CHAPTER IV

METHODOLOGY

The purpose of the study is to find out the actual facilitations available for the modernization of chemistry teaching in the schools of Kerala. This will be determined in terms of facilities and resources available in and around schools, the competency of teachers, administrative factors, teacher training, inservice training facilities, curricular factors, textbooks, other instructional materials, conceptual and attitudinal dimensions etc. Similarly, factors which could operate as hindrances to modernization of chemistry teaching are also to be determined using proper tools. Topics and curricular concepts that are, or could be included in the chemistry syllabus of high school can be judged by experts and teachers for their comprehension and effectiveness. Textbooks and the issues associated with their production can be analysed from the point of view of their reflecting modernisation and facilitations/hindrances to it. Therefore the different aspects of
descriptive method with high component of analytical and appraisal models have to be used in this study. Descriptive research is not confined to fact-gathering, but it is also used for predicting and identifying relationships between variables. The descriptive data may be expressed either 'qualitatively' in verbal symbols or 'quantitatively' in mathematical symbols. The present study includes both forms of descriptive method.

The investigator adopted the descriptive method for solving specific problems selected, by gathering data through observations, questionnaires, rating scales, attitude scales, analysis and other data-collecting techniques. The position taken in this research is that the data collected may pin-point the weaknesses and enable the educators to make recommendations for change in the right direction on the administrative, instructional and curricular practices in our schools.

The various aspects of survey involved in the present study covered (1) the attitude of science teachers and experts towards the modernization of school chemistry programmes in the State of Kerala;
(2) the opinion of participants in education about the identified concepts of modernization of school science; (3) the factors that facilitate or hinder the modernization programme in school chemistry; (4) the administrative and situational facilities of the school for modernization of school chemistry; (5) the adequacy, acceptability, activities, allotment of time, feasibility, amount of content, instructional materials and other relevant factors which influence the process of modernization of chemistry curriculum in the schools of Kerala. The study also included an appraisal of the essential components in the school chemistry textbooks in selected dimensions.

Besides the survey aspect of the descriptive method, analysis is also considered relevant, particularly in the analysis of texts from the perspective of modernisation and modern pedagogy. Though historical method was not contemplated, the changes in syllabi during the period of research permitted analysis of two distinct trends in curriculum making.
Rationale for Constructing Research Tools

The investigator had to construct research tools to collect data, since no standardised ready-made tools of research pertinent to this study were available. An inherent difficulty in a study of this kind is that different people could have different concepts of modernisation of science and science education. The sociologists' concept of modernisation also should have its ramifications for modernisation, though it is conceivable and observable that in our specialized world one could be an authority on modernisation in the sociologist's sense while he is unaware of the latest trends in science education or even on 'scientific' education. These different concepts of modernisation can be subjected to empirical study to some extent.

But it is difficult and also futile to prepare an attitude scale or analytical schedule for text-book analysis with a heterogeneous frame concerning modernisation of science education. Here the position taken by some of the progressive systems after the Sputnik of 1957 - like the pedagogic stance underlying Nuffield Science in the U.K. have been taken as the investigator's stance in preparing the tools. But even within this
what stabilised framework there are differences among experts. Some specific stance had to be taken for preparing these tools. In such a case a position close to that of Bruner rather than Ausubel was taken, considering the age group of the school population in Kerala and the view that advance-organizing, verbal processing stance could pass on imperceptibly into verbalism in school system like that of Kerala whereas pseudo-discovery excesses could happen in some weak "progressive" systems in the U.S.A. (However the investigator is indebted to the strong systems in U.S.A. and elsewhere where real efforts at discovering approaches and activities which could help children at a lower age to grasp the structures of science disciplines). In fact without this spirit of modern pedagogy, the sudden upgradation of state science curriculum can be both cruel and futile. While taking the Brunerian stance, the investigator does not assume that the respondents would have a knowledge of Bruner, Piaget or Ausubel or even of the old essentialist position as represented by Bagay, Hutchins and others. In fact most persons. In fact most persons teaching science and even many who are responsible for preparing science syllabi and textbooks and conduct in-service courses in India seem to take progressive or traditionalist
positions, innocent of these and similar developments and armed only with some common sense and some knowledge of science and the 'materials' prepared by the NCERT and SCERTs. But anyone teaching science or preparing science curricula or textbook would be taking some point of view regarding these irrespective of whether he or she has gone through modern science education literature. It is these positions and their impact which is sought to be investigated through some of these tools. Reference to Brunerian and other constructs are made only from the point of analysis under some framework of analysis in modern science education literature.

