CHAPTER VI

SUMMARY AND CONCLUSIONS

6.1 Study in Retrospect
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SUMMARY AND CONCLUSIONS

The main objective of the present study was to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level. This chapter provides a retrospect of the study which contains the restatement of the problem, objectives of the study, hypotheses formulated for the study and methodology in brief. It also includes 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 given in the following heads.

6.1.1 Restatement of the Problem

The present study is entitled, “DEVELOPING WEB BASED MEANINGFUL ENGAGED LEARNING STRATEGY FOR LEARNING ASTRONOMY AT SECONDARY SCHOOL LEVEL”

6.1.2 Objectives of the Study

The objectives of the study are,

1. To develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level.

2. To analyze the present status of teaching Astronomy at Secondary school level.

3. To find out the Achievement in Astronomy of students at Secondary school Level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.
4. To compare the Achievement in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method for total sample and relevant subsamples.

5. To find out the Interest in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

6. To compare the Interest in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

7. To find out the Reasoning Ability in Science of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

8. To compare the Reasoning Ability in Science of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

9. To find out the Scientific Attitude of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

10. To compare the Scientific Attitude of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.

11. To assess the Retention of Achievement in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method.
6.1.3 Hypotheses Formulated for the Study

The following hypotheses are formulated for this study.

1. The Achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method for total sample and relevant subsamples.

2. The Interest in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.

3. The Reasoning Ability in Science of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.

4. The Scientific Attitude of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.

5. The retention of Achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.

6.1.4 Methodology in Brief

The present study was intended to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary School level. Before developing the strategy the investigator analyzed the present status of teaching Astronomy at secondary school level. For this, the investigator adopted Normative Survey method. In order to find out the effect of the developed strategy, the investigator adopted experimental method. The design selected was pre-test post-test non-equivalent group design (Best & Kahn, 2007).
6.1.4.1 Sample selected for the Survey

For analyzing the present status of teaching Astronomy the investigator selected 120 Secondary school Physical Science teachers from four districts of Kerala selected through Random Sampling Method.

6.1.4.2 Sample selected for the Experiment

As Astronomy topics are included in the Standards VIII and X of Kerala State Secondary School Science Syllabus, the investigator selected the students of both Standards VIII and X as the population of the study. From this, the investigator selected samples for Standard VIII and Standard X through Purposive Random sampling method.

- **Sample selected from Standard VIII**

  The investigator selected 320 students belonging to eight divisions of Standard VIII (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district).

- **Sample selected from Standard X**

  The investigator selected 320 students belonging to eight divisions of Standard X (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district).

  Thus the total sample consisted of 640 students. Of the schools selected, two were Government schools (Grama Panchayath Higher Secondary School, Kulanada and Government Model Higher Secondary School, Ambalapuzha) and the other two were Aided schools (SVGV Higher Secondary School, Kidanganoor and Devasom Board Higher Secondary School, Thakazhi). From each school, one division was taught using Web Based Meaningful Engaged
Learning Strategy (Experimental Group) and the other division using the existing Activity Oriented Method (Control Group).

**The tools used were,**

1. Questionnaire on the Present Status of teaching Astronomy
2. Lesson transcripts based on Web Based Meaningful Engaged Learning Strategy (for Standards VIII and X) - Prepared by the Investigator
3. Lesson transcripts based on existing Activity Oriented method (for Standards VIII and X) - Prepared by the Investigator
4. Raven’s Standard Progressive Matrices
5. Achievement Tests in Astronomy (for Standards VIII and X) - Prepared by the Investigator
6. Astronomy Interest Inventory - Prepared by the Investigator
7. Test of Reasoning Ability in Science - Prepared by the Investigator
8. Scientific Attitude Scale - Prepared by the Investigator

**Procedure Adopted in the Study**

A preliminary survey was conducted to find out the present status of teaching Astronomy at Secondary school level among 120 science teachers at secondary school level.

