CHAPTER V

Summary of Findings

The summary of the study is presented in this chapter. It gives an outline about various aspects such as, procedure adopted for the study, conclusion based on the findings in brief, together with suggestions for improving educational practice and for further research. The present study intends to examine the effectiveness of Selected learning strategies viz. Scientific inquiry based learning, Cooperative learning and problem based learning on Achievement in Biological science at secondary level. The study also intends to determine the relationship of Scientific inquiry based learning, Cooperative learning and Problem based learning with selected variables. The investigator also studied the influence of Selected learning strategies on Problem solving ability, Emotional intelligence, Scientific attitude and Science interest.

5.1 Need and Significance of the Study

Effective science teaching helps students to develop conceptual understanding and inquiry abilities necessary to be productive citizens and science learners. With support young children can engage in sophisticated scientific practices and develop deep understanding of appropriate science concepts. Typical and traditional science instruction however does not support students in achieving either of those outcomes. Typical curriculum materials do not reflect current thinking in science education reforms, where teachers prioritize learning science content over scientific inquiry. All together the present study may help to revamp the existing method of imparting instruction. The investigator is confident that the study will be helpful to teachers, educationalists, administrators and entire schools as a system to modify the learning strategies in the regular classrooms.
5.2 Statement of the Problem

The present study is entitled as ‘A STUDY ON THE EFFECTIVENESS OF SELECTED LEARNING STRATEGIES ON ACHIEVEMENT IN BIOLOGICAL SCIENCE AT SECONDARY LEVEL IN RELATION WITH CERTAIN VARIABLES’

5.3 Objectives of the Study

The objectives of the study are as follows:

1. To select a set of learning strategies suitable for teaching of Biological science at secondary level.
2. To develop suitable learning strategy materials based on Selected learning strategies to teach Biological science at secondary level.
3. To develop suitable achievement tests to measure the Achievement in Biological science at secondary level.
4. To validate the developed learning strategy materials to teach Biological science at secondary level.
5. To validate the developed achievement tests in Biological science at secondary level.
6. To find out the effectiveness of the validated learning strategy materials over the conventional method.
7. To find out whether any significant relationship exists between Achievement in Biological science at secondary level with Problem solving ability, Emotional intelligence, Scientific attitude and Science interest.
8. To find out the influence of the Selected learning strategies on Problem solving ability, Emotional intelligence, Scientific attitude and Science interest.
9. To find out whether any significant mean difference in Achievement in Biological science at secondary level exists with relation to the secondary variables viz. gender and locality

5.4 Hypotheses of the study

The hypotheses formulated for the present study were;

1. Students taught through Selected learning strategies will not differ significantly from students taught through conventional method of teaching with regard to Achievement in Biological science at secondary level.

2. There will be no significant relationship exists between Achievement in Biological science with the variables selected viz. Problem solving ability, Emotional intelligence, Scientific attitude and Science interest.

3. The Selected learning strategies have no significant influence on the selected variables viz. Problem solving ability, Emotional intelligence, Scientific attitude and Science interest.

4. There will be no significant difference in Achievement in Biological science with related to the secondary variables viz. gender and locality.

5.5 Methodology

The method adopted for the present study was experimental cum survey method. The pre test - post test equivalent group design (Best & Kahn, 1995) was selected to determine the effectiveness of Selected learning strategies viz. Scientific inquiry based learning strategy, Cooperative learning strategies and Problem based learning strategy over conventional method. Static - group comparison design (Best & Kahn, 1995) was adopted to study the relationship of Achievement in Biological science with the selected variables viz. Problem solving ability, Emotional intelligence, Scientific attitude and Science interest. To determine the effectiveness of Selected learning strategies on Problem solving ability,
Emotional intelligence, Scientific attitude and Science interest static - group comparison design (Best & Kahn, 1995)\textsuperscript{35} was adopted.

5.6 Tools Used for the Study

The following tools were used for treatment in the experimental and control group.

5.6.1 Lesson Transcripts Based on the Selected Learning Strategies

The investigator prepared lesson transcripts for the three Selected learning strategies viz Scientific inquiry based learning, Cooperative learning and Problem based learning and were used for the treatment of experimental group. In the three Selected learning strategies the topics selected for treatment were divided into 15 subunits.

5.6.2 Lesson Transcripts for Conventional Method of Teaching

Lesson transcripts for conventional method of teaching were prepared on the basis of the existing method implemented and prevailing in the schools of Kerala. The method of instruction followed in the control group was conventional and traditional. No separate learning aids were developed for the control group, but available teaching aids in the school were used.

