Chapter 1

Introduction

1.1 Introduction

Science is both a body of knowledge and the process of acquiring and refining knowledge" The word science comes from the latin word 'scientia' which means knowledge or to know. Science is a systematized body of knowledge gained by human observation, experience and experimentation. Science is dynamic. It is knowledge as well as the process of its continuous development and refinement. Science is both a product as well as a process. It is an endless process of observation, exploration and acquisition.

The present work focuses on the process of observation, exploration and acquisition of information vis-à-vis laboratory. The focus of the study is to prepare a course on laboratory management for the pre- service B.Ed. teachers and try out the course to find its impact on students. The details of the study are depicted in the sections below.

1.2 Statement of the Problem

Effectiveness of Science Laboratory Management Programme for Pre-Service Teachers

1.3 Operationalization of Terms

The terms that are of prime importance to the study are opertaionalised below.

Laboratory Management Programme

This includes a set of instructional materials and tasks that aims at developing the pre-service students' laboratory management skills. That is they will learn to maintain laboratory records and organise laboratory sessions.

Pre-Service Teachers

This refers to student teachers of the one year B.Ed. Course.

Effectiveness

The term effectiveness refers to the usefulness of the materials developed. The materials are evaluated for its usefulness or effectiveness on the basis of the following aspects.

a. Use of the materials to promote information about laboratory among student teachers.
b. Use of the materials to promote retention of information and its use vis-à-vis organising laboratory sessions
c. Reactions and views of students about the course.

The research was carried out with the following objectives in mind.

1.4 Objectives of the Study

1. To study the student teachers views about science laboratory and its use at secondary level.
2. To identify lesson / topics that can be taught through laboratory method at secondary method at secondary 9^{th} & 10^{th} Gujarat board state.
3. To prepare a programme for pre-service students to use science laboratory at secondary level.
4. To evaluate the effectiveness of laboratory management programme.
5. To suggest measures to use science laboratory at secondary level in Gujarat.

1.5 Hypothesis

A hypothesis is an intelligent guess or hunch. The researcher has framed a null hypothesis and has made attempts to test the same in the present study. The hypothesis states ‘There will be no significant difference in pre-test and post-test scores of pre-service teachers’.

1.6 Variables

In any experimental research variables are important.

In the present study, the Student teachers/ pre service teachers are taken as dependent variable and the course/ technique of teaching is considered to be as an independent variable.

The study has certain delimitations mentioned below.

1.7 Limitations of the Study

The study is carried out on a small group of students at theWaymade College of Education and the focus is more on theoretical inputs and conceptual understanding of the laboratory management vis-à-vis recording keeping, types of laboratory, its usefulness and preparing materials and first aid treatment.The exposures to practical sessions are given but it is limited to mock laboratory sessions. Its' not carried out in realistic classroom laboratory situations.

1.8 Significance of the Study

The researcher herself is a student of science. She has attended practical sessions in laboratory. The researcher strongly feels that some kind of formal training in laboratory management will enhance the performance of student teachers and in-service teachers in laboratory sessions and while using the laboratory method. Thus the researcher is keen to construct a course on laboratory management and try the same in order to evaluate its effectiveness.

Moreover, during the B.Ed. course thestudent teachers are expected to know the skills of laboratory. However no formal training course or programme is available for the same. The researcher has made attempts to do so. Laboratory is the heart of science teaching and laboratory method is a part of the syllabus and demands practical work and demonstration. The researcher has therefore made an attempt to study and investigate in this direction.

1.9 Scheme of Chapterisation

Chapter1 Introduction i.e. the present chapter focuses on the overview of the study, objectives and research questions of the study and significance of the study.

Chapter2 ConceptualFramework discusses the concepts related to the research and conceptual framework.

Chapter 3 includes the Review of Related Literature and its implications to the present study.

Chapter 4 aims at listing the Procedure of the Study and its Research Methodology.

Chapter 5 presents the Data Analysis and Interpretation.

Chapter 6 enlists the Discussion, Conclusion and Suggestions of the Study.

The following chapter presents the Conceptual Framework and includes the terms and Concepts Related to the Study.

Chapter 2

Conceptual Framework

2.1 Meaning of Science

According to the National Policy on Education (1986) states that**"**Every effortwillbemade to extend science education to the vast numbers who have remained outside the pale of formal education." This statement from the National Policy on Education reflects the importance of science education. Science has played a tremendous role in our lives during the past countries and has influenced our lifestyles.

According to Kothari Commission, 'Science is universal and so can be its benefits. Its material benefits are immense and for reaching-industrialization of agriculture and release of nuclear energy, to mention two examples- but even more profound is its contribution to culture. From above it is clear that science is one of the most important subjects taught in school and colleges. The nature of science can be described to be dynamic, honest theoretical and practical, close to life and useful hypothetical, testable and process cum product oriented'.

Science has been derived from the Latin word "Scientia" which means knowledge. It has been derived in a systematized body of knowledge.The curiosity of man to know about himself and the surroundings has led to an accumulation of vast body of knowledge, which is called as 'science'. Therefore, scientists define science as, an amalgamation of observation, identification, description, experimentation, investigation and theoretical explanation of the phenomenon that occurs in nature. (Emanuel, S. 1997)

Albert Einstein has expressed that 'Science searches for relations which are thought to exist independently of the searching individual'.

In addition Griggs has stated that science includes the following

1) Direct and indirect observations.
2) Scientific Inquiry-asking question.

3) The drawing of inference from evidences.
4) Recording observations.
5) Developing ways and means to find answers.
6) Classification and cheating evidences.

Thus, Science is a systematic & organized body of knowledge, based on cumulative observations, experiments & phenomenon of nature.(Kulshrestha S.P. &Sood, J.K. 1987)

2.2 Nature of Science Education and its Importance

The National Council of Educational Research and Training (2006) in the Sixth Survey of Educational Research (1993-2000) volume 1 states the nature of science as 'the values and assumptions inherent to science'. The efforts of reforming science teaching have often been restricted in scope and have focused mainly on updating the science content in text books. Hence in India, as in the West there have been attempts to changethe nature and practice of science as well as the teaching of science as a part of general education.

Lander man (1992) defines the nature of science as "The value and assumptions inherent to science." He also states that there exists a range of meanings to describe this complex human endeavor. The nature of science is described to be dynamic, practical, theoretical, close to life, philosophical yet pragmatic. In this context, there is a need for a philosophy of science education but it appears to be far from being formulated.

The National Council of Educational Research and Training (2006) in the Sixth Survey of Educational Research (1993-2000) volume 1 further states that 'In the absence of a comprehensive philosophy of science education, the question that most needs to answer is "what is justification for teaching science and technology in our school?" Is it to have an educated citizenship or to provide adequately prepared and motivated students to fulfill the industrial needs of the country? According to one definition, a scientifically literate individual is "one who makes informed decisions within a science and technology context by drawing upon their rich scientific knowledge, such as, an understanding of the concepts, principles, theories and processes of science." Many science educators view the achievements of scientific

literacy as the educational solution to the varied economic, social and environmental challenges of the 21st century. It is becoming clear that teaching science has no single unambiguous aim. Different groups in society view the aims of science education differently. Some see the aims in vocational terms (providing skilled work force); others perceive educational goals, in developing the individual potential of the child. The production of highly qualified scientists and engineers is a valued objective, while another is to produce educated citizens. There is no shortage of statements of aims, but the translation of their aims into measurable objectives results in the loss of important aspects and reduces science education to trivialities (Woolnough, 1989).'

The survey also describes science teaching as the second largest focus of research (18%) during the period of the survey. The role of the teacher was to facilitate school learning. This role of a teacher in science has taken on newer dimensions and added complexity with the introduction of technology as an addition to science education. The following section describes the science laboratory.

2.3 Meaning of Science Laboratory

Laboratory is a placed equipped for the performance of tests, experiments and investigative procedures and for the preparation of reagents, chemical reaction. Laboratory is a place equipped for experimental or for testing and analysis.

Thus, Laboratory is a place providing opportunitiesfor experimentation, observation and practice in a field of study. Laboratory is a room or building equipped for scientific research, or chemicals. Science laboratory is important in science education. Science cannot be taught effectively without testing, experiment, demonstrations of testing scientific facts and principles.

In the above mentioned approaches, the use of science laboratories is essential and provides hands on practice to the pupil. It is favourable to have a lecture room cum laboratory to make teaching learning process more interactive and conducive. For effective teaching of the various topics in the subject physics, chemistry and life sciences, it becomes essential to demonstrate certain experiments.

A science laboratory is thus defined as a workplace for the conduct of scientific research. It is a place where students do their experiments. The science laboratory has always been regarded as the place where students should learn the process of doing science, but summaries of research on the value of laboratory work for learning science show an appalling lack of effectiveness of laboratory instruction. Our Studies showed that most students in laboratories gained little insight into the concepts involved or toward the process of knowledge construction.(Novak 1988).

The science laboratory is an attempt to vary the learning environment in which students develop their understanding of scientific concepts, science inquiry skills, and perceptions of science. The science laboratory creates an unique learning environment and is a setting in which students can work cooperatively in small groups to investigate scientific phenomena. Hofstein and Lunettes (1982) and Lazarowitz and Tamir (1994) suggests that laboratory activities have the potential to enhance constructive social relationships as well as positive attitudes and cognitive growth. The social environment in a school laboratory is usually less formal than in a conventional classroom; thus, the laboratory offers opportunities for productive, cooperative interactions among students and with the teacher that have the potential to promote an especially positive learning environment. The learning environment depends markedly on the nature of the activities conducted in the lab, the expectations of the teacher (and the students), and the nature of assessment. It is influenced, in part, by the materials, apparatus, resources, and physical setting, but the learning environment that results is much more a function of the climate and expectations for learning, the collaboration and social interactions between students and teacher, and the nature of the inquiry that is pursued in the laboratory.

Form the above discussion it can be concluded that the study of science is not possible without a laboratory. Science teachers provides the learners an opportunity to observe facts and carry out experiments so that students obtain proper and complete knowledge of the subject. The student work is the laboratory by themselves, observes, and on the basis of these, they try to deduce conclusion/s.'Laboratories also help in the development of sense of cooperation and spirit of competition.

Thus, the science laboratory enables students to get practical experiences. The present study aims at preparing pre-service teachers to provide laboratory experiences to students.

