

A Study of Chemistry Laboratory Facilities in Senior Secondary Schools

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Abstract— Chemistry is an experimental science which gives opportunity to the learners to familiarize with the scientific methods and get them doing important scientific activities like observing, measuring, analyzing and describing. It also provides an opportunity to the teacher to teach chemistry as a way of investigation. Laboratory work is an essential component of chemistry curriculum. The development of powers of observation, measurement, prediction, interpretation and decision making are dependent on laboratory work experience of students. But unfortunately the present curriculum transaction approach in chemistry, like all other sciences, relies mostly on abstract thinking, writing long formulae and complex structures and handling complicated equipments. This method of teaching chemistry has discouraged both teachers as well as pupils. The main reason for this process is that the laboratories in most of the schools today are not adequate to get all science students actively engaged in experiments. Rather, schools heavily resort to either no experiments or if there is any urgency then as minimum as they can. Also, experiments which form a part of the syllabus are not relevant or interesting and are not related to the issues connected with the real life situations. Besides this, there are various constrains such as large teacher-pupil ratio in the class / laboratory, lack of physical facilities for performing experiments as required by the rigid and time-bound heavy syllabus. This paper discusses the outcomes of a study which attempted to examine the chemistry laboratories facilities at senior secondary schools of Delhi – NCR.

Key words: Existing Laboratory Facilities in Schools, Laboratory work, Chemistry Laboratory Facilities

I. INTRODUCTION

It is well known that chemistry is an experimental science which provides familiarity with the scientific method and in turn means doing something, observing, measuring, analyzing and describing. It also provides an opportunity to the teacher to teach chemistry as a way of investigation. Laboratory work is an essential component of chemistry curriculum. Students can be stuffed with facts and theories but without experiments they cannot experience the reality of chemistry as a science. The development of powers of observation, measurement, prediction, interpretation and decision making are dependent on laboratory work experience of students. But unfortunately at present

chemistry is generally taught as a subject which calls for abstract thinking, writing long formulae and complex structures and handling complicated equipments. This method of teaching chemistry has discouraged both teachers as well as pupils. One of the main reasons for this is poor laboratory infrastructure particularly in our government schools and constraints on procuring laboratory consumables. Private schools also seem not too generous in terms of willingness to have sufficient provisions for laboratory equipments and chemicals, etc. These are clubbed with the problem emerged out of large teacher-pupil ratio in the class and laboratory, lack of physical facilities for performing experiments as required by the rigid and time-bound heavy syllabus. The result is that the students feel disinterested and dull. It is, therefore, essential that a true and logical stock taking of laboratory facilities in our schools should be in place and the management of the schools – whether it is private or government – should give serious attention to it.

Laboratory work is one of the main forms of teaching used in chemistry and other areas of science discipline. Laboratories are one of the most important characteristic features of education in the sciences at all levels. It would be rare to find any science course in any institution of education without a substantial component of laboratory activity. However, very little justification is normally given for their presence today. It is assumed to be necessary and important. It is taken for granted that experimental work is a fundamental part of any science course and this is especially true for chemistry courses. Very frequently it is asserted that chemistry is a practical subject and this is assumed, somewhat naively, to offer adequate justification for the presence of laboratory work. Thus, the development of experimental skills among the students is often a suggested justification. Nonetheless, this argument needs to be questioned to justify the position or role of the laboratory in the field of chemistry education.

A. Existing Laboratory Facilities In Schools:

One of the most important aspects of the consideration here is to look at the available infrastructural facilities in our schools to provide adequate learning experience through laboratories. The following table presents an account of the existing laboratory facilities in our schools across the country.

Management	Rural			Urban			Total		
	A	B	C	A	B	C	A	B	C
Government	5187	4529	2813	3905	3748	2976	9092	8277	5789
Local Body	226	216	133	470	458	360	696	674	493
Private Aided	3029	2980	2341	4233	4193	3745	7262	7173	6086
Private Unaided	2093	2045	1884	5665	5627	5425	7758	7672	7309
Total	10535	9770	7171	14273	14026	12506	24808	23796	19677

Note: A – Number of schools offering Chemistry at +2 Level

B – Number of schools having facility of chemistry laboratory
C – Number of schools having adequate facility of chemistry laboratory