5.6.3 Achievement Tests in Biological Science (CRT)

Achievement tests in Biological science developed by the investigator were used as pre test and post test on the topics selected for the treatment. The entry behaviour and terminal behaviour of the students were measured using this test. Achievement test was prepared and used separately for each strategy viz Scientific inquiry based learning, Cooperative learning and Problem based learning. Altogether three achievement tests were developed and used.

5.6.4 Problem Solving Ability Scale

In the present study Problem solving ability was measured using the test of Problem solving ability developed by Garg (1998)\textsuperscript{101}. This
test consists of 22 items and four options were given. The test was prepared by incorporating the three components of Problem solving namely comprehending the problem, clarifying the problem and finding solution to the problem.

5.6.5 Emotional Intelligence Scale

Emotional intelligence was measured using a scale developed by Kumar and Shihab (2003). This scale consists of 46 items and it is modelled after Goleman (1996). The test consists of both positive and negative items belonging to five major aspects of Emotional intelligence.

5.6.6 Scientific Attitude Scale

Scientific attitude of the sample under study was measured using a scale developed by Gafoor and Ryni (2003). The scale is a multi factorial one prepared in English. The scale consists of 48 items and both positive and negative items belonging to eleven components of Scientific attitude.

5.6.7 Science Interest Inventory

Science interest of the subjects was measured using an inventory developed by Nair (2000). This scale consists of 48 items prepared with three options. The scale is a multi factorial one prepared in English. The subject has to respond all the items within a maximum time of 60 minutes.

5.7 Data collection

The experimental part of the study was conducted on a sample of 128 students of eight intact standard IX classes. The survey part of the study involves a total sample of 128 students of standard IX. The study was conducted in three English medium secondary schools. The experimental and survey part was conducted at NSS English Medium High school, Manjeri, Fathima Matha English Medium High school, Nilambur and MAO Higher Secondary School, Kavanur.
5.8 Data Analysis

Arithmetic mean, standard deviation, test of significance of difference between means, analysis of variance, analysis of co variance, Pearson’s product moment correlation and Standard error was used to compare the relevant variables between experimental and control group. The results obtained from the above experiment can be summarized as follows:

5.9 Findings of the Study

The major findings arrived at from the above experiment on the basis of the statistical analysis is given below.

5.9.1 Scientific Inquiry Based Learning strategy is more effective than conventional method on Achievement in Biological science at secondary level

The mean post test scores of Scientific inquiry based learning strategy ($M_1 = 27.06$) was found to be greater than that of conventional method ($M_2 = 20.06$). The obtained value of ‘t’ is significant at .01 level ($t = 7.71$). The analysis of variance of the pre test and post test scores of students in experimental and control group showed that there is significant difference between the means of the post test scores of two groups ($F = 59.48; p<.01$). The analysis of covariance shows that there is significant difference between two groups ($F_{Yx} = 93.43; p<.01$). The comparison of adjusted means of post test scores showed that the difference between them is statistically significant (the adjusted mean of the post test scores of experimental group, $M_{1Yx} = 27.30$; and that of control group $M_{2Yx} = 19.80$). The obtained ‘t’ value is significant (‘$t’ = 9.70; p<.01$). This confirms that the experimental group excels the control group in Achievement in Biological science.
5.9.2 **Cooperative Learning strategies are more effective than the conventional method on Achievement in Biological science at secondary level**

The mean post test scores of Cooperative learning Strategies ($M_1 = 26.44$) were found to be greater than that of conventional method ($M_2 = 20.30$). The obtained value of ‘$t$’ is significant at .01 level ($t = 5.80$). The analysis of variance of the pre test and post test scores of students in experimental and control group showed that there is significant difference between the means of the post test scores of two groups ($F_y = 33.69$; $p<.01$). The analysis of covariance showed that there is significant difference between two groups ($F_{yx} = 51.45$; $p<.01$). The comparison of adjusted means of post test showed that the difference between them is statistically significant (the adjusted mean of the post test scores of experimental group, $M_{1y} = 26.20$; and that of control group $M_{2y} = 20.50$). The obtained ‘$t$’ value is significant ($t' = 7.18$; $p<.01$). This confirms that the experimental group overpowers the control group in Achievement in Biological science.

5.9.3 **Problem Based Learning strategy is more effective than the conventional method on Achievement in Biological science at secondary level**

The mean post test scores of Problem based learning Strategy ($M_1 = 27.30$) were found to be greater than that of conventional method ($M_2 = 21.77$). The obtained value of ‘$t$’ is significant at .01 level ($t = 5.89$). The analysis of variance of the pre test and post test scores of students in experimental and control group showed that there is significant difference between the means of the post test scores of two groups ($F_y = 34.76$; $p<.01$). The analysis of covariance showed that there is significant difference between two groups ($F_{yx} = 35.38$; $p<.01$). The comparison of adjusted means of post test scores showed that the difference between them is statistically significant (the adjusted mean of
the post test scores of experimental group, $M_{1YX} = 27.3$; and that of control group $M_{2YX} = 21.8$). The obtained ‘t’ value is significant (‘t’ = 5.95; p<.01). This confirms that the experimental group excels the control group in Achievement in Biological science.