On the basis of the stances indicated and also of the qualities of a modern science textbook, whatever above, be the stance, tentative analytical frames were developed for textbook analysis. Since it is a question of analysing a few sets of textbooks, it was not a difficult task to handle multiple frames of analysis. Besides, the textbooks at least after 1970 seem to have been written with some view of modernization, however dimly they have been conceived by the authors and however indirect the source. The analyst needs to have an understanding of multiple points of view, and start
with an open mind to identify the point of view of
the book, analyse it with the logic or rules of the
game of that school, as well as from certain general
points of view.

THE TOOLS

Four survey tools have been prepared to collect
data for the study: (1) A checklist to measure the
views, opinions and judgements of the respondents to
the concept of modernization of school chemistry as
well as rating scales to measure factors that
facilitate and hinder the modernization of chemistry
curriculum; (2) an attitude scale to measure the
attitudinal facilitations and hindrances to the moderni-
ization of school science; (3) a questionnaire to
collect data relevant to the study regarding the
administrative and situational facilities in the school
and school curriculum; and (4) a curricular item
rating scale to measure the reactions of experts and
chemistry teachers towards a selected list of typical
curricular items taken from the Kerala high school
syllabus supplemented by certain items from Nuffield
and CHEM study from the point of view of a unified
curriculum model, and expected framework within which
the Kerala curriculum may be expected to fluctuate in further revisions.

The check list and rating scale of these (1) and (2) were incorporated together as one schedule since the population for which it was intended was the same.

1. The Schedule

Schedule Item I is a check list. The objective of the check-list used in item I of the schedule was to elicit the opinion of the respondents about the concept of modernization of school chemistry in positive and negative terms.

Statements on the concept of modernization of school science and particularly chemistry were collected by analysing books, journals and seminar reports in science and science education, as well as by conducting interviews with experts in science, eminent educationists, teachers and general public and discussions with colleagues, and postgraduate students of education and chemistry. The experience of the investigator as lecturer in Physical Science Education also helped her to frame statements on the concept of modernization of school chemistry.
Out of 110 statements on the concept of modernization of school science and school chemistry originally collected, the investigator was able to select 40 items, either by fusing identical concepts or by eliminating the defective and irrelevant ones. 31 statements were positive concepts and nine were negative, i.e., statements on what modernization is not. Whether a statement belongs to the positive or negative category was decided by the consensus of expert opinion.

All the 40 items, both positive and negative were grouped suitably for purposes of analysis.

In Parts II and III of the schedule the investigator presents a list of expected factors—both facilitations and hindrances prepared by surveying literature, observations, discussions, getting opinions on school science education and critically scrutinised and edited them. Twentysix items were included in the Hindrance Rating Scale (Part II). A four-point scale is used: very high/high/a little/none/to obtain the ratings.
Part III of the schedule presents a list of factors (20 in number) considered to be facilitating modernization of school chemistry were prepared to be judged by the respondents. Since the anticipated replies imply a change orientation, this Facilitation Rating Scale had the same four-point ratings as given for Hindrances, but two categories:

(1) 'extent to which it is being done now' and
(2) 'extent to which it should be done'.

All the 20 statements in the 'Facilitation Scale' were classified suitably for analysis. A copy of the schedule is presented in Appendix I.

The type of items included in the schedule are of a generalized nature without going into the specific facts with reference to the situation in the schools. Hence this could be relevant for a universe incorporating teachers, experts and post-graduate students. But, in a study of this kind information is needed regarding certain specifics also. Hence another tool was required for this purpose.

