SUMMARY FINDINGS AND SUGGESTIONS

CHAPTER 5

SUMMARY FINDINGS AND SUGGESTIONS

- Study in retrospect
- Variables of the Study
- Objectives
- Methodology
- Major Findings
- Tenability of Hypotheses
- Suggestions for Improving Educational Practice
- Suggestions for Further Research
SUMMARY, FINDINGS AND SUGGESTIONS

This chapter deals with the summary of the various phases in the process of the present investigation, major findings of the study, tenability of hypotheses, suggestions for improving educational practice and suggestions for further research.

5.1. STUDY IN RETROSPECT

The present study was intended to examine whether Methods of Teaching and Studying Approaches have differential influence on Achievement in Physics of secondary school students. It was an attempt to examine whether Achievement in Physics vary when Concept Attainment Model of Teaching is adopted in a regular classroom without much disturbing the organisational set up of the school. Hence the present study was executed in the context of a conventional classroom where select topics in Physics were taught through Concept Attainment Model and compared with a class taught through Objective Based Instruction.

The study was hence stated as INTERACTION EFFECT OF CONCEPT ATTAINMENT MODEL OF TEACHING AND
STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS OF SECONDARY SCHOOL STUDENTS.

5.2. VARIABLES OF THE STUDY

Variables selected for the present study are the following:

5.2.1. Independent Variables

The following are the Independent Variables selected for the study.

5.2.1.1. Concept Attainment Model of teaching

5.2.1.2. Objective Based Instruction

5.2.1.3. Studying Approach

The three Studying Approaches selected are:

(i) Deep approach

(ii) Surface approach

(iii) Strategic approach

5.2.2. Dependent Variable

Achievement in Physics and its retention were considered as the dependent variables.
5.2.3. Control Variables

The control variables in the experimentation were the following:

5.2.3.1. Previous Knowledge of Subject Matter

5.2.3.2. Non-Verbal Intelligence

5.3. OBJECTIVES OF THE STUDY

The present study was designed with the following objectives:

5.3.1. To compare the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) of the Control group and the Experimental group.

5.3.2. To compare the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of the Control group and the Experimental group.

5.3.3. To compare the mean Retention scores of Achievement in Physics Post-Test II (tested two months after experimentation) of the Control group and Experimental group.

5.3.4. To compare the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) of the Control group and Experimental group.
5.3.5. To compare the mean scores of Achievement in Physics Post-Test I of the groups formed on the basis of Studying Approach.

5.3.6. To compare the mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test) of the groups formed on the basis of Studying Approach.

5.3.7. To compare the mean Retention scores of Achievement in Physics Post-Test II of the groups formed on the basis of Studying Approach.

5.3.8. To compare the mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of the groups formed on the basis of Studying Approach.

5.3.9. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls.

5.3.10. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.
5.3.11. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

5.3.12. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

5.4. METHODOLOGY

The methodology of the present investigation is described below:

5.4.1. Design of the study

The experimental design used in this study was Pre-Test – Post-Test Equivalent Groups Design. The design is illustrated as follows:
5.4.2. Sample for the study

Intact groups of students from standard IX were selected as sample for the study. The groups were matched on the basis of Previous Knowledge of Subject Matter and Non-Verbal Intelligence. The experimental group was taught through Concept Attainment Model of teaching and the control group was taught through Objective Based Instruction. Each group consisted of 40 students.

5.4.3. Selection of Topics for Treatment

The topics which were amenable for treatment using Concept Attainment Model of Teaching and Objective Based Instruction were
selected. From the analysis of the syllabus of Physics at secondary classes the investigator selected thirty topics for the treatment.

5.4.4. Instructional Materials and Tools used for the Study

5.4.4.1. Lesson transcripts based on Concept Attainment Model
5.4.4.2. Lesson transcripts based on Objective Based Instruction
5.4.4.3. Studying Approach Inventory (Usha and Ampili, 2002)
5.4.4.4. Standard Progressive Matrices Test (Raven, 1958)
5.4.4.5. Achievement Test in Physics (Usha and Ampili, 2002)

5.4.5. Procedure Adopted for Data Collection

The procedure adopted for collecting necessary data were as follows:

5.4.5.1. Administration of Pre-Test

Pre-Test was administered to the Experimental Group and Control Group before the treatment was given.

