VI

CONCLUSIONS AND SUGGESTIONS

6.1 Study in retrospect  
6.2 Summary of results  
6.3 Implications of the study  
6.4 Suggestions for further research
Conclusion.

This chapter is meant for presenting a brief summary of the procedure adopted and the conclusions and suggestions derived from the study. The purpose of the study is to find out the effectiveness of integrating theory and practical in teaching high school physical science in Kerala. The study in retrospect is followed by a short description of the major findings of the study. The chapter concludes with a discussion of the recommendations and suggestions that can be derived from the present study for future research in the field of science education.

6.1 Study in retrospect.

6.1.1 Statement of the problem.

The problem has been stated as: ON A CRITICAL STUDY OF THE THEORY-PRACTICAL INTEGRATION IN THE TEACHING OF HIGH SCHOOL PHYSICAL SCIENCE IN KERALA.

6.1.2 Hypotheses of the study.

The following hypotheses are formulated for the study:

$H_1$ Teachers are competent in teaching all topics of high school physical science syllabus.
H2 In most of the schools, science is taught predominantly or wholly verbally without even demonstrating experiments.

H3 Pre-service and in-service educational programmes are beneficial for teachers.

H4 Many teachers lack the competence and expertise to conduct practical work in science teaching.

H5 Most of the science teachers in Kerala do not encourage pupil participatory learning through experiments, since they think it as a cause of indiscipline.

H6 The extent of conducting experiments in the classroom by teachers increases with their experience in teaching.

H7 The extent of conducting experiments in the classroom by teachers increases with their academic qualifications.

H8 The skill in conducting experiments by teachers increases with their experience in teaching.

H9 Young teachers are more competent and interested in making improvised materials than teachers with long years of service.

H10 The extent of improvising materials by teachers increases with their academic qualifications.

H11 Most of the schools lack the needed equipment, materials, chemicals and the needed infrastructure to do practical work.

H12 Aided schools have more facilities than government schools in teaching science.

H13 The extent of use of chemicals, equipment, materials, etc. by teachers of aided schools is more frequent than by teachers of government schools.
H14 The extent of use of chemicals, equipment, materials, etc. by pupils of aided schools are more frequent than by pupils of government schools.

H15 Boys are more interested in performing experiments, doing individual work and observing activities in science than girls.

H16 The learning outcomes of pupils who are taught using both theory and practical integrated are more than that of pupils who are taught with theory alone.

Hypotheses formulated on the basis of the extended study after revising the standard VIII science syllabus are:

H17 Activity oriented, pupil participatory method is much more interesting and effective for pupils than conventional methods adopted in previous years.

H18 The approach ‘participatory method’ recently adopted for teaching physical science in standard VIII helps to a great extent in the attainment of various aspects of learning science.

H19 The approach ‘participatory method’ demands a lot more of special effort on the part of teachers.

6.1.3 Objectives of the study.

The objectives of the study are:

1. To identify and categorize the different science teaching strategies adopted in the high schools in Kerala.
2. To find out whether the pre-service and in-service teacher education programmes are beneficial for the teachers.

3. To find out whether the teachers have got expertise in conducting experiments.

4. To find out the extent of improvisation of materials needed for science teaching by the teachers.

5. To survey the availability of facilities and environmental resources and extent of use of such resources while teaching physics and chemistry.

6. To survey the availability of equipment, materials, chemicals and the needed infrastructure in schools and the extent of their use in school science experiments.

7. To identify the learning strategies adopted by pupils in science.

8. To find out the pupils' opinion regarding the extent of practical experiments conducted by their science teachers and its benefits.

9. To evaluate the effect on the learning of pupils by the implementation of practical work in the teaching learning process.

10. Constructing a lesson plan of integrating theory and practice for select topics from physics and chemistry.

11. To compare the effectiveness of learning outcomes of pupils who are taught using both theory and practical integrated and that of those who are taught with theory alone.

12. To study the relationship among age, sex, years of service of teachers, type of school, locality and facilities available and the theory-practical integrated method of teaching adopted in science.
13. To analyze the activity oriented method adopted by teachers in teaching topics of physics and chemistry.

14. To find out the extent of relative effectiveness of pupil participatory methods adopted compared to the conventional method adopted in previous years.

15. To bring out the views of teachers on the need and effect of participatory method in the attainment of various objectives of learning science.

16. To study whether the participatory method adopted by teachers is more interesting than the conventional methods adopted in previous years.

17. To find out whether the teachers have to put special effort while implementing participatory method in teaching science.