5.9.4 **Achievement in Biological science and Problem solving ability is positively correlated and Scientific inquiry based learning strategy has significant influence on Problem solving ability in students at secondary level**

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Problem solving ability ($r = 0.367$). The obtained value is positive and significant at 0.01 level. The mean post test scores of Problem solving ability of the experimental group ($m_1 = 12.94$) were found to be greater than that of control group ($m_2 = 9.64$). The obtained ‘t’ value is significant (‘t’ = 5.40; p< 0.01). This pours light to the fact that Scientific inquiry based learning strategy significantly improves Problem solving ability in students at secondary level.

5.9.5 **Achievement in Biological science and Emotional intelligence is negligibly correlated and Scientific inquiry based learning strategy has no significant influence on Emotional intelligence in students at secondary level**

The Pearson’s product moment correlation analysis indicates that there exists negligible or indifferent correlation between Achievement in Biological science and Emotional intelligence ($r = 0.134$). The obtained value is positive and not significant at 0.01 level. The mean post test scores of Emotional intelligence of the experimental group ($m_1 = 114.27$) were found to be only slightly varied from that of control group ($m_2 = 115.14$). The obtained ‘t’ value is not significant (‘t’ = 0.179; p< 0.01). This implies the fact that Scientific inquiry based learning strategy has no significant influence on improving Emotional intelligence in students at secondary level.
The investigator felt that the short span of time of the experiment may be the reason for the above result.

5.9.6 Achievement in Biological science and Scientific attitude is negligibly or indifferently correlated and Scientific inquiry based learning strategy has no significant influence on Scientific attitude in students at secondary level

The Pearson’s product moment correlation analysis indicates that there exists no significant correlation between Achievement in Biological science and Scientific attitude \((r = 0.135)\). The obtained value is positive and not significant at 0.01 level. The mean post test scores of Scientific attitude of the experimental group \((m_1 = 119.47)\) were found to be only slightly varied from that of control group \((m_2 = 113.83)\). The obtained ‘t’ value is not significant \((t' = 1.110; p< 0.01)\). This implies the fact that Scientific inquiry based learning strategy has no significant influence on improving Scientific attitude in students at secondary level.

This result is really astonishing, and the investigator felt that if the strategy is incorporated in the curriculum and implemented for long period the result may be entirely different.

5.9.7 Achievement in Biological science and Science interest is positively correlated and Scientific inquiry based learning strategy has significant influence on Science interest in students at secondary level

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Science interest \((r = 0.412)\). The obtained value is positive and significant at 0.01 level. The mean post test scores of Science interest of the experimental group \((m_1 = 71.33)\) were found to be greater than that of control group \((m_2 = 59.44)\). The obtained ‘t’ value is significant \((t' = 8.385; p< 0.01)\). This pours light on to the fact that Scientific inquiry based learning strategy significantly improves Science interest in students at secondary level.
This result reveals that learning strategies can significantly influence interest in science.

5.9.8 **Achievement in Biological science and Problem solving ability is positively correlated and Cooperative learning strategies have significant effect on Problem solving ability in students at secondary level**

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Problem solving ability ($r = 0.510$). The obtained value is positive and significant at 0.01 level. The mean post test scores of Problem solving ability of the experimental group ($m_1 = 11.97$) were found to be greater than that of control group ($m_2 = 9.58$). The obtained ‘t’ value is significant (‘t’ = 3.970; $p < 0.01$). This clearly shows that Cooperative learning strategies can significantly improve Problem solving ability in students at secondary level.

5.9.9 **Achievement in Biological science and Emotional intelligence is negligibly correlated and Cooperative learning strategies have no significant influence on Emotional intelligence in students at secondary level**

The Pearson’s product moment correlation analysis indicates that there exists negligible or indifferent correlation between Achievement in Biological science and Emotional intelligence ($r = 0.080$). The obtained value is positive and not significant at 0.01 level. The mean post test scores of Emotional intelligence of the experimental group ($m_1 = 111.53$) were found to be only slightly varied from that of control group ($m_2 = 109.45$). The obtained ‘t’ value is not significant (‘t’ = 0.440; $p < 0.01$). This implies the fact that Cooperative learning strategies have no significant influence on improving Emotional intelligence in students at secondary level.