2. Attitude Scale

The revision of the High School syllabus in Chemistry is viewed as necessary by some, whereas others feel that upgrading is not at all necessary in
the schools. Thus we may have two groups of people, one in agreement with upgrading and others against it. And again there are certain well-accepted progressive stances regarding modernisation of the science syllabus. People's attitudes to these may vary on a progressive-traditionalistic continuum. Hence it was considered necessary to use an attitude scale in the study to measure the feeling tones on these aspects with some measure of precision.

Remmers and Gage\(^1\) define attitudes tentatively as "feelings for or against something". After explaining the various terms in the above statement they go on to develop a more precise definition: "An attitude may be defined as an emotionalized tendency, organised through experience, to react positively or negatively towards a psychological object."\(^2\)

A carefully constructed attitude scale consists of many items, which are selected and edited carefully - accordance with certain criteria. Each item can be otherwise called a statement. Edwards defines the

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attitude statement as, "anything that is said about a psychological object."

There are two common techniques used in attitude measurement — the equal appearing interval technique of Thurstone and the Summated Rating Technique of Likert. Thurstone's technique begins with a large number of attitude statements ranging from extremely favourable to extremely unfavourable. Scale values are assigned to the statements, on the basis of the median ratings of several judges. Items with high coefficients of ambiguity ($Q_3-Q_1$) are rejected. The subjects are asked to place check marks against the statements that they endorse the as close to their own opinion or attitude. This technique was not adopted because it requires a cumbersome scaling procedure and the subjects need not mark all the items, hence the opinion of the subject towards many specific items about which the investigator would like to have the respondents' reaction could not be known.

In the Likert method some statements (about 100) both favourable and unfavourable to the attitude object

2. Ibid., p. 384.
are collected from different sources. A considerable number of subjects, say 100 or 185, or 370 are asked to respond to them on a five point scale: "Strongly agree", 'agree', 'undecided', 'disagree', and 'strongly disagree'. The responses are then scored, assigning values from 5 to 1 (for strongly agree to strongly disagree) in the case of favourable statements and 1 to 5 in the case of unfavourable items beginning from 'strongly agree'. A subject's score is the total of the values indicated. The scores of each item are subjected to analysis and 20 to 25 statements having the highest discriminating values are selected and again administered for the final study on the selected sample of the population.

The investigator chose to adopt the Likert technique,¹ because it solves the trouble of scaling the items and also because each item has to be responded to, enabling a diagnostic analysis based on sub-component scores.

Construction of the Present Attitude Scale

The investigator collected more than 100 statements regarding the scientific advancement and need of modernization of secondary school science syllabus. These statements were collected mainly from books on education and science, scientific articles from journals, popular opinions expressed by educationists, leaders and scientists, opinions of science teachers, students and experts. These statements were reconstructed into favourable and unfavourable statements. Irrelevant, ambiguous, overlengthy, double barreled, factual or otherwise defective statements were rejected. The rest of the items seemed to be easy to react. Thus the investigator was able to use 78 items. The trial form of the attitude scale is presented as Appendix II.

This was administered to a sample of 185 consisting of teachers, experts and professional students. On the basis of the total scores a high scoring group and low scoring group of 50 each (top and bottom 27%) were made out and the mean difference between the two groups for each item was calculated, along with the critical ratio. On this basis 50 items having the desired discriminating power were chosen and were used
to construct the final attitude scale (vide Appendix III). These were subclassified suitably for further analysis.

Reliability and Validity

The reliability of the Attitude Scale was calculated using the split-half technique. The correlation coefficient between odd and even half item scores among the 50 selected statements was found to be 0.72. Since this represents the reliability of only the half test, it was corrected for the full test by the usual procedure and the reliability of the full test was found to be 0.82.

As it was difficult to find a satisfactory criterion measure to compute a statistical coefficient of validity, no attempt was made to have such a coefficient. However, there are some indirect indices of validity. The mean score of experts was found to be significantly higher than that of the teachers and again it was found to be significantly higher than that of students. Also the face validity of the tool was measured by careful reference to current literature on the subject and by the judgement of some experts in the field of science education.
The investigator had the advantage that there are almost identical scale in a parallel study conducted by Anandan Nair had already been administered and analysed. Cross reference to the results of that study is made under Analysis of Results, wherever relevant.

