CHAPTER – V

SUMMARY AND CONCLUSIONS

5.1 INTRODUCTION

Active learning is a term generally used to denote teaching learning strategies that engage and involve students in their learning process. It is an umbrella term that refers to several models of instruction that shifts the emphasis from teaching to learning and focus the responsibility of learning on the learner. Active learning is anything course-related that all students in a class session are called upon to do other than simply watching, listening and taking notes. In this mode of learning, students are engaged in activities including discovering, processing, and applying information (Felder and Brent, 2009). The term Active learning is used to encompass the approaches that have received a variety of labels in the pedagogy literature like the discovery learning, co-operative learning, collaborative learning, interactive engagement, team-based learning, peer-instruction etc. which focus on active and participative learning as opposed to mere passive forms of learning (Hendriksen, 1996). This is the broadest and the most inclusive learning principle and it undergirds all other key learning processes. The important characteristic of active learning is learners’ ownership and responsibilities for their learning progress and that the active role may be manifested in individual and cooperative learning situations. Anything that the students do in the class room other than merely listening to the lectures passively can be considered as active learning and any strategy that enables the learner to do so can be termed as Active Learning Strategy.
By placing students at the center of instruction, Active Learning Strategies shifts the focus from teaching to learning and promotes a learning environment more amenable to the metacognitive development necessary for students to become independent and critical thinkers. Active-learning instructional strategies lead to improved student attitudes and increased learning. With the effective use of Active Learning Strategies, science instruction becomes fast-paced, fun, supportive, and personally engaging bringing out higher levels of energy and participation and greater learning. Yoder and Hochevar (2005) emphasis that encouragement in Active learning can improve student’s performance in examination and Sivan et al. (2000) reports that various forms of Active Learning contributes to the qualities like Critical Thinking, problem solving, and the students become self-managed learner.

5.2 NEED AND SIGNIFICANCE OF THE STUDY

Learning is not a passive pursuit. It is not merely the process of absorbing information from external sources; on the contrary it is the act of processing of information in the ways that are meaningful to the learners. Students do not learn just by sitting passively in the classroom listening to teachers, taking notes, memorizing the answers or recalling facts. They must be actively involved in the process of learning by talking about what they are learning, writing about it, by relating it to past experiences and applying it to their everyday lives (Davis, 1993; Bonwell & Eison, 1991; Chickering & Gamson, 1987). Students learn best when they are actively embedded in the learning process. Active learning shifts the focus from teaching to learning, from students acquiring knowledge to students actively, independently,
critically and creatively generating meaning and constructing knowledge by themselves.

Current researches and anecdotal evidences on instructional practices worldwide indicate that the active learning approaches can increase student understanding of science concepts because they facilitate student learning processes resulting in improved student attitudes and retention of knowledge and promote a learning environment more amenable to the metacognitive development necessary for students to become independent and critical thinkers and self managed learners (Bransford et al., 2000; Michael, 2006; Prince, 2004; Preszler et al., 2007; Felder & Brent, 1997; Yoder & Hochevas, 2005; Sivan et al., 2000; Morable, 2000).

By considering all the benefit of Active learning, and more, many International agencies like UNESCO and the United Nations have made several attempts to sensitize and popularize the need for promoting the Active learning pedagogies worldwide. Following these worldwide efforts to respect the Rights of child and the call for participatory pedagogic practices, the educational system in India also witnessed several drastic revolutions in field of pedagogic principles and practices. NCF (2005) has proposed a shift in rote learning approaches in teaching and learning and outlined the need to institute Active leaning pedagogies in the classroom. These transitions in the pedagogic practices were also reflected in the Kerala Curriculum Framework (KCF, 2007). Hence it is imperative to employ participatory pedagogic practices in the classrooms that will promote the active learning in the learners and the number of active learning tasks is limitless.
However it is often observed that passive learning environment of teacher centered lectures remains the predominant environment encountered by students in classrooms and effective teaching method based on how people learn are often rarely applied in regular classroom.

