CHAPTER-V
Chapter – V

SUMMARY AND CONCLUSIONS

5.0 Introduction

Concept map is a device for representing the conceptual structure of a subject in a two-dimensional form, which is analogous to the road map. A concept according to Novak is regularity in objects or events designated by a specific label. Concept maps are the diagrammatic representations to show meaningful relationships between concepts in the form of propositions.

Maps represents ones knowledge. It always be the class of stimuli which have common character stics designated by a common term. The maps represents the concept in a symbolic form.

The concept mapping as an exemplary teaching-learning strategy, allows the students to understand the relationship between ideas by creating a visual map.

The classroom teachers can well use the concept maps to determine the extent of meaningful learning of any curricular subject in general and biology in particular. The use of mappings in the process of learning increase the integration of knowledge of students.

The methodology of using concept maps in process of teaching-learning will be quite a new novel and attractive to students than the conventional method of teaching. In the light of this, the usage of concept maps may find the place in the process of teaching-learning in the schools.

5.1 Need and Significance of the Study

Since the recommendations of secondary education commission report and other education commissions, we are teaching science on compulsory
basis through out the school stages from primary to secondary level because of its multifarious and many sided values to human beings. National Policy of Education (1986) remarkable suggests that science subject should be virtualized as the vehicle to train the child to think, reason out, analyse and articulate logically. Attainment or achievement in science is based on mastery of various fundamentals, concepts, principles and facts in science. The curriculum in science at secondary school level demands for rapid learning and clear understanding of new curriculum (Trimester system of education) which is newly introduced program in the field of education. In this curriculum more concepts, theories in Biological science have to be taught and students have to be trained and learn in attaining the teaching of objectives.

It is a matter of common experiences of many science teacher's and researchers that the actual achievement in science of the students of secondary schools is less when compared with their potential and also other following reasons such as:

- The traditional or conventional method of teaching may not help the student to attain the objectives of teaching science.
- Students do not have the attitude towards the study of science.
- Students are not taking interest or curiosity towards study of science.
- No proper evaluation procedure is used for evaluation of science to see the achievement of science.
- No proper use of medians related to teaching of science subject by science teachers.

In the present study the researcher has considered some of the psychological factors such as cognitive ability, problem solving ability and
scientific aptitude and teaching pedagogy that may effect the achievement in science of secondary students. Hence the present study is undertaken with a view to examine various psychological factors effecting on science achievement.

In the modern class room situation, the influence of science teaching is given vital importance and innovative instructional technology. Hence teaching science is a challenging task on the part of science teacher. These new innovative practices especially new pedagogies, strategies, self instructional materials, in individualized instructional materials and new electronic gadgets in teaching science brought significant changes in the process of teaching and learning science subjects to motivate the students for better performance in turn total science achievement. Hence the present study is undertaken with a view to study the effect of concept mapping on science achievement of secondary school students and to identify the relative effectiveness of both conventional instruction and concept mapping in relation to cognitive ability, problem solving ability and scientific aptitude. Hence the present study has been taken for investigation. Hope that the findings of the present study would help classroom practitioners, researchers, teacher educators, school practitioners and policy makers in modifying the structure of pedagogies in science theoretically.

5.2 General Statement of the Problem

The present problem can be restated as “Effect of Concept Mapping on Science Achievement of Secondary School Students as Moderated by Cognitive Ability, Problem Solving and Scientific Aptitude” – is the problem selected for research.
5.3 Objectives of the Study

The objectives of the study are as follows.

- To study the significant difference between pre-test and post-test scores of science achievement of secondary school students in control group.
- To study the significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in control group.
- To study the significant difference between pre-test and post-test scores of science achievement of secondary school students in experimental group.
- To study the significant difference between pre-test and post-test scores of scientific aptitudes of 1st trimester, 2nd trimester, 3rd trimester and their total of secondary school students in experimental group.
- To study the significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in experimental group.
- To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school students.
- To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school students.
- To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school students.
- To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school students.
• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of rural secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of rural secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude rural secondary school students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of rural secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of urban secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of urban secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of urban secondary school students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of urban secondary school students.
• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school boy students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school boy students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school boy students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school boy students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of secondary school girl students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school girl students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school girl students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school girl students.
• To study the significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of science achievement.

• To study the significant difference between rural and urban secondary school students with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.