In case of the variable Emotional intelligence no correlation were found out with the learning strategy implemented.
5.9.10 Achievement in Biological science and Scientific attitude is positively correlated and Cooperative learning strategies have significant influence on Scientific attitude in students at secondary level

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Scientific attitude \((r = 0.340)\). The obtained value is positive and significant at 0.01 level. The mean post test scores of Scientific attitude of the experimental group \((m_1 = 126.33)\) were found to be greater than that of control group \((m_2 = 100.05)\). The obtained ‘t’ value is significant \(‘t’ = 5.30; p< 0.01\). This pours light to the fact that Cooperative learning strategies significantly influence Scientific attitude in students at secondary level.

5.9.11 Achievement in Biological science and Science interest is positively correlated and Cooperative learning strategies have significant influence on Science interest in students at secondary level

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Science interest \((r = 0.242)\). The obtained value is positive and significant at 0.01 level. The mean post test scores of Science interest of the experimental group \((m_1 = 70.66)\) were found to be greater than that of control group \((m_2 = 64.33)\). The obtained ‘t’ value is significant \(‘t’ = 4.39; p< 0.01\). This pours light on to the fact that Cooperative learning strategies significantly influence Science interest in students at secondary level.

5.9.12 Achievement in Biological science and Problem solving ability is positively correlated and Problem based learning strategy has significant influence on Problem solving ability in students at secondary level

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological
science and Problem solving ability \( (r = 0.544) \). The obtained value is positive and significant at 0.01 level. The mean post test scores of Problem solving ability of the experimental group \( (m_1 = 12.67) \) were found to be greater than that of control group \( (m_2 = 9.48) \). The obtained ‘t’ value is significant \( (t = 4.990; p < 0.01) \). This clearly shows that Problem based learning strategy has significant influence to improve Problem solving ability in students at secondary level.

5.9.13 **Achievement in Biological science and Emotional intelligence is negligibly correlated and Problem based learning strategy has no significant influence on Emotional intelligence in students at secondary level**

The Pearson’s product moment correlation analysis indicates that there exists negligible or indifferent correlation between Achievement in Biological science and Emotional intelligence \( (r = 0.154) \). The obtained value is positive and not significant at 0.01 level. The mean post test scores of Emotional intelligence of the experimental group \( (m_1 = 110.25) \) were found to be only slightly varied from that of control group \( (m_2 = 110.30) \). The obtained ‘t’ value is not significant \( (t = 0.011; p < 0.01) \). This implies the fact that Problem based learning strategy has no significant influence on improving Emotional intelligence in students at secondary level.

5.9.14 **Achievement in Biological science and Scientific attitude is positively correlated and Problem based learning strategy has significant influence on Scientific attitude in students at secondary level**

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Scientific attitude \( (r = 0.326) \). The obtained value is positive and significant at 0.01 level. The mean post test scores of Scientific attitude of the experimental group \( (m_1 = 125.28) \) were found to be greater than that of control group \( (m_2 = 95.17) \). The obtained ‘t’ value is
significant (‘t’ =6.736; p< 0.01). This shows the fact that Problem based learning strategy has significant influence in improving Scientific attitude in students at secondary level.

5.9.15 **Achievement in Biological science and Science interest is positively correlated and Problem based learning strategy has no significant influence on Science interest in students at secondary level**

The Pearson’s product moment correlation analysis showed that there exists positive correlation between Achievement in Biological science and Science interest (r = 0.310). The obtained value is positive and significant at 0.01 level. The mean post test scores of Science interest of the experimental group (m 1 =68.67) were found to be very close to that of control group (m2 =66.58). The obtained ‘t’ value is not significant (‘t’ =1.348; p< 0.01). This pours light on the fact that Problem based learning strategy has no significant effect to improve Science interest in students at secondary level.

5.9.16 **Scientific inquiry based learning strategy is effective for boys and girls than the conventional method on Achievement in Biological science at secondary level**

Mean post test scores of the boys in the experimental group (m1 = 26.34) were found to be very close to that of the girls (m2 = 27.08). The obtained ‘t’ value is not significant (‘t’ = 1.12; p> 0.01). This pours light to the fact that Scientific inquiry based learning strategy is effective both for boys and girls than the conventional method on Achievement in Biological science at secondary level.

5.9.17 **Scientific inquiry based learning strategy is more effective for urban students than rural students on Achievement in Biological science at secondary level in comparison with the conventional method**

The mean post test scores of the urban students in the experimental group (M1 = 26.24) were found to be greater than that of the
rural students ($M_2 = 20.24$). The obtained ‘t’ value is significant (‘t’ = 5.80; $p< 0.01$). This shows that Scientific inquiry based learning strategy is more effective for urban students than rural students on Achievement in Biological science at secondary level in comparison with the conventional method.

