CHAPTER VI

SUMMARY AND CONCLUSIONS

6.1 The Study in Retrospect

6.2 Major Findings of the Study

6.3 Tenability of Hypothesis

6.4 Conclusions of the Study

6.5 Educational Implications

6.6 Suggestions for Further Research
SUMMARY AND CONCLUSIONS

This chapter gives a summary of the present study in retrospect which includes the restatement of the problem, objectives of the study, hypotheses of the study and methodology in brief. The main focus of this chapter is on the major findings and conclusions of the study, educational implications of the study and suggestions for further research.

6.1 THE STUDY IN RETROSPECT

The different aspects of the various stages of the present study are presented under the following heads.

6.1.1 Restatement of the Problem

The 5E Learning Cycle Model is an instructional strategy with 5 phases- Engagement, Exploration, Explanation, Extension and Evaluation. The study aims to find the effectiveness of 5E Learning Cycle Model on select variables such as Scientific Creativity, Scientific Interest and Achievement in Physics of students at secondary level. The topic selected for the study is entitled “EFFECTIVENESS OF 5E LEARNING CYCLE MODEL ON SCIENTIFIC CREATIVITY, SCIENTIFIC INTEREST AND ACHIEVEMENT IN PHYSICS OF STUDENTS AT SECONDARY LEVEL”

6.1.2 Objectives of the Study

1. To find out the Scientific Creativity of students taught using 5E Learning Cycle Model and Activity Oriented Method.

2. To compare the Scientific Creativity of students taught using 5E Learning Cycle Model and Activity Oriented Method.

3. To compare the Scientific Creativity of students taught using 5E Learning Cycle Model and Activity Oriented Method with respect to their learning style.
4. To find out the Scientific Interest of students taught using 5E Learning Cycle Model and Activity Oriented Method.

5. To compare the Scientific Interest of students taught using 5E Learning Cycle Model and Activity Oriented Method.

6. To compare the Scientific Interest of students taught using 5E Learning Cycle Model and Activity Oriented Method with respect to their learning style.

7. To find out the Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method.

8. To compare the Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method.

9. To compare the Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

10. To compare the Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method with respect to their learning style.

11. To compare the Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method with respect to their learning style under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

12. To assess the retention of Achievement in Physics of students taught using 5E Learning Cycle Model and Activity Oriented Method.

6.1.3 Hypotheses of the Study

1. The Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method.
2. The Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.

3. The Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method.

4. The Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to their learning style.

5. The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method.

6. The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to their learning style.

7. The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

8. The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to their learning style under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

9. The retention in achievement of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method.
6.1.4 Methodology in Brief

Since the study was intended to find out the effectiveness of 5E Learning Cycle Model on Scientific Creativity, Scientific Interest and Achievement in Physics of students at Secondary level, experimental method was adopted. The design selected was Pre-test, Post-test nonequivalent group design (Best and Kahn, 2004).

Sample selected for the Study

The investigator decided to adopt purposive random sampling keeping in view of the experimental nature of the study.

The initial sample consists of 335 students, studying in Standard IX of Kerala State syllabus from selected schools of Idukki and Ernakulam districts. After removing absentees in Pre-test and Post-test, the total number of students included in the study was 312, out of which 156 students were coming under the Experimental group and other 156 students under the Control group.

Tools used in the study

1. Lesson transcripts based on 5E Learning Cycle Model
2. Lesson transcripts based on Activity Oriented Method
3. Kolb’s Learning Style Inventory (Adapted version)
4. Raven’s Standard Progressive Matrices
5. Scientific Creativity Test (Prepared and standardized by the Investigator)
6. Scientific Interest Inventory (Prepared and standardized by the Investigator)
7. Achievement test in Physics (Prepared and standardized by the Investigator)
Procedure adopted in the study

The aim of this study is to find out the effectiveness of the 5E Learning Cycle Model on Scientific Creativity, Scientific Interest and Achievement in Physics of Secondary School students. For this, various tools were used by the investigator.

Before starting the experimental treatment, the investigator classified the selected students into Experimental and Control groups (four divisions each) by comparing their previous Achievement in Physics and their general mental ability. Then Scientific Creativity Test, Scientific Interest Inventory and Achievement test, were administered to both the groups as pre-test. Again by administering Kolb’s Learning Style Inventory (adapted version), students of both the groups were identified based on their learning style. After that the investigator herself conducted classes to both the groups. The Experimental group was taught using 5E Learning Cycle Model and Control group was taught using Activity Oriented Method. After the treatment, all the tests given as Pre-test were administered to both the groups as Post-tests. After one month from the completion of the Post-tests, Achievement test is again administered to both the groups as a delayed Post-test.

