CHAPTER VI

OVERVIEW OF THE STUDY, FINDINGS, TENABILITY OF HYPOTHESES
The present study, as pointed out in earlier contexts in the present report, is an attempt to explore an important issue relating to science education in the secondary schools of Kerala - how certain context variables affect the comprehensive science process measures of the pupils and to what extent the comprehensive science process measures is related to the achievement in science of the pupils. The study also attempts to analyse the instructional preferences of the science teachers, in terms of their teaching experience, number of in-service courses attended in the last two years and their rating on the school laboratory facilities. This chapter presents an overview of the study, its findings and tenability of hypotheses.

1. **OVERVIEW OF THE STUDY**

**Statement of the problem**

The present study has been entitled: “*Relation of Achievement in Science and Certain Context Variables with Comprehensive Science Process Measures at the Secondary School Level*”.

**Hypotheses**

Review of important studies relating to the influence of context variables and science process skills on the achievement in science, together with the researcher’s general perception of the possible level of relationship among them, formed on the basis of her experience as a science teacher and a teacher educator, helped the researcher to frame the following hypotheses.
Overview of the study

1. There are differences among sub-samples (by gender, location of the school and school management) on their acquisition of science process skills.

2. The context variables selected for the study will have a significant positive relationship with the acquisition of science process skills of the secondary school students.

3. The context variables selected for the study will exert a significant positive relationship on the achievement in science of the secondary school students.

4. There exists a significant positive relationship between acquisition of science process skills (basic, integrated and total) and achievement in science.

5. The instructional preferences of the science teacher is significantly dependent on the select teacher-related variables - teaching experience, the number of in-service courses attended in the last two years and the rating of school laboratory facilities.

Objectives of the study

1. To examine the extent to which, the secondary school students of Kerala acquire the various science process skills.

2. To examine the extent of acquisition of science process skills of secondary school students with respect to gender, location of school and the school management.

3. To examine the extent of relationship of select context variables with science process skills.

4. To examine the extent of relationship of select context variables with achievement in science.

5. To examine the extent of relationship between the acquired science process skills and achievement in science.
6. To analyze the instructional preferences of the science teachers and the extent to which science teachers perform to stimulate a learner-centred science classroom to accomplish the expected science learning outcomes.

7. To examine the extent of relationship between teaching experience, the number of in-service courses attended and the laboratory facilities available at school on the instructional preferences of the science teacher.

**Methodology**

The study adopted normative survey method. Analysis of relevant literature was done to explore the science process skills to be acquired at the secondary school level, the context variables that may have an influence on a science learner towards the acquisition of science process skills and achievement in science and the vital components expected of a science teacher to stimulate a learner-centred science classroom. Pilot study was conducted and the developed tools were validated for the study. Survey method was adopted to gather data using the validated tools. The methodology can be summarised as under:

(a) **Tools**

The following tools were developed and validated by the investigator to gather data for the present study.

1. Science Process Skill Elicitation Schedule *(SPROSES)*
2. Contextual Variable Scale *(CVS)*
3. Science Teachers’ Instructional Preference Analysis Scale *(STIPAS)*

The grades assigned for the achievement in science were based on the data of the final examination marks, taken from the respective schools as per school records.
(b) **Sample**

The pilot study was conducted on 86 secondary school students and 30 secondary school science teachers, adhering to the required government/private, boys/girls, rural/urban sub samples of Thiruvananthapuram and Ernakulam districts of Kerala. The final study was conducted on a representative sample of 716 secondary school students from 20 schools of Kerala using stratified random cluster sampling technique giving due weightage to the variables like gender, location of school, and school management. The sample consisted of students of grades 8 and 9. All the tools meant for collecting student data were administered on the same sample of students, towards the end of the academic year. The performance of the students of grades 8 and 9 at the end of the academic year indicated the learning outcome of the students of the particular grades and also the entry level performance of grades 9 and 10. Hence, the selected sample could represent the holistic nature of students at the secondary school level conducive for the present study. The data on the instructional preferences of the science teachers were collected from a representative sample of 103 secondary school science teachers of Kerala, using Science Teachers’ Instructional Preference Analysis Scale (STIPAS) developed and validated by the researcher.