The significant edge in achievement of urban students over rural students can be attributed to the novelty of the learning strategies implemented. Usually urban schools are more competition oriented and lecture demonstration method gets great privilege. Hence the investigator presumes that the enthusiasm expressed by the urban students given them a lead over rural counterparts.

5.9.18 Cooperative learning strategies are more effective for girls than boys on Achievement in Biological science at secondary level in comparison with conventional method

The mean post test scores of the Girls in the experimental group ($M_1 = 28.13$) were found to be greater that of Boys ($M_2 = 24.75$). The obtained ‘t’ value is significant (‘t’ = 2.68; $p> 0.01$). This pours light to the fact that Cooperative learning strategy is highly effective for girls than boys on Achievement in Biological science at secondary level compared with conventional method.

The significant advantage in achievement of girls over boys may be attributed to high group cohesiveness demonstrated by them during the implementation of learning strategies. Hence the investigator presumes that the well knit team effort carried out by girls provided them a lead ahead of boys.

5.9.19 Cooperative learning strategies are more effective for urban and rural students than conventional method on Achievement in Biological science at secondary level

The mean post test scores of the urban students in the experimental group ($M_1 = 27.73$) were found to be very near to that of the
rural students ($M_2 = 25.09$). The obtained ‘t’ value is not significant (‘t’ = 1.70; $p< 0.01$). This shows that Cooperative learning strategies is effective for urban and rural students than conventional method on Achievement in Biological science at secondary level.

**5.9.20 Problem based learning strategy is effective for boys and girls than conventional method on Achievement in Biological science at secondary level**

The mean post test scores of the boys in the experimental group ($M_1 = 24.84$) were found to be very close to that of girls ($M_2 = 24.22$). The obtained ‘t’ value is not significant (‘t’ = 0.59; $p> 0.01$). This pours light to the fact that Problem based learning strategy is effective for both boys and girls than conventional method on Achievement in Biological science at secondary level.

**5.9.21 Problem based learning strategy is more effective for rural students than urban students on Achievement in Biological science at secondary level in comparison with conventional method**

The mean post test scores of the rural students in the experimental group ($m_1 = 25.94$) were found to be higher than that of the urban students ($m_2 = 22.98$). The obtained ‘t’ value is significant (‘t’ = 2.72; $p<0.01$). This shows that Problem based learning strategy is effective for rural students than urban students on Achievement in Biological science at secondary level in comparison with conventional method.

The significant lead in achievement of rural students over urban students may be attributed to the extensive availability of resource and learning materials in the particular institution where the experiment was conducted. Hence the investigator presumes that the unequal instructional facilities lead to the advantage of rural students over urban students.
5.10 Discussion

The results of the present study reveals that Scientific inquiry based learning strategy significantly improves achievement in Biological science. This finding support the views expressed in the studies conducted by Gurumurthy (1990). Scientific inquiry based learning strategy were found effective in normal classes and the findings of Bennett (1996) was in same tune. Strategies can influence achievement (Alam, 1997, Schwartz & Bransford, 1998). Cognitive abilities can be developed through inquiry learning (Battista, 1999). The result of the present study supplement the above results.

Atwater (1991) pointed out that the role of the instructor should be a participant observer. The findings of the present study stand in tune with this assessment. Adams and Hamm (1998) emphasised the integration of subjects through inquiry learning. Lampert (2001) postulated integration of technology in inquiry is effective. The present research agrees with this finding as the investigator invariably tried to integrate technology in the Scientific inquiry based learning strategy.

The results reveal that Cooperative learning strategies are highly effective in enhancing Achievement in Biological science. This result supports the earlier views expressed by Slavin (1985), Malhara (1988), Sharan (1980), McLean & Kaufman (1992) and Khan (2008). Problem based learning strategy was found effective in enhancing Achievement in Biological science. The findings of Schmidt et al (1987), Gallagher et al (1995) and Dods (1997) were strengthened in the present study. This result was in contrast to that of Albanese (1993). Padhi (1993) found out that competency based activity curriculum was not effective on improving academic achievement. Finding in the present study contradicts the above view point. Graffith (1990), Copeland (2002) and Faryadi (2007) proposed no significant effects of Cooperative learning strategies on academic performance. The
findings contradict with the present one. The results of this study agrees with the views expressed by Jacobs (1995)\textsuperscript{127} that is, group interaction establishes available framework in the individual’s learning process.

