCH

Some of the suggestions for further research are presented below:

1. The present investigation is limited to the development of an instructional material in Biological Science based on Discovery Learning Model and its effectiveness for fostering Science Process Skills, Scientific Creativity and Science Curiosity in Higher Secondary students. Similar studies can be conducted on other models of teaching.

2. The experimental part of the study (based on DLM and LM) has been confined to XI standard only. To get a clear picture of the effectiveness of an Instructional material in Biological Science based on Discovery Learning Model
Conclusions and Suggestions

for other levels, an instructional material for Primary, Upper Primary, Secondary and College students may be prepared and tested.

3. The experimental part of the study has been confined to a limited sample only. The present study can be repeated on a large sample.

4. The experimental study has been confined to Thiruvananthapuram Revenue District only. The experiment may be repeated by systematic coverage of all districts of Kerala.

5. Similar studies can be conducted on tribal students and students belonging to coastal area to study the effectiveness of the model.

6. The effectiveness of the instructional material in Biological Science based on Discovery Learning Model was tested only in Biological Science. It is suggested that DLM on other disciplines can be prepared and tested.

7. Effect of Discovery Learning Model in varying group size of subjects, in terms of student’s achievement scores, retention scores and rate of learning can be studied.

8. An opinion study of the difficulties faced by teachers in the use of an Instructional material in Biological Science based on Discovery Learning Model of teaching can be carried out.

9. Effectiveness of an instructional material in Biological Science based on Discovery Learning Model on the achievement and retention of learning disabled student can be studied.
The investigator would feel gratified if the findings of this study would lead to better understanding of the teaching-learning process which helps students to learn in a more meaningful way, support curriculum planners to design new curriculum based on Discovery Learning Model and guide higher secondary Biological Science teachers to make teaching an interesting and rewarding experience and motivate researchers to undertake further research.