

Status and Use of Science Laboratories in the Secondary Schools of Sikkim

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Abstract

Science has always played an important role in understanding the natural phenomenon of the world. Thereby, scientific knowledge can become a characteristic of an individual by inculcating scientific temper at a young age, and for that, science practicum is an important aspect in the school curriculum. Science labs equipped with instruments, equipments and necessary glassware provides the conducive atmosphere for inculcation of science process skills. But the science labs at secondary stage lack all the elements which would have led to scientific temperament. This study reported the status and use of science labs in the secondary schools of Sikkim and highlighted the various policy implications which can go a long way in improving the condition of labs.

INTRODUCTION

Science learning is incomplete without performing experiments and activities in the laboratory. The laboratory experiments and hands-on activities enhance the learners' understanding and make them become active in the teaching-learning process. The experiments and project work suggested at the secondary stage develop basic skills of measurements,

handling some common apparatus, chemicals, microscope, making observations, collecting data and presenting it in appropriate format, interpreting the data and drawing conclusions (NCERT, 2013). Thus, it basically provides students with a lending hand in the attainment of the necessary science process skills, and in inculcating scientific attitude and temper among them.

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NCF 2005 emphasises that well-equipped laboratories and libraries, and access to computers are essential, and all efforts must be made to ensure that schools are well equipped with such resources. Laboratory experiences add on to the students' understanding of the complexity of the natural phenomena and learn the practical skills, such as making observations, formulation of hypotheses, collection of data and its interpretation. It assists the students to collaborate effectively with others in carrying out complex processes.

Central Board of Secondary Education (CBSE, 2005) has given some norms, based on which science laboratories need to be designed in schools for the secondary level. For secondary students, schools must have a composite science lab of minimum of 9m×6m in size. The science labs should be fully equipped. Schools can purchase equipments prescribed for science subjects from the Board. Following are the criteria given for designing of the lab in the schools.

- A laboratory could be located in the ground floor towards the end of the building.
- Laboratory should cover an area of 45×25 for an average class of 40 students.
- In laboratories, cement floor or concrete flooring should be used. Slippery floor should be avoided.
- Minimum two doors should be there in the lab.
- There must be provision for electric lightening apart from day light.
- Sinks must be installed near the walls.
- Every laboratory must have a proper drainage facility.
- Almirahs should be provided for storing the equipments and apparatus.

Furthermore, according to Dangbin (2008), practical activities using sufficient facilities help the learners to acquire cognitive skills, such as formulation of hypothesis, observing, predicting, recording data, etc., which are necessary for acquiring scientific skills and knowledge. Moreover, Adeyegbe (2005) in Yara (2010) has listed laboratory adequacy as one of the factors that affects the learning outcome of students.

Research evidence indicates that science learning is not happening the way it is expected to be. The transactional mode is still limited to lecture or demonstration method. Added to this, it was also found that laboratories are still not functional in some of the schools. As a result, students not only lack process skills but are also unable to meet the learning outcomes.

To overcome this situation, the Rashtriya Madhyamik Shiksha Abhiyan (RMSA) was launched to improve the quality of secondary schools and importance has been given to setting up of science laboratories in these schools. Funds have also been provided to improve the scenario of science labs in the

school. In this direction, a study of this kind is taken up to study the status of laboratory facilities in the schools at the secondary level.

NEED FOR THE STUDY

Laboratory activities have long been seen as an important resource, which has also been shown to stimulate and motivate students to learn more about science. These activities appeal as a way of allowing students to learn with understanding, and at the same time, engages in a process of constructing knowledge. Moreover student engagement in laboratory courses has been shown to positively impact achievement in science. While elementary schools can benefit from a science corner, secondary and higher secondary schools require well-equipped laboratories. Practical work makes an exceptional learning surrounding that help student to construct their knowledge, enhance logical inquiry and psychomotor skills (Mashita, Norita, and Zurida, 2009). Moreover, practical work offers an interactive experience to the students, where they can broaden the scope of constructivist learning (Umar, Ubramaniam and Ukherjee, 2005). It is believed that by carrying out practical work, students' knowledge can be expanded to understand the real world (Millar, 2004).