Statistical techniques used

The scores obtained by the students in the Pre-test and Post-test were classified, tabulated and subjected to statistical analysis. This includes comparison of mean scores of Pre-test scores, Post-test scores and Gain scores using ‘t’ test with a view to get a formal conclusion of the comparative effectiveness of the treatment. More precise conclusion was arrived at using the technique of Analysis of Covariance.
6.2 MAJOR FINDINGS OF THE STUDY

The major findings of the study are

I. Comparison of students in the Experimental and Control groups with respect to Scientific Creativity

6.2.1 On analysis of the Pre-test scores on Scientific Creativity of the Experimental and Control groups, the t value obtained was 0.96 which is not significant at 0.01 and 0.05 levels. On comparison of the Post-test scores (t =8.03) and Gain scores (t =11.04) of the Experimental and Control groups with respect to Scientific Creativity, it is revealed that the Experimental and Control groups differ significantly at 0.01 level. The value of the ‘t’ and mean scores reveals that students in the Experimental group attained more Scientific Creativity than the Control group. Thus it can be inferred that the teaching through 5E Learning Cycle Model might have helped the Experimental group to attain more Scientific Creativity than the Control group, taught through Activity Oriented Method.

6.2.2 On comparing the Experimental and Control groups with respect to Post-test scores using ANOVA, the obtained value of Fx=0.93, which is not significant. It shows that there is no significant difference between Pre-test scores of the Experimental and Control groups with respect to their Scientific Creativity. The obtained Fy value is 83.55, which is significant at 0.01 level. This shows that the two groups differ significantly on Post-test scores of Scientific Creativity.

6.2.3 Using ANCOVA the Pre-test and Post-test scores of the Experimental and Control groups were compared with respect to Scientific Creativity. The Fyx ratio obtained is 93.71. The significant Fyx ratio for the adjusted Post-test scores on Scientific Creativity shows that the final mean scores of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

6.2.4 The difference in Adjusted Means for Post-test scores of the Experimental and Control groups were tested for significance for df 1/309.
The obtained t value is 9.69 which is significant at 0.01 level. This shows that students taught through 5E Learning Cycle Model attained better Scientific Creativity than those taught through Activity Oriented Method.

6.2.5 The total Scientific Creativity is the sum of the components of Scientific Creativity namely, Fluency, Flexibility and Originality. The Pre-test scores of Experimental and Control groups based on Fluency, Flexibility, Originality and Total Scientific Creativity were tested for significance, using t-test, and the t values are 0.74, 0.60 1.61 and 0.37 respectively, which were not significant. It can be inferred that the Experimental and Control groups do not differ significantly before the experimental treatment. The Post-test scores of the Experimental and Control groups based on Fluency, Flexibility, Originality and Total Scientific Creativity were tested for significance, using t-test, and the t values obtained are 3.99, 5.84, 5.64 and 8.03 respectively, which were significant at 0.01 level. Fluency, Flexibility, Originality and Total scores of the Experimental group taught through 5E Learning Cycle Model are in an advantageous position than that of the Control group taught through Activity Oriented Method.

6.2.6 The pre-test scores of Scientific Creativity of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging, the ‘t’ value obtained are 1.27, 1.56, 0.72 and 0.91 respectively, which is not significant. This shows that the Experimental and Control groups do not differ significantly on Scientific Creativity in any of the learning style category before experimental treatment. Post-test scores of Scientific Creativity of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging and the t values obtained are 3.01, 3.79, 3.23 and 4.72. It is evident that the Experimental and Control groups differ significantly at 0.01 level with respect to their Post-test scores on Scientific Creativity in all four learning style categories. Thus the Experimental group taught through 5E Learning Cycle Model shows better Scientific Creativity than the Control group taught through Activity Oriented Method.
6.2.7 The Post-test scores of Scientific Creativity of the Experimental group were compared with respect to the sub-samples namely gender, type of school and locale of the school, and the t values obtained are 0.08, 3.32 and 5.84 respectively.

The t value obtained for the sub sample - Gender is not significant even at 0.05 level and it reveals that the Boys and Girls of the Experimental group shows no significant difference on Scientific Creativity. The t value obtained for the sub sample - Type of School is significant at 0.01 level and it shows that the Government and Aided school students of the Experimental group shows significant difference on Scientific Creativity. The aided school students show better Scientific Creativity when they are taught through 5E Learning Cycle Model than the Government school students. The t value obtained for the sub sample - Locale of the school is significant at 0.01 level and it infers that the Rural and Urban school students of the Experimental group shows significant difference on Scientific Creativity. The rural school students show better Scientific Creativity when they were taught through 5E Learning Cycle Model than the urban school students.