After comparing the previous Achievement in Physics and General Mental Ability of students belonging to Standards VIII and X, they were divided into two groups namely Experimental group and Control group for both Standards VIII and X. Before starting the experimental treatment, the investigator administered Achievement tests in Astronomy, Astronomy Interest Inventory, Test of Reasoning ability in Science and Scientific Attitude Scale as Pre-test for both groups belonging to Standards VIII and X. Then the Experimental group was taught through Web Based Meaningful Engaged Learning Strategy and the Control group through existing Activity Oriented method. Lesson transcripts for the whole units on Astronomy of Standards VIII and X were prepared and taught to the two groups. The duration of each lesson was 40 minutes.
After the experimental treatment, the investigator administered the same Achievement tests in Astronomy, Astronomy Interest Inventory, Test of Reasoning ability in Science and Scientific Attitude Scale as Post-tests for both groups of Standards VIII and X. In addition to that the Achievement test in Astronomy was again administered to both groups belonging to both the Standards VIII and X about one month after the administration of Post test (Delayed Post-test). The investigator tried to maintain same conditions with regard to the time allotted, instructions given during the test etc. for all the groups. The response sheets were collected back and scored.

**Statistical Techniques Used**

The scores obtained by the students in the Pre-test and Post-test were collected, tabulated and subjected to appropriate statistical techniques. The major statistical techniques used are ‘t’ test, ANOVA and ANCOVA.

**6.2 Major Findings**

The major findings that have emerged from the study are given below.

**Present Status of Teaching Astronomy**

6.2.1 Most of the Physical Science teachers feel difficulty in teaching Astronomy despite providing teacher’s handbook.

6.2.2 Most of the Physical Science teachers are not able to conduct night sky observations, visit Planetariums and utilize the benefits of Smart classrooms for teaching Astronomy.

6.2.3 Despite there are some instructional strategies, the curriculum transaction method in the present context is not appropriate for the Astronomy topics at secondary school level.

6.2.4 Even though some Physical Science teachers are utilizing the available resources for teaching Astronomy, majority are not doing the same to a greater extend.
Initial Comparison of Experimental and Control groups

A. Standard VIII

6.2.5 Before starting the experimental treatment, the students of Experimental and Control groups were compared with respect to their Previous Achievement in Astronomy (t = 0.01), General Mental ability (t = 0.04), Achievement in Astronomy (t = 0.05), Interest in Astronomy (t = 0.11), Reasoning Ability in Science (t = 0.36) and Scientific Attitude (t = 0.11). All these values are not significant at 0.05 level.

B. Standard X

6.2.6 Before starting the experimental treatment, no significant difference (at 0.05 level) was found between the students of Experimental and Control groups with respect to their Previous Achievement in Astronomy (t = 0.03), General Mental ability (t = 0.30), Achievement in Astronomy (t = 0.12), Interest in Astronomy (t = 0.43), Reasoning Ability in Science (t = 0.52) and Scientific Attitude (t = 0.30).

Achievement in Astronomy after Experimental Treatment

A. Standard VIII

6.2.7 The analysis of Post-test scores (t=8.47) and Gain scores (t=9.69) on Achievement in Astronomy of Experimental and Control groups revealed that the two groups differ significantly at 0.01 level. The ‘t’ value and mean scores helped to state that the Experimental group achieved more than Control group with respect to the Achievement in Astronomy.

The analysis of Variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there was no significant difference between the
means of Pre-test scores of the two groups (F_x = 0.00) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (F_y = 71.30) at 0.01 level. This shows that the Experimental group performed higher than the Control group in Post-test.

The analysis of Covariance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (F_{yx} = 100.31), at 0.01 level. From the value of F_{yx}, it is clear that the final mean scores of students in the two groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores on Achievement in Astronomy of the students in the Experimental and Control groups were compared, the difference between them was found to be statistically significant. The obtained ‘t’ value (10.02) is significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through existing Activity Oriented method.