Critical Thinking is ability or set of skills that is highly valued in students especially in contemporary world and development of Critical Thinking has become a promising strategy helping to increase learning effectiveness while teaching any subject matter. Improving Critical Thinking Skills is accepted as a crucial goal of education and schools are considered one of the best places where Critical Thinking Skills can be developed efficiently. However as a result of the current classroom practices, it is often noticed that learners are not encouraged to improve themselves as thinkers and overemphasis is placed on information transmission, memory, practice, rote learning etc., paying little focus on higher order thinking. Consequently, majority of school leavers are not able to think effectively and deal efficiently with many of the practical situations. Hence teachers need to realise that it is their prime duty to develop Critical Thinking Skills in the students by modifying the curriculum to integrate active, authentic and evidence based practices that will develop our students’ Critical Thinking Skills to the optimum level.

Thinking Styles are the preferred ways of using the abilities that one has. According to Sternberg’s Principles of Thinking Styles, Individuals have a style profile and it is possible to vary their styles to suit different tasks and situations. Styles further vary over the course of a lifetime, and change as a result of the role models they emulate at different points in their lives. Styles are modifiable are
Thinking Styles of the students can affect their learning considerably, hence different modes of teaching must be employed by the teachers for style differentiated instruction so that students can benefit the most from instruction. For this, at least some part of the instruction should match the styles of thinking of the students, even though it is not possible to provide a perfect match all the time. So therefore there is an urgent need for an overall revisiting of the pedagogic practices being followed presently in the class rooms and deliberate efforts should be taken to adopt Active Learning Strategies appropriate to develop the thinking faculties of the students at an earlier stage itself-so that they can make the fullest possible use of their thinking abilities and styles to realize the best ways to invest their true potentials. On looking into the researches conducted in the past, it was found that Active Learning Strategies had proved to be one of the best methods appropriate to develop the thinking abilities and attitudes in the learners and in many studies it was found that Critical Thinking is related to certain Thinking Styles. Majority of the studies reviewed on these lines were conducted abroad and very rarely were the studies on the analysis of the effectiveness of Active Learning Strategies on the thinking abilities were found to be held in India and particularly in Kerala. So, in the present study, the investigator intended to study the influence of certain Active Learning Strategies on Critical Thinking, Thinking Styles and Achievement in Physics of secondary school students of Kerala. This study was designed to investigate the influence of Active Learning Strategies like group investigation, Think-Pair-Share, K-W-L, concept mapping and One Minute Papers on Critical Thinking Skills, Critical Thinking Dispositions, Executive, Legislative and Judicial Thinking Styles and Achievement in Physics among the Secondary
School Students. Even though there were other categories of Thinking Styles, the investigation is confined only to the Thinking Styles based on the functions of mental self-government – the executive, Legislative and Judicial Thinking Styles. The secondary school students are in the beginning of their early phase of Piaget’s formal operational stage and their ability to think hypothetically and logically is nascent. A proper training and guidance given to the exercise of thinking at this stage will help the students to develop their thinking skills and styles to the optimum. So the present investigation is intended to study the influence of Active Learning Strategies on Critical Thinking, Thinking Styles and Achievement in Physics among secondary school students.

5.3 STATEMENT OF THE PROBLEM

The study attempts to develop instructional material integrating Active Learning Strategies to teach topics in Physics to students of standard IX and to study its’ influence on the Critical Thinking Skills, Critical Thinking Dispositions, Executive, Legislative and Judicial Thinking Styles and Achievement in Physics among Secondary School Students of Kerala. Hence, the study is entitled as: “A Study of Influence of Active Learning Strategies on Critical Thinking, Thinking Styles and Achievement in Physics Among Secondary School Students”.

5.4 VARIABLES OF THE STUDY

In the present study the approach to teaching has been considered as manipulated to find what kind of effect it can produce on dependent variables. In this study Active Learning Strategies is the independent variable.

A dependent variable is the measured or observed variable. By observing the dependent variable, the effect of the independent variable can be measured. The dependent variable is the phenomenon – that appears, disappears or changes
as the researcher applies, removes or varies the independent variable. It was to be tested whether the independent variable, the Active Learning Strategies would have an effect on the dependent variables like Critical Thinking, Thinking Styles and Achievement in Physics.