5.4.5.2. Administration of Other Tools

Prior to the introduction of treatment in the selected school, data on Non-Verbal Intelligence, and Studying Approaches of the subjects were collected. For this purpose Ravens Progressive Matrices Test and Studying Approach Inventory were administered. The procedure
suggested in the manual for the administration was followed especially for Ravens Progressive Matrices Test.

5.4.5.3. Treatment

After selection of the topics for treatment instructional materials and tools were prepared. Experimental Group was taught through Concept Attainment Model of Teaching and Control Group was taught through Objective Based Instruction.

5.4.5.4. Administration of Post-Test I

Post-Test I was administered to each group immediately after the treatment.

5.4.5.5. Administration of Post-Test II

Post-Test II was administered to each group two months after the treatment.

5.4.6. Statistical Techniques Used

The statistical processing of the data was done using computer facilities as Statistical Package for Social Sciences. The techniques used for analysing the data were the following:

(i) Test of Significance of difference between means.

(ii) Two-way ANOVA with 2x3 Factorial design.
(iii) Scheffe's Test of Multiple Comparison
(iv) Two way ANCOVA with 2x3 factorial design.

5.5. MAJOR FINDINGS OF THE STUDY

The major findings of the investigation are presented in the following sections.

5.5.1. RESULTS OF MEAN DIFFERENCE ANALYSIS OF ACHIEVEMENT IN PHYSICS OF EXPERIMENTAL AND CONTROL GROUP

Results of mean difference analysis of Achievement in Physics in Post-Test I and Post-Test II between Experimental Group and Control Group are given below:

5.5.1.1. Difference in the Mean Scores of Achievement in Physics Post-Test I of Experimental Group and Control Group

Significant difference was found in the mean scores of Achievement in Physics Post-Test I for the Total sample at 0.05 level ($t = 2.27$). But in the case of Boys ($t = 1.37$) and Girls ($t = 1.88$) no significant difference was found in the mean scores of Achievement in Physics Post-Test I.
5.5.1.2. Difference in the Mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) of Experimental Group and Control Group

Significant difference was found in the mean Gain scores of Achievement in Physics Post-Test I between Experimental Group and Control Group at 0.01 level for Total sample ($t = 3.37$) and Girls ($t = 2.81$). But in the case of Boys ($t = 1.96$), no significant difference was found in the mean Gain scores of Achievement in Physics Post-Test I.

5.5.1.3. Difference in the Mean Scores of Achievement in Physics Post-Test II of Experimental Group and Control Group

Significant difference was found in the mean scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample ($t = 4.30$), Boys ($t = 3.02$) and Girls ($t = 3.14$).

5.5.1.4. Difference in the Mean Gain Scores of Achievement in Physics (Post-Test II minus Pre-Test) of Experimental Group and Control Group

Significant difference was found in the mean Gain scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample ($t = 6.68$), Boys ($t = 4.92$) and Girls ($t = 4.59$).
5.5.2. RESULTS OF MEAN DIFFERENCE ANALYSIS OF ACHIEVEMENT IN PHYSICS OF STUDENTS HAVING DIFFERENT STUDYING APPROACHES NAMELY DEEP APPROACH, SURFACE APPROACH AND STRATEGIC APPROACH

5.5.2.1. Difference in the Mean Scores of Achievement in Physics Post Test I of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean scores of Achievement in Physics Post-Test I at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 33.99), between students having Deep Approach to Studying and Strategic Approach to Studying (t = 6.63) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 8.55).

5.5.2.2. Difference in the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean gain scores of Achievement in Physics Post-Test I at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 39.11) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 6.30). In the case of students having
Deep Approach to Studying and Strategic Approach to Studying, significant difference was found at 0.05 level in the mean gain scores of Achievement in Physics Post-Test I (t = 2.56).

