CHAPTER - III

PROCEDURE AND RESEARCH DESIGN

Introduction

Laboratory work provides an activity which can be profitable and emotionally satisfying. It provides opportunities for ingenuity. By performing laboratory operations confidence is built up and fear of risks are reduced. Problem solving situations also give rise to critical practice.*

The purpose of this study was to identify the chemistry laboratory skills needed to complete the class XII of senior secondary chemistry laboratory course and to develop tests to measure the achievement of these skills. Special attention was paid to the role of student, type of school, sex, type of Examination, Socio-economic status and out of school activities.

A) Procedure for the Study

The study was carried out in three phases. Tests were finalised in the first phase, the tests were administered in the second phase and the data was collected, in the third phase the responses were evaluated and analysed to elicit the important findings.

In the first phase the chemicstry practical syllabus of classes XII was analysed for the construction of Entry Level

Test. The chemistry practical syllabus of class XII was analysed for the construction of Terminal Level Test. Thus the chemistry laboratory skills for classes XI and XII were identified. On the basis of identified chemistry laboratory skills for class XI and the Entry Level Test was constructed. On the basis of identified chemistry laboratory skills for class XII the Terminal Level Test was constructed. In some cases more than one test-item on a single laboratory skill were prepared. Also a theory test based on the content of class XI & XII was constructed. Then the chemistry practical syllabus, tests and the list of the skills were sent to thirty experts (Science Education specialists, university/college/ senior secondary school chemistry teachers) for their identification and opinion. Experts were asked to express their opinions if a particular test-item measure/ and the particular laboratory skills for which it was been designed. They were also asked to express their opinion about the language and the content of the test items. They were further asked if the particular test item has been correctly categorised to a particular category.

The tests were further revised on the basis of the feedback obtained from the students and experts. A pre-pilot study of these tests (Entry Level Test, Terminal Level Test

---

(They were asked to express their opinion whether the test items are appropriate, adequate, measures or does not measure, needs any addition, deletion or modification).

and Theory Test (Pandit)/ was conducted. With 20 students. The testes were modified on the basis of their responses. The difficulty and discriminating values of different test-items of three tests in the total sample were calculated. Tests were revised on the basis of feed back thus obtained from the item analysis. The reliability of the three tests in the total sample were also calculated by analysing the students responses by split half technique using Spearman Brown prophery formula. A marking scheme for each test was also prepared. After establishingthe validity and reliability of the tests the tests were cyclostyled.

In the second phase three types of schools were selected. One section of class XII from each school was selected on a random basis. At the beginning of the academic session Entry Level Test was administered to the students. The test was of 45 minutes duration. The personal biodata form was also got filled in by the students. A questionaire was also got filled in by the teacher containing the details and facilities for chemistry laboratory instruction for class XII in that school. At the close end of the academic session two more tests were administered to the same students i.e. (Terminal Level Test & Theory Test (Pandit)). All the response sheets were collected, serially arranged and serially coded.

In the third phase all response sheets of various tests were marked and scores were entered in the composite record

sheets. The bio-data of students was also marked on the basis of criteria as mentioned in chapter V. Their socio-economic status was determined by adding the individual scores of Father's profession, Mother's Profession, Family Income, Father's Education & Mothers Education. Students were grouped into six categories on the basis of ranges of marks (as given in Chapter V).

Involvement in personal hobbies /scientific activities,/work experience/vocational job was also marked on the basis of criteria, explained in Chapter V. The performance of each student on these counts was also entered in the composite record sheet. The scores of manipulative items & cognitive items in each test (Entry Level Test and Terminal Level Test) were computed seperately. Finally all the relevant data were punched on a card for carrying out the necessary statistical analysis. Lastly, a comparison was made of the facilities (staff, equipment, chemicals, Financial grant, physical facilities) available in each school. The relevant numbers are presented in a tabular form to facilitate the analysis of this factor.

3) Research Design For the Study

The laboratory instruction is very costly especially in developing and under developed countries.