Also, it was found that the use of chemistry laboratory helped in the development of scientific attitude, such as honesty, patience, skepticism as well as scientific skills for problem

solving in students towards the learning of chemistry, it trained the students in using scientific method (Akani, 2015). The findings of another study revealed that inadequate laboratory facilities have affected the teaching and learning in schools and in turn the academic performance of students (Oriade, 2008; Muhammad, 2017). From the review of the studies, it is evident that a large number of researches have been carried out at higher secondary level and undergraduate level compared to secondary level. Majority of the studies have focussed upon the status of chemistry laboratory rather than the integrated laboratory (Raju, Suryanarayana (2011), Oriade (2008) and Muhammad (2017).

NCERT (2015) conducted research studies in the schools of Madhya Pradesh, Karnataka and Rajasthan to find out the status of science lab and their use in learning science. The findings of these studies have revealed that in most of the schools of Karnataka and Rajasthan, separate science labs are not there and wherever the lab is found, it lacked the basic facilities. Only in majority of the schools of Madhya Pradesh, the laboratories are found to be effectively utilised by the teachers.

From the review of related literature, it was observed that rarely any studies have been conducted in north eastern states related to the status of utilisation of lab facilities. Hence, it is felt necessary to take up a study to find out the status of

laboratory facilities and the extent of utilisation in the schools at secondary level in Sikkim. Moreover, the findings of this research study will throw light on the concerns or issues related to the status and utility of science labs which can go into policy or schemes.

OBJECTIVES OF THE STUDY

1. To examine the availability of lab facilities for the teaching of science
2. To assess the utilisation of available lab facilities in science teaching
3. To study the extent of integration of theory and practicum in the teaching of science
4. To identify the factors for underutilisation and non-utilisation of available lab facilities

Research Questions

1. To what extent are the labs equipped and used by the secondary school teachers and students?
2. Are theory and practical activities integrated while teaching science by the teachers?
3. What are the reasons for under utilisation or non-utilisation of available facilities?

Research Design

The research was descriptive in nature, wherein the descriptive survey method was used to collect data from principals, teachers and students using various tools.

Sample of the Study

In Sikkim, the north, south, east and west districts of Sikkim were

considered. Six schools each from north, south and west Sikkim and seven schools from east Sikkim were randomly selected. The sample included urban and rural schools; secondary and senior secondary schools; and girls', boys' and co-education schools. From the schools of Sikkim purposive sampling technique is employed to select secondary school principals, science teachers and students from Class IX and X.

Selection of Students

Twenty students were selected from each school, such that 10 students were from Class IX and 10 were from Class X. The total sample for the study is 500 students (20 students × 25 schools).

Selection of Teachers

The teachers teaching science to Class IX and X were selected as the sample for the study. The total number of science teachers in the sample are 94, from 25 selected schools of Sikkim.

Selection of Principals

The principals of all the selected 25 schools were considered as a sample for the study.

Classroom Observation Sampling

One science lab session or science classroom teaching for secondary classes in each school was observed, thus making it a total of 25 observations.

DEVELOPMENT OF TOOLS

The following tools were developed, finalised and used in the study:

Questionnaire about Lab Facilities for Principal

The purpose of the questionnaire is to examine the availability and adequacy of lab facilities for teaching of science. The questionnaire consists of 16 questions divided into five categories, namely infrastructure and lab facilities, human resources and training, teaching-learning process, financial resources and future plans. It includes both subjective and objective type of questions.

Questionnaire about Lab Facilities for Teachers

The focus of the questionnaire was to assess the utilisation of available lab facilities in teaching of science and to identify factors for underutilisation and non-utilisation of lab facilities. The questionnaire consists of 35 questions divided into seven categories, namely infrastructure and lab facilities, human resources and training, teaching-learning process, computer lab, assessment, financial resources and suggestions.