2.4 Importance of Science Laboratory

Science laboratory is important in science education. Science cannot be taught effectively without testing, experimenting, demonstrating scientific facts, theories, laws and principles. In the above mentioned approaches, the use of science laboratories is essential and provides hands on practice to the pupils. It is favorable to have a lecture room cum laboratory to make teaching learning process more interactive and conducive. For effective teaching of the various topics in the subject physics, chemistry and life sciences, it becomes essential to demonstrate certain experiments. Achieving objectives of teaching science demands rigorous hands on experiences along with lectures in the classroom. So, there arises a need of laboratory where students can hypothesize, experiments and verify results, concepts and various laws.

The importance of science laboratory can be understood in light of its objectives.

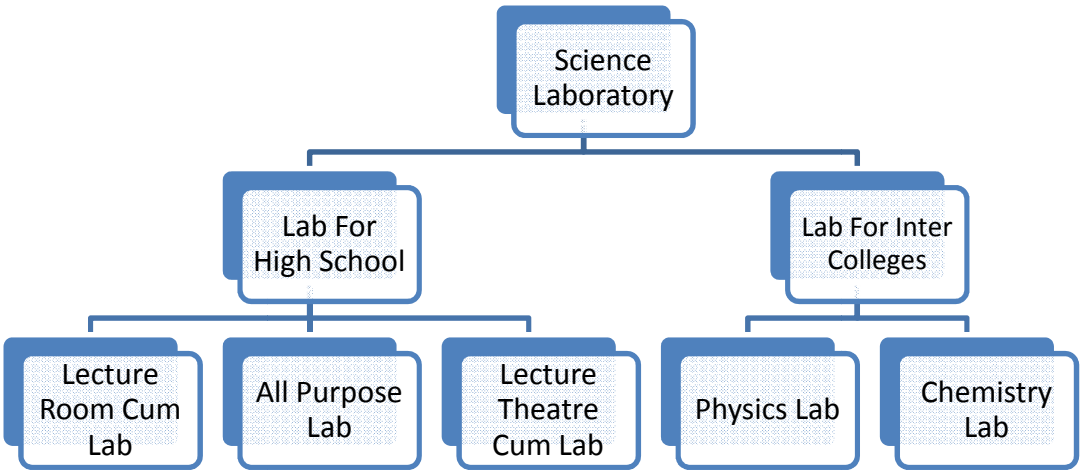
1. To develop scientific attitude among children through practical work in the laboratory.
2. To develop the skill in handing scientific apparatus, instruments &equipments.
3. To provide opportunity for the training in scientific method.
4. To relate theory and practical of concepts, facts and theories.
5. To help students in developing the feeling of cooperation, resourcefulness initiative, self-dependence, self-confidence, cohesion, sociability, self-reliance, and self-discipline.
6. To provide real and stable knowledge of science.
7. To provide opportunities to think, observe, reason and to arrive at a decision/conclusion independently.
8. To encourage students to save the time, resources as well as energy.

9. To arrange an atmosphere which is very conducive for learning science.
10. To enable them to interpret & verify the various science-principles and substances.

The following section focuses on the different types of science laboratory.

2.5 Types of Science Laboratories

There are various types of science laboratories. A broad classification of the different types of science laboratories is depicted below.



Lecture Hall cum Laboratory

Lecture room cum laboratory plan was originally suggested by Dr.R.H. White House (Formely Principal Central Training Institute, Lahore). It is an economical plan and very much suitable to our conditions. It is more beneficial in developing science climate as well as more convenient for the students & teachers.

DetailsofthisPlanaregivenbelow

1. **TheLayout**

In this plan, it is suggested to have a room of 45'x25' for a class and it should be partitioned into two equal compartments, one of which may be used as the lecture room and the other, for laboratory purpose. This lecture room can accommodate 40 to 50 students and in the laboratory 20 to 25 students can work for the science practical.

2. **Walls & Floor**

Walls & floor of the lecture room cum laboratory should be quite tough & durable. It is suggested to have the thickness of the walls equal to $1\frac{1}{2}$ feet. The walls should be well- plastered and painted up to a height of 90cm and rest bewhite washed or distempered. The floor should be cemented or tiled with a proper drainage system. These should be round corners between the wall & floor to avoid dirt lodging. A slight slope in the floor is better as the water may be swept easily.

3. **Door**

The rooms should have doors facing north for getting more sunlight and fresh air. There should be two doors, one near the lecture room and another near the laboratory. These should open outwards as it saves the space and also convenient for emergency exist, one door may be used for entrance and another for exist. Whatever plan is adopted, a rigid observance of the rules of entrance & exist is a must .There can also be a door connecting both the apartments, i.e. lecture room and laboratory.

4. **Windows**

On the side opposite to the doors three windows each 6'x8'x8' should be provided.Out of these, one should be near the practical benches and two of these should be near the seating accommodation. The windows are open out wards so that inner skills of the windows may be used as shelves. Wire gauze screens are fitted to avoid flies and mosquitoesetc. Provision should be made for the window blinds for darkening the room required for various experiments. Proper ventilation is necessary and for this, adequate arrangements for ventilations be made. The window and doors should have glass panes to bring sky- light in the laboratory.

5. Furnishing

There should be a blackboard of 10'x4' size. Teacher's table should be at a distance of about three feet. The size of the table should be 6'x2' high, so that it may also be used as a demonstration table. No raised platform is required for the table. The lecture room should have a seating arrangement for 40 students. There should be 20 dual tables of $3\frac{1}{2}$ x $1\frac{1}{2}$ x2' high with to students on each table. The top of the table should be flat. The chairs on stools may be of wood or iron, are $1\frac{1}{2}$ high. The area allowed for dual tables and two chairs be $3\frac{1}{2}$x $3\frac{1}{2}$, with a passage way of $1\frac{1}{2}$ for single file and a space of $2\frac{1}{2}$ to$3\frac{1}{2}$ at the sides. Thus, the total area needed for 40 students is $18\frac{1}{2}$ x $17\frac{1}{2}$. The dual tables should be placed at a distance of 9cm to 120cm from the walls.

6. Laboratory

A blackboard of 10'x4' should also be provided in the laboratory. There should be a provision of 6 big plain- table (systematically arranged) for conducting experiments. There should be one smaller table for the use of the teacher near the blackboard, which may also be used for keeping the apparatus & other material required for the experiment. It may also act as the demonstration table. The six big tables (referred above) should have a shelf along the working sides for placing books and papers. The top of each table is waxed or may be fixed with sheets of aluminium or glass to act as acid resistant. The size of the table should be 6' x $3\frac{1}{2}$ x3'. Each table accommodates 4 students. No sinks be provided with the laboratory tables. However, three sinks should be fitted one for teacher, and two for the students (one fitted in the window recess and another in the recess in the wall), each sink is provided with a straight drown pipe leading to a bucket. A drainage board be provided to drip water over the sink. Beakers cylinders, flasks etc. may be invested on it for drying and draining off water. The recesses in the walls should be 1' wide and at a height of $3\frac{1}{2}$ feet from the ground where balances can be placed and there should be 8 admirals, each of 7' high and 5' wide and $1\frac{1}{2}$ deep and 6' projected in the room are provided for storage accommodation. Notice boards and bulletin boards may be find place b/w the windows or just inside the doors. For the laboratory, proper arrangement should

be made for water supply and electricity. This plan may be modified as per todays' need requirements and budget etc.

All-purpose Laboratory

This type of laboratory may serve the dual purpose of practical as well as theory work. It is also known as integrated plan of both physical and life sciences. For seating 30 to 32 students a laboratory of an area of 45'x25' is sufficient. There can be placed around 16 tables and on each table 2 students can work. The size of the table is generally 6'x2' but if the table is required 4 students then the size of the table is 6' x 4'.In between the tables there should be a tap from where the student can take water easily. The table should have a polish so that they are not spoiled by water acid or alkali. A cupboard is also arranged for each student to keep the articles for experiments. There should be a tap, gas burner etc. on the seat of each student, there should be arrangement of stools of height 22" to 62" for the students to sit and perform experiment. The legs of the stool should be rubberized so as to avoid making noise. The teacher's table in the laboratory is of a size of 10' x 4' and behind it a blackboard. The position of the blackboard should be such that all students can see it. There should be proper lighting and ventilation in the laboratory. Every equipment should have fixed place in the laboratory and there should be books related to practical's kept in the admirals. The tables of the students should be close to the walls near the windows to give proper light. The students are to given apparatus for the session and collected back at the end of the session. The entire window should be fitted with good blinds so that the laboratory may be darkened in order to use film projector, slide projector and epidiascope etc.

Subject Specific Laboratories: Physics, Chemistryand Biology.

The subject specific laboratories may be of the following type.

Lecture-cum-Laboratory

This is the plan suggested by Panel**,** forscienceinsecondary school as given in its report on science teaching in school by UNESCO. The details of this plan are given below

1. **Location**

Accordingtothisplan the laboratory should be located on a ground floor on extreme side of school so that other classes may not be disturbed and if finances permits, extension of the laboratory may be done.

2. **Lay out**

It is suggested that 825 square feet area for 42 students and if the need arises, another laboratory measuring 490 sq. ft. may be provided. This will be an extension of the lecture-cum laboratory room with a common store-cum-preparation room of 150 sq. ft. in b/w.The area in these two labs comes to 125 sq. ft. and 20.4 sq. ft. per student. Laboratory 'A' may be used for Chemistry and Laboratory 'B' for Physics and Biology.

3. **Furnishing**

Portable furniture is needed in the Laboratory. There should be tables of 4' x $1\frac{3}{4}$x$2\frac{1}{2}$ for laboratory 'B' along with the provision of under shelves to keep books etc. In laboratory 'A' the size of the tables should be $3\frac{1}{4}$ x $3\frac{1}{4}$x$2\frac{3}{4}$. If it is to be used for chemistry practical's, then should be painted with acid proof paint and no shelves are recommended in these tables. They recommended thatdemonstration table or teacher's table should have the size of 8' x $2\frac{1}{2}$ x $2\frac{3}{2}$ and should be on the raised platform of 7" height. It should have sink, gas and light arrangements for demonstration of experiments. A side cupboard and drawer may also be provided. There should be a blackboard of 8' x3' size near the teacher's table. Panel considered black color as the dull color and recommended green or brown colorof theBoard. No cupboard is recommended for students. Sinks are recommended in the walls. Thick dark curtains be there, to make it as the dark room if needed. Provision of other fittings are also made for railing also the walls for hanging charts, graphs, pictures and shelvesfor display of the material.