6.1.4 Methodology.

Survey and experimental methods were used in the study. Survey method was used to gather information from teachers about their content competence and methods of teaching topics of high school physical science. This method was used to gather information about the availability of equipment, materials and chemicals in schools and the extent of utilisation by the teacher and by the pupil. Experimental method was used to study the relative effectiveness of pupil's achievement on adopting both the traditional and practical oriented methods in the classroom, using identical experimental and controlled groups of pupils from secondary schools.
6.1.4.1 Tools used.

The tools used in the study are a questionnaire cum checklist for teachers, checklist for pupils for collecting data relevant for the study. A questionnaire for teachers based on the revised eighth standard science curriculum was also used.

6.1.4.2 Sample.

The sample for the study consisted 215 secondary school physical science teachers, 98 teachers who teach in standard VIII alone (for revised physical science curriculum) and 513 secondary school pupils, the sample was availed randomly from all over Kerala. For the experimental study 263 pupils were selected from five schools in Alappuzha district of Kerala state.

6.1.4.3 Procedure of the analysis of data.

Relevant statistical techniques were used for analysis of data like; computation percentages, mean and standard deviation. Z-value to find out the significant difference between proportions and difference between means are also calculated. The Kolmogrov-Smirnov (K-S) test and t-value were also calculated.
6.2. **Summary of findings**

6.2.1 **Major conclusions of the study and tenability of hypotheses.**

The findings that have emerged through the present study are summarised below:

1. Majority of the teachers are well aware of all the topics of high school physical science curriculum. Hence the hypothesis formulated in this context H1 is accepted. This conclusion is based on the following major findings:
   (a) 85% of the teachers are well aware of all the topics of standard VIII physics and chemistry.
   (b) 81.9% of the teachers are well aware of all the topics of standard IX physics.
   (c) 83.5% of the teachers are well aware of all the topics of standard IX chemistry.
   (d) 80.5% of the teachers are well aware of all the topics of standard X physics.
   (e) 76.1% of the teachers are well aware of all the topics of standard X chemistry.

2. Majority of the teachers adopted lecture demonstration method to teach topics of high school physical science curriculum and therefore the hypothesis H2 in
this context is rejected. This conclusion is based on the following major findings:

(a) 71.4% of the teachers adopted the lecture demonstration method in teaching topics of standard VIII physics and 20.5% of them adopted lecture method, but reading method was not at all adopted by any of them.

(b) 59.8% of the teachers adopted lecture demonstration method to teach topics of standard VIII chemistry, 25.2% of them adopted lecture method and only 2.3% of them adopted reading method.

(c) 72.8% of the teachers adopted lecture demonstration method to teach topics of standard IX physics, 20.5% of them adopted lecture method and only 1.4% of them adopted reading method.

(d) 71% of the teachers adopted lecture demonstration method to teach topics of standard IX chemistry, 22.8% of them adopted lecture method and only 1.8% of them adopted reading method.

(e) 66.8% of the teachers adopted lecture demonstration method to teach topics of standard X physics, 22.6% of them adopted lecture method and only 0.4% of them adopted reading method.

(f) 68.2% of the teachers adopted lecture demonstration method to teach topics of standard IX chemistry, 28.9% of them adopted lecture method and only 1.4% of them adopted reading method.
3. Majority of the teachers opined that pre-service and in-service courses were beneficial for them. Hence the hypothesis H3 in this context is accepted. This conclusion is based on the following major findings:

(a) 58.4% of the teachers said that most of the content gap is filled through the training courses. 14.02% of them said that all of the content gap is closed through pre-service and in-service courses.

(b) 52.8% of them opined that they have cleared their doubts on difficult topics through in-service programmes.

(c) 50% of them said that they have discussed subject-related matters with other teachers and 43.4% of teachers said that they got information about different methods of teaching through pre-service and in-service courses.

(d) 40.19% of them said that they have updated information on science content and science teaching methods.

4. Majority of the teachers (58.8%) conducted experiments ‘to some extent’ in the classroom and 13.08% of them conducted experiments ‘to a great extent’. 28.04% of them have ‘not at all’ conducted experiments.

5. Majority of the teachers (73.83%) have the needed skill in conducting experiments ‘to some extent’ while only 26.17% of them have skill in conducting experiments ‘to a great extent’. Therefore the hypothesis H4 formulated in this context is rejected.
6. 56.67% of teachers said that the reason for not conducting experiments in the classroom is that they think it as a cause of indiscipline; therefore the hypothesis H5 formulated in this context is accepted.