(c) **Statistical Techniques:**

The analysis of quantified data was done using the following statistical techniques:

- Tests of significance for difference between means
- Tests of significance for difference between correlations
- Karl Pearson’s coefficient of correlation
- Spearman’s rank correlation coefficient
- Chi-Square test
2. FINDINGS

1. ANALYSIS OF COMPREHENSIVE SCIENCE PROCESS SKILL MEASURES

- Regarding the eight basic science process skills area (observing, classifying, using time-space relationships, using numbers, measuring, inferring, predicting and communicating), 19.7% (N=141) of the total sample are high achievers, 18.2% (N=130) are low achievers and 62.2% (N=445) are medium achievers of basic science process skills.

- Regarding the five integrated science process skills areas (identifying and controlling variables, defining operationally, experimenting, interpreting data and hypothesizing), 20.1% (N=144) of the total sample are high achievers, 15.1% (N=108) are low achievers and 64.8% (N=464) are medium achievers of integrated science process skills.

- It is seen that 18.9% (N=135) of the sample are high achievers of total science process skills measures, while 20.1% (N=144) are low achievers. Most of the students, 61.0% (N=437) possess medium total science process skills measures.

- The acquisition of basic, integrated and total science process skills of girls is significantly higher than that of boys at 1% level of significance. The critical ratios for the basic, integrated and total science process skills are 4.665, 5.964 and 5.467 respectively.

- The acquisition of basic, integrated and total science process skills of urban school students is significantly higher than that of rural school students at 1% level of significance. The critical ratios for the basic, integrated and total science process skills are 12.817, 12.934 and 13.815 respectively.
• The acquisition of basic, integrated and total science process skills of private school students is significantly higher than that of government school students at 1% level of significance. The critical ratios for the basic, integrated and total science process skills are 10.707, 10.309 and 11.285 respectively.

2. ANALYSIS OF CONTEXT VARIABLES
• The analysis of the ‘total’ context variables shows that 16.3% (N= 117) of the sample (N= 716) are in the high group, while 17.6% (N=126) are in the low group. Most of the students, 66.1% (N= 473) are in the medium group.

• The data pertaining to the ‘science instructional’ variables reveals that 13.8% (N=99) of the sample are in the high group, 17.2% (N=123) are low achievers and 69% (N=494) are medium achievers. Regarding the ‘motivational’ variables, 16.6% (N= 119) of the sample are in the high group, 16.5% (N=118) are low achievers and 64.8% (N=464) are medium achievers. In the ‘familial’ variable category, 16.3% (N= 117) of the sample are high achievers and 14% (N= 100) are low achievers. Most of the students, 68.9% (N= 493) are medium achievers.

3. RELATION BETWEEN COMPREHENSIVE SCIENCE PROCESS MEASURES AND CONTEXT VARIABLES
• There is a significant positive correlation between the ‘total’ science process skills and the ‘total’ context variables at 1% level of significance (critical ratio= 3.01).

• There is a significant positive correlation between the ‘basic’ science process skills and the ‘total’ context variables at 1% level of significance (critical ratio= 3.37).

• There is a significant positive correlation between the ‘integrated’ science process skills and the ‘total’ context variables at 5% level of significance (critical ratio= 1.98).
• There is a significant positive correlation between the ‘total’ science process skills and the ‘science instructional’ variables at 1% level of significance (critical ratio=2.33).

• There is a significant positive correlation between the ‘total’ science process skills and the ‘motivational’ variables at 1% level of significance (critical ratio=4.08).

• There is a positive correlation between the ‘total’ science process skills and the ‘familial’ variables, but not significant at 0.05 level (critical ratio=1.58).

4. ANALYSIS OF ACHIEVEMENT IN SCIENCE

• It is observed that 29.6% of the sample secured A grade and 39.5% secured B grade, while 19.8% got C grade and only 11.0% got D grade. The percentage of students having higher grades (grades A & B) is greater than that of students having lower grades (grades C & D). 69.1% of students have higher grades compared to 30.8% of students having lower grades.