4. **Construction Material**

It is recommended to use locally available material for construction purpose. It will be cheaper, prefabrication or pre casting etc. may be employed to reduce the costly steel and concrete material. The walls can be plastered and ceiling be white washed. The floor may be cemented preferably with grey cement windows should be iron grilled and ventilators should have exhaust fans and fly wire on the external face.

5. **Light, Water & Drainage Facilities**

Adequate system of light, water &drainage be worked out. Ventilation should be such that ample day light is there. The windows should be 3' high, so that ample light may be there in the laboratory. The windows should open outside, (The window area of 15-20% of the floor area is considered adequate for light). Artificial light should be avoided as far as possible. The proper arrangement is made for water supply. Four water points with sinks of 12"x9"x6" be provided on the walls, on teacher's table, working tables and in preparation room. Where water is not available, small drums for storing water should be arranged. Underground drainage is considered better then uncovered drains.

2.6 Role of Teacher in the Science Laboratory

Oneof the chief objectives of laboratory work is to allow pupils to learn for themselves, by solving the problems that they encounter in their work. After purposes have been defined and procedures outlined, the place for the teacher in the laboratory is in the background. A teacher may move from group to group, giving encouragement, clarifying procedures, straightening out misunderstandings, and stimulating fast-working pupils to undertake new problems. But his presence in the classroom should not be required for successful operations. A teacher should try to avoid interrupting the work of his class with announcements. Separate groups are in different stages of their work and thinking; if announcements are made, the progress of their activities will be broken, so that time and continuity are lost.

Keeping the role of the teacher in mind the course for laboratory management is designed. The following section describes the laboratory method used to teach science in laboratory.

2.7 Laboratory Method

The word laboratory was originally applied to the work room of a chemist, a place devoted to experimental studies in nature and physical science. Hence, the term laboratory method was first widely used in sciences to characterize the teaching procedure that makes use of experimentation with the apparatus and materials in order to verify chemical laws and other facts. Laboratory method is a planned, learning activity dealing with original or raw data in solution of a problem. It is a procedure involving first hand experiences with material or facts derived from investigation or experimentation and verification. Laboratory method involves the process of investigation and verification. Individuals or group may take up any practical work at the laboratory. The process of investigation more or less takes the form of inductive procedure to find out solution/s to a problem or to study the fact, principle or law, concept, etc.

Theprocessof verification takes the form of deductive procedure to verify the principle or lawalready established by investigation. In the laboratory method, these two aspects are taken into consideration. In the laboratory method, pupils learn to do by doing. Therefore, the experience in the laboratory is an important part of total experience of the school. Here, the learners are permitted to discover facts and understand the theory.

Discovering the facts is the aim of this method. The teacher functions mainly as a supervisor, rendering individual help and guidance as and when required. Laboratory experience under the supervision of teachers provide first step in the development of manipulative and managerial skills. Personal involvement in experimentation promotes development of sprit of spirit of inquiry, acquisition of needed information and objectivity in observation. By this method, maximum pupil activity can be achieved. They remain active at conclusion of the experiment. Therefore, the laboratory method of teaching science is psychologically sound as it satisfies the natural urge for activity.

Moreover, one of the aims of teaching science is to train the pupils in scientific method. Therefore, it is imperative that some individual laboratory work be done by every student. The laboratory method should not be considered independently but should from a part of the total science program. The laboratory

experiences help the students to explain, illustrate and to prove principles or laws. Laboratory method is experimental, observational and productive. In fact, if properly planned, provides exciting experience in the laboratory and goes a long way to make the students interested in pursuing their study in science and take science as a vocation.

Characteristics of Laboratory Method

1) The laboratory method is a method which is based on the principle of learning by doing.
2) Science can be taught effectively through the method of laboratory, where student's gets first-hand experience with materials and learn facts to the manipulation of knowledge.
3) This method involves providing learning situation on activity based in the laboratory itself.
4) In this method learning procedure is adopted to solve problems or re-discover the principles and thoughts.
5) This laboratory method helps the students to develop the skills of experimentation, construction, improving scientific attitude, interest and appreciation.
6) This method also helps the students to verify theoretical knowledge and statement and retained with their mind for long time.
7) This method will over rule the dull atmosphere of the four wall class room.
8) This method demands active participation from the students. The students become scientific in their approach in problem solving.
9) In this method there is chance of developing habit of cooperation resourcefulness, self-dependent and how to find solution for day-to-day life scientific happenings.
10) In this laboratory method the capacity of observation discrimination and discards the false believes and superstitions.

Steps of Laboratory Method

1. Statement of the problem

2. Setting the apparatus and introducing it
3. Demonstration
4. Providing opportunity to experimentation
5. Analysis discussion and conclusion
6. Recording
7. a) Planning phase

   b) Doing phase

   c) Evaluation phase or conclusion phase

Planningphase

In the planning period, pupils and teachers together develop a plan for the whole experiment. They set the goals,outline the procedures to be followed.The teacher gives introduction for the practical work considering the theoretical aspects taught. They (students) are enthused to work independently and to discover facts for themselves. The experiments are to be planned and regarded according to the age level and ability of the pupils. The necessary preparatory work should have been completed and checked the day before the practical work to be carried out. For laboratory work tow continuous periods are given.

Doing phase

During the ‘doing’ or work period experimentation, observation and production are carried out by the pupils. At this stage, they have to follow the rules displayed both outside and inside the laboratory. The students are given specific and clear instructions before they start practical work through laboratory manual, instructions before they start practical work through laboratory manual, instructional card or oral directions. Students may be instructed to follow the instructions strictly. The teacher supervises the individual and group work which has been done according to the plan developed. The teacher gives assistance and attention to those who needs them most, the teacher is alert to all that is going on in the laboratory. This is the period for individual teaching to develop good working standards. Therefore, the teacher should do bestow of a greater care to watch the posture of pupils while working, the method they use, orderliness and cleanliness of work place, sanitary practices and safety. The student should be engaged in doing the

allotted work without disturbance, confusion or noise. They should maintain a record book in which the experiment is described and observations recorded following a definite style of writing.

Evaluation phase

During the evaluation period, the product and the method of work are evaluated by pupils and teachers. The observations are summarized, judged and discussed in the class. Pupils display the results and evaluate the work with the help of scores of checklist developed for the purpose.

Merits of Laboratory Method

1. The method is based on the faith that we learn to do by doing.
2. Knowledge and skills develop simultaneously in the laboratory.
3. The method develops self-confidence and self-reliance among students. The students get knowledge from this method.
4. The laboratory method provides creative thinking among the students.
5. Students remain very active during the laboratory sessions.
6. The method stimulates thinking and enables learners to interpret, observe and draw conclusions.
7. Through the laboratory method the illustration can be provided, phenomenon principles, facts, and laws of nature can be studied.
8. It trains the students in scientific method and scientific attitude.
9. Theory and practicals can be related.
10. The method caters to individual differences and develop&self-potentiality and confidence.
11. It fosters creative talent.
12. The method develops sprit of inquiry and investigation.

Demerits

1. It is an expensive method and require skill.
2. The teacher should be exclusively skilled and competent.
3. Some damages or accidents may occur in the laboratory.

4. The syllabus cannot be covered by the laboratory method, because it is highly time consuming.
5. It is a time consuming process.
6. This method cannot be adopted as a general method for all topic listed in the subject.
7. This method (technique) becomes more or less very mechanical.

The above mentioned are some delimits of laboratory method.

In the present chapter an attempt was made to discuss the nature of science, its objectives and importance of laboratory in teaching sciences.

The following chapter focuses on the review of studies, books, articles published in the past.

Chapter 3

Review of Related Literature

3.1 Introduction

The review of related literature is the base for any research. It helps the researcher develop insights into the research area and methodology. Review means a critical appraisal of a book, a play or other work or a formal assessment of something with the intention of instituting change if necessary. Review of related literature means to referring material related to the research topic. The present chapter includes reviews of past dissertations of M.Ed. and Ph.D., articles and internet resources.

The following sections presents the reviews related to books and researches in science.

3.2 Review Related Literature

Kulshrestha, S.P. and Pasricha, H. (2005) describes various forms of practical work in science teaching. The various forms are used are assessment, record writing for science projects, rules of designing science and biology laboratory, and care of equipment and apparatus. The various methods used to teach science are lecture-cum-demonstration method, problem solving method, demonstration method, experimental method, observation method, lecture method and laboratory method. The authors mention that in the laboratory the apparatus received be arranged in almirahs provided with glass fronts and preferably be fitted with mortise locks to avoid dust getting in. The apparatus should be arranged either subject-wise or alphabetically. If we arrange the apparatus subject-wise we find that some articles fall under more than one handing and if we arranged them alphabetically we find that glass and metal articles are coming together in which there is more likelihood of breakage. The apparatus needed only for demonstration purposes may be stored in separate almirahs subject-wise.

Kulshrestha, S. P. and Pasricha, H. (2005) have mentioned about the science laboratory, they mention details of laboratory. They includes planning a science

laboratory, organization of laboratory, types of science laboratories in schools, lecture-room-cum-laboratory, all-purpose laboratory, lecture-cum-laboratory, laboratories for intermediate colleges, chemistry laboratory, suggestion for these organization of laboratory, guide line for laboratory teachers, pupil practical note-books, common laboratory accidents and their remedies, first aid box, storage of chemicals, duties of laboratory, reference book in laboratory, rules of maintaining laboratory discipline, equipment for laboratories, apparatus needed in laboratory, In this book he had describes "Laboratory word is used for large room where practical classes are conducted and a group of students carry out practical's. Science laboratory is needed to keep instruments, apparatus, chemical and other materials safe and secure and ready for use. For organised teaching of science, the laboratory should have a preparation room, store room, science room and dark room. In the preparation room of laboratory such apparatus are collected which are to be used in the laboratory or 'science room'. In this room apparatus for daily experiments are kept. The laboratory assistant or the teacher can prepare the experiment in the 'preparation room'. This room should be kept locked, there should be one door opening in the 'science room'. The articles should be properly arranged in large glass almirahs, and the various articles should be labelled. There should be proper light and ventilation. In the science room the teacher demonstrates the practical/experiment. There should be a black-board at the back or towards the left, which the teacher can use whenever required. There should be pictures of scientists on the walls. The 'dark room' is permanently dark but ventilated.