Control variable is a variable that has the potential to have an impact on the dependent as well as the independent variable, but its effects are removed or controlled by the research design or statistical manipulation. When variables are not amenable to physical or selective manipulation, they may be controlled by statistical techniques. Statistical controls can achieve the same precision as other methods when they are employed to evaluate a variable effect. The variable that was statistically controlled in the present study was the intelligence of the students. Classes chosen for the experimental treatment, content to be taught and the age of the students were also controlled.

Those variables that have an unpredictable or unexpected impact on the dependent variable were unable to control. Some of these variables were Socio-economic status, home environment, absence of students during experiment, etc. Situational variables like time, duration of treatment, Type of management of schools, content to be taught etc. were controlled.

5.5 OBJECTIVES OF THE STUDY
1. To study the influence of Active Learning Strategies on the Critical Thinking of secondary school students.
2. To study the influence of Active Learning Strategies on the Thinking Styles of secondary school students.
3. To study the influence of Active Learning Strategies on the secondary school students’ Achievement in Physics.
4. To study the main and interaction effects of intelligence and gender on secondary school students’ Critical Thinking, Thinking Styles and Achievement in Physics.

5. To study the relationship among Critical Thinking, Thinking Styles and Achievement in Physics of secondary school students.

6. To study the reactions of students towards Active Learning Strategies.

**5.6 HYPOTHESES OF THE STUDY**

1. The experimental group will be better in Critical Thinking when compared to the control group as a result of implementation of Active Learning Strategies.

2. There will be a difference in Thinking Styles of experimental group when compared to control group as a result of implementation of Active Learning Strategies.

3. The experimental group will be better in Achievement in Physics when compared to the control group as a result of implementation of Active Learning Strategies.

4. There will be differences in Critical Thinking, Thinking Styles and Achievement in Physics among high, average and low intelligence group of students of the experimental group as a result of implementation of Active Learning Strategies.

5. There will be no differences in Critical Thinking, Thinking Styles and Achievement in Physics with respect to gender among the students of experimental group as a result of implementation of Active Learning Strategies.
6. There will be differences in Critical Thinking, Thinking Styles and Achievement in Physics after the implementation of Active Learning Strategies as a result of interaction effect of intelligence and gender.

7. There will be a relation among Critical Thinking, Thinking Styles and Achievement in Physics of the students of the experimental group.

5.7 RESEARCH QUESTIONS OF THE STUDY

1. Is there any influence of Active Learning Strategies on Critical Thinking, Thinking Styles and Achievement in Physics of secondary school students?

2. Is there any effect of intelligence on Critical Thinking, Thinking Styles and Achievement in Physics of secondary school students?

3. Is there any effect of gender on the Critical Thinking, Thinking Styles and Achievement in Physics of secondary school students?

4. Is there an interaction effect of intelligence and gender on the Critical Thinking, Thinking Styles and Achievement in Physics of the secondary school students?

5. Is there any relation among Critical Thinking, Thinking Styles and Achievement in Physics of the secondary school students?

6. What are the reactions of the students towards Active Learning Strategies?

5.8 DESIGN OF THE STUDY

The present study adopted quasi experimental pre-test post-test two group design, wherein a control and an experimental group were employed. A non-equivalent control group design was used. The pretest and post-test were administered to the two non-equivalent samples in the form of intact groups of class IX of two different schools.
5.9 SAMPLE OF THE STUDY

The population of this study consisted of students of secondary schools of Kerala following the SCERT curriculum. Purposive sampling technique was used where in samples were drawn from two intact divisions of standard IX of SNMHS, Moothakunnam and HMYSHS, Kottuvalikkad as experimental and control groups respectively. Purposive sampling was used since it was not possible to employ randomization, which would upset the class schedules. The class as a whole was considered for implementing the study. The students of standard IX were chosen because they are in the beginning of their early phase of Piaget’s formal operational stage and a proper training and guidance given to the exercise of thinking at this stage will help the students to develop their thinking skills and styles to the optimum. Intact group of 44 students in the experimental group and 46 students from control group were initially taken for the study. Later 3 students from experimental group and 5 students from control group who could not attend the pre-test or post-test were eliminated from the data. Finally the sample for the study was reduced to 41 each in experimental group and control groups.