II. Comparison of students in the Experimental and Control groups with respect to Scientific Interest

6.2.8 The analysis of the Pre-test scores on Scientific Interest of the Experimental and Control groups shows that the ‘t’ value obtained is 1.09 which is not significant at 0.01 and 0.05 levels. On comparison of the Post-test scores \( (t=9.52) \) and Gain scores\( (t=10.51) \) of the Experimental and Control groups with respect to Scientific Interest, it is revealed that the Experimental and Control groups differ significantly at 0.01 level. The t value and mean scores reveals that students in the Experimental group achieved more Scientific Interest than the Control group. Thus it can be inferred that the teaching through 5E learning Cycle Model might have helped the Experimental group to develop more Scientific Interest than Control group, taught through Activity Oriented Method.
6.2.9 On comparing the Experimental and Control groups with respect to Post-test scores using ANOVA, the obtained value Fx = 0.79, which is not significant. It shows that there is no significant difference between Pre-test scores of the Experimental and Control groups with respect to their Scientific Interest. The obtained Fy value is 140.54, which is significant at 0.01 level. This shows that the Post-test scores of the Experimental and Control groups differ significantly on Scientific Interest.

6.2.10 Using ANCOVA the Pre-test and Post-test scores of the Experimental and Control groups were compared with respect to Scientific Interest. The Fyx ratio obtained is 301.74 which is greater than the table value and is significant at 0.01 level. The significant Fyx ratio for the adjusted Post-test scores on Scientific Interest shows that the final mean scores of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

6.2.11 The difference in Adjusted Means for Post-test scores of the Experimental and Control groups were tested for significance for df 1/309. The obtained t value is 17.39, which is significant at 0.01 level. This shows that students taught through 5E Learning Cycle Model attained better Scientific Interest than those taught through Activity Oriented Method.

6.2.12 Before conducting the experiment, the t-value obtained for Assimilating, Accommodating, Converging and Diverging learning styles are 0.44, 1.77, 1.80 and 1.79 respectively. None of the values are significant at 0.05 levels. This shows that the Experimental and Control groups do not differ significantly on Scientific Interest in any of the learning style categories before the experimental treatment. Post-test scores of Scientific Interest of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging and the t values obtained are 4.45, 4.19, 6.23 and 4.66. It is evident that the Experimental and Control groups differ significantly at 0.01 level with respect to their Post-test scores of Scientific Interest in all four learning style categories namely Assimilating, Accommodating, Converging and Diverging. Thus the Experimental group taught through 5E Learning
Cycle Model attained better Scientific Interest than the Control group taught through Activity Oriented Method.

6.2.13 The Post-test scores of Scientific Interest of the Experimental and Control groups were compared with respect to the sub-samples namely Gender, Type of school and Locale of the school, and the t values obtained are 4.00, 0.87 and 3.52 respectively.

The t value obtained for the sub sample - Gender is significant at 0.01 level and it reveals that the Boys and Girls of the Experimental group shows significant difference on Scientific Interest. The t value obtained for the sub sample - Type of School is not significant even at 0.05 level and it shows that the Government and Aided school students of the Experimental group shows no significant difference on Scientific Interest. The Aided school students showed better Scientific Interest than the Government school students when they were taught through 5E Learning Cycle Model. The t value obtained for the sub sample - Locale of the school is significant at 0.01 level and it infers that the Rural and Urban school students of the Experimental group shows significant difference on Scientific Interest. The Rural school students showed better Scientific Interest than the Urban school students when they are taught through 5E Learning Cycle Model.

III. Comparison of students in the Experimental and Control groups with respect to Achievement in Physics

6.2.14 The analysis of the Pre-test scores on Achievement in Physics of the Experimental and Control groups gives the t value as 0.13 which is not significant at 0.01 level and 0.05 levels. On comparison of the Post-test scores \( (t=8.72) \) and Gain scores \( (t=9.21) \) of the Experimental and Control groups with respect to Achievement in Physics, it is revealed that the Experimental and Control groups differ significantly at 0.01 level. The t value and mean scores reveals that students in the Experimental group achieved better than the Control group. Thus it can be inferred that the teaching through 5E learning Cycle Model might have helped the Experimental group
to achieve better in Physics than Control group, taught through Activity Oriented Method.

6.2.15 On comparing the Experimental and Control groups with respect to Post-test scores using ANOVA, the obtained value of Fx=0.02, which is not significant. It shows that there is no significant difference between Pre-test scores of the Experimental and Control groups with respect to their Achievement in Physics. The obtained Fy value is 78.10, which is significant at 0.01 level. This shows that Post-test scores of the Experimental and Control groups differ significantly on Achievement in Physics.

6.2.16 Using ANCOVA the Pre-test and Post-test scores of the Experimental and Control groups were compared with respect to Achievement in Physics. The Fyx ratio obtained is 87.38 which is greater than the table value and is significant at 0.01 level. The significant Fyx ratio for the adjusted Post-test scores on Achievement in Physics shows that the final mean scores of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

6.2.17 The difference in Adjusted Means for Post-test scores of the Experimental and Control groups were tested for significance for df1/310. The obtained t value is 9.35, which is significant at 0.01 level. This shows that students taught through 5E Learning Cycle Model performed better than those who are taught through Activity Oriented Method.