Emanuel, S. (2007) illustrates the constructivist approach to the teaching of science. The various approaches that can be used to teaching of science are understanding constructivism, constructivism in class rooms. "Constructivism is undoubtly a major theoretical influence in contemporary science. If we want to produce scientist like Newton, Einstein, HomiBhabha, Dr. Abdul kalam, we need to make sure that science classrooms and laboratories are actively used to construct knowledge rather than just verifying what the previous generalization did. The author describes various view related to science investigations, guides lines for a teacher to carry out a science investigation, states that, our classroom need to develop in our students the habit and art of thinking. Many psychologists have experimented with the nature of thinking

and problem solving. A science teacher needs to study the assumptions of various theories that have classroom implications to enable his/her students to think. In the constructivist classroom, a teacher facilitates learners in their personal investigations. The investigations and experiments in a constructivist classroom require to be made a worthwhile adventure, more often than not we fail to achieve much of what is expected in science classrooms.The main reasons for this is the talk and chalk mode of presentation. One of the main objectives of carrying out an experiment or investigation is to help the students master the art of 'learning by doing' and 'learning to learn' by developing curiosity in them. A master must plan before she/he conducts an experiment or an investigation in the classroom. The teacher need to list the details of the experiment such as the aim of experiment, equipment's/chemicals required to conduct that is to be followed, the expected results and the predictions respectively. The teacher is responsible to ensure that all the materials required for the experiment are available to the students. In addition, to make the session interesting the teacher can display on the board the history of the experiment, the name of the scientist who invented/conducted the experiment fist, the year of discovery etc. The teacher needs to prepare worksheets in order to conduct the experiment effectively.

Emanuel, A. and Emanuel, S. (2011) illustrates the effectiveness of using worksheets in teaching of science. They describe meaning and importance of worksheets in science education that a worksheet allows learners to express their views, ideas information etc. about a particular topic. The worksheet may guide students to perform a particular task. They have also mentioned various worksheets that can be used to teach science are vocabulary worksheet, observation worksheet, research Worksheet, Drawing worksheet, classification worksheet etc.

Kandi, J.S. and Digumarty, B.R. (2004) describes various methods of teaching science. The methods used are Lecture method, Laboratory method, Scientific method, Project method and Heuristic method. They state that science is a process by which we can increase our knowledge of external world. There are facts, theories, concepts an also a way of working which together constitute the subject science. Further they describe some guiding principle for determining teaching methods that

every method should be based on an understanding of the pupils in classroom. Every method should stimulate he pupils to think and cooperate actively.

Sood,J.K. (2005) have mentioned about objective of teaching science and place of science in school curriculum. Theauthor states that direction and objective of science teaching have undergone many changes after the World War II.Science for all has become slogan all over the world.NPE (1986) and National Curriculum framework for school education 2000 have included science in school curriculum as a core subject. Science is an integral part of learning both at primary and secondary level. Knowledge of science and technology as a part of general education will provide basic knowledge and skill.

Sood, J.K. (2005) describes various methods used to teach science. The various methods are Lecture method, Demonstration method, Problem solving method and discussion method. The authors mention that in the Lecture method "As a science teacher you should careful in planning a lecture and should use it with the help of diagrams, charts, models, and films. If a lecture is properly planned, it can in motivating, inspiring and stimulating students". He also mentioned that in the demonstration method and problem solving method. Demonstration is a process or means of showing of how something works or is used. It is an act to display working of some experiment. The demonstration method is 'natural' method of teaching and provides foundation for the initiative behaviour through example. Similarly, demonstration provides foundation for apprenticeship training. When a chemistry teacher is showing the presence of carbohydrate in food materials, he/she is demonstrating. When a science teacher is showing the reaction of acid or alkali on litmus paper he/ she are demonstrating. Similarly, when a general science teacher is showing a model of a human being and its parts, she/he is demonstrating. When a science teacher is showing the reaction of acid or alkali on litmus paper he/she is demonstrating. Similarly, when a general science teacher is showing a model of a human being and its parts, she/he is demonstrating. Thus, demonstration is one of the most common methods used by the science teachers. Science is based on sensory experience and in learning by observation and experimentation a student used his sensory organs. Thus, demonstration can contribute to both, when properly utilized this method can be effective as well as useful. In science it is a significant method

where students learn to do practical's after the demonstrations are given by the teacher. Problem solving is a goal of teaching science and it is equated to inquiry learning and concept formation. Problem solving is an important approach which has its own place in science teaching. Risk has mentioned that problem solving may be defined as a planned attack upon a difficulty or perplexity for the purpose of finding a satisfactory solution. This involves the process of reflective thinking, not merely the accumulation of facts or the blind acceptance of ideas which someone in authority gives us. Similarly, Risk, has further elaborated this point. He says that problem solving teaching procedure is defined as a process of raising a problem in the minds of students in such a way to stimulate purposeful, reflective thing in arriving at a rational solution.

Alsop, S. and Hicks, K. (2003)illustrates the practical work in science. The author mentions the details of practical work in science. The role of practical work in science, demonstrations, individual laboratory work, developing skills through practical work, safety and science practical work, useful addresses and publications for safety information in school science.

Sree, K. and Rao, D. (2004) in the book Method of Teaching Science is expresses that, Science is a way of knowing, a method of learning about nature. Rooted in common sense, its formal, systematic method is called scientific inquiry. In doing scientific inquiry, scientists use a verity of empirical approaches techniques and procedure to collect data from nature, examine and analyse that data, and construct knowledge based on it. This knowledge relates to living organisms, non-living matter, energy and events that occur naturally. To analyse data scientists often, but not always apply logical arguments that obeys strict empirical standards and healthy scepticism. The product of scientific inquiry is the body of scientific knowledge. Scientific knowledge takes four forms: Hypothesis, Facts, Laws and Theories. Education in science serves there purposes. First, it prepares students to study science at higher levels of education. Second, it prepares students to enter the workforce, pursue occupations and take up careers. Third, it prepares them to become more scientifically literate citizens. The relative priority and alignment of these three purposes. Varies extensively across countries and cultures. Regardless of the setting, a sound education in science emphasizes that science is both a way of

knowing and a body of knowledge; it also emphasizes integrating scientific inquiry with scientific knowledge.

Kenneth, T.(2010) Research on Science Laboratory Activities: In Pursuit of Better Questions and Answers to improve learning state the importance of the school science laboratory. The author mentions that the school must have laboratories that provide practical experiences to the students. There is a relationship between the theory and practice of science.

Agnihotri (1987)studied the influence of methods of teaching physics on the achievement in physics of class x students in Delhi. The different methods used were lecture cum demonstration method, laboratory method, programmed instruction method and assignment cum- discussion method. He followed a pre-test, post-test experimental method and taught two units of physics. Systematically designed by him. He found that with respect to achievement in physics. Programmed instruction for teaching of physics was less effective than the instruction of physics systematically designed by the investigator. But programmed instruction was more effective than assignment cum discussion method and the traditional method or the lecture cum demonstration method. One of all the four methods systematically designed by the investigator was found to be most effective with respect to achievement in physics.

Agarwal and Gupta (1961)conducted a study of students' performance and infrastructure facilities and find that lack of library, laboratory and teaching materials, etc. are associate with pupils' performance.

Bahuguna(1980) conducted a study on interpersonal relations among teachers and students, It was that (1) high achieving schools are having somewhat better relationship than low achieving school. (2) teacher- teacher relationship was similar in high achieving schools as well as in low achieving schools further low achieving schools has better pupil- pupil relationship than high achieving school.

Begum (1990) conducted a study on problems of teaching new science syllabus for standard VII in Andhra Pradesh and their impact on pupils. The objectives of the study were (1) To examine the difficulty level and suitability level of all lessons and

exercise included in the new science syllabus as perceived by science teachers. (2) To examine the problems involved in the implementation of the students activities suggested in the new science textbook and problem there in. (3) To examine the problem faced by teachers about the content and teaching method in the in-service training programme. (4) To study the nature of execution of the exercises faced by teachers within the context of content, teaching method, audio-visual aids, suggest the measures which would improve the quality of science teaching.

The major findings of the study were (1) More than 60% of the teachers found the content in recent syllabus, now as well as over loaded. (2) Dictation of notes by teachers was dominating method of getting exercises done by the students. (3) Lack of facilities for science teaching conceived to bother teachers a lot. (4) It was observed that achievement in science favoured significantly those students, whose teacher had attended an in-service programme. (5) It is proposed that school condition need to be improved through, say supply of science kits and hand-books for teaching-learning process by practising processes of science such as classifying, inquiring and experimenting.

Bhattacharya (1979)conducted a critical study of science education in Assam & Meghalaya schools and found that all the teachers qualified to teach science taught other subjects as well. The economic condition of science teachers was poor private nations were most common. The schools had hardly any freedom for purchasing book, most of the schools did not subscribe to science journals. None of the school had a trained librarian.

Bandyopadhgay (1984) conducted a study on environ influence, academic achievement and scientific aptitude as determinants of adolescent's attitude towards science stream and found that (1) Pupils having a high positive attitude toward science and a negative attitude towards science were different with respect to the independent variable either in isolation or in interaction. (2) The obtained casual factors were environment, attitudinal & achievement related parent education and Social Economic Status (SES) led to favourable attitude towards science. Teacher's influence, peer's influence, vocational value of science of science & future aim of like were other contributory factors.

Goal and et. al(1990)conducted a study to compare the relative effectiveness of the individualized method and lecture- demonstration method of laboratory instruction ion students' acquisition of psychomotor and related cognitive skills when the specific behavioural objectives of five physics experiment in subject area of light were predisclosed to students before instruction.

The objectives of the study were to compare the relative effectiveness of the individualised method and lecture-demonstration method on acquisition of psychomotor and related cognitive skills among female pupils.