Researchers have been keen to find the validity of the laboratory Instruction. In order to find the validity of the laboratory instruction in the class XII of the senior secondary schools of the Union territory of Delhi the following statistical tests were performed.

a) Means and standard deviations were computed for the various variables in the total sample and three school sub samples in order to form a general idea of the levels and spread of these variables in different sub groups.

b) Correlations were computed between chemistry laboratory skills (Entry Level Test & Terminal Level Test) and all other variables in the three school sub samples and in the combined sample.

c) t-test was carried out to find the significance of differences between sex and type of school with regard to chemistry laboratory skills (Entry Level Test & Terminal Level Test). The test was performed between boys and girls of two schools and then between boys and girls of the same school this test was also performed to examine pairwise differences between the three types of schools.

d) Analysis of variance was used to test homogeneity across sex, type of school, type of examination, socio-economic

status, and out of school activities with respect to chemistry laboratory skills (Entry Level Test & Terminal Level Test).

To elaborate our earlier discussion it would be useful at this stage to reiterate that the present study is concerned with the following issues :

1) Identification of Chemistry Laboratory Skills normally needed to complete class XII of the senior secondary stage of the Central Board of Secondary Education, New Delhi in the Union Territory of Delhi.

2) Development of instruments to measure the achievement of these skills and the theory knowledge.

3) Computation of difficulty and discriminating indices of all items (ELT*, TLT** and theory Test (Pandit)) in the total sample.

4) Estimation of the mean levels and scatteredness (or dispersion) of all relevant variables for the individual school samples as well as the combined sample.

5) Comparison of mean levels of CLS on a binary basis between various groups e.g. sex, school type, examination type etc. using the t-test.

6) Examination of the hypothesis of homogeniety in various variables across several groups in a collective way using analysis of variance.

---

* ELT is the short abbreviation for Entry level Test.

** TLT is the short abbreviation for Terminal Level Test.

7) Quantification of the extent of linear relationship between various variables by means of the coefficients of correlations. The pairs of variables of special interest to us include (a) CLS* and theory test(Pandit) (b) CLS and theory test in class XII(CBSE)**, (c) CLS and Chemistry Practicals in class XII (CBSE) (d) Chemistry theory and chemistry practicals Class XII (CBSE) (e) manipulative skills and cognitive skills in ELT and TLT.

Specifically the questions that were researched into are as follows :-

1) What are the basic skills needed and developed in chemistry laboratory instruction of class XII of senior secondary stage ?

2) Can tests be developed to measure the achievement of these chemistry laboratory skills ?

3) What are the characteristics of such tests (content validity, Reliability, Item Analysis (Difficulty & Discriminating Indices) ?

4) Are differances in achievement of laboratory skills related to the sex of the student, type of school, he is studying in, type of examination he has taken, his socio-economic status, his out of school activities?

CLS* is the short abbreviation for chemistry Laboratory skills.

CBSE** is the short abbreviation for central Board of Secondary Education.

5) Is achievement of chemistry laboratory skills correlated with achievement of subject matter content in the same chemistry course?

6) Does achievement of manipulative skills vary systematically with achievement of cognitive skills?

7) Does achievement of manipulative skills of Entry Level Test bear a clear relationship with the manipulative skills of Terminal Level Test?

8) Is the achievement of cognitive skills of Entry Level Test correlated with the cognitive skills of Terminal level test?

9) Is the achievement of chemistry laboratory skills (Entry Level Test and Terminal Level Test) correlated with the chemistry practicals test of class XII (CBSE)?

10) Does the achievement of chemistry Theory Test (Pandit) vary in the same direction as the theory test class XII (CBSE)?

(C) Hypothesis of the Study

The study is thus concerned with testing the following hypothesis:

1) There is a significant relationship between achievement in chemistry laboratory skills and achievement in chemistry (theory), Labo[illegible].

2) There is a significant difference between boys and girls as far as chemistry laboratory skills are concerned, boys showing better performance than girls.

3) High achievers in chemistry theory perform sufficiently high on cognitive based skills than in manipulative skills.

4) There is a significant school variation in achievement of chemistry laboratory skills.

5) Students appearing in All India Higher Secondary examination show much better achievement in chemistry laboratory skills than students appearing in Delhi Board examination.