Questionnaire about Lab Facilities for Students

The questionnaire consists of 16 questions which are divided into three

categories, namely infrastructure and lab facilities, teaching-learning process and financial resources. The purpose of the questionnaire is to examine the availability and utilisation of lab facilities in teaching of science by students.

Focus Group Discussion with Students

A set of 13 questions were listed, which would help in probing the reasons for non-availability and inadequacy of the lab materials. It would throw light on the problems faced by the students as well as teachers while conducting the practicals in the lab.

Observation Schedule

The schedule was developed by the research team which consists of 17 statements which can have two responses—either yes or no. The focus of the schedule is to examine the extent of integration of theory and practicum in teaching of science, facilities available in the science lab and utilisation of science lab in science teaching. The members of the research team observe one class or lab session and record their observations as yes or no.

Table 1
Tools developed and used in the study

Tool Administered	Respondents
Questionnaire about Laboratory facilities	Principal
Questionnaire about Laboratory facilities and utilisation	Teachers
Questionnaire about Lab facilities and utilisation	Students
Focus group discussion with students	Students
Observation schedule	Researcher

STATISTICAL TECHNIQUE USED

Frequencies and percentages were calculated from the data collected through questionnaires of principals, teachers and students. Qualitative data collected from observations of the classrooms or lab sessions and Focus Group Discussion were analysed.

FINDINGS OF THE STUDY

The major findings of the study are as follows.

Availability of Lab Facilities

Majority of the schools (92 per cent) of Sikkim have science lab and only one school in each of south and west Sikkim does not have a science lab.

Table 2
Availability of Science Lab
District wise

	Available	Not available
North Sikkim	6 (100%)	0
South Sikkim	5 (83.3%)	1(16.6%)
East Sikkim	7 (100%)	0
West Sikkim	5 (83.3%)	1 (16.6%)
Total	23 (92%)	2 (08%)

The data collected from 94 teachers indicate that the labs lack proper water facility (50 per cent) and drainage system (36 per cent). The same was evident during the observations made. Most of the schools (92 per cent) have lab attendantes, whereas one school each of south and west Sikkim does not have lab attendant.

Science kits are available in all the schools of north Sikkim, whereas these are unavalable in one school each of south and west Sikkim and two schools of east Sikkim. Schools of east Sikkim have a better provision of ICT labs compared to the other three districts. The science labs have not been adapted for the Children with Special Needs (CWSN) in the schools.

Adequacy of Lab Facilities

The size of the science lab is not adequate to carry out the experiments in majority (78 per cent) of the schools of Sikkim.

In 64 per cent of the schools, lab equipments are inadequate to carry out the experiments with the students. It was found out that one school each in the south, east and west Sikkim have less than 25% of the required equipments, which were not adequate for the students' strength. Glasswares used in the laboratory are adequate (in quantity) in most of the schools (72 per cent) of Sikkim. In north Sikkim, all the schools have adequate number of glasswares to meet the students' need. When it comes to the adequacy of the chemicals, it was found that 28 per cent have adequate quantity of chemicals to conduct experiments, while 43 per cent do not. It was also found that 24 per cent of the schools do not have chemicals at all to perform the experiments.

Table 3
Adequacy of chemicals district wise

District	Adequate	Inadequate	Not present
North Sikkim	2 (8%)	3 (12%)	1 (4%)
South Sikkim	1 (4%)	4 (16%)	1 (4%)
East Sikkim	3 (12%)	2 (8%)	2 (8%)
West Sikkim	1 (4%)	3 (12%)	2 (8%)
Total	7(28%)	12 (48%)	6(24%)

The charts, models and specimens are found to be adequate in numbers in majority of the schools. The stock registers were available in all the schools listing out the consumable and non-consumable materials separately for physics, chemistry and biology lab.

Allocation of Lab Period

All the schools of south Sikkim have allocated science lab period in the time table, whereas two schools each of north, east and west Sikkim do not have allocation of science lab period in the time table. In most of the schools, the designated lab period is used for other works, such as revision, completing the

syllabus and practising for the school programmes.