The present investigation showed that intervention of Selected learning strategies significantly enhances Achievement in Biological science. The above finding supports the results of Bagchi (1993)\textsuperscript{27} and Schonwetter (1994)\textsuperscript{220}. Shui fong (2007)\textsuperscript{232} described that there is no relationship between competitive and non competitive groups. Engel (1991)\textsuperscript{87} and Gyanani & Pahuja (1996)\textsuperscript{117} reported the effectiveness of Problem based learning. Comprehensive understanding is improved through Problem based learning (Dods, 1997)\textsuperscript{78}. The present study strengthens this finding. Problem based learning strategy improves students sense of ownership of the knowledge (Cockrell \textit{et al}, 2000)\textsuperscript{61}. Regarding achievement in Biological science the results of the present study nourishes the findings of Nair (1984)\textsuperscript{185}, Narayanan (1987)\textsuperscript{187}, Indira (1989)\textsuperscript{126} and Preetha (1996)\textsuperscript{205}. The result is contradictory with that of Jayasree (1991)\textsuperscript{129} and Prasad (1995)\textsuperscript{204}.

Negative relationship between Problem solving ability and achievement were noticed in studies conducted by Haridasan (1989)\textsuperscript{118} and Fawcett & Garton (2005)\textsuperscript{91}. In this study it was revealed that Achievement in Biological science and Problem solving ability is positively correlated and Selected learning strategies are influencing Problem solving ability positively. Boone and Kahle (2002)\textsuperscript{40} interpreted that science teaching can improve Problem solving ability. Gill (1990)\textsuperscript{106} revealed that training strategies influence creative Problem solving ability. Curtis (1995)\textsuperscript{71} pointed out that learning concentrating on Problem solving ability improves the ability. The present study found that Selected learning strategies improve Problem solving ability.

In the present study negligible relationship were found between Emotional intelligence and Achievement in Biological science as
revealed in the previous studies conducted by Tapia (1999)\textsuperscript{249} and Umadevi (2009)\textsuperscript{252}. Certain studies (Niradhar 2009\textsuperscript{194}, Sheeba, 2007\textsuperscript{230}) found positive relationship between Emotional intelligence and achievement in contrast to this study. Verma (2003)\textsuperscript{256} found out that Emotional intelligence is positively connected with general wellbeing. Bruno and Eileen (2002)\textsuperscript{48} postulated that participation would increase pro social responding. Results of the present study coincide with the above finding. Morris and Elizabeth (2002)\textsuperscript{177} reported significant relationship between Emotional intelligence and scholastic achievement. The present study contradicts with this finding. Susmitha (2009)\textsuperscript{245} suggested improvement in the present educational system for developing emotional component of the affective domain. The present study agrees with this suggestion.

According to Moore & Foy (1989)\textsuperscript{176} and Koutsantoni (2004)\textsuperscript{143} there was no relationship between Scientific attitude and achievement in science. The present study reveals positive relationship between scientific attitude and achievement. Bhaskar (2001)\textsuperscript{36} noticed that self concept and Scientific attitude were positively connected. Selected learning strategies were having profound influence on enhancing Scientific attitude. Kumar & Morris (2005)\textsuperscript{149} and Aghadiuno (1995)\textsuperscript{3} identified that learning models can influence Scientific attitude and this study supports this finding. Nwagbo (2006)\textsuperscript{198} found that guided inquiry method improved Scientific attitude and achievement. This study substantiates the above research finding. Resnick and Zurawsky (2007)\textsuperscript{211} revealed that guided scientific investigation can improve science learning. Brady (2008)\textsuperscript{43} found out that collaborative efforts improve science teaching. The present study supplements this result. This study contradicts the views expressed by Vidhante (1997)\textsuperscript{257}. 
5.11 Tenability of the Hypotheses

The hypotheses formulated for the present study were;

5.11.1 Hypothesis - 1

Students taught through Selected learning strategies will not differ significantly from students taught through conventional method of teaching with regard to Achievement in Biological science at secondary level

Null hypothesis is rejected because there is significant difference in the achievement scores of the experimental and control group in the intervention of Selected learning strategies viz Scientific inquiry based learning strategy, Cooperative learning strategies and Problem based learning strategy. Thus it proves that the selected learning strategies have significantly contributed to improve the level of achievement among the subjects of experimental group.

5.11.2 Hypothesis - 2

There will be no significant relationship exists between Achievement in Biological science with the variables selected viz. Problem solving ability, Emotional intelligence, Scientific attitude and Science interest

The null hypothesis is partially rejected. There is significant correlation exists between Problem solving ability and Achievement in Biological science in the intervention of Selected learning strategies. It is found that no significant correlation exists between Emotional intelligence and Achievement in Biological science. Achievement in Biological science and Scientific attitude seems positively correlated during the intervention of Cooperative learning and Problem based learning strategy. No significant correlation exists between Achievement in Biological science and Scientific attitude during the intervention of Scientific inquiry based learning strategy. Achievement in Biological science and Science interest is positively correlated in the intervention of Selected learning strategies.
5.11.3 Hypothesis - 3

The Selected learning strategies have no significant influence on the selected variables viz. Problem solving ability, Emotional intelligence, Scientific attitude and Science interest

The null hypothesis is partially rejected. Selected learning strategies significantly influence in improving Problem solving ability. None of the Selected learning strategies significantly influences in enhancing Emotional intelligence. Cooperative learning strategies and Problem based learning strategy improves Scientific attitude. It is also found that Scientific inquiry based learning strategy have no marked influence on Scientific attitude. Scientific inquiry based learning strategy and Cooperative learning strategies influence in enhancing Science interest. Problem based learning strategy has no significant influence on Science interest.