6) There is a significant difference between the achievements of chemistry laboratory skills of students coming from families with different socio-economic status.

7) There is significant difference in the achievement of chemistry laboratory skills of students with different out of school activities.

8) There is a significant difference in the achievement of chemistry laboratory skills among the various types of school on account of material and manpower variations in these schools.

9) There is a significant correlation between manipulative skills and cognitive skills of a student

10) There is a significant correlation between the achievement in chemistry laboratory skills and chemistry practical score in the Board examination (CBSE).

11) There is a significant correlation between the achievement in demistry theory test (Pandit) and chemistry theory test class XII (CBSE).

12) There is a significant correlation between manipulative skills of Entry Level Test and manipulative skills of Terminal Level Test.

13) There is a significant correlation between cognitive skills of Entry Level Test and cognitive skills of Terminal Level Test.

(D) Selection of the Schools

In the Union Territory of Delhi there are four types of schools at the senior secondary level. These are (a) public schools, (b)Kendriya Vidyalayas, (c) Delhi Administration schools and (d) Aided schools. Aided schools are financed by the Delhi Administration to the tune of 90% but run exactly on the pattern of Delhi Administration schools in every detail except that they are controlled by private managements. The idea was to have one type

of school from each group. But in view of the little difference between (c) and (d) the type of schools effectively reduces to only three. Thus, three schools in the Union territory of Delhi were selected for the try out of the study. One of them was a Kendriya Vidyalya. This was one of the twelve Kendriya Vidyalayas in the Union territory of Delhi. Kendriya Vidyalaya belongs to a chain of government Public schools (about 550) throughout India. They are being controlled by Kendriya Vidyalya Sangathan, an autonomous organisation working Under the Union Ministry of Human Resources and is fully financed by government of India. Kendriya Vidyalayas are meant for the Children of transferable central government servants (where priority is given to combatant defence personnel). Most of the students are from lower middle class. They have strong social background though not very good economic background. Academically they are highly motivated. In terms of facilities both men and materials, Kendriya Vidyalayas are among the best among the government schools. That is, in fact, why they are known as government "public" schools.

The second type of school was a Public School. This is one of the three best public schools of Delhi. It is also one of the best public schools in the country. This school is managed by a trust and receives no government aid. Consequently, it is completely dependant upon its own finances. Most of the students come from affulent business families and prosperous professionals. Economically and socially these students are the best in the sample. Academically they are not so well motivated. In terms of facilities both men and material, no school in the union territory nor many in the entire country are as well provided as in this public school. On top of these facilities that are normally available in any other school the students of this school have many more facilities for extra curricular activities.

To represent the third type of school we have selected a Government Boys Senior Secondary School,* This is one of the [illegible] 450 Schools run by the Department of Education, Delhi Administration. It is meant only for boys living in its immediate neighbourhood. They are mostly the children of the junior government servants who are economically and socially poor. Academically too they are not too well motivated. The school is completely financed by the Delhi Administration. In terms of facilities both men and

---

* Most of the Government Senior Secondary Schools are either Boys School or Girls School.

materials, this school is comparatively better placed than an average government school because of its being located in a colony inhabitated by government servants themselves.

(E) Selection of Students

Type I & type II schools had three sections while school type III had only two sections studying chemistry in class XII. One section from each school was chosen at random for this study. The total sample consisted of 107 students distributed among the three types of schools and as boys & girls as shown in Table 3.1.

Table 3.1 -

Sample of Students

S.No.	Name of the School	Type	No. of Students	Boys	Girls
1.	Kendriya Vidyalaya	I	34	25	9
2.	Public School	II	36	24	12
3.	Govt. Boys Senior Secondary School.	III	37	37	-

clearly, two schools, Kendriya Vidyalaya and Public School, are co-educational while Government Boys Senior Secondary School is only for boys.

The tables below and overleaves reflect the schoolwise parental profession, Family Income, Parental Education, and Socio-economic status. The tables show the social and economic stratification of the students in different schools.