The major findings of the studies were (1) A significant difference was followed the individual laboratory method and the lecture demonstration method. (2) The group of students following the individual laboratory method achieved significantly better on the psychomotor skills than did the lecture-demonstration group. (3) Students who followed the lecture-demonstration method achieved at a higher level related cognitive skills than did the group of students which followed the individual laboratory method.

Ghoush (1977)conducted study on methods of teaching and found that unsuitable methods of teaching used by teachers is one of the factor responsible for the poor performance in west Bengal.

Mehna (1986)studied the factors affecting academic achievement in science, the research finding imply that the pupils performance in science can be improved (1) If teachers succeed in generating a feeling of liking science among pupils.(2) If teachers develop aptitude for science among children by providing scientific information.(3) If teachers motivate children to learn science subjects. This needs adequate training for teachers in making science teaching interesting & in training them in the technique of arousing pupils' motivation for leasing science.

Ekpoj (1991) studied chemistry laboratory, safety skill and practice students education in selected secondary school in AKWA, Ibom state. Objectives of the study were to assess the chemistry laboratory safety skill by students and to assess the chemistry laboratory safety practices adopted by students. It was found that more than 70% students failed to protect their eye, face, hands, and their body too. They

did not wear apron and gloves while engaged in chemical experimentation. They had poor knowledge about identified emergency facilities and equipment's, study revealed evidence of poor experimental technique.

Pandit, B.L.(1989) made effort for the identification and measurement of chemistry laboratory skill of senior secondary school students of Delhi. Objectives of the study were to identify chemistry laboratory skill at class XII in senior secondary school.To construct test to measure the achievement of student in chemistry laboratory skill. To find out the effects of factor such as type of school activity, sex, type of examination, socio-economic status and out of school activities on the development of chemistry laboratory skill. The study found that from the cognitive psychomotor domains of learning a comprehensive list were prepared. Chemistry laboratory skills were prepared which were needed for class IX students out of the categories in the comprehensive list. It was possible to construct test for measuring various chemistry laboratory skills with a high degree of reliability and validity. It was possible to classify several chemistry laboratory skills into major skills. A significant correlation was found between the ability to learn the subject matter content and the ability to learn cognitive as well as manipulative laboratory skill.

Pandya, J. H. (1978)madeasurveyoflaboratory of higher secondary school. Objectives of the study were to prepare the student for the university. To make the student read a terminal course for certain petty occupations and there by self-sufficient and also to life situation. To have a uniform pattern of education through the tuition.To study the process of vocationalisation of education. It was found that personnel's prepared for jobs of teacher, lab-assistance, lab-peon, opinion/view, laboratory facilities availability, laboratory equipment and its utilization, use of A.V.Aids in the laboratory, use of science library facilities, financial condition of schools, laboratory and its expenditure.

Rao, K. N. and Gupta, M. K. (1990) inquired into the science laboratory in secondary school in selected states. Objectives were to identify the deficiencies and inadequacies in the existing laboratory facilities. To ascertain if the required number of teachers demonstrations and students practical are performed. To examine if the laboratory is adequately utilized.To see if the equipment in the laboratory is adequate. To find out if there is any provision for improvisation of science

equipment. Major findings were it was observed that in Maharashtra 111 out of secondary school, 105 had science laboratory almost 97% in urban areas, 92% rural areas. 70% higher secondary schools which responded, 59 had science laboratory in urban area, 94.7% were having science laboratory as against 71.9% in the rural areas. Out of the 105 secondary school which had science laboratory. I.e. hardly 25% in the urban areas the position was better than the rural areas. Time devoted to science practical differed in urban and rural schools. The position in urban school was worse than the rural areas. The facilities of separate laboratories were available in 91.9% urban science as compared to 85.7% rural schools.

Mandira, G. S. (1992) studies the organisation of laboratory work and its contribution in the understanding of physics in the students of class IX in the few English medium of Baroda. Objectives were to study the organisation of laboratory work and contribution that it makes towards understanding the subject. To study the organisation of learning experience and contribution that there made towards proper understanding of the subject.To find out the opinion of the students themselves regarding their practical.To find outthe opinion of the teachers regarding organisation of laboratory work. Major finding schools develop lesser time for practical. In most of the schools the lab-assistant generally arranges the apparatus and keep the experiment ready for the teacher and students to study the problem so that they do not waste their time. The student wants rectification in the existing practice in order to understand correctly. Teachers opine they agree to provide reason, session to these students; who did not understand and whose work remained incomplete.

Makkar, **G**. **L**. **(1991)** mentioned in the 5thsurvey of education, in his research note made some observations regarding education and scientific research in Japan. Here, lengthy reviews in historical perspective are urgently required for drawing appropriate lessons for our country.

Malhotra, V. (2006)havementioned various view of Method of teaching science, in this book he havemention about, Understanding science teaching, Teaching and Learning of science, Instructional materials in science teaching, Teaching the nature of science, and Effective science teaching.

Peter, C. School of Education San Diego State University.John Wiley & Sons New York Santa, Barbara London Sydney Toronto (1977).Science in elementary education third edition. In this book the author mention about How to improve children's thinking skill like- observing, classifying, measuring, communicating, inferring, experimenting, text book experiments, summary of the thinking skills, conservation, thinking, applying theory to classroom science, experimental and non-experimental activities.

Jadhao, V.G. and Parida, B.K. (1996) mentioned in the 6th survey of education , titled " Teaching of force, work and energy at the lower primary level", attempted to review the use of these concepts in the NCERT text books and reported that teaching of these concepts as delineated in the books would lead to the development of misconceptions among students. Other studies focused on the lessons that could be learned when focusing on teaching some specific content.

Saxena, A.B. (1996) in his work mentions that "Lessons from teaching shadow and eclipses in a primary school", aimed at identifying the difficulties faced by teachers and at suggesting effective teaching methods. The activity approach using locally available materials was found to increase the achievement levels of students substantially. The context of teaching was often the subject of research, such as, teaching in large or rural classrooms.

Ramesh, C. (2005)thegeneralaimofscienceeducation is to help develop well defined abilities in cognitive and affective domains, besides enhancing psychomotor skills. It helps to foster an uninhibited spirit of inquiry, characterized by creative, innovative and objective approaches. Educational program me are designed to help unravel the mysteries of the interrelationship between science and day- to- day life, health, agriculture, industry, and indeed, the individual and the universe. Scientific wisdom, knowledge and skills are ammunitions that instil confidence and inspire the individuals to challenge existing beliefs, prejudices and practices. They work as a liberating force and serve as a reliable tool in one's search for truth, harmony and order in different aspects of life. Science education, as one of the most expensive area of the curriculum, has become vulnerable to the effects of parsimonious resourcing. Radically new technologies of production and access to information are beginning to permeate the developing world.

Other than the researches mentioned above, the sixth survey of education identifies a range of researches conducted in the file of science education. A brief description of the same is depicted below.

3.3 Implications of the Review

From the above review of books and researches it is evident that science is an important subject and is an important part of the curriculum at all levels. Moreover, the review of related literature from books suggested a range of teaching learning methodologies used to teach science.

The review of related literature helped the researcher decided the objectives, tools and data analysis techniques for the study. The next chapter focuses on the Research Planning and Procedure. The details of the research methodology are indicated in the subsequent sections.

Chapter 4

Research Planning and Procedure

4.1 Introduction

This chapter contains research design, research type, population, sampling technique, tools description, data collection process and an over view of the data analysis techniques. It gives the clear idea of the study conducted by the researcher and the process of the research endeavor.

4.2 Research Design

The present research was an Experimental Research. It followed the pre-experimental design one group pre- test post- test design. Attempts were made by the researcher to prepare a set of materials for laboratory management and the same were tried out on a group of pre service students. The details of the same are further mentioned in subsequent sections.

4.3 Research Type

Research as mentioned in the above section was experimental in nature. It followed one group pre-test post-test pre experimental design. The research was qualitative as well as quantitative in nature. Attempts are made by the researcher to triangulate the qualitative as well as quantitative findings and thus the nature of research is descriptive yet statistical analysis finds a significant place in the next chapter.

4.4 Population

The population is said to be the scope of the study i.e. the unit where generalizations with respect to the findings of the study can be made.

All the B.Ed. students of science method studying in B.Ed. colleges constitute the population of the study.

4.5 Sample

The sample is the working unit of the research. It is a group of subjects that the researcher works and interacts with.

The convenient sampling technique was used in the present research. The B.Ed. Advanced Students of theWaymade College of Education comprised the sample for the present study.

4.6 Tools

Tools enable the researcher to interact with the subjects and get their responses. In the present study the researcher used an achievement test and evaluation rubric for getting the quantitative data for the research as well as a reaction scale to find the reactions of the student teachers about the course. The field notes and anecdotal records for getting the qualitative data and qualitative indicators for the study.

4.7 Data Collection / Procedure / Steps of the Research

The researcher studied the Text book of std 9^{th}and10^{th}Gujarat state board and thereby identified the topics- related to laboratory. The researcher then prepared a Laboratory course and tools. They were shown to three experts and their comments were incorporated. The same was administered on the sample. The details of the experiment is depicted in Appendix 3.

4.8Data Analysis Technique

Qualitative as well as quantitative data analysis was done using content analysis technique, percentage analysis and chi- square.

Chapter 5

Data Analysis and Interpretation

5.1 Introduction

Data analysis and interpretation of the data collected is the focus of this chapter. The data for the present study was collected during the academic year 2011-12. An outline of the data collection schedule/phase is presented below.

Date	**Details of Data**
26-11-11	Pre-test
28-11-11to 3-12-11	Experiment
5-12-11	Post-test

The details of the data analysis and interpretation are presented in the present chapter in separate sections as depicted below.

5.2 Data Analysis and Interpretation of pre-test

5.3 Data Analysis and Interpretation of experiment

5.4 Data Analysis and Interpretation of post-test

5.2 Data Analysis and Interpretation of Pre-test

The pre-test administered on 26-11-2011. The pre-test comprised of a set of questions (Refer to Appendix 2). This was mainly administered on the Pre-service Teachers to find the level of awareness about laboratory / laboratory work, the information they know about the same and the exposure student teachers have to laboratory and laboratory method.

A detailed analysis of the pre-test was done by the researcher using content analysis. The table 1 below shows the major responses of the student teachers and its percentage respectively.