5.5.2.3. Difference in the mean scores of Achievement in Physics Post-Test II of Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean scores of Achievement in Physics Post Test II at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 27.07), between students having Deep Approach to Studying and Strategic Approach to Studying (t = 3.51) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 7.32).

5.5.2.4. Difference in the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) of students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying

Significant difference was found in the mean gain scores of Achievement in Physics Post-Test II at 0.01 level between students having Deep Approach to Studying and Surface Approach to Studying (t = 5.07) and between students having Surface Approach to Studying and Strategic Approach to Studying (t = 5.53). No significant difference was found in
the mean gain scores of Achievement in Physics Post-Test II between students having Deep Approach to Studying and Strategic Approach to Studying.

5.5.3. MAIN EFFECT AND INTERACTION EFFECT OF METHODS OF TEACHING AND STUDYING APPROACH ON ACHIEVEMENT IN PHYSICS

5.5.3.1. Main Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I

Significant main effect of Methods of Teaching on Achievement in Physics Post-Test I was found to exist for Total Sample \( F = 25.73 \), Boys \( F = 22.98 \) and Girls \( F = 8.82 \) at 0.01 level of significance. The main effect of Studying Approach on Achievement in Physics Post-Test I was also found to be significant for Total Sample \( F = 201.22 \), Boys \( F = 164.43 \) and Girls \( F = 75.61 \) well beyond 0.01 level of significance.

5.5.3.2. Main Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II

The main effect of Methods of Teaching on Achievement in Physics Post-Test II was found to be significant for Total Sample \( F = 95.90 \), Boys \( F = 72.12 \) and Girls \( F = 54.09 \) at 0.01 level of significance. Significant main effect of Studying Approach on Achievement in Physics Post Test II was found to exist for Total Sample
(F = 170.52), Boys (F = 105.54) and Girls (F = 118.78) well beyond 0.01 level of significance.

5.5.3.3. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I

Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I was found to be significant at 0.01 level for Total sample (F = 7.94) and for Girls (F = 6.68). But for Boys (F = 3.99) at 0.05 level.

5.5.3.4. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II

Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample (F = 23.21), Boys (F = 11.48) and Girls (F = 26.50).

5.5.4. POST-HOC COMPARISON OF GROUP DIFFERENCES

5.5.4.1. Difference in Mean Scores of Achievement in Physics Post-Test I and Post-Test II between Experimental Group and Control Group

Significant difference was found in the mean scores of Achievement in Physics Post-Test I for the Total sample at 0.05 level (t = 2.27) but no significant difference was found in the mean scores of Achievement in Physics Post-Test I for Boys (t = 1.37) and Girls (t = 1.88) even at 0.05
level. Significant difference was found in the mean scores of Achievement in Physics Post-Test II between Experimental Group and Control Group at 0.01 level for Total sample ($t = 4.30$), Boys ($t = 3.02$) and Girls ($t = 3.14$).

5.5.4.2. Difference in Mean Scores of Achievement in Physics Post-Test I among Groups formed on the basis of Studying Approaches

Results of Multiple comparison using Scheffe test of the three groups formed on the basis of Studying Approaches (Deep Approach, Surface Approach and Strategic Approach) with respect to mean Achievement in Physics Post-Test I reveal the following:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sample</th>
<th>Groups compared</th>
<th>F-value</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>268.33</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>57.20</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>79.42</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>Boys</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>184.54</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>49.71</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>41.43</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>Girls</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>99.26</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>14.99</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>40.40</td>
<td>0.01</td>
</tr>
</tbody>
</table>
It is revealed from the summary of the result that significant mean difference exist at 0.01 level in all the nine comparisons. Hence it can be concluded that significant difference in Achievement in Physics Post-Test I exist among groups formed on the basis of Studying Approaches.