7. The extent of conducting experiments in the classroom by teachers increases as their experience in teaching increases. Therefore the hypothesis formulated in this context H6 is accepted. The difference is significant at 1% level ($Z=2.688$) between experience groups 10-19 years and above 19 years. The difference is significant at 5% level ($Z=1.991$) between experience groups above 19 years and less than 10 years.

8. The extent of conducting experiments in the classroom by teachers decreases as their academic qualification increases. Therefore the hypothesis formulated in this context H7 is rejected. The difference is significant at 1% level ($Z=3.145$) between teachers with lower and higher academic qualifications.

9. The skill in conducting experiments by teachers increases with their experience in teaching and there is no significant difference among the three experience groups viz. less than 10 years and 10 -19 years, 10-19 years and above 19 years and above 19 and less than 10 years groups. Therefore the hypothesis H8 formulated in this context is accepted.

10. The skill in conducting experiments by teachers decreases with increasing academic qualifications. The difference is significant at 5% level ($Z=2.177$) between teachers with lower and higher academic qualifications.

11. Male teachers utilised facilities and environmental resources more frequently than that by the female teachers while teaching physics and chemistry.
12. Urban school teachers utilised facilities and environmental resources more frequently than that by rural school teachers while teaching physics and chemistry.

13. Young teachers are more competent and interested in making improvised materials than that by teachers with long years of service. Therefore the hypothesis formulated in this context H9 is accepted.

14. Teachers with less academic qualifications improvised materials more frequently than that by teachers with long years of service. Therefore the hypothesis formulated in this context H10 is rejected.

15. Teachers who had identified and utilised the environmental resources are very few.

16. Most of the schools are equipped with sufficient materials, equipment, chemicals and the needed infrastructure to do practical work. Therefore the hypothesis formulated in this context H11 is rejected. This conclusion is based on the following major findings.

   In almost all schools:

   (a) All type of glassware is readily available.

   (b) All items of measuring devices are readily available.

   (c) All items of electrical devices are available.

   (d) All items of equipment/materials are available.

   (e) All items of tools are available.

   (f) All types of acids are available.

   (g) All items of chemical compounds are available.
(h) All elements needed to teach chemistry are available.
(i) All acid/base test items are available.
(j) Charts and teaching aids are available.

17. Aided schools have more facilities than government schools in teaching science. Hence the hypothesis H12 formulated in this context is accepted.

18. The extent of use of glassware, measuring devices, tools and devices, acids, chemical compounds, charts and teaching aids by government school teachers are more frequent than that being utilised by aided school teachers. Hence the hypothesis H13 formulated in this context is rejected.

19. The extent of use of glassware, measuring devices, electrical devices, equipment/materials, tools and devices, acids, chemical compounds, elements, acid/base test items, charts and teaching aids by pupils of aided schools are more frequent than they are being used by pupils of government schools. Hence the hypothesis formulated H14 formulated in this context is accepted.

20. Boys adopt individual work to learn physics and chemistry more frequently than girls. Hence the hypothesis H15 formulated in this context is accepted.

21. Majority of the teachers (96.9%) agreed that the activity oriented, participatory method is more effective and interesting for pupils than conventional methods adopted in previous years. Therefore the hypothesis H16 formulated in this context is accepted.

22. The recently adopted participatory method for teaching modified physical science curriculum in standard VIII helps to a great extent in the attainment of
various aspects of learning science. Hence the hypothesis $H_{17}$ formulated in this context is accepted. This conclusion is based on the following major findings:

(a) $93.87\%$ of teachers opined that objectives are attained to a large extent through participatory method.

(b) $74.48\%$ of teachers agreed that skill development is attained to a large extent through participatory method.

(c) $67.34\%$ of teachers opined that knowledge in new situations is being applied to a large extent through participatory method.

(d) $57.14\%$ of teachers responded that proficiency in manipulating equipment is attained by pupils to a large extent through participatory method.

(e) Only $39.79\%$ of them opined that content learning is attained to a large extent through participatory method.

23. The approach participatory method demands a lot more of special effort on the part of teachers. Therefore, the hypothesis $H_{18}$ formulated in this context is accepted. This conclusion is based on the following major findings.

(a) $57.14\%$ of the teachers said that intensive preparation is required by them ‘to a great extent’ to implement participatory method.

(b) $59.18\%$ of them opined that extended subject knowledge is needed ‘to a large extent’ to implement participatory method.
(c) 73.46% of the teachers opined that enhanced teacher pupil relationship is required to 'a large extent' for the effective implementation of the participatory method.

(d) 69.38% of them agreed that challenging situations are to be faced by them 'to a large extent' while implementing the participatory method.

(e) 64.28% of the teachers said that environmental exploration is required 'to a large extent' by them while implementing the participatory method.