• Girls excel in achievement in science, as the percentage of girls having higher grades (grades A & B) is greater than that of boys. 75.12% of girls have good grades compared to boys (61.47%). Also, in the lower grades (grades C & D), the percentage of girls (24.88%) is lesser than that of boys (38.53%).

• Urban school students excel in achievement in science, as their percentage having higher grades (grades A & B) is greater than that of rural school students. 77.47% of urban school students have good grades compared to rural school students (62.24%). Also, in the lower grades (grades C & D), the percentage of urban school students (22.53%) is lesser than that of rural school students (37.76%).
• Private school students excel in achievement in science, as their percentage having higher grades (grades A & B) is greater than that of government school students. 75.38% of private school students have good grades compared to government school students (61.94%). Also, in the lower grades (grades C & D), the percentage of private school students (24.62%) is lesser than that of government school students (36.06%).

5. RELATION BETWEEN ACHIEVEMENT IN SCIENCE AND COMPREHENSIVE SCIENCE PROCESS MEASURES

• There exists a significant positive relationship between acquisition of ‘basic’ science process skills and achievement in science of secondary school students. The Chi-Square test (C.R= 181.297, p-value <0.01) and Spearman’s rank correlation coefficient (r=0.411, critical ratio= 12.05) indicate that there is a significant positive correlation between achievement and ‘basic’ science process skills at 1% level of significance.

• There exists a significant positive relationship between acquisition of ‘integrated’ science process skills and achievement in science of secondary school students. The Chi-Square test (C.R=164.039, p-value <0.01) and Spearman’s rank correlation coefficient (r=0.393, critical ratio=11.42) indicate that there is a significant positive correlation between achievement and ‘integrated’ science process skills at 1% level of significance.

• There exists a significant positive relationship between acquisition of ‘total’ science process skills and achievement in science of secondary school students. The Chi-Square test (C.R=213.292, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.433, critical ratio=12.84) indicate that there is a significant positive correlation between achievement and ‘total’ science process skills at 1% level of significance.
6. **RELATION BETWEEN ACHIEVEMENT IN SCIENCE AND CONTEXT VARIABLES**

- There exists a significant positive relationship between ‘science instructional’ variables and achievement in science of secondary school students. The Chi-Square test (C.R= 27.922, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.105, critical ratio=2.82) indicate that there is a significant positive correlation between achievement in science and ‘science instructional’ variables at 1% level of significance.

- There exists a significant positive relationship between ‘motivational’ variables and achievement in science of secondary school students. The Chi-Square test (C.R=18.413, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.181, critical ratio=4.92) indicate that there is a significant positive correlation between achievement in science and ‘motivational’ variables at 1% level of significance.

- There exists a significant positive relationship between ‘familial’ variables and achievement in science of secondary school students. The Chi-Square test (C.R= 17.872, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.125, critical ratio=3.37) indicate that there is a significant positive correlation between achievement in science and ‘familial’ variables at 1% level of significance.

- There exists a significant positive relationship between ‘total context’ variables and achievement in science of secondary school students. The Chi-Square test (C.R=36.820, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.189, critical ratio=5.14) indicate that there is a significant positive correlation between achievement in science and ‘total context’ variables at 1% level of significance.
7. ANALYSIS OF THE SCIENCE TEACHERS’ INSTRUCTIONAL PREFERENCES

• The data reveals that 16.5% of the teachers belong to high instructional preference Index (IPI) group of ‘teacher instructional preferences’, while 23.3% fall in the low group. 60.2% of the teachers are in the medium group.

• 21.4% of the sample of secondary school science teachers have teaching experience of less than 5 years, 16.5% have experience 5 to 9 years, 27.1% have experience 10 to 14 years, and 35% have 15 or more years of experience in teaching science.

• 25.2% of the sample of secondary school science teachers had no chances of attending any in-service training courses, 15.5% had attended 1 or 2 courses, 27.2% had attended 3 or 4 courses and 32.1% had attended 5 or more courses in the last two years.

• 17.5% of the sample of secondary school science teachers have rated the laboratory facilities in their school as excellent, 52.4% as good, 23.3% as average and 6.8% as poor.