3. The Questionnaire to Teachers

The chief difference in approach between the other tools used in the study and the questionnaire is that the questionnaire sought to elicit the actual status in schools with reference to facilitating or hindering factors. The specific aim of the questionnaire was to collect in a quick, easy, facile and reliable manner, certain relevant facts and information regarding the facilitations and hindrances to the teaching of chemistry in schools from teachers who teach chemistry in the schools of Kerala State. Care was taken to make the questionnaire precise, concrete, interesting, relevant, specific and non-biased. Much attention was paid to avoid annoying and misleading items. Care was also taken to guard against unduly long responses and excess of suggestive or too unstimulating approach. The closed form (i.e., checking and rating items) as well as 'open-end' questions were asked according to the nature of data required.
The questionnaire consisted of ten sections. In Part I the details of personal data of the respondent including his academic status was sought. Details of work-load of the teacher and the nature of work undertaken were elicited through the second part.

The third part was intended to find out the relative effectiveness of academic attainment and courses undergone by the teacher, particularly from the point of view of closing the gap between the teacher scholarship level and the curricular expectation and provisions to close the gap. Part IV was meant to elicit the details regarding in-service courses, like the agency which conducted the course, duration and type of the course, etc. The benefits and defects of the courses were also sought through check-lists.

Details regarding professional satisfaction of the teachers as well as adequacy of salary, sources of additional income, special interests, hobbies were to be elicited through Part V. Part VI was designed to bring out the details regarding the availability and the extent of use of environmental resources and their effect on the teaching of chemistry in schools.
Some possible local resources were listed to be rated on four dimensions such as 'available near school', 'prominent examples', 'already made use of', 'can be made use of'.

The purpose of Part VII was to elicit details regarding the laboratory facilities in the schools. A check-list form and a few open questions were used.

Part VIII of the questionnaire was intended to bring out information regarding the co-curricular activities which enhance teaching of chemistry in schools. Particulars of the functioning of science clubs in schools were given prominence in this part.

Reference materials being a facilitating factor in modernizing school chemistry, Part IX was designed to bring out the details of availability and use of such materials. This part was presented as a check-list cum-rating scale.

The last part was intended to collect data on administrative factors, both educational and social, which influence the modernization of school chemistry. Rating items and check-lists as well as open-ended questions were used.
At the close, space was provided for the respondents to express anything that would act either as a facilitation or hindrance to the process of modernization of school chemistry. Ample space was provided for free responses.

No pilot study was conducted with this Questionnaire, but an informal try-out was made with a few chemistry teachers in schools.

4. Curricular Item Rating Scale

The actual curricular rating scale opened with certain personal data which is item followed by a list of 97 curricular items. These items were collected from the textbooks of 8th, 9th and 10th Standard chemistry of Kerala High Schools. A few more items were incorporated from the Nuffield Chemistry textbook for High Schools and CHEM study materials. The rationale for selecting items from sources like CHEM study is to ensure coverage of potential items which could be introduced conceivably at this level. Since there was one revision of the syllabus during the period of investigation, this wider pool for selection of items is justified. A lot of time was spent on
content analysis of the syllabi, for which besides
the supervising teacher, Prof. George Varghese,
Professor of Chemistry, University College, Trivandrum
also contributed much of his precious time. A pilot
study was conducted before finalising the test by
circulating the items to a few experts and from that
study the final items were collected.

The respondents were requested to rate these
items on nine dimensions. They were (1) Difficulty
level (2) Applicability in life situations (3) Teacher's
mastery of subject matter, (4) Procurement of instruments
(5) Feasibility to do experiments (6) Availability of
environmental/resources (7) Whether it should be taught
(8) Stage at which it has to be introduced (9) Time
needed for effective teaching.

Dimensions 1 to 6 were to be rated on a three point
scale while dimension 7 was on a five point scale. Since
these five points are not strictly linear, it would be
useful to specify them here: Yes, only terms/
understanding concepts/Experiments to verify principles/
Mathematical treatment/Not to be taught. In item 8,
the respondents were invited to tick the stages Primary/Secondary/College. Column 9, time needed for effective teaching is expected to be filled in by the respondents.