6.2.8 The analysis of the Post-test scores on Achievement in Astronomy with respect to sub-sample categories namely gender and type of School revealed that the Experimental group scored significantly higher than the Control group among boys(t=7.69) and girls (t=9.04) and students of Government(t=8.01) and Aided(t=8.99) schools. All these values are significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through existing Activity Oriented method under the sub sample categories namely gender and type of school.
B. Standard X

6.2.9 On comparing the Post-test scores (t=8.91) and Gain scores (t=11.09) of Experimental and Control groups it was revealed that the two groups differ significantly at 0.01 level. The ‘t’ value and mean scores helped to state that, the Experimental group achieved more than Control group with respect to the Achievement in Astronomy.

The analysis of Variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx = 0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy = 78.96) at 0.01 level. This shows that the Experimental group performed higher than the Control group in Post-test.

The analysis of Covariance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx = 134.74) at 0.01 level. From the value of Fyx, it is clear that the final mean scores of students in the two groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores on Achievement in Astronomy of the students in the Experimental and Control groups were compared, the difference between them was found to be statistically significant. The obtained ‘t’ value (11.61) is significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through existing Activity Oriented Method.
6.2.10 The analysis with respect to sub-sample categories namely gender and type of School revealed that the Experimental group scored significantly higher than the Control group among boys \( t=8.95 \) and girls \( t=8.91 \) and students of Government \( t=9.39 \) and Aided \( t=8.45 \) schools. All these values are significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through existing Activity Oriented Method under the sub sample categories namely gender and type of school.

**Achievement in Astronomy under the category of Objectives**

**A. Standard VIII**

6.2.11 While analysing the Pre-test scores on Achievement in Astronomy of Experimental and Control groups under different categories of objectives, it was revealed that the ‘t’ value obtained is not significant at 0.05 level (Knowledge-1.57, Understanding-1.03, Application-0.19, Analysis-0.11, Synthesis-1.68 and Evaluation-0.64). This shows that the Experimental and Control groups do not differ significantly on Achievement in Astronomy under the different categories of objectives before starting the experimental treatment.

When the Post-test scores on Achievement in Astronomy under different categories of objectives were compared, the ‘t’ value obtained is significant at 0.01 level (Knowledge-3.52, Understanding-6.95, Application-6.99, Analysis-5.13, Synthesis-4.31 and Evaluation-4.01). This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Post-test scores of the two groups reveals that after the experimental treatment the Experimental group achieved better than the Control group.
When the Gain scores on Achievement in Astronomy under different categories of objectives were compared, the ‘t’ value obtained is significant at 0.01 level (Knowledge-2.19, Understanding-6.14, Application-7.37, Analysis-4.14, Synthesis-4.61 and Evaluation-3.36). This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Gain scores of the two groups reveal that, after the experimental treatment, the Experimental group achieved better than the Control group. Thus it can be inferred that the experimental group taught through Web Based Meaningful Engaged Learning Strategy achieved better than the Control group which was taught through existing Activity Oriented Method with respect to the Achievement in Astronomy under different categories of objectives.

Through the analysis of Variance of Pre-test (Fx) and Post-test (Fy) scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives it was found that there was no significant difference between the means of Pre-test scores of the two groups. The value of Fx for the objectives are, Knowledge-2.45, Understanding-1.05, Application-0.04, Analysis-0.01, Synthesis-2.81 and Evaluation-0.40. All these values are not significant at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups under the different categories of objectives (The value of Fy for objectives: Knowledge-12.34, Understanding-48.06, Application-48.58, Analysis-26.15, Synthesis-18.48 and Evaluation-15.96). This shows that the Experimental group is superior to that of the Control group in the Post-test of Achievement in Astronomy under different categories of objectives.
The analysis of Covariance of Pre-test and Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives showed that there is significant difference between the means of Post-test scores of the two groups at 0.01 level. The value of $F_{yx}$ for objectives: Knowledge-10.08, Understanding-46.71, Application-53.78, Analysis-26.97, Synthesis-20.44 and Evaluation-15.95. The significant $F_{yx}$ ratio reveals that the final mean scores on Achievement in Astronomy under the different categories of objectives of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives were found and tested for significance using ‘$t$’ test, the obtained ‘$t$’ values for objectives: Knowledge-3.32, Understanding-6.85, Application-7.33, Analysis-5.19, Synthesis-4.54 and Evaluation-4.00, are significant at 0.01 level. This leads to the inference that the students in the Experimental and Control groups differ significantly with respect to Achievement in Astronomy under the different categories of objectives namely Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation.