8. ANALYSIS OF THE SCIENCE TEACHERS’ INSTRUCTIONAL PREFERENCES:
BASED ON TEACHER – RELATED VARIABLES

A. Teaching Experience and Science Teacher Instructional Preferences

The analysis reveals that the instructional preference of the secondary school science teacher is significantly dependent on his/ her teaching experience. It is seen that there is significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following six categories with respect to teaching experience:

• Teacher- Pupil Interaction Dynamics

• Influence of Life-Skill Integration
Overview of the study

• Styles of Meta-Cognitive Strengthening
• Adoption of the Spirit of Inter-Disciplinarity
• Technology Woven Procedural Enrichment
• Professional Growth and Auto-Empowerment

At the same time, there is no significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following four categories with respect to teaching experience.

• Flexible cum Viable Instructional Strategy Integration
• Process Skill Application in Procedures
• Adaptation of Multi-Pronged Assessment Techniques
• Preference for Quality of Life Enhancement

B. Number of in-service courses attended in the last two years and Science Teacher Instructional Preferences

The analysis shows that the instructional preference of the secondary school science teacher is significantly dependent on the number of in-service courses attended in the last two years.

It is found that there is significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following six categories with respect to the number of in-service courses attended in the last two years:

• Process Skill Application in Procedures
• Adaptation of Multi-Pronged Assessment Techniques
• Adoption of the Spirit of Inter-Disciplinarity
• Technology Woven Procedural Enrichment
• Preference for Quality of Life Enhancement
• Professional Growth and Auto-Empowerment
At the same time, there is no significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following four categories with respect to the number of in-service courses attended in the last two years.

- Teacher-Pupil Interaction Dynamics
- Influence of Life-Skill Integration
- Flexible cum Viable Instructional Strategy Integration
- Styles of Meta-Cognitive Strengthening

C. Rating of school laboratory facilities and Science Teacher Instructional Preferences

The analysis shows that the instructional preference of the secondary school science teacher is significantly dependent on their rating of school laboratory facilities.

It reveals that there is significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following eight categories with respect to their rating of school laboratory facilities.

- Teacher-Pupil Interaction Dynamics
- Flexible cum Viable Instructional Strategy Integration
- Process Skill Application in Procedures
- Styles of Meta-Cognitive Strengthening
- Adaptation of Multi-Pronged Assessment Techniques
- Adoption of the Spirit of Inter-Disciplinarity
- Technology Woven Procedural Enrichment
- Professional Growth and Auto-Empowerment

At the same time, the analysis reveals that there is no significant variation in the percentage of teachers belonging to various levels of science instructional preferences in the following two categories with respect to their rating of school laboratory facilities.
3. TENABILITY OF THE HYPOTHESES

The tenability of the stated hypotheses of the study as verified using various statistical techniques is summarised below.

**Hypothesis 1 (a): There is a significant difference between secondary school boys and girls in their acquisition of science process skills.**

The test of significance of means shows that there is a significant difference at 0.01 level, between girls and boys with respect to their acquisition of basic, integrated and total science process skills. The critical ratios for the basic, integrated and total science process skills are 4.665, 5.964 and 5.467 respectively, which are higher than the table value (2.33) at 1% level of significance. It is thus found that the acquisition of basic, integrated and total science process skills of girls is significantly higher than that of boys at 1% level of significance. Thus, the stated hypothesis 1 (a) is accepted.

Studies have revealed that girls are generally more academic-oriented than boys. Proper emphasis, if given, to the inculcation of the science process skills at schools, girls would have benefited than boys. The result is hopeful as the science educational scenario focuses on the process domain of the learner.

**Hypothesis 1 (b): There is a significant difference urban and rural secondary school students in their acquisition of science process skills**

The test of significance of means shows that there is a significant difference at 0.01 level, between urban and rural secondary school students with respect to their acquisition of basic, integrated and total science process skills. The critical ratios for the basic, integrated and total science process skills are 12.817, 12.934 and 13.815 respectively, which are higher than the table value (2.33) at 1% level of significance. It is thus found that the acquisition of basic, integrated and total
science process skills of urban secondary school students is significantly higher than that of rural secondary school students at 1% level of significance. Thus, the stated hypothesis 1 (b) is accepted.