6.2.18 When the Pre-test scores of the Experimental and Control groups were compared with respect to Achievement in Physics under different categories of objectives/domains, the t value obtained is not significant at 0.01 level (Knowledge - t=1.42, Process - t=1.34, Attitude - t=1.04, Creativity - t=0.90, Application - t=1.04).

This shows that there is no significant difference between the Experimental and Control groups with respect to Pre-test scores under different objectives / domains - Knowledge, Process, Attitude, Creativity and Application. The mean Pre-test scores of both the groups reveal that after the treatment the Experimental group achieved better than the Control group.
Thus it can be inferred that the Experimental group taught through 5E Learning Cycle Model achieved better than the Control group taught through Activity Oriented Method with respect to different objectives/domains.

6.2.19 When the Post-test scores of the Experimental and Control groups were compared with respect to Achievement in Physics under different objectives/domains, the t values obtained are significant at 0.01 level (Knowledge - t=8.43, Process - t=11.80, Attitude - t=8.74, Creativity - t=5.20, Application – t =10.54).

This shows that there is significant difference between the Experimental and Control groups with respect to Post-test scores under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application. The mean Post-test scores of both the groups reveal that after the treatment the Experimental group achieved better than the Control group. Thus it can be inferred that the Experimental group taught through 5E Learning Cycle Model achieved better than the Control group taught through Activity Oriented Method with respect to different objectives/domains.

6.2.20 When the Gain scores of the Experimental and Control groups were compared with respect to Achievement in Physics under different categories of objectives/domains, the t values obtained are significant at 0.01 level (Knowledge - t=14.23, Process - t=19.27, Attitude -t=13.69, Creativity - t=8.18, Application - t=14.57).

This shows that there is significant difference between the Experimental and Control groups with respect to gain scores under different domains/objectives - Knowledge, Process, Attitude, Creativity and Application. The mean and gain scores of both the groups reveal that after the treatment the Experimental group achieved better than the Control group. Thus it can be inferred that the Experimental group taught through 5E Learning Cycle Model achieved better than the Control group taught through Activity Oriented Method with respect to different objectives/domains.

6.2.21 On comparing the Experimental and Control groups with respect to Post-test scores on Achievement in Physics under different
objectives/domains - Knowledge, Process, Attitude, Creativity and Application using ANOVA, the obtained values of Knowledge-Fx=2.19, Process-Fx =1.98, Attitude-Fx =1.24, Creativity -Fx=0.82 and Application -Fx=1.08, which are not significant. It shows that there is no significant difference between Pre-test scores of the Experimental and Control groups with respect to their Achievement in Physics under different objectives/domains. The obtained Fy values for the objectives Knowledge-Fy=150.46, Process- Fy=139.7, Attitude-Fy=74.87, Creativity-Fy=27.09 and Application-Fy=80.64, which are significant at 0.01 level. This shows that Post-test scores of the groups differ significantly on Achievement in Physics under different objectives/domains.

6.2.22 Using ANCOVA the Pre-test and Post-test scores of the Experimental and Control groups were compared with respect to Achievement in Physics under different objectives/domains-Knowledge, Process, Attitude, Creativity and Application. The Fyx ratio obtained for different objectives Knowledge-Fyx =209.86, Process-Fyx =298.84, Attitude-Fyx =126.21, Creativity–Fyx =34.56 and Application-Fyx =134.27, which are greater than the table value and are significant at 0.01 level. The significant Fyx ratio for the adjusted Post-test scores on Achievement in Physics under different objectives/domains shows that the final mean scores of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

6.2.23 The difference in Adjusted Means for Post-test scores on Achievement in Physics under different objectives/domains of the Experimental and Control groups were tested for significance for df 1/310. The obtained t value for different objectives/domains are Knowledge-t=14.54, Process-t=17.34, Attitude-t=11.26, Creativity-t=5.89, Application-t=11.56, which are significant at 0.01 level. Thus it is clear that the Experimental and Control groups differ significantly with respect to Achievement in Physics under different objectives/domains- Knowledge, Process, Attitude, Creativity and Application. This shows that students taught through 5E Learning Cycle Model achieved better in Physics than those who taught through Activity Oriented Method.
6.2.24 The t value obtained for Pre-test scores on Achievement in Physics based on Assimilating, Accommodating, Converging and Diverging learning styles are 0.62, 0.67, 0.62, and 0.48 respectively and are not significant at 0.01 level. This shows that Experimental and Control groups do not differ significantly on Achievement in Physics in any of the learning style categories before Experimental treatment.

The t value obtained for Post-test scores on Achievement in Physics based on Learning Style categories - Assimilating, Accommodating, Converging and Diverging are 8.64, 5.35, 8.23 and 4.89 respectively and are significant at 0.01 level. It is evident that the Experimental and Control groups differ significantly with respect to their Post-test scores on Achievement in Physics in all four learning style categories namely Assimilating, Accommodating, Converging and Diverging. Thus with respect to each category of learning style, the Experimental group taught through 5E Learning Cycle Model shows better achievement than the Control group taught through Activity Oriented Method.