**5.5.4.3. Difference in Mean Scores of Achievement in Physics Post-Test II among Groups formed on the basis of Studying Approaches**

Results of multiple comparison using Scheffé test for the three groups formed on the basis of Studying Approaches (Deep Approach, Surface Approach and Strategic Approach) with respect to mean Achievement in Physics Post-Test II reveal the following.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sample</th>
<th>Groups compared</th>
<th>F-value</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>120.54</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>18.20</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>46.73</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>Boys</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>57.71</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>11.95</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>16.93</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>Girls</td>
<td>Deep Approach Vs. Surface Approach</td>
<td>62.88</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Approach Vs. Strategic Approach</td>
<td>6.57</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Approach Vs. Strategic Approach</td>
<td>31.93</td>
<td>0.01</td>
</tr>
</tbody>
</table>
It is revealed from the summary of the results that significant mean difference exist at 0.01 level in eight out of nine comparisons and at 0.05 level in one comparison i.e., between Deep Approach and Strategic Approach for the sample of Girls. Hence it can be concluded that significant difference in Achievement in Physics Post-Test II exist among groups formed on the basis of Studying Approaches.

5.5.5. RESULTS OF ANALYSIS OF COVARIANCE

Altogether fifty four Analysis of Covariance effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II were estimated by controlling Previous Knowledge of Subject Matter and Non-Verbal Intelligence one by one and in combination. The results are summarised in the following sections.

5.5.5.1. Main Effect of Methods of Teaching on Achievement in Physics Post-Test I and Post-Test II with Previous Knowledge of Subject Matter as Covariate

When Previous Knowledge of Subject Matter was taken as Covariate, the analysis for Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values obtained are 47.39, 23.82 and 28.89 for Total sample, Boys and Girls respectively.

With Previous Knowledge of Subject Matter as Covariate, the analysis for Post-Test II revealed that all the F-values are significant at
0.01 level. The F-values obtained are 168.73 for Total sample, 73.33 for Boys and 88.92 for Girls.

5.5.5.2. **Main Effect of Methods of Teaching on Achievement in Physics Post-Test I/Post-Test II with Non-Verbal Intelligence as Covariate**

When Non-Verbal Intelligence was taken as covariate, the analysis for Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values obtained are 62.20 for Total sample, 28.38 for Boys and 60.55 for Girls.

When Non-Verbal Intelligence was taken as Co-variate, the analysis for Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values obtained are 166.34 for Total sample, 73.33 for Boys and 134.83 for Girls.

5.5.5.3. **Main Effect of Methods of Teaching on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Covariates**

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as Covariates, the analysis of Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values are 63.65 for Total sample, 27.58 for Boys and 59.64 for Girls.
When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as Covariates, the analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 196.01 for Total sample, 70.93 for Boys and 136.27 for Girls.

5.5.5.4. Main Effect of Studying Approach on Achievement in Physics Post-Test I / Post-Test II with Previous Knowledge of Subject Matter as Covariate

When Previous Knowledge of the Subject Matter was taken as co-variate, the analysis of Post-Test I revealed that all the F-values are significant at 0.01 level. The F-values are 292.80 for Total sample, 214.38 for Boys and 116.02 for Girls.

When Previous Knowledge of Subject Matter was taken as Covariate, the analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 56.18 for Total sample, 7.09 for Boys and 37.00 for Girls.

5.5.5.5. Main Effect of Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Non Verbal Intelligence as Co-variate

When Non-Verbal Intelligence was taken as Co-variate, the analysis of Post-Test I revealed that all the F-values are significant well beyond 0.01 level. The F-values are 384.36 for Total sample, 255.47 for Boys and 248.30 for Girls.
When Non-Verbal Intelligence was taken as co-variate, the analysis of Post-Test II revealed that the F-values are not significant even at 0.05 level. The F-values are 2.50 for Total sample, 2.75 for Boys and 1.30 for Girls.

5.5.5.6. Main Effect of Studying Approach on Achievement in Physics Post-Test I / Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test I revealed that all the F-values are significant well beyond 0.01 level. The F-values are 393.31 for Total sample, 248.17 for Boys and 244.58 for Girls.