5.10 INSTRUMENTS USED IN THE STUDY

The tools used in the study are Raven’s Progressive Matrices Test (Raven, 1976), Achievement Test in Physics, Test on Critical Thinking Skills in Physics (TCTSP), Critical Thinking Dispositions Scale (CTDS), Thinking Styles Inventory (TSI) and Student’s Reactions Scale (SRS).

a) Raven’s Progressive Matrices

Raven’s Progressive Matrices were used to measure the mental ability of the students. Mental ability is the ability of the person to apprehend, observe and
conceive relations and develop a systematic method of reasoning which indicates his capacity for intellectual activity and clarity in thinking. The test consists of five sets of diagrammatic puzzles exhibiting serial changes in two dimensions simultaneously. Each set has 12 items thus constituting 60 items in total. In each set the first problem is self-evident as nearly as possible. Every problem in the test is readily the source of thought for the next. The problems which follows becomes progressively more difficult and hence the name “Progressive Matrices”. The RPM has test retest reliability ranging from 0.80 to 0.93 and internal consistency ranging from 0.87 to 0.97. In the present study, RPM was administered to both the experimental and control groups in the pretest stage. The total raw scores of the experimental and control group were found and was taken as covariate in the present study.

b) Achievement Test in Physics

In order to measure the performance of the students before and after the experimentation an achievement test was prepared and standardized by the investigator based on the topics to be transacted using Active Learning Strategies. The achievement test was constructed based on objectives of science education and included the objectives like Knowledge, comprehension and application and skill. The test items were of objective type including multiple choice items, supply type items, matching type items and short answer type. The duration of the test was 60 minutes and carried a maximum weightage of 50 marks. The same test was used as pretest and post-test for the study. The items were pooled based on the objectives framed and appropriate weightages were given to objectives, content and form of questions. The items thus framed were further scrutinized and edited.
from the point of view of language suitability, ambiguity, and for the correspondence to specific behavioural outcomes and comprehensibility. The content validity of the test was obtained by giving it to senior Physics teachers, teacher educators and subject experts in the field. The item analysis was carried out on the guidelines of Ebel and Fresbie (1991). The test retest coefficient of the test was found to be 0.72. The Cronbach’s $\alpha$ (alpha) was found to be equal to 0.87. The final form of the test consisted of 55 items including 30 multiple choice items, 10 fill in the blanks, 5 Matching type and 10 short answer questions with a total mark of 50.

**c) Test on Critical Thinking Skills in Physics**

The cognitive skills given in the Delphi Report (1990) were used for the construction of the test. The dimensions of Critical Thinking Skills considered for the study were Interpretation, Analysis, Inference, Evaluation, Explanation and Self-Regulation. Items for the test were in the form of multiple choice questions on the Critical Thinking Skills keeping in mind the age, mental ability and grade of the students. Items were mostly related to topics in Physics and utmost care was taken to ensure that more priority is given to the thinking aspects involved in answering the questions rather than on the content. The investigator consulted several subject experts in the field for proper guidance and suggestions and with their inputs, forty items appropriate to the subjects was prepared. The scoring key was also prepared simultaneously. After item analysis, ten items were rejected there by retaining only thirty items in the test. The final form of the Test on Critical Thinking Skills in Physics consisted of five items each from the dimensions interpretation, inference, analysis, evaluation, explanation and self-
regulation thereby making a total of thirty items. A score of one was given to each correct answer thus making the total score of the test equal to thirty. The duration for the test was about forty minutes. The reliability of the test was established using test–retest method. The coefficient of correlation was calculated using Pearson’s Product Moment Correlation. The coefficient of correlation was found to be 0.79. Cronbach’s $\alpha$ of the test was found to be equal to 0.81.