5. Text book Analysis

Many investigators and NCERT-initiated evaluators use completely closed Text-book analysis schedules. Many of the items here are devoted to external aspects. Some do relate to content and manner of presentation, but they usually consist of some qualitative adjectives to be responded on a three or five point rating scale. Since objective criteria are not usually specified, the results of such analysis consist only the pooled subjective judgements. In most cases there is reason to suspect that the respondents as well as the investigators have been out of touch with modern developments in educational practice.

The present investigator has chosen to dispense with a formal Analysis schedule, at the expense of throwing herself open to the change of non-precision. On the other hand she chose to go about the business with an "analytical frame of mind" contributed by the
type of science education literature already reviewed. The emphasis has been on chemical content, structure and process, and the external aspects have been given only minor importance. The nature of the analytical frame will be clear from the pages which follow in this chapter and in the next.

**The Rationale of the Choice of Universe/Population**

**Text-book Analysis**

Text-books are perhaps the most important single index of curricula and the extent of their modernisation, particularly in systems which tend to be highly text-book centred. Hence the analysis of text-books are given a special place in this study.

The study was conceived in the middle seventies when the first set of upgraded books for Upper Primary and high school science - chemistry, physics and mathematics - were creating astir in the minds of pupils, parents and teachers. The unavoidable delay in completing certain aspects of the present study enabled the investigator to analyse complete sets of books representing at least two different curricular
stand points - the ones which were in vogue from middle 1970s to the S.S.L.C. Examination of March 1984 and also the set which was released from the commencement of the academic years 1984 to 1986. Now it was felt that it would be possible to estimate what was the modernization quantum attempted in the 1970s by analysing the text-books which were in vogue in the 1960s. Hence the universe of text-books to be analysed included three distinct strata in recent history of education - the textbooks of 1960s mid 1974 to 1984 March and 1984 (June) upward. It is expected that the kind of analysis of texts over three strata in time would give an idea of two phases of modernization of science in schools.

Some investigators use survey techniques for textbook analysis using schedules which would be answered by hundreds of respondents regarding their estimate of different aspects of textbooks. In essence this is actually 'a survey', usually of the views and pictures which a population has about the textbook. Sometimes the schedule is made very analytical in an attempt to make such studies really an analysis. But it is very difficult to carry this beyond relatively surface aspects. For example, some of the analytical schedules administered to large samples may have an item
on language of the text—in dimensions such as clarity, correctness etc., rated on a three point scale. On the other hand if specific deviations from accepted grammatical norms, and norms, for the language of science are analysed or if the lexis, morphemes and syntactical or discourse patterns are analysed according to objective linguistic principles one knowledgeable and diligent analyst could be more effective than a hundred judges operating at a relatively surface level.

This is the position taken in this investigation. The same investigator equipped with multiple frame works and knowledge of textbook characteristics would be in a better position to judge the finer aspects of textbooks relevant for this study (like one referee in basketball against ten thousand spectators). In this approach, the subjective bias could arise, especially while judging the more intricate aspects of content and pedagogic presentation. The steps taken to reduce this area explained later. The nature of the analytical frame used will also be clear from the results reported in the next chapter.
Curricular Item Rating Scale

In order to get a pool of items for the curricular item rating scale, the upgraded curriculum of the 1970s was used as the primary base, since it is this upgradeation which provided the occasion for the present study on modernisation of school chemistry. But while making the pool of items, the international material which could have directly or indirectly inspired the change, such as Nuffield chemistry, CHEM study, CSU were also consulted, the rationale being that in the climate in which the new syllabi (of the 1970s) were prepared many of these were potential items for inclusion in the school syllabus and the potentiality probably would continue in further revisions also. In fact many of the heaviest items from these external syllabi (which we would now call +2 level syllabi) were in fact included in the first edition of the book of the 708. It is also of interest that the Nuffield materials, in the lower classes represented, what Bruner would call the 'honest form' of major chemical concepts.