Table 3.2

Father's Profession

Grade	Description	Schools			Total
		Type I	Type II	Type III	
I	Specialist	02	07	01	10
II	Professional	08	23	05	36
III	Semi-Professional	10	05	08	23
IV	Technician	11	01	05	17
V	Skilled Worker	02	X	06	08
VI	Other Categories	01	X	12	13
	Total	34	36	37	107

Table 3.3

Mother's Profession

Grade	Description	Schools			Total
	666	Type I	Type II	Type III	
I.	Specialist	X	04	X	04
II.	Professional	X	05	X	05
III	Semi-Professional	03	10	[illegible]	13
IV	Technician	X	01	02	03
V.	Skilled worker	01	X	X	01
VI.	Other categories	30	16	35	81
	Total	34	36	37	107

Tables 3.2 and 3.3 show the difference in the parentage of students in the three schools. Type II school clearly stands c out while most fathers are professional large proportion of mothers are semi professionals. Type III school is another extreme and type I is somewhat in the middle.

The economic status as indicated by income in table 3.4 presents more or less the same picture. For type II school half the students come from parents with income exceeding Rs.5,000/-. On the other had the predominant number of pupils in type III school come from families with incomes between Rs.1,000/- & Rs.1500/-. For type I school half the pupils enjoy family income between Rs.2000/- & Rs.3000/-.

A similar situation holds with regard to educational background of the parents of students in the three schools. Tables 3.5 & 3.6 show that School type II is dominated by these at the upper end of the educational spectrum, school type III by the lower end and type I is in the middle.

Table 3.4

Family Income

Grade	Description	Schools			Total
		Type I	Type II	Type III	
I	Above Rs. 5000/-	03	18	X	21
II	Rs.4,000/- to Rs.5,000/-	03	04	X	07
III	Rs.3000/- to Rs.4,000/-	02	13	06	21
IV	Rs.2000/- to Rs.3,000/-	17	01	11	29
V	Rs.1500/- to Rs.2,000/-	05	X	06	11
VI	Rs.1000/- to Rs.1,500/-	04	X	14	18
	Total	34	36	37	107

Table 3.6

Mother's Education

Grade	Description	Schools			Total
		Type I	Type II	Type III	
I.	Postgraduate Professional degree/M.Sc.Ph.D.	X	06	X	06
II	Professional degree/ M.Sc. M.A.LL.B/M.A. BEd.	X	04	X	04
III.	M.A./M.Com.	X	11	X	11
IV.	B.Sc./Diploma Engineering/B.A.LL.B/B.A. B.Ed.	03	03	01	07
V.	B.A./B.Com Language Honours.	09	07	05	21
VI.	Intermediate or below	22	05	31	58
	Total	34	36	37	107

Table 3.7

Socio-Economic Status

Grade	Score range	Schools			Total
		Type I	Type II & III	Type III	
I	41-65	05	22	01	28
II	34-40	06	12	03	21
III	27-33	17	02	13	32
IV.	21-26	04	X	10	14
V.	14-20	02	X	08	10
VI.	1-14	X	X	02	02
	Total	34	36	37	107

Table 3.7 presents in an aggregative manner the background of students in the three schools. Naturally, it gives us even more clearly the pattern that follows from the earlier tables. For school type I half the number of pupils corresponds to grade III (score range 27-33). For school type II all but 2 pupils correspond to the first two grades with scores ranging from 34 to 65. In contrast, in school type III only 4 (out of 37) students are from families within the first two grades. Half of them are in fact from grades III and IV. This, in a way sums up the relevant characteristics of the three schools.

(E) Construction of Tools

In order to measure chemistry laboratory skills two tests were developed namely the Entry Level Test and Terminal Level Test. The Entry Level Test was based on the relevant chemistry laboratory skills of class XI. It was used to find the achievement of students in chemistry laboratory skills at the beginning of the academic session of class XII. It had 42 items (14 manipulative test items in Section A, and 28 test items of paper pencil type in Section B) Section A was meant to find the performance of students in manipulative skills (psychomotor domain) and section B was meant to find out the performance of students in cognitive skills (cognitive domain).