5.11.4 Hypothesis - 4

There will be no significant difference in Achievement in Biological science with related to the secondary variables viz. gender and locality

The null hypothesis is partially accepted. In the intervention with Scientific inquiry based learning strategy, no significant difference is observed in respect of sex. Urban students achieved more comparing to rural students in respect to locality. Girls achieved more than boys in Cooperative learning strategies. There is no significant difference observed in the intervention of Cooperative learning strategies with respect to locality. In the intervention with Problem based learning strategy no significant difference is observed in respect of gender. Rural students show more achievement comparing to urban students in the treatment with Problem based learning strategy.
5.12 Educational Implications of the Study

The existing system of education is narrow, bookish, academic and unattractive. Students merely study facts and principles from text books and reproduce them in examinations. The present teaching learning strategies are too far from the actual and social contexts of learning. In the classroom, teaching strategies are reduced into lecturing cum discussion where learners are forced to accustom with cramming. There is no scope for applying scientific method, interactive learning is hindered, learner activity is eliminated and total artificiality prevails in our classrooms. It does not provide the growing children to meet the demands of daily life and is far from reality and the needs of society. There is an urgent need to change school curricula so that they may provide adequate opportunities to transfer skills, habits and attitudes from the classrooms to the outside world. There seems to be an imbalance between acquisition of theoretical knowledge inside the classroom and its application outside the classroom.

Even though ideological provisions are provided for learner centered, activity based and interactive learning contexts, due to the infrastructural and instructional deficiencies teachers go for their convenient teaching practices like lecture demonstration and discussion. Most of the secondary school teachers are inadequately trained and lacks enthusiasm and know how to implement such group learning strategies.

For educational systems to serve the needs of every learner, instructional decision must focus on the individual learner with an understanding of the learning process. The learning process can be simplistic and rote with importance on knowledge creation and skill standards. In the present study learning is enhanced in contexts, where learners have supportive relationships, have a sense of ownership and control over the learning process, and can learn with and from each other in creative learning contexts. In the Selected learning strategies viz.
Scientific inquiry based learning, Cooperative learning and Problem based learning student learning is emphasized in conjunction with social and cognitive contexts.

**5.12.1 Selected Learning Strategies- A Way for Higher Interaction**

In the classes where Selected learning strategies were implemented students were very active in the learning process and the teacher, a learning facilitator or a setter of the stage. In these approaches students learn through small groups in which each member is accountable for the successful completion of the task and through the cooperative spirit, unknowingly each student gets a say in the learning process. Here students critically evaluate the knowledge created and the strategies adopted by employing higher level learning processes. When children collaborate, they share the process of constructing their ideas, instead of simply labouring individually.

**5.12.2 Nurturing Effects**

The Selected learning strategies viz. Scientific inquiry based learning, Cooperative learning and Problem based learning caters to the psychological, social, emotional and intellectual development of the learners than the conventional classroom system. Thus the class room is converted into a miniature society in which the classroom activities are quiet social and natural to the learners. So in a multi cultural society like India where students of various communities, religions and socio - economic background exists, this strategies will be very much effective in materializing the democratic and national objectives of education. Students learn self discipline and work cooperatively for the successful completion of the assigned task.

Scientific attitude and Science interest has improved significantly by the intervention of Selected learning strategies. It clearly shows that in a conservative society the Selected learning strategies can even change the outlook of the citizens positively towards science.
Selected learning strategies support student initiative through which they can cognize the organizing principles and carry the new knowledge to real life. They also play a part in designing the assignment patterns. There was much scope for multiple interpretations and expression of learning.

5.12.3 Redesigning the Curriculum

In traditional curriculum the teacher’s role is that of the sole giver of knowledge and the student’s role is that of the passive recipient. In the present study with three Selected learning strategies, the ideas and interests of students influence the learning process where the teacher serves as a guide rather than the source of knowledge. To provide learning centered education, curriculum should provide opportunities for positive interdependence, individual accountability, heterogeneous grouping, and shared leadership with teaching of social skills. Based on the findings of the study the investigator argues for implementing a curriculum which help students to address higher level thinking including application, skill, analysis, synthesis and evaluation. Such a redesigned curriculum should provide tools such as organized problem solving and inquiry based learning activities with which students formulate and test their ideas, draw conclusion and inferences.