• To study the significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of scientific aptitude.

• To study the significant difference between rural and urban secondary school students with respect to cognitive ability scores and problem solving ability.

• To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of science achievement.

• To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.

• To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of scientific aptitude.

• To study the significant difference between boy and girl students of secondary schools with respect to cognitive ability scores and problem solving ability.
• To study the significant difference between high and low concept mapping of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant difference between high and low scientific aptitude of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant difference between high and low cognitive ability of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant difference between high and low problem solving ability of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school total students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in control group.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in experimental group.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of rural secondary school students.
• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of urban secondary school students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school boy students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school girl students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school total students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school students in control group.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school students in experimental group.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of rural secondary school students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of urban secondary school students.
• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school boy students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school girl students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school total students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in control group.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in experimental group.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of rural secondary school students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of urban secondary school students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school boy students.
• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school girl students.

5.4 Hypotheses of the Study

In pursuance of the above stated objectives the following hypotheses were formulated.

\( H_1 \) There is no significant difference between pre-test and post-test scores of science achievement of secondary school students in control group.

\( H_2 \) There is no significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in control group.

\( H_3 \) There is no significant difference between pre-test and post-test scores of science achievement of secondary school students in experimental group.

\( H_4 \) There is no significant difference between pre-test and post-test scores of scientific aptitudes of 1\(^{st}\) trimester, 2\(^{nd}\) trimester, 3\(^{rd}\) trimester and their total of secondary school students in experimental group.

\( H_5 \) There is no significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in experimental group.

\( H_6 \) There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school students.

\( H_7 \) There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1\(^{st}\), 2\(^{nd}\), 3\(^{rd}\) trimester and their total of secondary school students.
There is no significant difference between control and experimental
group with respect to pre-test and post-test scores of scientific aptitude
of secondary school students.

There is no significant difference between control and experimental
group with respect to cognitive ability scores and problem solving
ability scores of secondary school students.

There is no significant difference between control and experimental
group with respect to pre-test and post-test scores of science
achievements of rural secondary school students.

There is no significant difference between control and experimental
group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd
trimester and their total of rural secondary school students.

There is no significant difference between control and experimental
group with respect to pre-test and post-test scores of scientific aptitude
rural secondary school students.

There is no significant difference between control and experimental
group with respect to cognitive ability scores and problem solving
ability scores of rural secondary school students.

There is no significant difference between control and experimental
group with respect to pre-test and post-test scores of science
achievement of urban secondary school students.

There is no significant difference between control and experimental
group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd
trimester and their total of urban secondary school students.
There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of urban secondary school students.

There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of urban secondary school students.

There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school boy students.

There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school boy students.

There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school boy students.

There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school boy students.

There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of secondary school girl students.

There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school girl students.
There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school girl students.

There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school girl students.

There is no significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of science achievement.

There is no significant difference between rural and urban secondary school students with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.

There is no significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of scientific aptitude.

There is no significant difference between rural and urban secondary school students with respect to cognitive ability scores and problem solving ability.

There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of science achievement.

There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.
H₃₂  There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of scientific aptitude.

H₃₃  There is no significant difference between boy and girl students of secondary schools with respect to cognitive ability scores and problem solving ability.

H₃₄  There is no significant difference between high and low concept mapping of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

H₃₅  There is no significant difference between high and low scientific aptitude of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H₃₆  There is no significant difference between high and low cognitive ability of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H₃₇  There is no significant difference between high and low problem solving ability of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H₃₈  There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school total students.
H₃⁹ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in control group.

H₄₀ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in experimental group.

H₄¹ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of rural secondary school students.

H₄² There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of urban secondary school students.

H₄³ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school boy students.

H₄⁴ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school girl students.

H₄⁵ Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school total students.

H₄⁶ Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school students in control group.
Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school students in experimental group.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of rural secondary school students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of urban secondary school students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school boy students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school girl students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school total students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in control group.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in experimental group.
There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of rural secondary school students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of urban secondary school students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school boy students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school girl students.

5.5 The Variables Considered in the Study

The following are the variables considered for the present study.