The Terminal Level Test was based on the relevant chemistry laboratory skills of class XII. It was used to

find the achievement of students in chemistry laboratory skills/at the end of the academic session of class XII. It had 41 test items (14 manipulative test items in Section A was 27 test items of paper pencil type in Section B). Section A is meant to find the performance of students in manipulative skills (psychomotor domain) and Section B was meant to find out the performance of students in cognitive skills (cognitive domain).

The theory test was/ based on the chemistry theory syllabus of classes XI and XII prescribed by the Central Board of Secondary Education, New Delhi. It was used to measure the achievement of students in chemistry theory at the end of the academic session of class XII. It has 40 test items. All of them are multiple choice items having four alternatives each. Six test items are related to knowledge, 28 test items are related to understanding and six test items are related to application.

(G) Collection of Personal bio-data

A form was constructed wherein all the personal bio-data and interests of the students relevant to the development of chemistry laboratory skills were included. Apart from Name, age, Father's Name, Mother' tongue, it also asked about Father's profession, Mother's profession, Family Income, Father's Education and Mother's Education. Some of the other questions asked about were personal hobbies, Interest in Educational television/

Educational broadcasts/Science Magazines/Science Clubs/Science Exhibitions/Science Museums/Popular science lectures/Science programmes of television/Science programmes of radio/Involvement in work Experience or Vocational job.

Father's profession, Mother's profession, Family Income, Father's Education and Mother's Education were used to determine the socio-economic status of the students. The criteria to judge the socio-economic status was as under. Students were divided into six categories on account of Father's/ Mother's Profession (specialist, Profession, Semi-Professional, Technicaian, skilled worker/and(Semi Skilled worker Clerical/ shop owner/Farm owner/others). The marks, alloted on this account ranged from 15 in case of specialist to 6 in case of semi skilled worker etc. (The details on account of socio-economic factors are given in chapter -V).

Six categories were also used for monthly Family Income (All sources). Above Rs.5000/-, Rs.4000/- to Rs.5000/-, Rs.3000/- to Rs.4000/-, Rs.2000/- to Rs.3000/-, Rs.1500/- to Rs.2000/-, Rs.1000/- to Rs.1500/-, the marks alloted on this account ranged from 15 in the case of monthly family Income Above Rs.5000/- to 4 in the case monthly family income Rs.1000/- to Rs.1500/-

The students were also divided into six categories on account of Father's/Mother's Education, i.e. (post-graduate professional degree/M.Sc. Ph.D., Professional degree/M.Sc./

M.A.,LL.B./M.A.B.Ed.) ,(M.A.,M.Com.), (B.Sc./Diploma in Engineering/B.A.LL.B/B.A. B.Ed.), B.A./B.Com./Language Honours, Intermediate Pass & Below, The marks alloted on account of Father's/Mother's Education, ranged from 10 in the case of Post-graduate Professional degree/M.Sc. Ph.D. to 4 in the case of Intermediate Pass and Below.

The individual score of each student on account of Father's profession, Mother's Profession, Family Income, Father's Education and Mother's Education were added up. If the total score was above 40 the student was assigned category I, If the score ranged from 40 to 34 student was assigned category II. If the total score was between 27 and 33 the student was assigned category III. If the total score ranged between 21 and 26 the student was assigned category IV, If the total score ranged between 14 and 20 the student was assigned Category V, if however the total score was below 14 the student was assigned category VI.

(H) Collection of the data regarding out of School activities.

The involvement in personal bobbies/scientific activities/work experience/vocational job were taken into account for judging the development of chemistry laboratory skills. The criteria for judging the extent of involvement

in personal hobbies/scientific activities/work experience/ vocational job are given in Chapter V.

All the students were divided into six categories on account of involvement in out of school activities. The purpose of the construction of this form was to gather data so as to know how out of school activities of scientific nature and the socio-economic status of the student helps. the development of chemistry laboratory skills.