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as covariates, the analysis of Post-Test II revealed that two out of three F-values are not significant even at 0.05 level (F-values for Boys (2.24) and Girls (3.23)). The F-value for Total sample (4.67) was found to be significant at 0.05 level.
5.5.5.7. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter as Covariate

When Previous Knowledge of Subject Matter was taken as covariate, the analysis of Post-Test I revealed that two out of three F-values are significant at 0.01 level. The F-values are 12.98 for Total sample, and 7.99 for Girls. In the case of Girls, the F-value (4.37) was found to be significant at 0.05 level.

When Previous Knowledge of Subject Matter was taken as Co-variate analysis of Post-Test II revealed that all the F-values are significant at 0.01 level. The F-values are 45.57 for Total sample, 16.18 for Boys and 34.22 for Girls.

5.5.5.8. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post Test I/Post Test II with Non-Verbal Intelligence as Covariate

When Non-Verbal Intelligence was taken as co-variate, analysis of Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values are 15.85 for Total sample, 6.50 for Boys and 19.14 for Girls.

When Non-Verbal Intelligence was taken as Co-variate, analysis of Post-Test II revealed that all the F-values are significant beyond 0.01 level.
The F-values are 41.13 for Total sample, 14.54 for Boys and 50.99 for Girls.

5.5.5.9. Interaction Effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I/Post-Test II with Previous Knowledge of Subject Matter and Non-Verbal Intelligence as Co-variates

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test I revealed that all the F-values are significant beyond 0.01 level. The F-values are 16.57 for Total sample, 5.97 for Boys and 18.18 for Girls.

When Previous Knowledge of Subject Matter and Non-Verbal Intelligence in combination were taken as co-variates, the analysis of Post-Test II revealed that all the F-values are significant beyond 0.01 level. The F-values are 51.02 for Total sample, 14.53 for Boys and 49.79 for Girls.

5.6. TENABILITY OF HYPOTHESES

The tenability of the hypotheses of the present study was examined on the basis of the findings. The study showed that most of the hypotheses set for the study are substantiated.
5.6.1. First hypothesis states that "There will be significant difference in the Mean Scores of Achievement in Physics Post-Test I (tested immediately after the treatment) between Control Group and Experimental Group"

Comparisons of mean Achievement in Physics on Post-Test I were done for Total sample, Boys and Girls. The t-value for the Total sample was found to be significant. But the t-values for Boys and Girls were not found to be significant. Hence first hypothesis is partially substantiated.

5.6.2. The second hypothesis states that "There will be significant difference in the mean Gain Scores of Achievement in Physics (Post-Test I minus Pre-Test) between Control Group and Experimental Group"

The mean Gain Scores (Post-Test I score minus Pre-Test score) on Achievement in Physics was computed and compared between Experimental Group and Control Group for Total sample, Boys and Girls. Two out of three t-values were found to be significant. The second hypothesis is therefore, substantiated to a greater extent.

5.6.3. The third hypothesis states that "There will be significant difference in the mean Retention scores of Achievement in Physics Post-Test II (tested two months after the treatment) between Control Group and Experimental Group"

Three comparisons of mean retention in Physics Post-Test II between Experimental Group and Control Group were done. All the t-
values were found to be significant. Hence the third hypothesis is fully substantiated.

5.6.4. The fourth hypothesis states that "There will be significant difference in the mean Gain Scores of Achievement in Physics (Post-Test II minus Pre-Test) between Control Group and Experimental Group"

Significant difference beyond 0.01 level in the mean gain scores on Achievement in Physics (Post-Test II minus Pre-Test) between Experimental Group and Control Group was noticed for Total sample, Boys and Girls. Hence fourth hypothesis is fully substantiated.

5.6.5. The fifth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean scores of Achievement in Physics in Post-Test I"

Three comparisons of mean Achievement in Physics Post-Test I were done between Groups formed on the basis of Studying Approaches. All the t-values were found to be significant. Hence fifth hypothesis is fully substantiated.
5.6.6. The sixth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test)

Significant difference in the mean gain scores of Achievement in Physics (Post-Test I minus Pre-Test) was noticed between Groups formed on the basis of Studying Approaches. Hence this hypothesis is fully substantiated.