Table No. 1 DATA ANALYSIS OF PRE-TEST

Q. No.	Responses	**Percentage of response**
Q1.What is a science laboratory?	1) Student says laboratory is a place to conduct experiments or give opportunity to observed, scientific fact, concept and principles.	69.23%
	2) A large room related to science laboratory Work to provide to keep apparatus and Materials.	69.23%
	3) A place with performance of test, Demonstration of test, experiment And investigator procedure for the preparation of reagents, chemical reaction	7.69%
	4) Laboratory / practical work through student as well as teacher get accurate knowledge, self- learning and fill confidence and develop skill among the student in experiment.	30.76%
Q2. Why do you think science laboratory is important?	1) Science laboratory is important for understanding scientific fact, theory, and helpful for learning, knowledge in the science subject.	38.46%
	2) To do practical work and conduct laboratory work in science & learning by doing	84.61%
	3) Students can learn easily and to get knowledge about concept through experiment/ laboratory work.	53.84%

Q3. What are the types of activities that are done in secondary school science laboratory?	1) Demonstration done by making a group/ pair of student.	15.38%
	2) Instruction and introduction given about the experiment, instruments, materials, chemicals, equipment's to the students.	23.07%
	3) To conduct /organize simple experiments in secondary school levels.	53.84%
	4) Different methods to teach science laboratory in secondary school demonstration problem solving experimental project.	38.46%
	5) Preparing model through activity in activity in laboratory.	7.69%
Q4.What points do you think you will keep in mind when you organize a laboratory session?	1) Through instructions / organize conduct laboratory session and how to handle apparatus.	53.84%
	2) Given equal chance to all students, either group work or individually to do laboratory work systematically.	46.15%
	3) Systematically, planning arrangement of all the materials and space requirement in the laboratory work.	76.92%
	4) Observation through practical work/knowledge, and motivate them to do practical work.	15.38%
	5) According to levels of students to provide laboratory work and time management.	23.07%
Q5. What problems do you think a teacher faces in laboratory and while managing a	1) Arrangement of apparatus, materials and its using systematically.	46.15%
	2) Assistant teacher is requiring in the laboratory session/ work and conducting experiment.	30.76%

laboratory?	3)Time management	23.07%
	4) Given instruction for poisonous chemicals to all students before starting practical works.	61.53%
	5) Maintain the high cost or low cost chemicals, instrument and materials in the laboratory.	53.84%
	7) Controlling the experiment/practical session.	15.38%
Q6.Which topic in science from std.IX and X do you think can be taught through laboratory work?	1)Theoretical knowledge about practical work	76.92%
	2) Observation through laboratory work/experiment.	92.30%
Q7.What is laboratory method?	1)To teach effectively or student learn practically in science, learning by doing	76.92%
	2) Conducting experiment through student learn observation and to get aqurate results/knowledge and actual information in science subject.	61.53%
	3) Guidance through arrangement/managing of laboratory work.	30.76%
Q8.Is there any difference between experiment, demonstration and task?	1)Yes	100%
Q9. Which types of laboratories have you visited?	1)School laboratory/high school and science laboratory	61.53%
	2) Laboratory for high school- chemistry laboratory, physics laboratory and chemistry laboratory.	84.61%
	3)Forensic science laboratory	30.76%

	4)Math laboratory	30.76%
	5)Clinical laboratory	7.69%
	6)Biology drug/pharmacy	7.69%
	7) Plant tissue culture laboratory and agricultural laboratory.	23.07%
	8) Psychology laboratory	15.38%
Q10.Have you conducted any laboratory sessions?	1)No	61.53%
	2)Yes	38.46%
Q11. What records do you think are maintained in the laboratory? Who maintains them?	1)Assistant/teacher through maintain/arrangement of the laboratory and recode	92.30%
	2)All material, equipment's, chemicals and apparatus are available in laboratory and ready for use and list for apparatus require a/c to no. of student	92.30%
	3)Issues and returns the apparatus	7.69%
Q12. What points will you keep in mind, when you plan laboratory session for your students?	1)Managing the instruction given to the student into the group and time management	61.53%
	2)Strength of students in practical classes where students are capable to do practical work or not	38.46%
	3)Requirement of large room and arrangement of apparatus, materials, chemicals and instrument in the laboratory work/session	53.84%
	4)Give freedom to the learners in the laboratory	15.38%
Q13. What type of help/support will you give to the students in the laboratory?	1)Guidance and instruction should be given to the students a/c to strength of student and also motivate them to do practical work	100%
	2)Observation through practical work as well as theoretical	38.46%

	3)Require materials, chemicals and apparatus	23.07%
Q14. According to you what type of training should be a given to the teacher to use laboratory effectively?	1)Theoretical or discussion through practical knowledge	46.15%
	2)To maintain/conduct practical work and teacher should be given guidance/training to the learners and time management required	92.30%
Q15. What do you mean by effective use of the laboratory?	1)Maintain the records and proper use of materials or arrangement through effective of laboratory	46.15%
	2)Conducting experiment without any mistake	30.76%
	3)Observation through practical knowledge/work ,learning by doing in science subject	30.76%

From the above table it is clear that the student teachers were aware of the concept of laboratory and importance of laboratory. The table above depicted detailed question wise analysis. The major observations derived from table are presented below:

69.23% student teachers said that the laboratory is used to conduct experiments. The also mentioned that laboratories are large room that enables students to demonstrate and do practical work.

30.76% student teachers expressed that laboratory and laboratory method can be used for during self- directed work. Student teachers were aware that laboratory sessions would make learners confident and skillful.

38.46% student teachers were aware of the importance of science laboratory.

84.61% student teachers said that mainly practical work was done in class and that student could learn through these practical activities.

53.84% mentioned that laboratory sessions increase comprehension ability of students.

15.38% student teachers mentioned pair work or group work is normally done in laboratory.

Moreover, student teachers could also mention some points that they would keep in mind while conducting laboratory sessions. They included activities like giving instructions, doing demonstrations etc.

38.46% student teachers identified demonstrations method, project method and problem solving method as methodologies for laboratory sessions. Student teachers identified time management, arrangement of apparatus, and classroom organization as major challenges of laboratory sessions.

53.84% student teachers said that low quality of materials in laboratory and its maintained would be a challenge.

Almost 76.92% could identify some features of laboratory work and laboratory method like experimenting and demonstrating.

All student teachers had visited laboratories like school laboratory, science laboratory, forensic laboratory, math laboratory, clinical laboratory, biology drug/pharmacy laboratory, agricultural laboratory, psychology laboratory, plant tissue culture laboratory etc.

38.46% student teachers said that they had conducted a laboratory session in the past.

61.53% student teachers did not conducted a laboratory sessions.

All the student teachers mentioned that the laboratory sessions must include proper guidance and instructions for students.

Future, 38.46% student teachers mentioned that the task should be given as per clever of the students.

From the data analysis of the pre-test, it is evident that the student teachers were aware of basic concepts and practices related to the laboratory. The researcher could conclude that the student teachers were clear about the theoretical concepts of the laboratory. Moreover, some of the student teachers who had experiences organizing laboratory sessions could state the features of laboratory management.

The student teachers also showed readiness to learn about both the theoretical and practical components of laboratory management.

Keeping the above aspects in mind the researcher conducted laboratory management sessions for the B.Ed. students from 26th November 2011 to 5thDecember 2011. All the practical sessions were conducted using stimulated situations. The details of which are given in the following sessions.

5.3 Data Analysis and Interpretation of Data Gathered During Experimental Sessions

The researcher conducted the experiment and engaged a number of sessions with the student teachers to teach them the essentials of Laboratory Management. A brief description of this phase is presented below. The course developed by the researcher is annexed in appendix 3.

Table No 2 EXPERIMENTAL PHASE

Day/Date	Time Hour	Theme of session and overall response of student teachers	Teaching points
Day1, 26.11.2011	1 hour	The investigator conducted a session from 2:40pm to 3:30pm. The focus of session was to administer the pre-test on the student teachers to find the laboratory exposure and information they have about laboratory work and management.	Pre-test
Day2, 28.11.2011	1 hour	The investigator conducted a session from 2:40pm to 3:30pm. The focus ofthe sessionwas to teach concept of laboratory and there activities: Meaning of laboratory and importance of laboratory. The student teachers were involved in the following activities: The student teachers said that they learnt definition, meaning and	Concept of Laboratory Importance of laboratory: Develop scientific attitude, some values like, punctuality,

		importance of laboratory in science education.	regularity vis-à-vis laboratory work
Day3, 29.11.2011	1hour	The investigator conducted a session from 2:40pm to 3:30pm. The focus of the session was to teach the advantages of laboratory and also conduct cum demonstrate experiment on the topic diffusion. The student teachers were involved in the following activity: discussion, observing the experiment. The student said that we learnt how to hold beaker and other apparatus during demonstrations, give instructions and also learnt to conduct experiment.	Advantage of laboratory: Experiment on diffusion. Materials used Beaker, water, test tube, test tube stand, ink.
Day4, 30.11.2011	2 hours	The investigator conducted a session from 2:40pm to 4:30pm. The focus of the session was to teach the types of laboratory and given task to conduct experiment on the topic osmosis to a group of student teachers with the help of a given instruction cum experimental sheet. The student teachers were involved in the following activity: conducting experiment, scooping potato, making sugar solution etc. The student teachers said they learnt to conduct experiment and demonstrate the same by giving suitable instructions. They also learnt how to arrange materials, equipment, apparatus and allthings needed in the laboratory room.	Used OHP to show general laboratory room or all purpose of laboratory. Experiment on Osmosis. Materials used: Potato, spoon, sugar solution for conducting experiment osmosis.
Day5, 01.12.2011	1 hour	The investigator conducted a session from 2:40pm to 3:30pm. The focus of the session was task of conduct experiment in	Arrangement of Laboratory

		group work, and then they are conducting experiment chemical combination, combustion. The student teachers were involved in the following activity: discussion with others, asking different questions and observing experiment. The student teachers said that they learnt theoretical knowledge through laboratory work and arrangement of laboratory	Experiment on chemical combination and combustion. Materials used:Glass, water and calcium carbonate for chemical combination, glass, candle, and match box for combustion.
Day6, 02.12.2011	1 hour	The investigator conducted a session from 2:40pm to 3:30pm. The focus of the session was to demonstrate lecture cum demonstration method used in laboratory. The investigator used lecture cum demonstration to teach parts of flower (china rose). The students were involved in the following activity: observing, drawing the parts of flower and discussion. The student said we learnt demonstration about parts of flower.	Lecture cum Demonstration Method Parts of flower Demonstration Skills among Student teachers. Materials used: flower, blade,etc.
Day7, 03.12.2011	2 hours	The investigator conducted a session from 2:40pm to 4:30pm. The focus of session wasto teach role of a teacher in laboratory, record keeping in laboratory and experiment done by students in the pair work, the topic focused was Newton's third law of motion, acid (ascorbic acid) The student teachers were involved in the following activity. They were busy	Role of teacher in laboratory Record keeping in laboratory Experimental work Balloon, wire, nail For Newton's third

		observing and doing experiment. The student teachers said we leant role of the teacher in laboratory.	law of motion. Blue litmus paper, tomato and lemon for acid(ascorbic acid).
Day8, 05.12.2011	1 hour	The investigator conducted a session from 3:40pm to 4:30pm. The focus of session was to administer the post-test and take feedback from student teachers.	Post-test

Thus from the table it is clear that the student teachers got opportunities to learn about both theory and practical of laboratory management.