(f) 83.6% of them said that more creativity is needed by them 'to a large extent' for the implementation of the participatory method.

24. The learning outcomes of pupils who are taught using both theory and practical integrated, are more than that of the pupils who are taught with theory alone. Thus the hypothesis H19 formulated in this context is accepted. This conclusion is based on the following major findings.

(a) The level of achievement of standard VIII pupils in physics of experimental group is far higher in cognitive and psychomotor aspects, than that of the control group ($df=71$, $t=8.84$, difference in the attainment is significant at 1% level).

(b) The level of achievement of standard VIII pupils in chemistry of experimental group is far higher in cognitive and psychomotor aspects, than that of the control group ($df=64$, $t=15$, difference in the attainment is significant at 1% level).
(c) The level of achievement of experimental group in both cognitive and psychomotor aspect is far higher than that of the control group of pupils in physics of standard IX. (df=56, t=11.1, difference in the attainment is significant at 1% level).

(d) The level of achievement of standard IX pupils in chemistry of experimental group is far higher in cognitive and psychomotor aspects, than that of the control group (df=64, t=7.43, difference in the attainment is significant at 1% level).

6.3  **Implications of the study.**

The results of the present study can significantly influence the field of science education and have potential value in furthering our understanding of learning behaviour in science. Hence the present study has a number of implications, which will provide the basis for the improvement of science education. The findings of the study can be of use in the following ways.

1.  **Improvement of teaching methods.**

Recognising the importance of the development of cognitive ability, due consideration should be given for the development of cognitive ability by adopting adequate methods of teaching in schools. By adopting proper learner-centred methods of teaching such as project method, individual laboratory work, group work,
experimental method, assignment method and field trip, teaching of science can be made to promote cognitive development well. Teaching of science should aim at promoting reasoning abilities and skills such as observation, hand-eye co-ordination, accuracy in measurement, current recording of observed facts and the ability to generalise and draw conclusions.

2. **Improving the quality of pre-service and in-service teacher education programmes.**

Most of the teachers believe that their science degree is outdated and it does not help their teaching in any way. This deficiency can be overcome by including topics of contemporary development in science and importance should be given to the pre and in-service teacher education programmes, so that teachers become aware of it. Besides, training can be given on the use of the latest and sophisticated teaching aids, and to improvise materials and devise experiments. This will help teachers a lot to positively modify their teaching strategies in the classroom, gain confidence and guide pupils properly. They can also be given awareness of how and when to utilise the available facilities and environmental resources optimally.

3. **Make provisions for adequate facilities in schools.**

From the analysis it is found that most of the schools are equipped with the needed facilities for effective science teaching. Since adequate facilities such as
glassware, measuring devices, electrical devices, tools, equipment and materials, acids, compounds, elements and teaching aids are made available to all schools irrespective of their management - Government or aided, either by the government or any other agency, it should be a cause of encouragement to teachers to utilise it adequately and effectively. This can improve the quality of science teaching in the classrooms of our State.

4. **Restructuring the present curriculum**

Modern trends in education emphasise the mental development of pupils which is necessary for solving problems in real life situations intelligently. For structuring school curriculum to cope with the present needs, an understanding of the different aspects of development of a child is required. The school curriculum should focus on the mental development of the pupil, which will be of help for the pupil to come out with flying colours in any field of study and in future to face well professionally. The curriculum framers are trying to revise the school curriculum on the basis of activity based methods so that science learning becomes more interesting and achieve all goals of science education in particular and all round development of the pupil in general. This procedure can be extended to other stages also, so that when the pupil leaves the school, he/she can opt science for their future career. Teachers can also integrate theory and practical to teach all topics of high school physical science, so that pupil get deep rooted understanding of the subject.
6.4 Suggestions for further research

In the light of the present study, some suggestions for further research can be presented and are given below:

1. Based on the revising curriculum of standard IX and X, similar studies can be conducted on the methods adopted by teachers to teach the respective topics.

2. A comprehensive survey of the facilities in schools based on the revised curriculum can also be conducted.

3. An experimental study based on topics of standard X also can be conducted.

4. A common design of integrating theory and practical for all topics in physics and chemistry can be designed for the teachers to utilise it effectively in their classroom while teaching.

5. A comparative study between the Kerala state school syllabus and other curriculum streams such as ICSE and CBSE can be conducted so as to find out the depth of understanding the topics by pupils and also to find out the place of practical experiments in such other streams.

6. The study can be extended to other science areas such as biological sciences also, so as to evaluate the effectiveness of integrating theory and practical.