Table 1: Management-wise Schools according to availability of Chemistry Laboratory facility at +2 Level
Source: 7th All India School Education Survey – 2006

At implementation level, a major area of concern in chemistry teaching is the gradual decline of practical work and experimentation at senior secondary levels. The oft-repeated recommendation of integrating experimental work and theory teaching has not been realized because of perceived lack of facilities and trained teachers in most of the schools. The “Seventh All India School Education Survey Report” points that out of 24,808 higher secondary schools offering chemistry as a subject 19,677 (79.31%) schools are having the adequate facility of chemistry laboratory (Table: 1). The government schools having adequate chemistry lab facilities are 63.67 percent. This itself points towards the gap between ‘what ought to be’ and ‘what is there’.

II. THE PRESENT STUDY

The data presented in the above table is a statistical account of the availability of laboratories in our schools. However, this does not reflect what happens in the schools. In other words, the tabular facts and figures as presented above gives a “macro” information about the school laboratories, whereas for a micro-detail of the status of chemistry laboratories in schools, a study was planned to be conducted in the senior secondary schools of Delhi and NCR (The National Capital Region). The sample of the comprised of 10 teachers of government schools and 10 teachers of private schools, situated in Delhi and NCR, affiliated to CBSE (Central Board of Secondary Education). The study adopted survey method to collect data and simple descriptive statistical techniques for the subsequent analysis.

III. ANALYSIS AND DISCUSSION

In order to assess the chemistry laboratory facilities in existing senior secondary schools in NCR, twenty CBSE affiliated schools in NCR (National Capital Region of India) were randomly chosen and visited to collect the relevant data. Information about available facilities was collected through a self-designed questionnaire and a checklist from chemistry teachers of the surveyed twenty senior secondary schools. The analysis of data so collected, about the available chemistry laboratory infrastructure and facilities in the surveyed schools, is as the following:

To find out on whether chemistry laboratory/laboratories are adequate for + 2 level students, the teachers were asked to state whether they considered the chemistry laboratories in their schools adequate for the chemistry students of senior secondary classes. Table 2 presents the results of the findings.

Response	Frequency	Percent
Yes	9	45
No	11	55
No Response	0	0
Total	20	100

Table 2: Teachers’ opinion on whether laboratory/laboratories are adequate for chemistry students of senior secondary classes

The uniqueness of the laboratory lies principally in providing students with opportunities to engage in processes of investigation and inquiry but despite this, majority of the schools’ chemistry laboratories were found not so adequate for the students of class XI and XII. According to table 2, 55 % of the teachers felt that the chemistry laboratories in their schools were not adequate, particularly in terms of space, furniture, apparatus, and chemicals; since they had a large number of students. Therefore, learning that involves practical work could not be carried out properly.

Teachers were also asked to state the frequency at which they conducted practical lessons in chemistry. Table 3 presents the results of the findings on teachers’ response about frequency of conducting chemistry laboratory classes.

No. of Periods	Frequency	Percent
0 – 15	2	10
15 – 30	6	30
30 – 45	9	45
45 – 60	3	15
Total	20	100

Table 3: Teachers’ response on frequency of conducting chemistry practical lessons

The CBSE chemistry laboratory curriculum for + 2 level prescribes 60 periods for chemistry practicals in class XI and 58 periods of practicals in chemistry in class XII, apart from 10 periods suggested for carrying out project work in both the classes. However, according to the information provided by the teachers, as shown in the table 3, 10 % of the respondent teachers conducted up to 15 chemistry laboratory periods in their schools during the preceding session, 30 % of the teachers conducted 15 to 30 practical periods, 45 % of the teachers conducted around 30 to 45 laboratory periods, and 15 % teachers utilized 45 to 60 laboratory periods in their respective schools. Teachers cited a number of reasons for not being able to conduct the prescribed number of chemistry laboratory periods. This included Time – Table constraints to heavy curricular loads and several other issues.

Teachers were also asked to comment on type of experiment they most frequently use in their schools. The following table 4 presents the results of the findings about teachers’ response on the type of experiments that they most frequently use.