1) Control Variables
   a) Concept Mapping Strategy
   b) Conventional Method

2) Dependent Variable
   a) Achievement in Biological Science

3) Independent Variables
   a) Cognitive Ability
   b) Problem Solving Ability
   c) Scientific Aptitude

4) Personal Variables
   a) Gender (Male / Female)
   b) Locality (Rural / Urban)
The above variables were selected by taking into the account of the effectiveness of concept mapping on science achievement of secondary school students is moderated by cognitive ability, problem solving ability and scientific aptitude. Also the selection of the above variables are based on review of related literatures, researcher's experience and experts opinion.

5.6 Tools Used for the Study

The following tools were used for data collection:

1) Concept Mapping in 9th Biology*
2) Conventional Method
3) Science Achievement Test*
4) Cognitive Ability – OTIS General Mental Ability Test
5) Problem Solving Ability Test
6) Scientific Aptitude Test*

* = Constructed and Standardized by the Researcher

5.7 Sample of the Study

The study involved a sample of n=241, IX standard students of Coorg districts in such a way as to make available all categories of schools. Stratified random sampling technique is used to select the sample for the study.

Table 5.1: Table showing break up of sample in terms of variables

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Sex</th>
<th>Rural</th>
<th>Urban</th>
<th>Total</th>
</tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
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<td>30</td>
<td>74</td>
</tr>
<tr>
<td>2</td>
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<td>20</td>
<td>65</td>
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<tr>
<td></td>
<td>Total</td>
<td>*59</td>
<td>82</td>
<td></td>
<td>241</td>
</tr>
</tbody>
</table>
5.8 Statistical Techniques Used

1) Descriptive Statistics

Descriptive statistics, such as mean and standard deviation, t-test, were used to study the significant difference among the mean scores of the groups.

2) Correlation Analysis

Correlation Analysis was also used to investigate the correlation or relationship between independent variables with dependent variables. Pearson’s correlation coefficient technique was applied and simple relationships were obtained.

3) ANOVA

ANOVA test and ‘t’ test were applied to investigate the significant, non-significant relationships among the variables.

4) Regression Analysis

Regression Analysis was used to reveal the degree to which each independent variables on the corresponding dependent variables.

5) Path Analysis

Path Analysis was also used to find the direct and indirect effects of independent variables on the corresponding dependent variables.

All the statistical techniques were carried out by using SPSS 11.0 statistical software.

5.9 Major Findings of the Study

The major findings of the study are as follows.

1. The post-test science achievements scores are higher compared to pre-tests scores of secondary school students in control group.

2. The post-test scientific aptitudes scores are higher compared to pre-tests scores of secondary school students in control group.
3. The post-test science achievements scores are higher compared to pre-tests scores of secondary school students in experimental group.

4. The post-test scientific aptitude of 1st trimester scores are higher compared to pre-tests scores of secondary school students in experimental group.

5. The post-test scientific aptitude of 2nd trimester scores are higher compared to pre-tests scores of secondary school students in experimental group.

6. The post-test scientific aptitude of 3rd trimester scores are higher compared to pre-tests scores of secondary school students in experimental group.

7. The post-test total scientific aptitude scores are higher compared to pre-tests scores of secondary school students in experimental group.

8. The students of secondary school belong to control and experiment group have similar pre-test science achievement scores.

9. The students of secondary school belong to control and experiment group have similar post-test science achievement scores.

10. The students of secondary school belong to control and experiment group have similar pre-test scores of concept mapping in first trimester.

11. The students of secondary school belong to control and experiment group have similar pre-test scores of concept mapping in second trimester.

12. The students of secondary school belong to experiment group have higher pre-test scores of concept mapping in third trimester compared to control group students.
13. The students of secondary school belong to experiment group have higher pre-test total scores of concept mapping in all trimesters compared to control group students.

14. The students of secondary school belong to control group have higher pre-test scientific aptitude scores compared to experiment group students.

15. The students of secondary school belong to control and experiment group have similar post-test scientific aptitude scores.

16. The students of secondary school belong to control group have higher cognitive ability scores compared to experiment group students.

17. The students of secondary school belong to control and experiment group have similar problem solving ability scores.

18. The students of rural secondary school belong to control group have higher pre-test science achievement scores compared to experiment group students.

19. The students of rural secondary school belong to control group have higher post-test science achievement scores compared to experiment group students.

20. The students of rural secondary school belong to control and experiment group have similar pre-test scores of concept mapping in first trimester.

21. The students of rural secondary school belong to experiment group have higher pre-test scores of concept mapping in second trimester compared to control group students.