(I) Details of Chemistry Laboratories & Other School Facilities

The purpose of collecting the details of the chemistry laboratory and other school facilities in three types of schools was to find how these facilities help in the development of chemistry laboratory skills. What variations and differences do the chemistry laboratory and other school facilities make in the achievement of chemistry laboratory skills in three types of schools. Some of the details relate to name of the school, date of establishment, date of introducing (+2) classes in science, academic and training qualifications of the chemistry teacher. The details about the concerned post graduate teacher was his educational qualifications, total teaching experience, teaching experience at (+2) stage, experience of any special in

in service training programmes, period of inservice training programme, and the Age of the teacher, the number and the qualifications of supporting staff, (supporting staff includes other (post graduate/trained graduate) teachers/demonstrators/ laboratory assistants/laboratory attendants/sweepers). The annual grants for the chemistry laboratory, physical dimensions and other facilities available in the laboratory (The quantity of chemicals/glassware/apparatus).

Among the pieces of equipment the items which were included in the questionnaire for response were beakers (various sizes) Funnels, flat bottom flasks (various sizes) glass rods, Glass tubes, graduated pipettes (various sizes) ignition tubes, Liebigs condenser, Measuring cylinders (various sizes), Beehive shelves, calorimeter, dry cells, connecting wires, China crucibel, Ammeter, Electric bulb-holder, Electric bulb, circuit key, Measuring scale (Various sizes), Thermometer (Various ranges) water bath, Rubber cork.

Among the Inorganic chemicals which were included in the questionnaire for response were Alum, Ammonium sulphate, Aluminium sulphate, Ammonium Molybedate, Arsenious sulphide, Barium chloride, Bromine, Copper chips, Ferric chloride, Di-Sodium hydrogen Phosphate, Ferric sulphate, Ferrous Ammonium sulphate, Iodine, Iron metal, Lead metal, Magnesium metal,

Mercury, Mangneese dioxide, Mono-Sodium hydrogen phosphate, Potassium Permanganate, Potassium dichromate, Potassium Ferrie Cyanide, Potassium Nitrate, Potassium bisulphate, Potassium Chlorate, Potassium Iodide, Potassium bromide, Potassium thiocyanate, sodium chloride, sodium carbonate, sodium thiosulphate, sodium Acetate, Sodium Potassium tartarate, Sodium Nitro prousside Sodium peroxide, Sodium Metal, Sulphur, Schiffs Regant, Tin Metal, Zinc Metal.

Among the organic compounds included in the questionnaire for response were Acetaldehyde, Accetic Acid, Acetone, Aniline, Acetamide, Bendicts Regant, Benzene, Benzyl Alcohol, Benzoic Acid, Butanol, Carbolic acid, Carbon disulphide, carbon tetrachloride, casein, chloroform, citric acid, chloral hydrate, Dimethyl glyoxime, p-dichloro benzene, Ethyl alcohol, Ethyl amine, Formaldehyde, Formic acid, Fructose, Gulcose, Lactose, Maltose, Methyl Alcohol, [redacted], Methyl oxolate, Methyl orange, Napthalene, L-Naphthol, Ninhydrin, Oxalic acid, Phenol, Phenolpthalein, Phenyl hydrazine hydrochloride, phthalic acid, starch, sucrose, urea.

Among the miscellaneous substances included in the questionnaire for response were Agar-Agar, Ajwain, (aniseed) Brass Alloy, Bronze Alloy, Blue Ink, charcoal powder, cellophane, coconut oil, vegetable oil, ghee, duralumin, Fibres (cotton, silk, rayon, woolen, terylene etc.). Filter paper (whatman's), Gelatin, Gum, Glass, Cardimum, wool, Gram flour, Groundnut oil,

Kerosene oil,"Mahuva oil"Mustard oil, olive oil, Ink, standard market soap, saw-dust, saunf, threads, tea samples, turpentine oil Wax(paraffin), wooden chips, wheat flour, yeast powder.

The physical facilities available which have been included in the questionaire for response were covered area of the chemistry laboratory, size of the chemistry laboratory, ceiling height of the chemistry laboratory, cross ventilation in the chemistry laboratory , provision of suction fans near the ceiling, number of working tables, number of working seats, Average height of the working table from the ground floor, size of the working table, provision of sinks in the working table, provision of drainage and waste disposal in the chemistry laboratory, availability of electricity in the chemistry laboratory, availability of gas in the chemistry laboratory, availability of other sources of heat, provision of a fuming cupboard, availability of dumping places for broken glassware, provision for store room, provision for lighting, provision of first aid and fire extinguisher.