6.2.25 On comparing the Pre-test scores on Achievement in Physics of the Experimental and Control groups based on the learning style - Assimilating for different objectives/domains - Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 0.74, 0.33, 0.48, 0.95, and 0.72 respectively. All the values are not significant. It shows that the Experimental and Control groups do not differ significantly with respect to their achievement in Physics under different categories of objectives/domains based on Assimilating learning style.

While comparing the Post-test scores of Achievement in Physics of the Experimental and Control groups based on the learning style - Assimilating for different objectives/domains - Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 4.36, 6.82, 3.79, 6.07 and 5.64 respectively. All the values are significant at 0.01 level. This substantiates that the students taught through 5E learning Cycle Model shows better performance than that of students taught through Activity Oriented Method.
based on the learning style category –Assimilating, under different objectives/domains.

6.2.26 On comparing the Pre-test scores of Achievement in Physics of the Experimental and Control groups based on the learning style - Accommodating for different objectives/domains- Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 0.92, 1.32, 1.03, 0.19 and 1.23 respectively. All the values are not significant. It shows that the Experimental and Control groups do not differ significantly with respect to achievement in Physics under different categories of objectives/domains based on Accommodating learning style.

When the Experimental and Control groups were compared based on Accommodating learning style category with respect to the objectives/domains of Achievement in Physics - Knowledge, Process, Attitude, Creativity and Application the t values obtained are 7.26, 8.29, 4.41, 5.23 and 8.28 respectively. All the values are significant at 0.01 level. This substantiates that the students taught through 5E Learning Cycle Model shows better performance than that of students taught through Activity Oriented Method based on the learning style category - Accommodating, under different objectives/domains.

6.2.27 On comparing the Pre-test scores of Achievement in Physics of the Experimental and Control groups based on the learning style - Converging for different objectives/domains - Knowledge, Process, Attitude, Creativity and Application, t values obtained are 1.05, 0.45, 0.40, 0.23 and 1.03 respectively. All the values are not significant. It shows that the that the Experimental and Control groups do not differ significantly with respect to their achievement in Physics under different categories of objectives/domains based on Converging learning style.

While comparing the Experimental and Control groups based on Converging learning style category with respect to the objectives/domains of achievement in Physics - Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 6.44, 6.19, 3.97, 3.35 and 6.27
respectively. All the values are significant at 0.01 level. This substantiates that the students taught through 5E learning Cycle Model shows better performance than that of students taught through Activity Oriented Method based on the learning style category-Converging, under different objectives/domains.

6.2.28 On comparing the Pre-test scores of Achievement in Physics of the Experimental and Control group based on the learning style - Diverging for different objectives/domains- Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 1.22, 0.97, 1.57, 1.00 and 1.49 respectively. All the values are not significant. It shows that the Experimental and Control groups do not differ significantly with respect to Achievement in Physics under different categories of objectives/domains based on Diverging learning style.

While comparing the Experimental and Control groups on Achievement in Physics under the objectives/domains - Knowledge, Process, Attitude, Creativity and Application, the t values obtained are 7.81, 7.92, 5.00, 6.94 and 6.97 respectively with respect to Diverging learning style. All the values are significant at 0.01 level. This substantiates that the students taught through 5E learning Cycle Model shows better Achievement in Physics than that of students taught through Activity Oriented Method based on the learning style category-Diverging under different objectives/domains.

6.2.29 The Post-test scores of Achievement in Physics of the Experimental and Control groups were compared with respect to the sub-samples namely Gender, Type of School and Locale of the School, and the t values obtained are 1.80, 2.15 and 2.97 respectively.

The t value obtained for the sub sample - Gender is not significant even at 0.05 level and it reveals that the Boys and Girls of the Experimental group shows no significant difference on Achievement in Physics. The t value obtained for the sub sample - Type of School is significant at 0.05 level and it shows that the Government and Aided school students of the Experimental group shows significant difference on Achievement in Physics. The aided
school student shows better Achievement in Physics when they were taught through 5E Learning Cycle Model than the Government school students.

The t value obtained for the sub sample - Locale of the school is significant at 0.01 level and it reveals that the Urban and Rural students of the Experimental group shows significant difference on Achievement in Physics.

IV. Comparison of students in the Experimental and Control groups with respect to Retention of Achievement in Physics

6.2.30 On comparing the scores of Delayed Post-test scores on Achievement in Physics (post-test) of the Experimental and Control groups, the ‘t’ value obtained is 10.66 and is significant at 0.01 level. Thus it can be concluded that Experimental group taught through 5E learning Cycle Model shows better retention than the Control group taught through Activity Oriented Method on Achievement in Physics.

6.2.31 While comparing the scores on Achievement in Physics (post-test) and Delayed Post-test scores on Achievement in Physics of students in the Experimental group, the ‘t’ value obtained is 1.09 which is not significant at 0.01 level. This means that the two test scores do not vary significantly. This leads to the inference that the Achievement in Physics was retained significantly by the Experimental group which was taught through 5E Learning Cycle Model.