**B. Standard X**

6.2.12 The analysis of the Pre-test scores on Achievement in Astronomy under different categories of objectives revealed that the ‘$t$’ value obtained is not significant at 0.05 level (Knowledge-1.19, Understanding-1.19, Application-0.70, Analysis-0.68, Synthesis-0.46 and Evaluation-1.61). This shows that the Experimental and Control
groups do not differ significantly on Achievement in Astronomy under the different categories of objectives before the experimental treatment.

When the Post-test scores on Achievement in Astronomy under different categories of objectives were compared, the ‘t’ value obtained is significant at 0.01 level (Knowledge-3.56, Understanding-7.31, Application-6.68, Analysis-5.55, Synthesis-3.94 and Evaluation-4.85). This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Post-test scores of the two groups reveals that after the experimental treatment the Experimental group achieved better than the Control group.

When the Gain scores on Achievement in Astronomy under different categories of objectives were compared, the ‘t’ value obtained is significant at 0.01 level (Understanding-6.64, Application-7.39, Analysis-4.76, Synthesis-3.88 and Evaluation-5.88) except that of the objective Knowledge. For Knowledge the value of ‘t’ is 2.31, which is significant at 0.05 level. This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Gain scores of the two groups reveals that, after the experimental treatment the Experimental group achieved better than the Control group. Thus it can be inferred that the experimental group taught through Web Based Meaningful Engaged Learning Strategy achieved better than the Control group which was taught through Activity Oriented Method with respect to the Achievement in Astronomy under different categories of objectives.

The analysis of Variance of Pre-test (Fx) and Post-test (Fy) scores of students in the Experimental and Control groups on Achievement in
Astronomy under the different categories of objectives showed that there was no significant difference between the means of Pre-test scores of the two groups. The value of Fx for the objectives: Knowledge-1.42, Understanding-1.42, Application-0.60, Analysis-0.45, Synthesis-0.21 and Evaluation-2.59. All these values are not significant at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups under the different categories of objectives (The value of Fy for objectives: Knowledge-12.57, Understanding-53.14, Application-44.41, Analysis-30.58, Synthesis-15.43 and Evaluation-23.40). This shows that the Experimental group is superior to that of the Control group in the Post-test on Achievement in Astronomy under different categories of objectives.

The analysis of Covariance of Pre-test and Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives showed that there is significant difference between the means of Post-test scores of the two groups at 0.01 level. The value of Fyx for objectives: Knowledge-11.40, Understanding-51.38, Application-53.48, Analysis-30.26, Synthesis-16.26 and Evaluation-31.53. The significant Fyx ratio reveals that the final mean scores on Achievement in Astronomy under the different categories of objectives of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives were found and tested for significance using ‘t’ test, the obtained ‘t’ values for objectives:
Knowledge-3.38, Understanding-7.18, Application-7.32, Analysis-5.50, Synthesis-4.03 and Evaluation-5.64, are significant at 0.01 level. This leads to the inference that the students in the Experimental and Control groups differ significantly with respect to Achievement in Astronomy under the different categories of objectives namely Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation.

**Interest in Astronomy**

**A. Standard VIII**

6.2.13 By analysing the Post-test scores (t=7.48) and Gain scores (t=10.72) with respect to Interest in Astronomy of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Interest in Astronomy than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =55.58) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Interest in Astronomy.

The analysis of Covariance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there is significant difference between the means
of Post-test scores of the two groups (Fyx =152.47) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Interest in Astronomy of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Interest in Astronomy of students in the Experimental and Control groups were compared, the ‘t’ value (t=12.35) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Interest in Astronomy. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Interest in Astronomy than those taught through existing Activity Oriented method.

**B. Standard X**

6.2.14 The analysis of Post-test scores (t=6.45) and Gain scores (t=7.50) on Interest in Astronomy of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Interest in Astronomy than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.18) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =41.38) at 0.01 level. This reveals that the
two groups differ significantly in their Post-test scores on Interest in Astronomy.