22. The students of rural secondary school belong to experiment group have higher pre-test scores of concept mapping in third trimester compared to control group students.
23. The students of rural secondary school belong to experiment group have higher pre-test total scores of concept mapping in all trimesters compared to control group students.

24. The students of rural secondary school belong to control group have higher pre-test scientific aptitude scores compared to experiment group students.

25. The students of rural secondary school belong to control have higher post-test scientific aptitude scores compared to experiment group students.

26. The students of rural secondary school belong to control group have higher cognitive ability scores compared to experiment group students.

27. The students of rural secondary school belong to control group have higher in problem solving ability scores compared to experiment group.

28. The students of urban secondary schools belong to control and experiment group have similar pre-test science achievement scores.

29. The students of urban secondary schools belong to control and experiment group have similar post-test science achievement scores.

30. The students of urban secondary schools belong to control and experiment group have similar pre-test scores of concept mapping in first trimester.

31. The students of urban secondary schools belong to control group have higher pre-test scores of concept mapping in second trimester compared to experiment group students.

32. The students of urban secondary schools belong to control and experiment group have similar pre-test scores of concept mapping in third trimester.
33. The students of urban secondary schools belong to control and experiment group have similar pre-test scores of concept mapping in all the three trimester.

34. The students of urban secondary school belong to control group have higher pre-test scientific aptitude scores compared to experiment group students.

35. The students of urban secondary school belong to control have higher post-test scientific aptitude scores compared to experiment group students.

36. The students of urban secondary school belong to control group have higher cognitive ability scores compared to experiment group students.

37. The students of urban secondary school belong to control and experiment group have similar scores of problem solving ability.

38. The secondary school boy students belong to control and experiment group have similar pre-test science achievement scores.

39. The secondary school boy students belong to control and experiment group have similar post-test science achievement scores.

40. The secondary school boy students belong to control and experiment group have similar pre-test scores of concept mapping in first trimester.

41. The secondary school boy students belong to control and experiment group have similar pre-test scores of concept mapping in second trimester.

42. The secondary school boy students belong to experiment group have higher pre-test scores of concept mapping in third trimester compared to control group students.
43. The secondary school boy students belong to experiment group have higher pre-test total scores of concept mapping in all trimesters compared to control group students.

44. The secondary school boy students belong to control group have higher pre-test scientific aptitude scores compared to experiment group students.

45. The secondary school boy students belong to control and experiment group have similar post-test scientific aptitude scores.

46. The secondary school boy students belong to control and experiment group have similar cognitive ability scores.

47. The secondary school boy students belong to control group have higher in problem solving ability scores compared to experiment group.

48. The secondary school girl students belong to control and experiment group have similar pre-test science achievement scores.

49. The secondary school girl students belong to control and experiment group have similar post-test science achievement scores.

50. The secondary school girl students belong to control group have higher pre-test scores of concept mapping in first trimester compared to experiment group.

51. The secondary school girl students belong to control and experiment group have similar pre-test scores of concept mapping in second trimester.

52. The secondary school girl students belong to experiment group have higher pre-test scores of concept mapping in third trimester compared to control group.
53. The secondary school girl students belong to control and experiment group have similar pre-test scores of concept mapping in all the trimesters.

54. The secondary school girl students belong to control group have higher pre-test scientific aptitude scores compared to experiment group students.

55. The secondary school girl students belong to control have higher post-test scientific aptitude scores compared to experiment group students.

56. The secondary school girl students belong to control group have higher cognitive ability scores compared to experiment group students.

57. The secondary school girl students belong to control and experiment group have similar problem solving ability scores.

58. The rural secondary school students have higher pre-test science achievement scores compared to urban secondary school students.

59. The rural secondary school students have higher post-test science achievement scores compared to urban secondary school students.

60. The rural and urban secondary school students have similar pre-test scores of concept mapping in first trimester.

61. The rural and urban secondary school students have similar pre-test scores of concept mapping in second trimester.

62. The rural and urban secondary school students have similar pre-test scores of concept mapping in all the trimesters.

63. The rural and urban secondary school students have similar post-test scores of concept mapping in first trimester.
64. The urban secondary school students have higher post-test scores of concept mapping in second trimester compared to rural school students.

65. The urban secondary school students have higher post-test scores of concept mapping in third trimester compared to rural school students.