The major points focused in the course were

- Concept of laboratory: Meaning and definitions of laboratory.
- Importance and advantage of laboratory.
- Teaching activities in lab0ratory: Observe, give direction, pre-plan, Experimental sheets, need to plan reasoning task.
- Types of laboratory: 1) Laboratory for inter college and 2) Laboratory for high school.
- All- purpose laboratory, Lecture room cum laboratory and Lecture Theater cum laboratory.
- Lab for high school: Safety measures, requirements, depth knowledge, specific aim, environment.
- General laboratory: Important things is needed- electricity, water supply, demonstration table, working table, equipment, glass wares, apparatus-subject requirement, specimen, models, charts, chemicals, indicators/stains, air and sink, glass line, refrigerator, distilled water.
- Role of a teacher.
- Record keeping: Time table, register, unbreakable apparatus, book for chemicals, glass apparatus, equipment's, infrastructure of the lab, resource materials etc.
- Manages laboratory.
- Evaluator: learning out com, evaluates the progress of the students.

- Pre-plan: Time duration, task/experiment, concept sheet, materials needed, prepare check list, concept clarity.
- Experiments: Diffusion, osmosis, chemical combination, combustion, acid (ascorbic acid), Newton's third law of motion, etc.

The student teachers did the following activities during the course on laboratory management.

- Observed laboratory sessions.
- Participated in organizing laboratory sessions and teaching in laboratory through simulate situations.
- Prepared laboratory sheets for experiments
- Performed demonstrations
- Attended theory classes
- Practiced demonstrations skills
- Observed each other's work and gave peer feedback
- Questioned and discussed laboratory experiments and time table details in groups

Therefore, the student teachers did get opportunities to conduct their laboratory sessions in groups in artificial – simulated situation.

The overall feedback of the student teachers obtained during the sessions is depicted below.

- The sessions were interactive.
- We got opportunities to do experiment and observe each other.
- We feel confident to do experiments and simultaneously give instructions.
- We enjoyed learning about laboratory and its management aspects
- We got opportunities to arrange lab
- We could understand the record keeping and experimental set up registers.

Thus from the above responses it is evident that the student teachers did learnt different aspects of laboratory management. The subsequent session was undertaken to administer the post- test and thereby get feedback of the students.

5.4 Data Analysis and Interpretation of Post-test

After the experimental sessions were completed the researcher administered the post test (Refer to Appendix 2). The post-test was administered mainly to find the reactions and feedback of student teachers about the course. And, also to confirm whether they felt enriched and confident to conduct laboratory sessions. The researcher wanted to get the feedback and through the feedback analyse the effectiveness of the course. The detail of the responses sought through post-test is depicted in table number 3.

Table No. 3 DATA ANALYSIS OF POST-TEST

Q No.	Response	Percentage
Q1. What is your experience about the topic that were taught to you?	1)Laboratory work	30.76%
	2)Students learnt to organize/conduct laboratory management work and how to arrange different types of materials, equipment	76.92%
	3)Theoretical knowledge about lab management and teachers role in the laboratory	30.76%
	4)Learnt through trial & error	7.69%
	5)General response of students as good session	23.07%
	6)Motivation to do to laboratory work and free in lab stimulation session	15.38%
Q2. What were your learning values?	1)Students learnt how to conduct/organize/arrangement of laboratory management work systematically	84.61%
	2)Students learnt role as a teacher in the laboratory work	46.15%
	3)Students learnt theoretical knowledge about necessary requirement and precaution to be taken in a laboratory	15.38%
	4)Need and importance of laboratory work in the school or theoretical knowledge about laboratory	30.76%

	work in the school	
	5)Laboratory work through get/develop knowledge about actual real- life situation in future, self-learning, scientific attitude, skills, techniques	38.46%
	6)Students get practical work/experiment through experience in science subject	7.695
	7)Students learnt by asking different type of question, reasoning question , conducting experiment/demonstration	15.38%

The post-test as administered on 05-12-2011 to get the feedback/ responses of student teachers about the sessions. The responses obtained are depicted question wise below.

Q1. What is your experience about the topic that were taught to you?

The student teachers expressed that they learnt to manage laboratory sessions. Moreover, the students also mentioned that they could understand both theory and practice of laboratory method.

30.76% of student teachers said that they got opportunity to work in the laboratory and conduct laboratory sessions.

76.92% student teachers expressed that they learnt organize laboratory sessions and also developed insights into the 'Know-how' of laboratory. They also learnt to arrange different types of materials in the laboratory.

30.76% of student teachers developed clarity about the philosophy and concept of laboratory sessions.

Some of the student teachers i.e. 7.69%mentioned that they learnt science concepts through trial &error.

23.07% of student teachers expressed that the sessions enabled them practice laboratory method in the stimulated manner.

15.38% student teachers clearly mentioned that they felt motivated to conduct laboratory sessions.

Some of expressions of student teachers are mentioned below:

“The experience was nice, it was good. We had learned about how to conduct a laboratory session, what different types of laboratories are and what is the role of a teacher in laboratory and also she has explained well about the topics were demonstrated some experiments”

Another student teachers mentioned that “According to my opinion, the topic of laboratory which were taught in the class were relevant. Demonstrations done based on different topics of science were appropriate which help in understanding how to conduct laboratory experiments in the classroom for an effective teaching-learning process”.

Yet another, student teachers mentioned that “I gained knowledge about how to demonstrate, conduct experiments and take precautions in the laboratory”.

Q2. What were your learning values?

84.61% student teachers learnt to manage laboratory sessions.

46.15% developed clarity about their roles in the laboratory.

15.38% student teachers expressed they could now take precautionary measures in laboratory.

30.76% student teachers understood the relevance of labs in school. They said that after experiencing the laboratory sessions in simulated manner they could relate to school situations and importance of practical work in science.

30.46% student teachers said that laboratory work developed process skills in them as well as realized that it would help in shaping the attitude of students to wards science education.

7.69% student teachers learnt to demonstrate and conduct practical session.

15.38% student teachers said laboratory sessions developed their HOTS (higher order thinking skill).

Further, the f feedback of student teachers is mentioned below.

Student teachers said that ….

“I learned how I can conduct laboratory sessions in a better and systematic way and how I can manage the laboratory well. I also learned what should be my role as a teacher in the laboratory”.

Another student teachers mentioned …

“I got confidence for demonstration method, and learnt more on laboratory method. If I am teacher what precautions are needed that all things understand to me so, it is more getting knowledge”.

Another student teachers mentioned …

“I learnt how to manage the laboratory session as well as what is the role of a teacher while performing and managing laboratory as well as importance of laboratory”.

Yet another student teachers mentioned that…

“This topic of laboratory provided information, it will help us in future for actual real-life situations of how to conduct and manage the lab sessions in the class room”.

In addition, some of the responses obtained through the post-test is mentioned below.

Name of Student teacher Shilpa. p. S

Name of College W.M.C.E.

Please read the following Question and answer them in the space provided

1. What is your experience about the topic that were taught to you?

I have enjoy this class. because in this laboratory method already learned in +2 class and degry. class. so that remembrence also Prelud ed in this sessions. It is an interested topic. because already know some ideas. then it is very interactive section were each students do one demonstration method. It is more interesting. It is an interactive class.

2. What wear your learning values?

(2) (confident) I got were coefficients for demonstration method.

I learnes more on laboratory method. If I am teacher what precousions are needed that all thing understanded to me. It is more geting knowledge.

Name of Student teacher AKANKSHA SINGH

Name of College WAYNAAD COLLEGE OF EDUCATION

Please read the following Question and answer them in the space provided

1. What is your experience about the topic that were taught to you?

(1) The experience was nice. It was good we had learn about how to construct a laboratory, what are different types of laboratories, what is the role of a teacher in laboratory. She has explained well about the topics with demonstrated some experiments

2. What were your learning values?

we have learn about :-

1) what is laboratory.
2) Significance of laboratory
3) Needs of laboratory session
4) Application of laboratory
5) Types of laboratories
6) Role of teacher in laboratory
7) Demonstration

Name of Student teacher Shilpa. P. S

Name of College M.M.C.E.

Please read the following Question and answer them in the space provided

1. What is your experience about the topic that were taught to you?

I have enjoy this class. because in this laboratory method already I earned in +2 class and degry. class. so that remembrance also Includ ed in this sessions. It Is an interested topic. because already know some Idea. then It Is very interactive section. each students do one demon stration method. It Is more interesting. It Is an interactive class.

2. What wear your learning values?

I get coefficients for demonstration method. I learnes more on laboratory method. If I am teacher what precousions are needed that all thing understanded to me. It Is more geting knowledge.

2 confident

Name of Student teacher Taslim Gandhi.

Name of College Mayanadu College of Education.