The analysis of Covariance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (F_{yx} = 63.97) at 0.01 level. This significant F_{yx} ratio reveals that the final mean scores on Interest in Astronomy of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Interest in Astronomy of students in the Experimental and Control groups were compared, the ‘t’ value (t=8.00) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Interest in Astronomy. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Interest in Astronomy than those taught through existing Activity Oriented method.

**Reasoning Ability in Science**

**A. Standard VIII**

6.2.15 The analysis of Post-test scores (t=5.59) and Gain scores (t=7.26) on Reasoning ability in Science of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the Experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Reasoning ability in
Science than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups ($F_x = 0.13$) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups ($F_y = 31.05$) which is significant at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Reasoning ability in Science.

The analysis of Covariance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups ($F_{yx} = 63.19$) at 0.01 level. This significant $F_{yx}$ ratio reveals that the final mean scores on Reasoning ability in Science of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups were compared, the obtained ‘t’ value ($t = 7.95$) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Reasoning ability in Science. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Reasoning ability in Science than those taught through existing Activity Oriented method.
B. Standard X

6.2.16 The analysis of Post-test scores ($t=6.89$) and Gain scores ($t=11.45$) on Reasoning ability in Science of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Reasoning ability in Science than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups ($F_x =0.27$ ) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups ($F_y =47.28$) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Reasoning ability in Science.

The analysis of Covariance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups ($F_{yx} =146.75$ ) at 0.01 level. This significant $F_{yx}$ ratio reveals that the final mean scores on Reasoning ability in Science of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups were compared, the obtained ‘t’ value ($t=12.12$) is significant at 0.01 level. This shows that there is significant
difference between the Experimental and Control groups with respect to Reasoning ability in Science. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Reasoning ability in Science than those taught through existing Activity Oriented method.

Scientific Attitude

A. Standard VIII

6.2.17 Through the analysis of Post-test scores (t=3.10) and Gain scores (t=5.45) on Scientific Attitude of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Scientific Attitude than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =9.56) which is significant at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Scientific attitude.

The analysis of Covariance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =32.17) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Scientific
Attitude of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Scientific Attitude of students in the Experimental and Control groups were compared, the ‘t’ value (t=5.67) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Scientific Attitude. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Scientific Attitude than those taught through existing Activity Oriented method.

B. Standard X

6.2.18 The analysis of Post-test scores (t=2.92) and Gain scores (t=6.78) on Scientific Attitude of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. The ‘t’ value and mean scores shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy gained more Scientific Attitude than the Control group which was taught through existing Activity Oriented method.

The analysis of Variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.09) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =8.48) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Scientific attitude.
The analysis of Covariance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx = 47.40) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Scientific Attitude of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Scientific Attitude of students in the Experimental and Control groups were compared, the ‘t’ value (t=6.89) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Scientific attitude. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Scientific Attitude than those taught through existing Activity Oriented method.

**Retention of Achievement in Astronomy**

**A. Standard VIII**

6.2.19 The comparison between the Experimental and Control groups with respect to the delayed Post-test scores on Achievement in Astronomy revealed that the ‘t’ value obtained (12.37) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with regard to their retention in Achievement in Astronomy in the Post-test scores. The mean scores on delayed Post-test on Achievement shows that the Experimental groups taught through Web Based Meaningful Engaged Learning Strategy is having more retention than the Control groups taught through existing Activity Oriented method.
While comparing the Post-test and delayed Post-test scores on Achievement in Astronomy of students in the experimental groups, the ‘t’ value obtained (1.24) is not significant at 0.01 level. This shows that the Achievement in Astronomy can be retained even after one month to those students who were taught using Web Based Meaningful Engaged Learning Strategy.

On comparing the Post-test and delayed Post-test scores on Achievement in Astronomy of students in the Control groups, the ‘t’ value obtained (4.98) is significant at 0.01 level. This shows that the Achievement in Astronomy cannot be retained even after one month to those students who were taught using existing Activity Oriented method. Thus it can be concluded that the retention of students taught through existing Activity Oriented method is less when compared to the retention of students taught using Web Based Meaningful Engaged Learning Strategy.