5.6.7. The seventh hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying will have significant difference in their mean Retention Scores of Achievement in Physics Post-Test II

Three comparisons of mean Retention in Physics Post-Test II between Groups formed on the basis of Studying Approaches were done. All the t-values were found to be significant beyond 0.01 level. Hence this hypothesis is fully substantiated.
5.6.8. The eighth hypothesis states that "Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test)"

Two out of three t-values were found to be significant for the comparison of mean Gain Scores of Achievement in Physics Post-Test II for Groups formed on the basis of Studying Approaches. Hence this hypothesis is substantiated to a greater extent.

5.6.9. The ninth hypothesis states that: There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls"

Significant main effect of Methods of Teaching on Post-Test I was found to exist since all the F-values were significant for Total sample, Boys and Girls.

Main effect of Studying Approach on Achievement in Physics Post-Test I was found to be significant for Total sample, Boys and Girls.

The interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test I was found to be significant for Total sample, Boys and Girls.

Hence the hypothesis is fully substantiated.
5.6.10. The tenth hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls"

Main effect of Methods of Teaching on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample, Boys and Girls.

Main effect of Studying Approach on Achievement in Physics Post-Test II was found to be significant at 0.01 level for Total sample, Boys and Girls.

Interaction effect of Methods of Teaching and Studying Approach on Achievement in Physics Post-Test II was found to be significant in all the cases.

Hence the hypothesis is fully substantiated.
5.6.1. The eleventh hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial difference in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination"

To test this hypothesis, twenty-seven ANCOVA were attempted. In all the cases the F-values were found to be significant.

Therefore the eleventh hypothesis is fully substantiated.

5.6.12. The twelfth hypothesis states that "There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination"

Twenty seven ANCOVA were done to test this hypothesis. Out of these twenty two F-values were found to be significant and five F-values were found not significant.

Hence this hypothesis can be substantiated to a greater extent.
5.7. SUGGESTIONS FOR IMPROVING EDUCATIONAL PRACTICE

Based on the findings of the present investigation, the following suggestions are put forth for improving the existing educational practice in schools.

1. From the present study, it is noticed that Concept Attainment Model is effective in the teaching of the select topics in Physics for Achievement in Physics of standard IX students. It is to be specially noted that Concept Attainment Model which focuses on concept and thinking processes and not merely on rote learning of content is feasible in a normal secondary school class with a rigid organisational set up. This Method of Teaching ensures more active participation of students in learning process and better content mastery of the essential concepts which especially have a carry over value.

2. During the experiment, using Concept Attainment Model it was observed that students enjoy the lessons well since the class starts in the form of a game. For students who were weak and shy in the beginning, the use of appropriate prompts by the teacher helped for better learning of concepts.
3. In Concept Attainment Model of Teaching students are forming hypotheses. This enhance their thinking ability and scientific attitude. The analysis of thinking strategies help the students to become scientific and systematic in their studies. This has a carry over effect in day-to-day life. Therefore teachers should follow this method of teaching since it will improve the outlook and personality of students.

4. In Concept Attainment Model of Teaching all the students are actively participating and forming their own hypotheses about the labelled examples. Hence Concept Attainment Model has an inbuilt mechanism for attending to individual differences of the learners.

5. Teachers in Concept Attainment Model especially in the Reception Oriented Strategy have the full responsibility of leading the classroom instruction, monitoring the thinking process of students and providing feedback to students concerning their errors. The preparation of lesson transcripts, carefully selecting and ordering labelled examples, and organizing the sequencing of the lesson very carefully consume a considerable amount of time of the teacher in preparing for teaching. This may require special training for teachers not only for preparation of lesson transcripts, but also for
effective classroom transaction. But once a lesson transcript is prepared, this can be used in successive years, with modification whenever it is found necessary. Different Physics teachers can pool their expertise and extra time for preparing lesson transcripts in CAM format and can successfully implement these in Physics syllabus.