Responses	Frequency	Percent
Group Experiments	8	40
Teacher Demonstration	12	60
Individual Experiments	0	0
Total	20	100

Table 4: Teachers’ response on type of experiment most frequently used

The above Table-4 shows that though the teachers did carry out practical lessons in varying degree, most of the practical lessons carried out by the teachers interviewed were group experiments (40 %) and teacher demonstrations (60 %). Though the importance of teacher's demonstration cannot be denied as some of the chemistry experiments are very risky to perform without knowing the implicit hazards. Still, after demonstration, students must be given opportunity to perform such experiments, under teacher's supervision.

Teachers were further asked to give reasons for carrying out group experiments and teacher demonstrations in their schools. Table 5 presents the results of the findings on teachers' views on constraints felt in conducting chemistry practicals the way they were doing.

Responses	Frequency	Percent
Lack of apparatus	4	20
Lack of chemicals	7	35
Lack of practical manuals	0	0
Save on Time	9	45
Lack of reference books	0	0
Any other reason	0	0
Total	20	100

Table 5: Teachers' response on reasons for carrying out group experiments and teacher demonstrations

Most teachers expressed their desire and willingness to carry out practical lessons that students would be able to handle and / or manipulate the apparatus on their own. But due to certain factors such as lack of apparatus (20 %), saving on time (45 %), lack of chemicals (35 %) among others, hinders them from doing so (table 5). Besides these reasons, teachers were of the view that the heavy curriculum load particularly the theoretical component is so compelling that they are expected to spend less time in laboratory and complete the syllabus within the stipulated period of time otherwise students' results suffer. In all the surveyed schools, practicals are conducted once a week. If students are assigned to do practicals individually, it would consume much more time slots than what schools are providing now.

This implies that the students are deprived of the necessary skills to be able to carry out an experiment on their own hence hindering them from internalizing the essential concepts and skills of chemistry laboratory activities. Some teachers were of the view that since the chemistry practical examinations are conducted in groups and even student viva is conducted in groups, so it is wastage of time and resources if individual practicals activities are organized; hence the use of group experiments and teacher demonstrations in the absence of apparatus and chemicals and on saving time.

Teachers were also asked to state whether there is space adequate space for all the students in the chemistry laboratory during a practical lesson in their respective schools. The following table 6 presents the results of the findings.

Response	Frequency	Percent
Yes	14	70

No	6	30
No Response	0	0
Total	20	100

Table 6: Teachers' response on availability of adequate space for students in chemistry laboratory during a practical lesson

Since creating a healthy learning environment is an important goal for many contemporary science educators, it was necessary to find out whether the laboratories had enough space to accommodate a whole class during a practical lesson. According to table 6, 30 % of the respondents felt that the laboratories do not have adequate space for all the students during a practical lesson while only 70 % felt that the space is enough. Teachers were further asked to comment on the status of available apparatus in their respective schools' chemistry laboratories. This was further substantiated by a detailed checklist on available lab apparatus. Table 7 presents the results of the findings.

Response	Frequency	Percent
Yes	9	45
No	11	55
No Response	0	0
Total	20	100

Table 7: Availability of sufficient apparatus in chemistry laboratory

According to the table 7, 45 % responded that their school laboratory/ laboratories had sufficient apparatus whereas 55 % observed that their chemistry laboratories lacked sufficient apparatus.

Teachers were also asked to comment on the status of available chemicals in their respective schools' chemistry laboratories. This was further substantiated by a checklist on available chemicals. The following table 8 presents the results of the findings.

Response	Frequency	Percent
Yes	9	45
No	11	55
No Response	0	0
Total	20	100

Table 8: Availability of sufficient chemicals in chemistry laboratory

According to the table 8, 45 % responded that their school laboratory/ laboratories had sufficient apparatus whereas 55 % observed that their chemistry laboratories lacked sufficient apparatus.

Teachers were also asked to comment on the adequacy of the laboratory furniture in their schools. Table 9 presents the results of the findings.

Response	Frequency	Percent
Adequate	11	55
Inadequate	9	45
No Response	0	0
Total	20	100

Table 9: Teachers' response on adequacy of laboratory furniture

A substantial number of laboratories in the schools visited lacked furniture. According to table 9, 45 % of the teachers felt that the furniture present in the chemistry laboratory in their schools was inadequate while 55 % teachers felt it was adequate. Lack of furniture brings discomfort among the students during practical lessons hence negatively impacting by reducing their interest in the subject.