5.12.4 Training for Teacher Trainees and Teacher Educators

Scientific inquiry based learning strategy, Cooperative learning strategies and Problem based learning strategy should be incorporated in the existing curriculum of Pre primary teachers training course, Teachers training course, Bachelor of Education, Master of Education etc. Teacher trainees and teacher educators must be trained with these learning strategies.

5.12.5 Need of Teacher Commitment

Scientific inquiry based learning strategy, Cooperative learning strategies and Problem based learning strategy can be applied in the present classroom without much effort, if the teacher is aware of the
strategies well. Of course, it will reduce the monotony of the conventional method for the teacher and the taught as well. Thus it can be suggested that the existing classroom situation may be changed in order to facilitate the implementation of Selected learning strategies and thereby ensuring high academic performance.

5.13 Suggestions in the Light of Findings

The analysis of the data reveal that instruction through the Selected learning strategies viz. Scientific inquiry based learning, Cooperative learning and Problem based learning has certain implications in educational practices. On the light of these implications following suggestions are made.

1. Opportunities for interaction between student - student and student - teacher in classrooms can be provided.
2. Scientific way of solving problems should be implemented for teaching Biological science.
3. Learning strategies can be made structured and organized with predetermined learning sequences.
4. The present curriculum of Biological science may be redesigned to transact through Scientific inquiry based learning, Cooperative learning and Problem based learning.
5. Teachers must be encouraged to apply Scientific inquiry based learning, Cooperative learning and Problem based learning while teaching.
6. Teachers can be given proper in service training to use Scientific inquiry based learning, Cooperative learning and Problem based learning while teaching.
7. Lesson transcripts on topics in Biological science at secondary level based on Scientific inquiry based learning, Cooperative learning and Problem based learning may be developed by teachers and experts for the curriculum transaction.
8. Ideas regarding Scientific inquiry based learning, Cooperative learning and Problem based learning can be given to students, teachers and parents to improve better teaching - learning environment.

9. Scientific inquiry based learning, Cooperative learning and Problem based learning practices should be included as part of teacher education programmes.

10. Sufficient learning resources for teaching and learning of Biological science can be provided to our schools in order to implement Scientific inquiry based learning, Cooperative learning and Problem based learning.

11. Club activities can facilitate interaction among students and this should be utilised for the implementation of Scientific inquiry based learning, Cooperative learning and Problem based learning.

12. Well equipped laboratories must be provided in secondary schools for learning Biological science.

13. Gardening and farming in school compound may be done by the active involvement of students and it can be utilised for learning.

14. Animal house should be maintained in schools and students may be encouraged to contribute.

15. A Biological museum should be maintained with specimens contributed by students.

16. Video and television programmes on nature shall be utilised for learning Biological science.

17. Use of web should be encouraged for learning.

18. Community resources can utilise to implement Scientific inquiry based learning, Cooperative learning and Problem based learning effectively.

19. Teaching of Biological science can be conducted in class cum laboratory and library.

20. The seating arrangement should be in a semicircle form.
21. School cluster should be formed with a focus on sharing learning resources.
22. Field visits to biologically important places should be carried out.
23. Class strength at the secondary level should be reduced from the present strength to 25 – 30.
24. Administrative provisions should be made for collaborating schools and institutions of excellence in Biological science.

**5.14 Suggestions for Further Research**

On completion of the study the investigator feels that there is wide scope for allied studies in line of the present one. Such related studies may extend the scope of the present one and further generalisation become possible. Some of the possible areas in which further studies can be carried out are listed below.

1. Replication of the study using more classes in different schools and with sophisticated experimental designs such as multiple group time series design, post test only equivalent groups design etc.
2. The study can be extended to other disciplines like Language, Mathematics, Social science etc with large sample.
3. The study can be extended to investigate the effectiveness of Selected learning strategies in developing interpersonal relationship and leadership qualities.
4. Replication of the study to higher levels of education such as higher secondary, Degree and Teacher education classes to examine the effectiveness of Selected learning strategies.
5. The study can be extended to investigate the effects of Selected learning strategies with other student specific variables like study habits, learning styles and study approaches on achievement.
6. Investigations can be done on the effectiveness of Selected learning strategies on inter group relations, self esteem, main streaming etc.
7. Selected learning strategies can be compared with more than one teaching methods.

8. More than the cognitive outcomes, affective outcomes of Selected learning strategies can be studied.

9. Teacher effectiveness with Selected learning strategies can be studied.

10. Problems of implementing Selected learning strategies in schools can be studied.

11. Administrative, institutional and infrastructural modifications needed to implement Scientific inquiry based learning, Cooperative learning and Problem based learning can be studied.