The other very important item included in the questionaire was the total Annual budget for the chemistry laboratory.

(J) Laboratory Facilities

Table 3.8

Comparison of three school laboratories

Type of School	Type I	Type II	Type III
Annual Budget	Rs.5000/-	Rs.35,000/-	Rs.3800/-
Qualifications of Teacher	M.Sc.M.Ed.	M.Sc.,B.Ed.	M.Sc. B.Ed.
Experience of Teacher	25 yrs.	23 yrs.	17 yrs.
No. of students using the laboratory	400	270	360
No. of demonstration	-	-	-
No. of Laboratory Assistant.	1	3	1
No. of Laboratory attendants	-	1	-
No. of sweepers	1	1	1
Floor Area of the laboratory	450sq.ft.	2000 sq.ft.	750 sq.ft.
Height of the laboratory	10 feet	15 feet	12 feet
provision of exhaust fans	yes	yes	yes
provision of drainage	yes	yes	yes
provision of water	yes	yes	yes.
Provision of electricity	yes	yes	yes
Provision of gas	yes	yes	yes
Provision of enough air and Sunlight	yes	yes	yes
Provision for waste disposal	yes	yes	yes
Provision for first aid & fire extinguisher.	yes	yes	yes

(K) Administering the tests

The Entry Level Test was administered at the beginning of the academic session of class XII. Before administering the Entry Level Test in the chemistry laboratory all preparations were made. All the chemicals/materials/equipment/glassware were available at different laboratory seats. Care was taken that students need not ask for anything while performing the tasks. All the laboratory seats were marked from one to fourteen with the help of paper boards. First the students were taken to the chemistry laboratory where they were asked to complete the part - A of the test by doing the 14 assigned tasks. These 14 tasks were arranged at 14 laboratory seats in the chemistry laboratory. The students went at random to different seats so that every one could do the assigned task and there is no crowding anywhere. Then they were asked to complete the Part-B of the test by answering 28 paper pencil tests. The whole test was completed in 45 minutes duration. The personal Bio-data form was also got filled in by the students. Similarly at the end of academic session of class XII two tests were administered i.e. Terminal Level Test & Theory Test (Pandit). Both of them were 45 minutes duration. In the part A of the Terminal Level Test students were asked to go to different laboratory seats, perform the assigned tasks and then move to the next laboratory seat. Before administering the Terminal Level Test in the chemistry laboratory all relevant preparations were made.

All the chemicals/materials/glassware/equipment were made available at different laboratory seats. It was ensured that students do not waste time by asking for anything while performing the tasks. All the laboratory seats were duly marked from one to fourteen with the help of paper boards. The students went at random to different laboratory seats so that everyone could do the assigned task and there is no over crowding anywhere. Then they were asked to complete the part B of the test by answering 27 paper pencil tests.

Similary students were asked to answer 40 paper pencil tests items in Theory Test (Pandit) in 45 minutes.

(L) Evaluation of the tests and other details

All the answer sheets were serially arranged and code number was alloted to each student. The coded number was incorporated on each answer sheets of every student. Each test was alloted 100 marks (the marking scheme of the three tests can be found in Chapter V). After marking and totalling all the answer sheets, the marks achieved by every student in various tests were entered in the composite record sheet.

Similarly bio-data forms of students and bio-data forms of concerned teachers and school laboratories were serially arranged. A code number was alloted to each student/teacher or school as in the earlier case. The code number was incorporated on the bio-data form of each student/teacher/school.

The bio-data details of each student were marked. A total of 65 marks were alloted to his socio-economic status (Fathers Profession, Mothers Profession, Family Income, Fathers Education, & Mother's Education). A total of 20 marks were alloted to his school activities (student's hobbies (ordinary and scientific)/Scientific activities, work experience and involvement in vocational job). The involvement of each student in out of school activities was marked and a category was alloted to him out of six categories. Similarly the socio economic status of each student was judged, on the basis of marks obtained by him. He was allotted a category out of six categories. (For details see chapter V). The relevant category of each student in socio-economic status and involvement in out of school activities was entered against his code number in the composite record sheet.