B. Standard X

6.2.20 The comparison between the Experimental and Control groups with respect to the delayed Post-test scores on Achievement in Astronomy revealed that the ‘t’ value obtained (11.23) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with regard to their retention in Achievement in Astronomy in the Post-test scores. The mean scores on delayed Post-test on Achievement shows that the Experimental groups taught through Web Based Meaningful Engaged Learning Strategy is having more retention than the Control groups taught through existing Activity Oriented method.

While comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the experimental groups, the ‘t’ value obtained (1.29) is not significant at 0.01 level. This
shows that the Achievement in Astronomy can be retained even after one month to those students who were taught using Web Based Meaningful Engaged Learning Strategy.

On comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the Control groups, the ‘t’ value obtained (4.50) is significant at 0.01 level. This shows that the Achievement in Astronomy cannot be retained even after one month to those students who were taught using existing Activity Oriented method. Thus it can be concluded that the retention of students taught using existing Activity Oriented method is less when compared to the retention of students taught using Web Based Meaningful Engaged Learning Strategy.

6.3 Tenability of the Hypotheses

The tenability of the hypotheses formulated was tested by examining the veracity of the findings obtained from the experimental study conducted and are presented below:

Hypothesis I

The Achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method for total sample and relevant subsamples.

The findings 6.2.7 - 6.2.10 shows that the achievement (total) in Astronomy of students taught through Web Based Meaningful Engaged Learning strategy is significantly higher than that of those taught through existing Activity Oriented method for the total sample. The findings 6.2.11 & 6.2.12 reveals that the achievement is Astronomy under the different categories of objectives namely, Knowledge, Understanding, Application, Analysis,
Synthesis and Evaluation is significantly higher than that of those taught through existing Activity Oriented method. Hence the above hypothesis is substantiated.

**Hypothesis II**

*The Interest in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.*

The findings 6.2.13 & 6.2.14 indicates that the Interest in Astronomy of students taught through Web Based Meaningful Engaged Learning strategy is significantly higher than that of those taught through existing Activity Oriented method. Hence the above hypothesis is substantiated.

**Hypothesis III**

*The Reasoning ability in Science of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.*

The findings 6.2.15 & 6.2.16 indicates that the Reasoning Ability of students taught through Web Based Meaningful Engaged Learning strategy is significantly higher than that of those taught through existing Activity Oriented method. Hence the above hypothesis is substantiated.

**Hypothesis IV**

*The Scientific Attitude of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.*

The findings 6.2.17 & 6.2.18 indicates that the level of Scientific Attitude of students taught through Web Based Meaningful Engaged Learning strategy
is significantly higher than that of those taught through existing Activity Oriented method. Hence the above hypothesis is substantiated.

**Hypothesis V**

*The retention of Achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.*

The findings 6.2.19 & 6.2.20 indicates that the students taught through Web Based Meaningful Engaged Learning strategy have better retention of Achievement in Astronomy than that of those taught through existing Activity Oriented method. Hence the above hypothesis is substantiated.

**6.4 Conclusions of the Study**

The major conclusions that are arrived at from the study are noted below:

1. The achievement (total) in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method. So it can be concluded that Web Based Meaningful Engaged Learning strategy is better than existing Activity Oriented method in learning Astronomy at secondary school level.

2. While comparing the objective wise (Knowledge, Understanding, Application, Analysis, Synthesis, Evaluation) Achievement in Astronomy of students in the Experimental and Control groups, it was found that the students taught through Web Based Meaningful Engaged Learning strategy achieved more than that of students taught through existing Activity Oriented method. Thus it can be concluded that Web Based Meaningful Engaged Learning strategy is better than existing Activity Oriented method in learning Astronomy at secondary school level.
3. While comparing the achievement in Astronomy of students in the Experimental and Control groups under the subsample categories like gender and type of school, it was found that the students taught through Web Based Meaningful Engaged Learning strategy achieved more than those taught through existing Activity Oriented method. Thus it can be concluded that Web Based Meaningful Engaged Learning strategy is better than existing Activity Oriented method on Achievement in Astronomy at secondary school level under the subsample categories like gender and type of school.