Utilisation of Lab Facilities

The science lab is being utilised by secondary students in the schools. Most of the schools of all the four districts are average in terms of utilisation of the lab facilities. Opportunities are provided to students to handle the lab apparatus and to carry out the experiments on their own in most of the schools. The students are allowed to use lab equipments in the classroom for experimentation and projects.

Experiments are being conducted in groups of four to six students and as demonstrations but rarely are conducted individually.

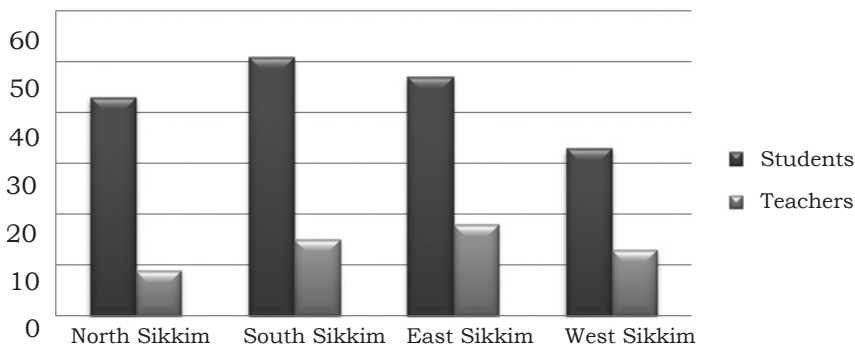


Figure 1. Use of lab equipments for project work

Working of Students in the Lab in Sikkim

In terms of students’ involvement, 78 per cent of the teachers expressed that the students are moderately involved during an experiment in the lab in majority of the schools.

teach the students. Students’ responses also supported this. Seventy-six per cent of the students expressed that lab work helped them in learning science better. During interaction with students, they even mentioned that lab work helped them in remembering concepts for a

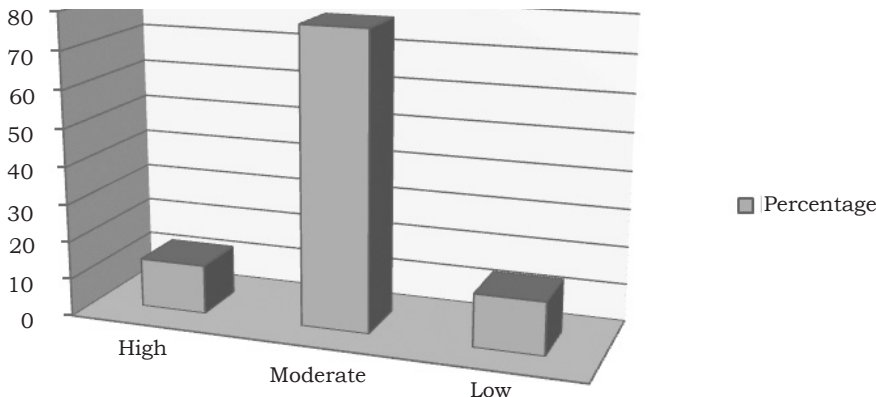


Figure 2. Student involvement in experiments

Teachers Training

Most of the science teachers (96 per cent) underwent training in lab skills, but a very few were trained in the use of science kits (20 per cent). Sixty-eight per cent of the teachers revealed that they use science kits to

longer duration of time and abstract topics are understood in an easy and better way.

Most of the teachers (85 per cent) felt that there is no need of improvisation to the activities proposed in the science textbook. Teachers believe

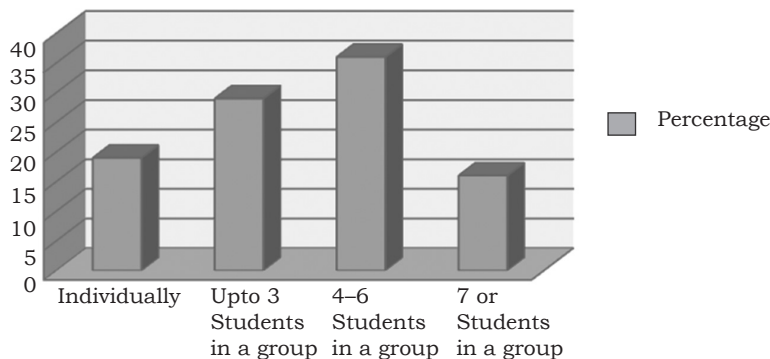


Figure 3. Students’ work in lab

that lab work helps in enhancement of learning of the science concepts and promoting process skills like observing, measuring, experimenting and reasoning skills.