d) Critical Thinking Dispositions Scale

The Likert Type Critical Thinking Dispositions Scale was constructed by the investigator by including the dimensions Open mindedness, Inquisitiveness, Truth seeking, Analytic, systematic and self-confidence. For this, the investigator listed all possible statements including both favourable and unfavourable statements in each dimension and thus a total of 65 items on a five-point scale were included in the preliminary form of the dispositions scale. Each item contained five alternative responses such as strongly agree (SA), agree (A), agree or disagree (A/S), Disagree (D) and Strongly Disagree (SD). The scoring based on a five point Likert Type Scale designed for positive items weighed a score of 5 for (SA), 4 for (A), 3 for (A/D), 2 for (D) and 1 for (SD). The summative score of all the items provided total Critical Thinking Disposition score. The Critical Thinking Dispositions Scale thus prepared was tried out on a group of 100 students of standard IX. The responses of the subjects were scored by allotting weightage to the items and item analysis was carried out. For item analysis, the procedure suggested by Edward (1957) was used. Five items were deleted through item analysis from the initial draft of Critical Thinking Disposition scale to get the final form of the test comprising of 60 items including both positive and negative
statements. The maximum score possible was 300 and minimum was 60. To establish the face validity, the items of the Critical Thinking Dispositions Scale were subjected to experts’ evaluation. The reliability of the scale was established using test–retest method. The coefficient of correlation was calculated using Pearson’s Product Moment Correlation. The coefficient of correlation was found to be 0.72. Cronbach’s $\alpha$ of the scale which is a coefficient of reliability indicating the internal consistency was found to be equal to 0.78. Thus there were sixty items in the final scale and the duration of the scale was forty five minutes.

e) Thinking Styles Inventory

The adopted version of Sternberg-Wagner Inventory on the Thinking Styles was used in the study. Sternberg-Wagner Inventory on Thinking Styles contains 24 Statements in total; 8 each pertaining to the Executive, Legislative and Judicial Thinking Styles. In the original version of the test, Each item contained seven alternative responses such as Not at all well, Not very well, slightly well, somewhat well, well, very well and Extremely well. In the attempt to adopt the tool, these alternative responses were reduced to five such as Highly True (HT), Mostly True (MT), Quite True (QT), Least True (LT) and Not True (NT). The scoring based on a five point Likert Type Scale designed for positive items weighed a score of 5 for (HT), 4 for (MT), 3 for (QT), 2 for (LT) and 1 for (NT). The summative score of the 8 items under each style provided total score for the respective styles. Among the three Thinking Styles, the one that gets the highest summative score is considered as the preferred Thinking Style of the subject. The tool was administered on 100 students of standard IX. The responses were scored and item analysis was carried out in the way similar as in the case of Critical
Thinking Dispositions Scale. As all the items showed significant difference, between the low and high groups, all were included in the tool thus the final form of the tool contained 24 items.

f) Students’ Reaction Scale

A reaction scale was constructed in order to study the reactions of the students towards Active Learning Strategies. The Reaction Scale consisted of three main components namely

1. The activities
2. The materials used and
3. The class environment

With regard to each component a few statements were provided that would help them recall the experimentation period. The students were asked to indicate how well they agree to the given statements. Against each statement three alternatives such as To a great extent (GE), To some extent (SE) and To a limited extent (LE) were given. The students were asked to tick one among the three options, which they considered the best.

5.11 PROCEDURAL DETAILS OF THE STUDY

The study was carried out in two phases, the Developmental Phase and the Experimental Phase.

I) The Developmental Phase

This phase included the preparation of instructional material integrating Active Learning Strategies to teach selected topics in Physics of class IX.
The instructional materials were prepared on 4 units in Physics of class IX. The units selected for the study were

1. Fluids
2. Periodic Motion and Sound
3. Magnetism and Electricity and
4. Heat

In order to prepare the instructional material, the investigator analysed these units in Physics to identify the major points, expected learning outcomes, materials and resources required, learning activities to be implemented, modes of assessment etc. Concept map for each unit was prepared and strategies and activities appropriate for each topic were decided. The detailed lesson plans with plans for assessment were also prepared.

- **Unit planning**

  A unit is a mutually related content area. It may consist of several subunits or topics. A unit is organized in such a manner so that each lesson plays a role in the development of the unit. Planning of the unit includes unit overview, major points, learning outcomes, materials and resources required, learning activities, supplementary activities, etc.