4. The Interest in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more Interest in Astronomy than those taught using existing Activity Oriented method.

5. The Reasoning ability in Science of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more Reasoning ability in Science than those taught using existing Activity Oriented method.

6. The Scientific Attitude of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more Scientific Attitude than those taught using existing Activity Oriented method.

7. The retention of Achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using existing Activity Oriented method.
It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to gain more retention of Achievement in Astronomy than those taught using existing Activity Oriented method.

6.5 Educational Implications of the Study

The ultimate goal of the present study was to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level. The findings revealed that learning Astronomy using Web Based Meaningful Engaged Learning Strategy helped students to gain more Achievement in Astronomy, Interest in Astronomy, Reasoning ability in Science and Scientific Attitude. These findings have certain educational implications for the school education programmes. The implications are outlined below:

1. In order to reveal the mystery of the universe and to understand this, knowledge of Astronomy is essential. Astronomy learning has many limitations. To overcome these limitations and enjoy Astronomy learning, Web Based Meaningful Engaged Learning Strategy is found to be effective and therefore should be introduced in the Secondary school curriculum. In Web Based Meaningful Engaged Learning Strategy, students are heterogeneously and flexibly grouped to increase cooperation among them. It is a student centered learning strategy. Here the teacher acts as a facilitator, guide and co-learner and the student as an explorer, as well as a cognitive apprentice. The students are self-regulated and are responsible for their own learning. As students are intrinsically motivated, students will generate a lifelong passion to understand and solve problems.

2. The present study has came out with a Web Based learning material in the form of a Website specially designed to teach topics on Astronomy of Kerala state secondary school syllabus. The developed Web Based material helps to provide a simple and unique visual impact on students.
Astronomical softwares included in the prepared Web Based material permits a journey to the virtual representation of outer space, enabling students to zoom in or out as they wish, easily changing their viewpoint and perspective and thereby study the different objects of this universe. Such a learning environment will promote learning through exciting learning experiences.

Videos as well as images related to Astronomy provided in the Web Based learning material provide vivid and spectacular renderings of various celestial objects and phenomena.

The softwares, videos and images related to Astronomy in this material appear to provide an added rhetorical value to the presentation of the content.

Incorporating more softwares, animations on Astronomy and using smart classroom will make Astronomy learning more appealing and meaningful. Special attention must be provided in making in-service training to teachers in Astronomy through orientation classes, refresher courses, seminars and workshops for preparation and usage of software, websites and web blogs on Astronomy.

3. Another important contribution of the study, in addition to its wider theoretical and practical implications is that, it has came out with a set of standardized instruments for measuring the variables of the study, viz., Achievement tests in Astronomy (for Standard VIII & Standard X), Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude scale. These tools can be further used widely in the field of education and in particular Astronomy education.

4. From the findings of the study, it is evident that Web Based Meaningful Engaged Learning Strategy will enhance the Achievement in Astronomy. It proved to be a powerful strategy to overcome the hurdles of Astronomy education to some extent. Our officials should take necessary steps to incorporate this strategy in our curriculum and
provide training for teachers in this strategy. Model lesson transcripts on Web Based Meaningful Engaged Learning Strategy should be generated by the experts in education in collaboration with computer personnel. NCERT and SCERT should take initiatives for implementing Web Based strategies in the classrooms.

5. This strategy has proved a real way to enhance Interest in Astronomy. Generating Interest in Astronomy will not only help them to understand the mysteries of this universe but also supplements their daily life through various applications along with exciting career opportunities. Teachers must arrange extracurricular activities related to Astronomy such as conducting Space camps, exhibitions, projects, workshops, celebrating Astronomy week, arrange interactions with eminent scientists in Astronomy as well as conducting sky watching during various celestial phenomena.

6. This strategy enhances the Reasoning ability in Science of students. Reasoning ability will act as an invaluable asset for students for coping with the ever changing world. There must be provisions in the curriculum itself for improving and enhancing Reasoning ability in students.