66. The urban secondary school students have higher post-test scores of concept mapping in all the trimesters compared to rural school students.

67. The urban secondary school students have different pre-test scores of scientific aptitude compared to rural school student.

68. The urban secondary school students have different post-test scores of scientific aptitude compared to rural school student.

69. The urban secondary school students have different pre cognitive ability compared to rural school student.

70. The urban secondary school students have different pre problem solving ability compared to rural school student.

71. The boy and girl students of secondary schools have similar pre-test science achievement scores.

72. The girl students of secondary schools have higher post-test science achievement scores compared to boy students.

73. The boy and girl students of secondary schools have similar pre-test scores of concept mapping in first trimester.

74. The boy and girl students of secondary schools have similar pre-test scores of concept mapping in second trimester.

75. The boy and girl students of secondary schools have similar pre-test scores of concept mapping in third trimester.
76. The boy and girl students of secondary schools have similar pre-test scores of concept mapping in all the trimesters.

77. The boy and girl students of secondary schools have similar post-test scores of concept mapping in first trimester.

78. The boy and girl students of secondary schools have similar post-test scores of concept mapping in second trimester.

79. The girl students of secondary schools have higher post-test scores of concept mapping in third trimester compared to boy students.

80. The girl students of secondary schools have higher post-test scores of concept mapping in all the trimesters compared to boy students.

81. The boy and girl students of secondary schools have similar pre-test scores of scientific aptitude.

82. The boy and girl students of secondary schools have similar post-test scores of scientific aptitude.

83. The girl students of secondary schools have higher scores of Cognitive ability compared to boy students.

84. The boy and girl students of secondary schools have similar scores of Problem solving ability.

85. The secondary school students of control with high concept mapping have smaller in pre and post-test scores of science achievement compared to students with low concept mapping.

86. The secondary school students of experiment with high and low concept mapping have similar in pre and post-test scores of science achievement.
87. The secondary school students of both control and experiment with high and low concept mapping have similar in pre and post-test scores of science achievement.

88. The secondary school students of control with high scientific aptitude have higher in pre and post-test scores of science achievement compared to students with low scientific aptitude.

89. The secondary school students of experiment with high and low scientific aptitude have higher post-test scores of science achievement.

90. The secondary school students of both control and experiment with high scientific aptitude have higher in pre and post-test scores of science achievement.

91. The secondary school students of control with high cognitive ability have higher pre and post-test scores of science achievement.

92. The secondary school students of experiment with high cognitive ability have higher post-test scores of science achievement.

93. The secondary school students of both control and experiment with high cognitive ability have higher in pre and post-test scores of science achievement.

94. The secondary school students of control with high problem solving ability have higher in pre and post-test scores of science achievement.

95. The secondary school students of experiment with high and low problem solving ability have similar in pre and post-test scores of science achievement.

96. The secondary school students of both control and experiment with high problem solving ability have higher in pre and post-test scores of science achievement.
97. The concept mapping increasing (decreasing) with increasing (decreasing) in the science achievement of students of secondary schools as a whole.

98. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of students of secondary schools as a whole.

99. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of students of secondary schools as a whole.

100. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of students of secondary schools as a whole.

101. The concept mapping increasing (decreasing) with decreasing (increasing) in the science achievement of control group students of secondary schools.

102. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of control group students of secondary schools.

103. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of control group students of secondary schools.

104. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of control group students of secondary schools.

105. The concept mapping increasing (decreasing) with increasing (decreasing) in the science achievement of experiment group students of secondary schools.
106. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of experiment group students of secondary schools.

107. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of experiment group students of secondary schools.

108. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of experiment group students of secondary schools.

109. The concept mapping increasing (decreasing) with decreasing (increasing) in the science achievement of rural secondary school students.

110. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of rural secondary school students.

111. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of rural secondary school students.

112. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of rural secondary school students.

113. The concept mapping increasing (decreasing) with increasing (decreasing) in the science achievement of urban secondary school students.

114. The scientific aptitude increasing (decreasing) with decreasing (increasing) in the science achievement of urban secondary school students.
The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of urban secondary school students.

116. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of urban secondary school students.

117. The concept mapping increasing (decreasing) with increasing (decreasing) in the science achievement of boy students of secondary schools.

118. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of boy students of secondary schools.

119. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of boy students of secondary schools.

120. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of boy students of secondary schools.

121. The concept mapping increasing (decreasing) with increasing (decreasing) in the science achievement of girl students of secondary schools.

122. The scientific aptitude increasing (decreasing) with increasing (decreasing) in the science achievement of girl students of secondary schools.

123. The cognitive ability increasing (decreasing) with increasing (decreasing) in the science achievement of girl students of secondary schools.

124. The problem solving ability increasing (decreasing) with increasing (decreasing) in the science achievement of girl students of secondary schools.
5.10 Conclusion

The present study has a significance in improving the Biological science achievement of secondary school students. Hence, every teacher and teacher educator, curriculum designer, textbook writer, has to adapt the concept mapping strategy of teaching in their classroom practices. Since concept mapping strategy emphasizes on concepts which are linking and associating each and every concept that frequently appears in the biological science. Therefore, every concept must be organized, logically and psychologically in such a way that learners will easily attain the concepts and retain in his/her mind.

As far as possible the concepts must be in the form of pictorial or graphical, so that they will appeal to the students and result in better understanding of the concepts. So the concepts should be arranged in a logical and systematic pattern. Hence, the concept mapping plays a very significant vital role in the process of teaching-learning.

5.11 Educational Implications

The findings of the present study has very much clear and significant implications for teachers, parents, school guidance and counselors.

Concept Mapping provides students a clear mode of learning which has a great significant performance in Biological Science. The concept mapping also enhances the students abilities to learn the subject matter at conceptual levels. The use of concept mapping provided an opportunity for all type of students who hail from rural as well as urban areas.

The scientific aptitude is not a totally inherited quality but a trainable one and it is possible to develop the scientific aptitude among children by
providing suitable and significant science experiments.

The study also helps in designing certain Cognitive Ability activities like problem solving exercises, solving puzzles, exercises pertaining to reasoning ability, word association tests which mainly involve convergent and divergent thinking.

Independent variables such as scientific aptitude, cognitive ability and problem solving ability has a significant effect on achievement of students in biology, hence these variables may also be used on all subjects and students.

In performing concept mapping strategy meaningfully which is necessarily associated with independent variable.

It is helpful for classroom teachers to teach the science subjects like physics and chemistry with the help of concept mapping.

The parents must be well informed and be aware of the cognitive abilities, problem solving abilities and other abilities of their children so that they can provide suitable experiences at home for preparing concept mapping on different subjects.

5.12 Suggestions to Improve Students Science Achievement in Biology

Based on the findings of the present study and taking into consideration its limitations, the following suggestions are offered to improve Science Achievement in Biology.

❖ Use of teaching aids: Both projected and non-projected aids and experiments along with concept maps may be ensured while teaching Biology for concrete understanding of the concepts.

❖ Use of other model of teaching along with the concept mapping strategy to have clear understanding of concepts.
• Greater and active participation of students must be ensured by the teachers for quick grasping of the concepts and improvement in achievement.

• Development of clear understanding of objectives of Biological Science education based on the review of literatures have found that this improved the level of achievement of students in school using concept mapping techniques.

5.13 Suggestions for Further Studies

Based on the findings of the present study the investigator felt the need for understanding the following studies in the field of concept mapping.

- Similar studies may be undertaken to investigate the effect of concept mapping on all the component areas of psychological variables.

- Similar studies may be undertaken for all the units of 8th and 9th standard students.

- Similar studies can also be undertaken for CBSE and ICSE syllabus.

- Similar studies may be extended in the development and validation of concept mapping strategy on its material based:
  1) Multimedia Package
  2) Programmed Instruction and Concept Mapping
  3) Virtual Classroom Packages (e-gadgets) for teaching all subjects at different levels.

- Such studies can be taken up for finding the differences among the various levels, types of educational institutions.

- Studies may be undertaken to investigate the effect of concept mapping on the other variables such as personality traits, reasoning skills and development of scientific temper.
• Similar studies may be conducted at +2 stage also and higher educational levels.

• The present study was conducted on a limited sample. Hence, to know about the effect of concept mapping strategy and its standardization purpose a large sample is necessary.

• Comparative studies of concept mapping techniques with models of teaching can be undertaken.

• Therefore concept mapping techniques can also be used as a supplement within conventional teaching of science because students like to understand and attain various different grades of concepts through concept maps of tree type.