- **Preparation of lesson plans**

  A set of lessons were planned for each unit by integrating Active Learning Strategies. The content in lessons was systematically organized following the doctrines of teaching. The instructional materials were prepared in consultation with the supervisor, subject experts, senior Physics teachers and teacher educators. To prepare the instructional material, Fink’s model (1999) of Active learning was
followed. This model suggests that all learning activities involve some kind of experience or some kind of dialogue. The two main kinds of experience are Observing and Doing. The two main kinds of dialogue are Dialogue with Self and Dialogue with Others.

Before selecting the Active Learning Strategies for the present study, the opinions of the secondary school Physics teachers regarding the type of activities they would like to use in their classes were also sought. The suggestions given by the teachers were considered while selecting the strategies for preparing the instructional material. The investigator selected the Active Learning Strategies after an intensive review of the related literature, considering the opinions and suggestions of the experts and the experienced in the field. The major Active Learning Strategies used in the present study were

1. Group Investigation (GI)
2. Think-Pair-Share (T/P/S)
3. K-W-L
4. Concept Mapping (CM)
5. One Minute Papers (OMP)

These strategies were incorporated in the various stages of lesson development in a sequential order as indicated by the chart.
Pilot study of the instructional material

Pilot study was undertaken to test the suitability of lesson plans and to obtain insights about the practical difficulties in actual implementation of the instructional programme so that necessary precautions can be taken while carrying
out the actual implementation of the study. The instructional programme was subjected to pilot study on students of class IX to ensure feasibility of the material, find the suitability of the material to the given group and attainability of objectives. The pilot study was carried out in a government aided school of Ernakulam district of Kerala after getting the prior permission from the head teacher of the school. Thirteen lesson plans prepared on the unit Fluids were taught to the students of class IX in their Physics periods for duration of one and a half month. In the beginning the students were given awareness about the Active Learning Strategies and the purpose along with the instruction on their new role in the class room. Regular Science teachers of the school were also invited to observe the classes in order to get their opinion on the new instructional programme. On the basis of the direct class room experiences while teaching the lessons, interaction with students and suggestions and feedback from science teachers a thorough discussion was held with the supervisor and other experts in the field and the activities and exercises were modified and the instructional materials were finalized. Thus thirty lesson transcripts on all the 4 units of second volume of Physics text book for class IX were prepared.

II) Experimentation Phase

The Experiment was carried out in four stages

1. Administration of pretest
2. Implementation of the Treatment
3. Administration of post-tests
4. Analysis of the data
• **Administration of Pre-test tests**

The students of both experimental and control group were simultaneously pre-tested on Raven’s Progressive Matrices, Critical Thinking Skills test, Critical Thinking Dispositions Scale, Thinking Styles Inventory and Achievement in Physics one by one. One test was given per day for both the groups to avoid fatigue. After administering the above mentioned tests, it was scored which served as the pretest scores of the sample.

• **Implementation of the Treatment**

The instructional material developed by the investigator integrating Active Learning Strategies were implemented for a period of 5 months to the experimental group for teaching 4 units in Physics of class IX. After consulting with the regular science teachers of experimental and control groups details regarding the duration, number of lessons and number of class periods required for teaching the selected units etc. were decided. The classes for the experimental group were taken by the investigator during the regular Physics periods of the school according to the time table without disturbing the school schedule. While in the control group classes were taken by their regular teacher who covered the units approximately in the same number of periods.

The students of experimental group were taught using Active Learning Strategies like Group Investigation, T/P/S, K-W-L, Concept mapping and One minute paper, which were not familiar to them. Hence the investigator gave them necessary information about the new instructional practices and the transformed roles the students have to play in this mode of learning. Assignments were given at the end of each lesson as supplementary activity and were assessed regularly by
the investigator using rubrics. At the end of each unit, test papers were conducted and the marks scored by the students were also recorded promptly. The investigator collected continuous feedback from the students of the experimental group and from their Physics teacher. The investigator recorded the experiences, particularly the cases of noticeable accomplishments or disappointments without fail.

The students of control group were taught by their regular teacher using strategies like lecture, demonstration, group discussion and at times note dictation. The investigator regularly conducted discussions with the teacher which helped to get information regarding the mode of teaching, duration of lessons, methods of assessment etc. that she followed in the class. Some of the lessons given by the teacher were also observed by the investigator in order to know the strategies followed and to get idea of the relevant practices that were followed in the class.