Teachers were also asked to comment on frequency of procuring laboratory facilities by the school administration in their schools. Table 10 presents the findings.

Response	Frequency	Percent
More frequently	0	0
Frequently	6	30
Rarely	12	60
Very rarely	2	10
Total	20	100

Table 10: Frequency of procuring laboratory facilities by the School Management

Maintenance of laboratory related facilities requires continued funding to ensure that fine facilities are maintained in a state of acceptable standards. Table 10 indicates that 30 % of the teachers responded that their schools procured chemistry laboratory related facilities frequently, 60 % teachers stated that their schools procured laboratory facilities rarely, while 10 % of the respondents observed that it was very rarely done.

Teachers were also asked to whether laboratory safety procedures are properly followed the in the laboratory. Table 11 presents the results of the findings.

Response	Frequency	Percent
Yes	8	40
No	12	60
No Response	0	0
Total	20	100

Table 11: Laboratory safety equipments and arrangements, such as fire extinguisher, first-aid kit, ventilation system, and emergency exhaust system are adequate

In response to the question about adequacy of laboratory safety equipments, such as fire extinguisher, first-aid kit, ventilation system, and emergency exhaust system, 40% of the respondent teachers were affirmative while 60% teachers marked 'No' as their comments. Following lab safety rules is very important particularly in the case of chemistry experiments, and schools must have adequate arrangement for the same. Students should also be given proper instructions in this regard so that they can develop a sense of responsibility for the safety of themselves and of others.

Concluding the questionnaire on assessment of + 2 level chemistry laboratory, teachers were asked to rate the overall state of senior secondary chemistry laboratory in their respective schools. The following Table-12 presents the results of the findings.

Response	Frequency	Percent
Very Good	2	10
Good	5	25
Average	3	15
Poor	10	50
No Response	0	0
Total	20	100

Table 12: Overall state of Senior Secondary School Chemistry laboratories

In finding out the overall state of the senior secondary level chemistry laboratories, the results of table 12 show that 25% of the teachers felt that the state of their laboratory was good with 10% feeling very good and 15% feeling they were in average state respectively. However, 50% of the respondents felt that the laboratories were in a poor state.

IV. CONCLUSIONS

From the analysis of data collected on status of chemistry laboratory facilities, in the surveyed senior secondary schools of NCR, the following inferences are drawn:

- (1) Majority of schools do not have separate chemistry laboratory for +2 level students. Only 2 (D.P.S. Gr. Noida & Ram-Eesh International School, Gr. Noida) out of 20 surveyed schools (Appendix-VI) were found to have separate chemistry laboratory for senior secondary classes.
- (2) Majority of teachers felt that the laboratories were not adequate for senior secondary chemistry students. Despite CBSE's prescribed 60 laboratory periods requirement, only 15% teachers were able to conduct practicals between 45 to 60 periods. Rest of the teachers conducted much less than that.
- (3) Out of the conducted laboratory classes, majority (60%) of the teachers followed demonstration method for laboratory periods. Rest (40%) followed group experiments. None of them reported to have given students an opportunity to conduct practicals individually.
- (4) Reasons that teachers cited for conducting demonstrations and group experiments were mainly lack of chemicals, apparatus, and time saving.
- (5) Teachers admitted that though there was sufficient space and furniture in laboratory area for conducting experiments; yet, lack of sufficient apparatus and lack of sufficient chemicals were the main hindrance in conducting laboratory classes.
- (6) In most of the cases, teachers expressed that the procurement of laboratory facilities were not so frequent. This also controls, in some way, use of consumables and apparatus in laboratories.
- (7) Laboratory safety arrangement was another concern for majority of the respondents, as 60% of them felt that their schools lacked in having adequate provisions for safety equipments and arrangements in chemistry laboratory.
- (8) Survey of school laboratories clubbed with teachers' response on overall state of existing senior secondary school chemistry laboratories

revealed that at least 50% of the surveyed laboratories are in poor state, whereas 15% turned out to be average, 25% good and 10% could be termed as very good.

From the above analysis, it can be noted that there is a genuine need to improve on our senior secondary school chemistry laboratories in terms of their state and use. Even in those schools, where laboratories were in a better state, it served the cosmetic purpose only and laboratory sessions were conducted just to meet the formal curricular requirements as per the final examinations' demand.

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