7. By learning Astronomy through Web Based Meaningful Engaged Learning Strategy, the level of Scientific attitude among secondary school students is increased. This will make them open minded, curious, honest, objective, and create an ardent love for scientific experimentation. Teachers must plan activities to inculcate Scientific attitude among their students and thus help them to live in this society.

8. The results of the study revealed that the developed Web Based Meaningful Engaged Learning Strategy has more effect on the retention of Achievement in Astronomy as compared to that of existing Activity Oriented method. Hence curriculum developers should take efforts to
implement this strategy in the curriculum with minor adaptations to the specific needs of the learners so as to reinforce learning.

9. While checking the present status of teaching Astronomy at secondary school level of Kerala, it was found that our schools are not equipped for teaching Astronomy.

- Physical Science teachers are not provided with special training for teaching Astronomy. They should be encouraged to participate in different national as well as international seminars and workshops on Astronomy to update their knowledge in Astronomy. Special attention should be given in the Teacher preparation courses itself for practicing computers for teaching Astronomy.

- There are no provisions in the school to conduct teleconferencing or video conferencing with eminent scientists especially astrophysicists. Classes on Astronomy topics for teachers and students should be organized in collaboration with the scientists of ISRO, NASA and other national as well as international space agencies.

- The school libraries as well as laboratories are not equipped for learning Astronomy. The officials must take necessary steps to include more books on Astronomy as well as Astronomy journals in the library and equip the laboratory with telescopes and other sophisticated instruments for sky watching. More facilities in the form of books, laboratory equipments, computers, projectors must be provided in schools to enrich Astronomy learning.

- There are no necessary arrangements in our schools and homes for night sky watching. Provisions in this regard as well as during the happening of some interesting phenomena like Solar eclipse, conjunction of certain planets etc. must be provided in the schools for students as well as public for watching these.

10. The teaching or learning methods used in this study are not new but they are combined in new ways that was not done before. This strategy
includes the meaningful integration of technology to foster Astronomy learning. It is hoped that this strategy will pave a new way for learning Astronomy by giving virtual experiences in students through the judicious use of Web Based resources.

11. The findings of the present study is of great importance to curriculum planners, teacher educators, Physical Science teachers etc. as it provides guidelines to make necessary steps to make Astronomy learning more effective, meaningful and interesting.

The results of this study will contribute towards new learning strategies and will be helpful for all those who are concerned with the field of Physics as well as Astronomy education. Our educational system and higher education establishments have to utilise the immense potentials of our students by including these types of innovative learning strategies in the curriculum.

### 6.6 Suggestions for Further Research

In the light of the present study the investigator presents certain suggestions which can help others to think about the possibilities of further research related to this study and are given below.

- The experimental study has been confined to Alappuzha and Pathanamthitta districts only. To get a complete picture of the effectiveness of Web Based Meaningful Engaged Learning Strategy, similar studies can be conducted at different districts using larger sample.

- The experimental part of the study was limited to testing the effectiveness of Web Based Meaningful Engaged Learning Strategy with regard to Achievement in Astronomy, Interest in Astronomy, Reasoning ability in Science and Scientific Attitude. Similar studies can be conducted to find the effectiveness of Web Based Meaningful Engaged Learning Strategy in attaining other variables like Problem Solving ability, Scientific creativity, Critical thinking skill etc.
The survey part of the study has been confined to a limited sample. The study may be replicated on a larger sample systematically covering different districts in Kerala.

The effect of Web Based Meaningful Engaged Learning Strategy on students from coastal and tribal areas can be studied.

The present study can be conducted on under average, slow learners and students with different learning as well as cognitive styles.

A study can be conducted to find the effectiveness of the website created in this study through e-learning strategy.

A study can be conducted to identify the various astronomical misconceptions and its extent among students and teachers at school and college level.

A detailed study can be conducted to find out the difficulties experienced by teachers in transacting Astronomy curriculum in schools and colleges from various districts of Kerala.

A survey on the attitude of educational practitioners, administrators, curriculum planners, teachers and students towards the inclusion of this strategy in school and college curriculum can be studied.