- **Administration of post-tests**

After the implementation of the treatment for over a period of 5 months, the post-tests were administered to both experimental and control groups. The reactions of the students of experimental group were also collected to support the test results. The response sheets of both experimental and control groups were scored using the scoring keys prepared. Response sheets which were completely filled in all respects were taken into consideration. After scoring the response sheets, the scores of experimental and control groups obtained in each test were tabulated and consolidated separately.
5.12 STATISTICAL TECHNIQUES EMPLOYED

Various statistical techniques were used to analyse the data. Descriptive statistics was used to summarise the pre-test and post-test scores. They were tested to determine if the samples showed deviation from the normal distribution. Cronbach’s alpha was used to establish internal reliability of the tool. t-test, ANCOVA, ANOVA and Partial Correlation were employed to test the various hypotheses. Percentages were used to analyse the data qualitatively.

5.13 ANALYSIS OF DATA

The data collected were analysed both quantitatively and qualitatively. The quantitative analysis was done to analyse the influence of Active Learning Strategies on Critical Thinking, Thinking Styles and Achievement in Physics using appropriate statistical techniques. SPSS version 17.0 was used to analyse the data. Its influence on the different subcomponents of Critical Thinking Skills and dispositions were also analysed. The influence of Active Learning Strategies on these dependent variables with gender and high, average and low scorers in RPM were also studied. The relationship among the dependent variables were found using correlation technique.

5.14 MAJOR FINDINGS OF THE STUDY

The major findings of the study has been categorized into i) Findings related to Critical Thinking, ii) Findings related to Thinking Styles iii) Findings related to Achievement in Physics iv) Findings related to the relationship among Critical Thinking, Thinking Styles and Achievement in Physics.
(i) Findings related to Critical Thinking

- The Active Learning Strategies were effective in improving the Critical Thinking Skills of the secondary school students ($F=112.226$, $p<0.01$) when the pre-test score of Critical Thinking Skills and intelligence were taken as covariate.

- It was statistically found that the Active Learning Strategies were effective in enhancing all the dimensions of Critical Thinking Skills – Interpretation, Inference, Analysis, Evaluation, Explanation and Self-regulation among the secondary school students.

- The intervention was equally effective in improving the gain scores in Critical Thinking Skills of the experimental group of students, irrespective of differences in intelligence and gender and their interactions.

- The Active Learning Strategies were effective in improving the Critical Thinking Dispositions of the secondary school students ($F=46.287$, $p<0.01$) when the pre-test score of Critical Thinking Dispositions and intelligence were taken as covariate.

- It was found that the Active Learning Strategies were effective in enhancing the dimensions of Critical Thinking Dispositions except inquisitiveness and self-confidence among secondary school students. The dimensions-objectivity, analytic, systematic and truth seeking were found to have improved by the implementation of Active Learning Strategies.

- The intervention was effective in improving the gain scores in Critical Thinking Dispositions of the experimental group of students, irrespective of differences in intelligence and gender and their interactions.
(ii) Findings related to Thinking Styles

- Active Learning Strategies were effective in promoting Legislative and Judicial Thinking Style of secondary school students and were not supporting the Executive Thinking Styles in them.

- Active Learning Strategies were effective in improving Executive and Legislative Thinking Styles of the experimental group of students, irrespective of differences in intelligence and gender and their interactions. However, there was a significant effect of intelligence on the gain score of Judicial Thinking Styles of experimental group of students. While the effect of interactions of intelligence and gender on the gain scores of Judicial Thinking Style of experimental group of students were not significant.

(iii) Findings related to Achievement in Physics

- The Active Learning Strategies were effective in improving the Achievement in Physics of the secondary school students ($F=21.135, p<0.01$) when the pre-test score of Achievement in Physics and intelligence were taken as covariate.

- The intervention was effective in improving the gain scores in Critical Thinking Dispositions of the experimental group of students, irrespective of differences in gender and the interactions between intelligence and gender. However, there was a significant effect of intelligence on the gain score of Achievement in Physics of experimental group of students.