6. From the present study it is noticed that students having different Studying Approaches will differ significantly in their achievement. Students who have Deep Approach to Studying and Strategic Approach to Studying are found to be superior to students having Surface Approach to Studying in their Achievement and Retention in Physics. Hence teachers should make the students aware of the importance of their Studying Approach and should give them guidance in adopting proper studying approaches.

7. The study of Wilding et al. (2006) revealed that there is consistent relation between general life goals and studying approaches of the individual. In the present system of educational practice prevalent in Kerala students do not know the goals of education. The purpose of the study is just to get good grade in examination. The acquired knowledge remain isolated and not integrated with life activities. There should be deliberate attempt on the part of educators and
teachers to make the students aware of learning as a life long process. A shift should be made in the goals of science education to make it future oriented. In order to develop a better studying approach students should be made aware of the importance of the subject matter they learn, its relation to life and the reasons for practising it during studies.

8. The present study indicates that deep approach to studying is associated with seeking meaning, organising ideas and using logic. The surface approach is associated with rote memorisation, fragmented knowledge, lack of purpose and syllabus boundedness. The present system of examination and evaluation practised in secondary schools of Kerala is syllabus bounded. This will create more students with surface approach to studying. Therefore the evaluation system should be reformed and more stress should be given to formative evaluation in the secondary school curriculum.

9. Studies of many researchers like Tait and Entwistle (1993, 1995), Karaquannopoulou et al. (2005), Richardson (2005), Struyven (2006) and Mimirinis and Bhattacharya (2007) indicate that studying approach is positively related with perception of the students about the learning environment. The studying approach depends on the institutional set up and requirements. Therefore
educational administrators and teachers should make an effort to create the right perception in students about the course of study and institutional environment. Classrooms should be equipped with modern facilities in tune with the technological advancement of the world. Education should be made more vivid, enriched and experience based. Teachers and the school authorities can provide extra reading materials and other facilities to encourage students to have an in depth study of the different subjects.

10. The present study stresses the importance of appropriate studying approach for better academic outcome. The studies of Abouserie (1995), Andreou et al. (2006) and Wilding et al. (2006) indicate that studying approach depends on many individual characteristics of the learner. Therefore the learning environment should cater to individual differences. Multiple learning opportunities, diversified curriculum and courses rich in learning experience should be provided to develop better studying approach and in turn better academic outcome. Students should be made aware of the importance of studying approach for better academic performance. Separate and deliberate instructional training should be given to students for learning how to study. Teachers should try to improve the studying approach of low achievers by modifying the learning
environment and achieving a balance between teaching strategy and studying methods.

11. In order to create more students with deep approach to studying science classes should provide chances for observation and experimentation. Students should seek evidences and clarifications and learning should be made syllabus free and enjoyable. In order to create interest and motivation in students learning should be life oriented. Thinking ability and creativity should be enhanced and students should be made self reliant and independent. Projects and assignments should not be examination bound but should cater to individual differences. To achieve this, innovative teaching strategies like Concept Attainment Model should be provided in secondary school science curriculum.

5.8. SUGGESTIONS FOR FURTHER RESEARCH

The findings of the present study can further be extended by future researchers on the lines suggested below.

1. The replication of the study can be attempted on other concepts in Physics from secondary school curriculum.
2. Interaction effect of Concept Attainment Model of Teaching and Studying Approach on Achievement in Physics of Upper Primary Students and Higher Secondary Students can be studied.

3. The study can be replicated for Chemistry and other Science subjects.

4. Interaction effect of Concept Attainment Model and Studying Approach on Achievement in Physics by considering Examination Anxiety, Self-Concept, Creativity as Control variables can be studied.

5. The study can be attempted for the subsamples based on English/Malayalam medium, rural/urban, private/government population.

6. The study can be replicated on students with learning disabilities, special needs, social disadvantage and of different classroom learning environment.

7. A study on the interaction effect of Methods of Teaching and Studying Approach on Academic Achievement can be conducted for the population of teacher trainees.

8. The interaction effect of other information processing Models of Teaching and Studying Approach on Achievement in Physics can be experimented.