Studies have revealed that urban schools have greater academic facilities than rural schools. Moreover, the academic bent of mind and future aspirations of the urban population is generally higher than that of the rural population. Accordingly, there would be a difference in the approach of the urban schools in imparting the science curriculum, giving due importance to the science process skills, which has contributed towards the greater acquisition of science process skills in the urban school students.

**Hypothesis 1 (c): There is a significant difference government and private secondary school students in their acquisition of science process skills.**

The test of significance of means shows that there is a significant difference at 0.01 level, between private and government school students with respect to their acquisition of basic, integrated and total science process skills. The critical ratios for the basic, integrated and total science process skills are 10.707, 10.309 and 11.285 respectively, which are higher than the table value (2.33) at 1% level of significance. It is thus found that the acquisition of basic, integrated and total science process skills of private school students is significantly higher than that of government school students at 1% level of significance. Thus, the stated hypothesis 1 (c) is accepted.

Studies have revealed that private schools have greater infrastructural and laboratory facilities than rural schools. Moreover, the private school authorities are keen in academic matters and are generally more result-oriented than the government school authorities. Accordingly, there might be a difference in the approach of the private schools in imparting the science curriculum, emphasizing the process domain, which might have contributed towards the greater acquisition of science process skills in the private school students.
Hypothesis 2: The context variables selected for the study will have a significant positive relationship with the acquisition of science process skills of the secondary school students.

Karl Pearson’s Correlation coefficient ($r = 0.112$) shows that there is a significant positive correlation at 0.01 level between the ‘total’ science process skills and the ‘total’ context variables (critical ratio = 3.01). It is thus found that context variables exert significant positive relationship with science process skills at 1% level of significance. The stated hypothesis 2 is thus accepted.

The process-oriented and activity-based approach of science teachers at the school, the favourable learning environment at home and the personal motivation of the learner towards learning science, would play an important role in fostering the process domain of the secondary school science learner.

Hypothesis 3 (a): There exists a significant positive relationship between ‘science instructional’ variables and achievement in science.

The Chi-Square test (Critical Ratio, C.R = 27.922, p-value <0.01) and Spearman’s rank correlation coefficient ($r = 0.105$, critical ratio=2.82) indicate that there is a significant positive correlation between ‘science instructional’ variables and achievement in science at 1% level of significance. Thus, the stated hypothesis 3 (a) is accepted.

It implies that the various instructional strategies, process oriented and interdisciplinary approaches, teacher-pupil interaction, provision of co-curricular activities, technological interventions and innovative assessment strategies adopted by the science teacher, contribute largely to the achievement in science of the secondary school students.
Hypothesis 3 (b): There exists a significant positive relationship between ‘motivational’ variable and achievement in science.

The Chi-Square test (C.R= 18.413, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.181, critical ratio=4.92) indicate that there is a significant positive correlation between ‘motivational’ variable and achievement in science at 1% level of significance. Thus, the stated hypothesis 3 (b) is accepted.

It implies that the motivation of the secondary school student plays an important role in their achievement in science. Both intrinsic and extrinsic motivation would help the student to pursue science learning with interest. The ‘science instructional’ variable at school and the ‘familial’ variable at home, would contribute towards imparting a conducive environment helpful for creating motivation in the learner leading to better achievement in science.

Hypothesis 3 (c): There exists a significant positive relationship between ‘familial’ variables and achievement in science

The Chi-Square test (C.R = 17.872, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.125, critical ratio=3.37) indicate that there is a significant positive correlation between ‘familial’ variables and achievement in science at 1% level of significance. Thus, the stated hypothesis 3 (c) is accepted.

It implies that the family is a major factor affecting the achievement in science of the secondary school students. The home environment, parental aspirations, facilities at home for study, permissiveness to do science activities at home, encouragement to read science books/articles/magazines, parental involvement and guidance in learning etc., offer a strong support to the student for better achievement in science.
Hypothesis 4 (a): There exists a significant positive relationship between acquisition of ‘basic’ science process skills and achievement in science.