(iv) Findings related to comparison of Relative influence of Active Learning Strategies on the Dependent variables

- On comparing the relative influence of Active Learning Strategies on these variables, it was found that maximum percentage of change was shown in Achievement in Physics (122.69%), followed by Critical Thinking Skills
Following these two, it was Legislative Thinking Styles (41.2%) and the percentage of change for Judicial Thinking Styles and Critical Thinking Dispositions were approximately equal (21.74% & 21.88%). The percentage change for Executive Thinking Style was found to be least (-7.63%).

- This indicated that the Active Learning Strategies have influenced the achievement of the students largely. Another notable finding was that the percentage of change for Critical Thinking Dispositions and Judicial Thinking Styles were almost equal. The disposition to think critically is a concept identical to the Judicial Thinking Style, which is preference to use the ability to judge and evaluate things and the result of the investigation reveals that the Active Learning Strategies have influenced these variables equally.

(v) Findings related to the relationship among Critical Thinking, Thinking Styles and Achievement in Physics

The study showed a positive significant correlation between Critical Thinking Skills and Critical Thinking Dispositions, Critical Thinking Dispositions and Judicial Thinking Style, Critical Thinking Skills and Achievement in Physics and Judicial Thinking Styles and Achievement in Physics.

5.15 EDUCATIONAL IMPLICATIONS OF THE STUDY

1. The study has examined the means to revive the system of science education by giving equal emphasis on the promotion of thinking abilities of the students as well improving the achievement in the content.

2. It was found that the utilization of Active Learning Strategies was effective in influencing the Critical Thinking, Thinking Styles and achievement of the
students. A study of this nature can popularize the use of similar pedagogical practices that aim at developing thinking faculties of the students in addition to improved achievement in the content.

3. The study revealed that Active Learning Strategies can influence in improving the Critical Thinking, Thinking Styles and achievement of the students. Hence it can be made an integral part of science curriculum in secondary schools and teachers should be encouraged to employ these strategies predominantly in their classes.

4. Active Learning Strategies can be integrated successfully in all subjects of secondary school curriculum so as to make learning a satisfying and enjoyable activity.

5. The study stresses the need to take deliberate efforts for promoting the thinking capacities of the students. Hence the teachers must be oriented about the various means of fostering the thinking skills of students and applying them according to their context and purpose.

6. The study revealed that students have enjoyed the classroom experiences and the strategies enabled them to be responsible in the process of learning. Therefore the such strategies can be made use of successfully in the classroom so as to promote a healthy learning environment and pleasurable learning experiences to the learners.

7. Adequate training should be given to teachers so as to develop the understanding and necessary skills for the successful implementation of these strategies in the class.
8. Effective steps should be taken for enriching the teacher education programmes by giving adequate priorities for the innovative instructional strategies in the theoretical and practical aspects of teacher education curriculum.

9. School authorities should provide sufficient support systems including availability of infrastructure, resource materials and flexibility in scheduling the classes so that teachers can employ these strategies easily and effectively.

10. Experts and researchers in the field of education should work for developing diverse pedagogical practices suitable to our classrooms and propagate them productively among the practitioners.

5.16 SUGGESTIONS FOR FURTHER RESEARCH

1. The study has investigated the combined effect of the select strategies in influencing the dependent variables. Further studies can be undertaken to explore the relative effectiveness of the individual strategies on these variables.

2. Similar studies can be undertaken to study the effectiveness of other Active Learning Strategies.

3. Surveys can be conducted to study the extent of implementation of Active Learning Strategies in the present classrooms and to identify the factors contributing or impeding the use of these practices.

4. Similar studies can be conducted to study the influence of these strategies on the other categories of Thinking Styles.

5. The relation between the Thinking Styles of teachers and Thinking Styles learners can be studied.
6. The study can be extended to explore the effectiveness of Active Learning Strategies on other higher order thinking skills.

7. It is possible to extend the study to other academic disciplines.

8. The perceptions of the teachers and classroom practices promoting thinking skills in the learners can be explored.

9. The study can be replicated in other populations including students at elementary or higher education using more sophisticated experimental designs.