6.2.32 On comparing the scores on Achievement in Physics (post-test) and Delayed Post-test scores on Achievement in Physics of students in the Control group taught through Activity Oriented Method, the ‘t’ value obtained is 3.65 which is significant at 0.01 level. This means that the two test scores vary significantly. This leads to the inference that the students taught through Activity Oriented Method has less retention on Achievement in Physics.
6.3 TENABILITY OF THE HYPOTHESES

Based on the analysis of data the tenability of the hypotheses is tested.

**Hypothesis I**

_The Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method._

The findings 6.2.1, 6.2.2, 6.2.3, 6.2.4 and 6.2.5 shows that the Scientific Creativity of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method. Hence the above hypothesis is substantiated.

**Hypothesis II**

_The Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style._

The finding 6.2.6 reveals that the Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning styles - Assimilating, Accommodating, Converging and Diverging. Hence the above hypothesis is substantiated.

**Hypothesis III**

_The Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method._

The findings 6.2.8, 6.2.9, 6.2.10 and 6.2.11 show that the Scientific Interest of students taught through 5E Learning Cycle Model is significantly
higher than that of those taught through Activity Oriented Method. Hence the above hypothesis is substantiated.

**Hypothesis IV**

*The Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.*

The findings 6.2.12 reveals that the Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style - Assimilating, Accommodating, Converging and Diverging. Hence the above hypothesis is substantiated.

**Hypothesis V**

*The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method.*

The findings 6.2.14, 6.2.15, 6.2.16 and 6.2.17 show that the Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of those taught through Activity Oriented Method. Hence the above hypothesis is substantiated.

**Hypothesis VI**

*The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method with respect to learning style.*

The findings 6.2.24 reveals that the Achievement in Physics of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning styles - Assimilating, Accommodating, Converging and Diverging. Hence the above hypothesis is substantiated.
Hypothesis VII

The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method under different categories of objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

The findings 6.2.18, 6.2.19, 6.2.20, 6.2.21, 6.2.22 and 6.2.23 shows that the Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of those taught through Activity Oriented Method under different objectives/domains. Hence the above hypothesis is substantiated.

Hypothesis VIII

The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented method with respect to their learning styles under different objectives/domains - Knowledge, Process, Attitude, Creativity, and Application.

The findings 6.2.25, 6.2.26, 6.2.27 and 6.2.28, reveals that the Achievement in Physics of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning styles - Assimilating, Accommodating, Converging and Diverging under different objectives/domains. Hence the above hypothesis is substantiated.

Hypothesis IX

The retention of Achievement of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method.

The findings 6.2.30, 6.2.31 and 6.2.32 reveals that the retention of Achievement of students taught using 5E Learning Cycle Model is
significantly higher than that of students taught using Activity Oriented Method. Hence the hypothesis is substantiated.

6. 4 CONCLUSIONS OF THE STUDY

The major conclusions arrived after the study is given below.

Conclusion 1

**Scientific Creativity of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.**

The above conclusion is arrived at on the basis of the following major findings.

Comparison of the Scientific Creativity of the Experimental and Control groups shows significant difference between the Pre-test and Post-test scores using t test and ANCOVA. The Experimental group shows better Scientific Creativity than the Control group.

The total Scientific Creativity is the sum of the components of Scientific Creativity namely Fluency, Flexibility and Originality. The Post-test scores of Experimental and Control groups based on Fluency, Flexibility, Originality and Total Scientific Creativity were significant. Fluency, Flexibility, Originality and Total scores on Scientific Creativity of the Experimental group taught through 5E Learning Cycle Model are in an advantageous position than that of the Control group taught through Activity Oriented Method. Thus it can be concluded that Scientific Creativity of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.

Conclusion 2

**The Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.**

The above conclusion is arrived at on the basis of the following major findings.
Post-test scores of Scientific Creativity of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging. From the results it is evident that the Experimental and Control groups differ significantly with respect to their Post-test scores on Scientific Creativity in all four learning style categories. Thus it can be concluded that the Scientific Creativity of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.

Conclusion 3

Scientific Interest of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.

The above conclusion is arrived at on the basis of the following major findings.

Comparison of the Scientific Interest of the Experimental and Control groups shows significant difference between the Pre-test and Post-test scores using t test and ANCOVA. The Experimental group shows better Scientific Interest than the Control group. Thus it can be concluded that Scientific Interest of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.

Conclusion 4

The Scientific Interest of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.

The above conclusion is arrived at on the basis of the following major findings.

Post-test scores of Scientific Interest of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging. From the results it
is evident that the Experimental and Control groups differ significantly with respect to their Post-test scores on Scientific Creativity in all four learning style categories. Thus it can be concluded that the Scientific Interest of the students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.

**Conclusion 5**

_**Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.**_

The above conclusion is arrived at on the basis of the following major findings.