Having decided the universe for the pool of curricular items, it became necessary to decide the universe for obtaining a judgement on it. Here obviously
the judgement of one person would not be sufficient. At the same time any group – even the usual population of teachers – would not be competent to judge this. What was needed was a universe of experts who could understand the intricacies of the concept presented, know the type of appliances needed, and also know of the conditions in Kerala schools to make a judgement about difficulty for pupils, teacher's mastery, practicability etc... This is a type of work which requires willingness to spend time for this cause, carefully going through the items and making a judgement. Hence school teachers of a superior calibre, college teachers having some touch with school work, progressive workers in the cause of science etc. were the universe from which experts were to be chosen.

Questionnaire covering actual conditions

The questionnaire relates to facilitations and hindrances as actually obtaining in school conditions, the best sources of information to the school teachers. It is possible that at least during the first few years, the new curricular expectations might at certain points
exceed the teacher competencies. But it is the teacher who has to transact the new curriculum in the actual class-room. Hence irrespective of the fact whether the teachers with the old type of educational training may understand the issues involved in the modernization of chemistry in schools, they have to be included in the study because of their mediatory role. In fact all categories of teachers of chemistry, old and new constitute the population.

The Schedule

There is another Schedule regarding certain concepts of modernisation and estimate of hindrances and facilitations in a generalized context. In this case a wider population - teachers, experts students etc. would be in order. Here the universe of teachers is the same as before. Experts in this context have to constitute a heterogenous body because it is very difficult to find persons combining the multifaceted content competencies, science education competencies and the modernization approaches. The population has to be envisaged in terms of those who possess one or more of these assumed that the ordinary administrator, well versed in rules and regulations, could be considered
an expert in a matter like modernisation, but even this
type of 'expert' would be competent to pass judgements
on certain aspects where the shoe pinches. Hence the
universe of the expert includes lecturers teaching under-
graduate and post-graduate class in science, university
teachers in the department of education, and interested
teachers in the department of science and school teachers
in touch with modern trends in science and education.

In the student population, the pupils are considered
too immature to answer questionnaire or schedule of the
type concerned in this study. Tests and inventories
designed carefully to measure the impact of the new
syllabi on pupils is possible, but it would take a very
long time and since this would be one minor aspect of
the study, it was felt that the investment of time in
this approach would be too much in a broad-based study
like the present one. Hence it was proposed to limit
the student population to post-graduate science students
and Education students (specializing in physical science)
Incidentally these students would have been in the
school studying the books produced in the 70s (about
5 years prior to 1982). As past pupils in the new
scheme, they should know 'where the shoe pinches',
'whether there were any invitations' to science to be taken etc. As mature post-graduate students or education students, they should be able to make the type of judgements needed to answer the various schedules and scales.

The Sample

For the textbook analysis, the investigator did not use a sample of experts. She herself did the analysis, checking where necessary with other experts.

For the curricular rating a purposive sample of 98 experts who were competent and willing to spend the time on this task was taken.

For the other aspects of the survey too a large or random sample could not be chosen, but care was given to see that representation was given to various relevant strata.

The questionnaire was answered by 248 teachers: 122 men, 126 women; 144 urban, 104 rural.

The Schedule of general interest was answered by a sample of 202: 104 men and 98 women; 91 teachers, 69 experts and 42 students.
The attitude scale was also answered by the same sample that answered the schedule.

**Validity and Reliability**

The reliability of the attitude scale has been reported already. It was difficult to calculate reliability in statistical terms for the other tools. But there was a remarkable consistency in the responses of the respondents.

It was difficult to find external criteria to validate the results obtained from these tools. Hence statistical validity coefficients could not be calculated. Besides, it could be argued that the low sample could also affect the validity of the study.

But the agreement between the results obtained through different tools where such convergence could be noted, another source of validation came from a parallel study in physics on an otherwise identical study conducted by Anandan Nair.

The present investigator and Anandan Nair prepared most of the tools in common. Only, in the case of the
attitude scale, item analysis yielded slightly different results and a small minority of items in the final scales were different for the two investigators. It was also decided that the present investigator would concentrate more on the qualitative side, and she added a text-book analysis running over a longer period. Anandan Nair emphasized the quantitative side, using much larger samples and using more sophisticated treatment of results. Though the present investigator used much smaller sample a remarkable amount of similarity was noted between the two studies, which could be claimed as an index of validity. These are reported along with the findings.