The Chi-Square test (= 181.297, p-value <0.01) and Spearman’s rank correlation coefficient (r=0.411, critical ratio= 12.05) indicate that there is a significant positive correlation between acquisition of ‘basic’ science process skills and achievement in science at 1% level of significance. Thus, the stated hypothesis 4 (a) is accepted.

It implies that pupils need to be introduced to the ‘basic’ science process skills early in their school experience as they are closely associated with their achievement in science. The basic learning which pupils achieve from these initial experiences can be used as the basis for building a more extensive understanding of science process skills in the later years of schooling.

Hypothesis 4 (b): There exists a significant positive relationship between acquisition of ‘integrated’ science process skills and achievement in science.

The Chi-Square test (C.R=164.039, p-value <0.01) and Spearman’s rank correlation coefficient (r=0.393, critical ratio=11.42) indicate that there is a significant positive correlation between acquisition of ‘integrated’ science process skills and achievement in science at 1% level of significance. Thus, the stated hypothesis 4 (b) is accepted.

It implies that the ‘integrated’ science process skills need to be given due weightage in the transaction of the science curriculum. If these process skills are emphasized during the science instruction, there would be a marked progress in the level of achievement of the learner, as they are productive in better learning and problem solving.

Hypothesis 4(c): There exists a significant positive relationship between acquisition of ‘total’ science process skills and achievement in science.

The Chi-Square test (C.R=213.292, p-value <0.01) and Spearman’s rank correlation coefficient (r= 0.433, critical ratio=12.84) indicate that there is a significant positive correlation between acquisition of ‘total’ science process skills
and achievement in science at 1% level of significance. Thus, the stated hypothesis 4 (c) is accepted.

Acquisition of science process skills, both basic and integrated, would facilitate learning and achievement in science, ensure active student participation, help students develop the sense of undertaking responsibility in their own learning, increase the permanence of learning, and also help imbibe research ways and methods. Hence, the process domain needs to be regarded as the centerpiece while transacting the science curriculum.

**Hypothesis 5(a): The instructional preference of the secondary school science teacher is significantly dependent on his/ her teaching experience.**

The Chi-square test (C.R= 19.293) for the total science instructional preferences shows that there is significant variation in the percentage of teachers belonging to various levels of science instructional preferences with respect to teaching experience at 1% level of significance. Thus, the stated hypothesis 5(a) is accepted.

Experience makes man perfect. The study reveals that teaching experience of the science teacher has an impact on his/ her science instructional preferences. Even though, the study highlights the significant relationship between the two, there are certain areas that need to be addressed. Science teachers need to invest and contribute their wealth of experience in different areas of science instruction, so as to bridge the many existing gaps and to embrace innovative and emerging educational practices.

**Hypothesis 5(b): The instructional preference of the secondary school science teacher is significantly dependent on the number of in-service courses attended by the secondary school science teacher.**

The Chi-square test (C.R=13.221) for the total science instructional preferences shows that there is significant variation in the percentage of teachers
belonging to various levels of science instructional preferences with respect to the number of in-service courses attended in the last two years, at 5\% level of significance. Thus, **the stated hypothesis 5(b) is accepted.**

Training is the vital component for any improvement. The time, money, effort and resources spent in the in-service training of science teachers are expected to bring gains to the field of science education. The study reveals that the new knowledge gained through in-service education is put into practice by the science teachers, which is a ray of hope in the science educational scenario. In-service training has to chisel the personality and abilities of the science teacher, so as to shape the best quality teachers who are entrusted with the responsibility to mould the future citizens fit for the 21\textsuperscript{st} century.

**Hypothesis 5(c): The instructional preference of the science teacher is significantly dependent on the rating of their school laboratory facilities**

The Chi-square test (C.R=22.863) for the total science instructional preferences shows that there is significant variation in the percentage of teachers belonging to various levels of science instructional preferences with respect to their rating of school laboratory facilities, at 1\% level of significance. Thus, **the stated hypothesis 5(c) is accepted.**

A well equipped, well maintained and well utilized science laboratory is the most important physical facility of a secondary school which is expected to be instrumental in bringing desirable science learning outcomes. Facilities add hands to the mind. Excellent science laboratory facilities incorporating new technological devices, provide the science teachers with opportunities to enhance learning and to relate the use of technology to science.