Comparison of the Achievement in Physics of the Experimental and Control groups shows significant difference between the Pre-test and Post-test scores using t test and ANCOVA. Experimental group shows better Achievement in Physics than the Control group. Thus it can be concluded that Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.

**Conclusion 6**

_**The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method with respect to learning style.**_

The above conclusion is arrived at on the basis of the following major findings

Post-test scores on Achievement in Physics of the Experimental and Control groups were compared with respect to their learning style categories namely Assimilating, Accommodating, Converging and Diverging. From the results it is evident that the Experimental and Control groups differ significantly with respect to their Post-test scores on Achievement in Physics.
in all four learning style categories. Thus it can be concluded that the Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of students taught using Activity Oriented Method with respect to learning style.

**Conclusion 7**

**Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method with respect to different objectives/domains - Knowledge, Process, Attitude, Creativity and Application.**

The above conclusion is arrived at on the basis of the following major findings.

Post-test scores on Achievement in Physics of the Experimental and Control groups were compared with respect to different objectives/domains - Knowledge, Process, Attitude, Creativity and Application. It shows that the Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of those taught through Activity Oriented Method under different objectives/domains. Thus it can be concluded that Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method with respect to different objectives/domains - Knowledge, Process, Attitude, Creativity and Application.

**Conclusion 8**

**The Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method with respect to their learning style under different objectives/domains - Knowledge, Process, Attitude, Creativity and Application.**

The above conclusion is arrived at on the basis of the following major findings.

Analysis of Post-test scores on Achievement in Physics of the Experimental group is significantly higher than that of the Control group with
respect to learning style - Assimilating, Accommodating, Converging and Diverging under different objectives/domains. Thus it can be concluded that the Achievement in Physics of students taught using 5E Learning Cycle Model is significantly higher than that of those taught using Activity Oriented Method with respect to their learning styles under different objectives/domains-Knowledge, Process, Attitude, Creativity and Application.

Conclusion 9

The retention of Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.

The above conclusion is arrived at on the basis of the following major findings

On comparing the scores of Delayed Post-test scores on Achievement in Physics of the Experimental and Control groups, Experimental group shows better retention than the Control group on Achievement in Physics.

While comparing the scores on Achievement in Physics and Delayed Post-test scores on Achievement in Physics of students in the Experimental group, the two test scores do not vary significantly. This leads to the inference that the Achievement in Physics was retained significantly by the Experimental group which was taught through 5E Learning Cycle Model.

On comparing the scores on Achievement test in Physics and Delayed Post-test scores on Achievement in Physics of students in the Control group taught through Activity Oriented Method, the two test scores vary significantly. The results leads to the inference that the students taught through Activity Oriented Method has less retention on Achievement in Physics. Thus it can be concluded that the retention of Achievement in Physics of students taught through 5E Learning Cycle Model is significantly higher than that of students taught through Activity Oriented Method.
6.5 EDUCATIONAL IMPLICATIONS OF THE STUDY

The 5E Learning Cycle Model is an effective way in terms of helping students enjoy Science, understand content, and apply scientific processes and concepts to authentic situations. By cultivating student’s interest in Science and developing reasoning skills, this model promotes deeper understanding of the nature of science and scientific inquiry.

5E model exposes students to problem situations (engage their thinking) and then provides opportunities to explore, explain and evaluate their learning. The learner asks questions, and these questions lead to the desire for answers to the questions or the solutions to the problem and that results in the beginning of exploration and hypotheses. These hypotheses lead to an investigation to test the hypotheses or find answers and solutions to the problem and the construction of knowledge based on the investigative findings. The learner discusses and reflects on this newly acquired knowledge, which in turn leads to more questions and further investigation. Teacher should facilitate safe, guided or open inquiry experiences and questioning so that the students might uncover their misconceptions about the concept.

The study reveals that 5E Learning Cycle Model is more effective in enhancing Scientific Creativity, Scientific Interest and Achievement in Physics than Activity Oriented Method. The following are the major implications drawn from the study.

1. Information on 5E and learning style provide a useful framework for understanding learners and identifying gaps in the teaching methods. Rather label students, teachers can use this knowledge to determine whether their approach to subject matter offers choice and variety.

2. During the first phase of 5E Learning Cycle Model (Engage), students’ attitudes towards Physics as a school subject can be
measured. So the teacher can teach the students on the basis of this assessment while teaching science.

3. The 5E Learning Cycle Model must strive to engage students in authentic learning experiences that initiates students into the way the scientist think about and act on science.

4. During the Engage phase, students are provided with disequilibrium with their existing conceptions, so that they will have to rethink and retry to reconstruct their knowledge.

5. 5E Learning Cycle Model is a constructivist approach and it gives importance to process rather than the product especially in the Explore and Extend phases of the model. Thus curriculum programs should be based on the constructivist perspective.