ASSESSMENT OF LAB WORK

Science question papers, report card and performance file of the students were collected from all the sampled schools. From all these documents, it can be concluded that only theoretical aspect of performance of the students in science is recorded in the school report card. There is no scope for indicating the performance of students in lab activities in the performance file. In majority of the schools, 10 marks are allotted for the lab work and students are awarded marks without conducting the practicals. It was also observed that in most of the schools, application-based questions were not asked in the tests. The questions were textbook oriented and only theoretical. The lab practical related or activity-based questions were hardly found in the test papers.

Integration of Theory and Practicum

From the lab class observation and focus group discussion, it was understood that in most of the schools where lab apparatus or equipment is used while teaching or lab session is conducted, they are done in vacuum. From the analysis, it is evident that teachers have tried to carry out practicals but still, the theory has not

been integrated with the practical. The practical records are copied from the records of the senior students and submitted. Homework or also projects are not used for assessing students' learning. More, over they are very theoretical, monotonous and rest for name sake.

Reasons for Underutilisation of Laboratories

Lack of availability of lab equipments and chemicals, high student strength and time constraint acts as a major barrier in conducting of experiments. There is no accountability for mishandling or damaging the lab equipments in most of the schools. Fifty-two per cent of the schools reported that they did not receive any grants for the lab and its maintenance, whereas 48 per cent of the schools who received said that they were insufficient. Stock verification is not done annually in the schools.

The science lab is not a priority in the School Development Plan in most of the schools. There is no separate lab period allocated for Class IX students in the schools that have classes up to X. Whereas, in composite schools (with Class I–XII), a specified number of lab periods for Class IX and X finds place in the time table. Despite the allocation, most of the lab hours are being used for completing the syllabus and revision.

Educational Implications

The findings of the study have implications for interventions in

the system. Some of the major implications are given below.

- The schools have science lab as well as lab attendant but still the labs are not maintained properly. The lab attendants should be assigned their role and responsibilities by the management and be monitored on a regular basis. To update themselves, the lab attendants should be given training on maintenance of labs.
- Science teachers should be provided with the in-service training in lab skills and science kits so that their knowledge and practical expertise can be enhanced. This would in turn help them in integrating theory and practicum in their regular teaching.
- Funds should be allotted on the basis of enrolments and the needs of each school. It is better to grant a separate fund for science lab and its maintenance to the schools and for upgradation of the labs. These grants are to be enhanced keeping the needs of CWSN into consideration to make science education inclusive.
- School management needs to consider the lab as an important constituent and as a result, they need to audit the stock and replenish it from time to time, especially consumables and breakable items like glassware, chemicals to meet the needs of the students.
- East Sikkim being the capital of the state has better facilities overall when compared to other three districts. The funds can be allocated more in the north, south and west Sikkim for lab infrastructure and maintenance.
- Teachers should make efforts to use locally available materials, develop equipments for conducting experiments or show demonstrations to students irrespective of poorly equipped laboratory.
- Students should take active role by sharing responsibility with the faculty in maintaining cleanliness in the lab. Ownership and accountability needs to be fixed on the students on school property and its maintenance, as a sustainability measure. Teachers need to encourage the students to take an active part in developing improvised apparatus using locally available materials or resources.
- The science practical period should be used only for learning science and should be allocated twice a week for Class IX and X in all the schools, so that science theory can be integrated to practical knowledge.
- Teachers should provide students with the opportunity to engage in lab work. It will help in developing scientific attitude and enhance their achievement in science. Engagement of students in lab work helps them in sharpening their science process skills and scientific attitude.

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