6. The concept of self-refinement or self-correction is the most progressive idea in editing the portfolio of students. The Evaluation phase of the 5E model provides best option for assessment and correction.

7. The 5E emphasizes the constructivist concept of peer-peer interaction and greater classroom community in learning.

8. 5E as a constructivist model has greater emphasis on learner’s prior experience rather than the teachers and on the active construction of knowledge than the passive reception of information.

9. Since the learning environment of the present model focus directly on students, the importance of context, authentic problems and task, discovery learning, student’s prior knowledge, group projects and discussions, student choice and authentic assessment, learning concentrates on how to think and understand.
10. In a constructivist classroom like 5E, students learn how to articulate their ideas clearly as well as effectively, sharing in group discussions. Students therefore exchange ideas and negotiate with others and evaluate their contribution in a socially acceptable manner.

11. This strategy of teaching-learning gives the teachers enough freedom to choose activities and materials of varying forms and this helps in planning the classroom activities according to the needs and interest of the students. This innovative planning will improve the creative level of teachers and students.

This strategy of teaching-learning gives enough freedom to choose activities and materials of varying forms and this helps in planning classroom activities according to the needs and interest of the pupils. Based on the implications of the 5E Learning Cycle Model, the following suggestions are made for improvement of the whole system of education. National and State level curriculum framers and educationalist should make immediate attention on these matters.

1. Since the study proves the effectiveness of the 5E Learning Cycle Model, the model should be introduced at secondary level for the attainment of Achievement in Physics, and for the development of Scientific Creativity and Scientific Interest.

2. In-service training should be organized in order to acquaint teachers with new instructional design strategies like 5E Learning Cycle Model. The concepts of models of teaching must be made familiar to secondary school teachers. In service teachers should train themselves to handle the model and sustain the interest and curiosity of the students.

3. In order to make the practice of the select learning strategies, lesson transcripts on suitable topics should be prepared by the expert team.
comprising of educationalists and experienced teachers and made available to teachers.

4. The students belong to different learning style learn different concepts differently. The learning styles of students should be kept in mind while teaching specially science subjects. New and more powerful instructional models such as 5E Learning Cycle Model must be implemented in class room keeping in mind the learning style differences of the student.

5. In teacher training programs, the trainees are not getting proper exposure to innovative approaches to teaching. They should be given every chance of close acquaintance with different models of teaching and should be given ample opportunities for practicing it.

6. Since this model gives due importance to exploration, every school should have facilities for library, computer laboratory with internet connectivity for teachers and students to learn new theory and practice that are experimenting across the globe.

7. Laboratory is the best place to practice 5E Learning Cycle Model, since it is a minds-on and hands-on method of instruction. So the science laboratories of every school must be well equipped and properly maintained.

8. Although there are laboratories in schools, they are not functioning properly. Overcrowded classrooms, lack of availability of a good number of laboratory equipment, shorter duration of the periods, and huge portion to complete in limited time etc. are the major reasons for not practicing the new instructional models in the class rooms. So educationalists and policymakers devote due care and attention on these matters.

9. All topics cannot be taught through the new instructional method such as 5E Learning Cycle Model, so the incorporation of different teaching and learning strategies based on constructivist models of teaching in
the present day Activity Oriented Method is best suited to get optimum achievement in science.

10. There are some extended models of 5E such as 7E Learning Cycle Model are proposed by incorporating the Phase Elicit before and after the Explain phase. The actions coming under this phase is automatically included in the Explain phase of the 5E Learning cycle Model. So there is no need of the separate phase in particular with the 5E Learning Cycle Model.

11. 5E learning Cycle Model can be extended to other topics and other disciplines since this model supports transfer of learning well.

6.6 SUGGESTIONS FOR FURTHER RESEARCH

The present study becomes a stepping stone for conducting more studies in future in the field of education. Some suggestions for further study are given below.

1. The present study is limited to secondary level students of Kerala state syllabi. A similar study can be extended to different educational levels and different syllabi such as CBSE and ICSE.

2. Similar studies can be conducted for a large sample for longer duration representing different districts to ensure the validity of the study.

3. A study can be conducted on developing learning materials using 5E learning Cycle model and to check and compare the effectiveness of the developed model on achievement.

4. A study can be undertaken to evaluate the opinion, reactions and ratings on 5E Learning Cycle Model in teaching and learning of both students and teachers.

5. A similar study can be extended to different variables like reasoning ability, higher order thinking skills etc.
6. Similar studies can be conducted using different combination of models
from different families of models and using other experimental design
to collect more reliable data.

7. Studies must be done on creating new innovative teaching and
learning methods by incorporating 5E Learning Cycle Model with other
learning models.

8. The effectiveness of 5E learning Cycle Model can be studied on other
branches of science and other topics on the same subject.

9. A study can be conducted to compare the effectiveness of 5E Learning
Cycle Model and Extended 5E Learning Cycle Model on different
variables, such as achievement motivation, higher order thinking skills
and other personality characteristics.