Please read the following Question and answer them in the space provided

1. What is your experience about the topic that were taught to you?

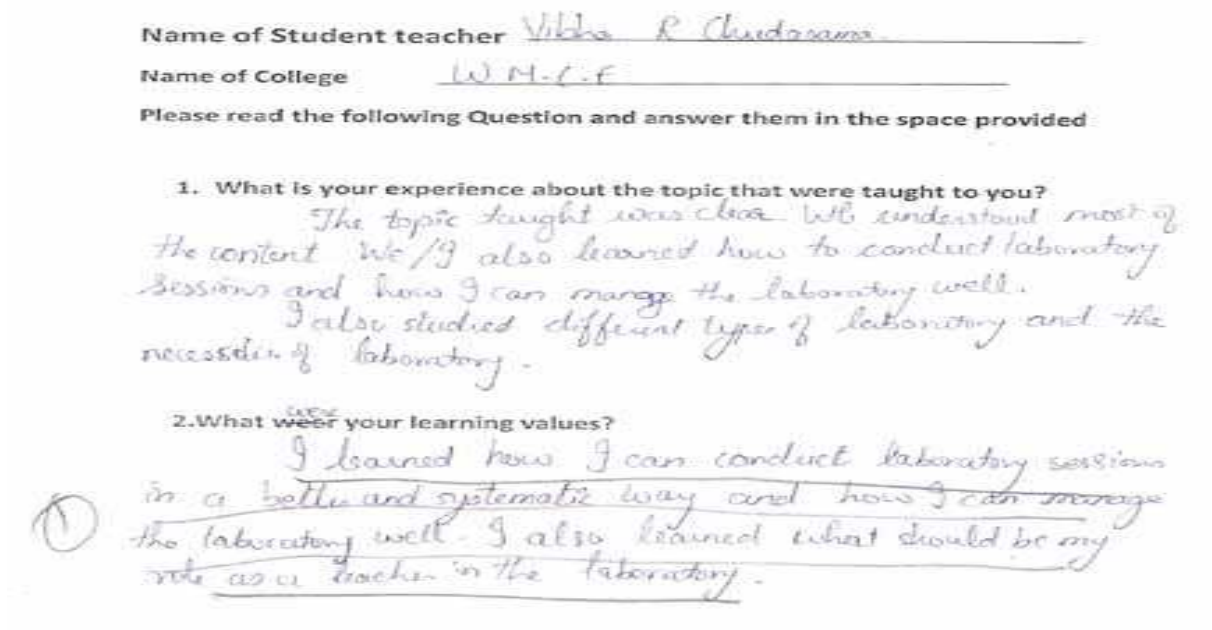
According to my opinion, the topic of laboratory which was taught in the class was relevant. Demonstrations also based on different topics of Science was appropriate which helps for understanding how to conduct laboratory Experiments in the classroom for an effective teaching-learning process.

2

2. What wear your learning values?

This topic of laboratory provides many information, It will help us in future for actual real-life Situations of how to conduct and manage the lab Experiments in the classroom. Science Subject which is mainly based on practicals for thorough concept of the topic will be enhanced by using laboratory method.

9



Name of Student teacher Vibha R Chudasama.

Name of College W.M.C.E

Please read the following Question and answer them in the space provided

1. What is your experience about the topic that were taught to you?

The topic taught was clear. We understood most of the content. We/I also learned how to conduct laboratory sessions and how I can manage the laboratory well.
I also studied different type of laboratory and the necessity of laboratory.

2. What ~~weer~~ were your learning values?

I learned how I can conduct laboratory sessions in a better and systematic way and how I can manage the laboratory well. I also learned what should be my role as a teacher in the laboratory.

Hence, above feedback was used to evaluate the effectiveness of the course/sessions.

5.5 Data Analysis and Interpretation with Respect to the Reaction Scale

The reaction scale was prepared to get the reason of the response of the student teachers about the module.The data collected through reaction scale was analysed using chi-square, the details are presented below.

Statement 1

The tasks given by teacher during the Laboratory sessions help me develop my practical skill.

Response to statement 1

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	2 (15.38%)	7 (53.84%)	4 (30.76%)
f_e	2.6	2.6	2.6	2.6	2.6

$\chi^2_{cal} = 13.52$ d f = (r-1). (c-1)

$\chi^2(Cal) > \chi^2(0.01)$ & (0.05) = (2-1). (5-1)

$\chi^2(Cal) > \chi^2$ (13.277) & (9.488) = (1). (4)= 4

Therefore the Null hypothesis is rejected.

There is a significant difference between f_o and f_e.

Interpretation

Fromthe above data depicted in the table, it can be said that 53.84% of student teachers found that the task given by the researcher during the laboratory sessions help them develop their practical skill most of the time while 30.76% student teachers found that the tasks given by the researcher during the laboratory sessions helped them develop their laboratory skill always and 15.38% student teachers found that the tasks given by the researcher during the laboratory sessions helped them develop their practical skill sometimes. Hence the researcher found that the tasks given by the researcher during the laboratory sessions helped all the student teachers develop their practical skill.

Statement 2

Duringthe tasks Iwas able to understand the organisation of Laboratory work.

Response to statement 2

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	1 (7.69%)	6 (46.15%)	6 (46.15%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2 Cal = 15.06 d f = (r-1). (c-1)

χ^2Cal > χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2Ca l> χ^2 (13.277)&(9.488) = (1). (4) = 4

Therefore Null hypothesisis rejected.

There is a significant difference between fo and fe.

Interpretation

46.15% student teachers found that during the tasks they were able to understand the organisation of laboratory work always and most of the time and only 7.69% student teachers found that during the tasks they were able to understand the organisation of laboratory work sometimes. Hence the researcher found that during the tasks majority of the student teachers were able to understand the organisation of laboratory work.

Statement 3

The tasks given by researcher during the Laboratory session help me to work in group.

Response to statement 3

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	1 (7.69%)	4 (30.76%)	5 (38.46%)	3 (23.07%)
F_e	2.6	2.6	2.6	2.6	2.6

$\chi^2_{cal} = 6.6$ d f = (r-1). (c-1)

χ^2 (Cal) > χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2(Cal)> χ^2(13.277)& (9.488) = (1). (4)= 4

Therefore Null hypothesisis rejected.

There is a significant difference between$f_o$andf_e

Interpretation

23.07% student teachers found that the tasks given by the researcherduring the laboratory session helped them work in group always while 38.46% student teachers found that the tasks given by the researcher during the laboratory session helped them work in group most of the time and only 7.69% student teachers found that the tasks givenby the researcher during the laboratory session helped them work in group rarely. Hence the researcher found that during the tasks majority of the student teachers were able to work in group.

Statement 4

I am now able to demonstrate certain experiments in science.

Response to statement 4

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	2 (15.38%)	4 (30.76%)	7 (53.84%)
f_e	2.6	2.6	2.6	2.6	2.6

$\chi^2_{cal} = 13.52$ d f = (r-1). (c-1)

$\chi^2_{(cal)} > \chi^2$ (0.01)&(0.05) = (2-1). (5-1)

χ^2 (Cal) > χ^2 (13.277)&(9.488) = (1). (4)= 4

Therefore the Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

53.84% student teachers found that they can now able to demonstrate certain experiments in science always while 30.76% student teachers found that they can now able to demonstrate certain experiments in science most of the timeand only 15.38% student teachers found that they can now able to demonstrate certain experiments in science sometimes. Hence the researcher found that majority of the student teachers can now able to demonstrate certain experiments in science

Statement 5

The Laboratory sessions and guidance by researcher helped me understand demonstration/experimental skills.

Response to statement 5

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	1 (7.69%)	2 (15.38%)	6 (46.15%)	4 (30.76%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2_{cal} = 12.59 d f = (r-1). (c-1)

χ^2 (Cal) > χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2 (Cal) > χ^2 (13.277)& (9.488) = 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

46.15% student teachers found that the laboratory session and guidance by researcher helped them understand their demonstration/experimental skills most of the time while 30.76% student teachers found that the laboratory session and guidance by researcher helped them understand their demonstration/experimental skills always and 15.38% student teachers found that the laboratory session and guidance by researcher helped them understand their demonstration/experimental skills sometimes and only 7.69% student teachers found that the laboratory session and guidance by researcher helped them understand theirdemonstration/experimental skills rarely. Hence the researcher found that the laboratory session and guidance by researcher helped majority of the student teachers understand their demonstration/experimental skills.

Statement 6

During the Laboratory sessions I was able understand the how to keep the record.

Response to statement 6

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	2 (15.38%)	7 (53.84%)	4 (30.76%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2cal = 17.21 d f = (r-1). (c-1)

χ^2 (Cal) >χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2 (Cal)>χ^2 (13.277 & (9.488) = (1). (4) = 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

30.76% student teachers found that during the laboratory session they were able to understand the how to keep the record always while 53.84% student teachers found that during the laboratory session they were able to understand the how to keep the record most of the time and only15.38% student teachers found that during the laboratory session they were able to understand the how to keep the record sometimes. Hence the researcher found that during the laboratory session majority of the student teachers were able to understand the how to keep the record.

Statement 7

I was able to understand importance of laboratory

Response to statement 7

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	1 (7.69%)	0 (0%)	5 (38.46%)	7 (53.84%)
F_e	2.6	2.6	2.6	2.6	2.6

χ^2cal = 19.99 d f = (r-1). (c-1)

χ^2 (Cal) >χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2 (Cal)>χ^2 (13.277)& (9.488) = (1). (4)= 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

53.84% student teachers found that they were able to understand importance of laboratory always while 38.46% student teachers found that they were able to understand importance of laboratory most of the time and 7.69% student teachers found that they were able to understand importance of laboratory rarely. Hence the researchers found that majority of the student teachers were able to understand importance of laboratory.

Statement 8

I don't like the tasks given by the researcher.

Response to statement 8

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	6 (46.15%)	5 (38.46%)	2 (15.38%)	0 (0%)	0 (0%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2cal = 11.98 d f = (r-1). (c-1)

χ^2 (Cal) >χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2 (Cal)>χ^2 (13.277)& (9.488) = (1). (4)= 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

38.46% student teachers found that they didn't like the tasks given by the researcher rarely while 46.15% student teachers found that they didn't like tasks given by the researcher not at all and only 15.38% student teachers found that they didn't like the tasks given by the researcher sometimes. Hence the researcher found that majority of the student teachers liked the tasks given by the researcher.

Statement 9

The tasks given by the researcher were appropriate.

Response to statement 9

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	5 (38.46%)	5 (38.46%)	3 (23.07%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2cal = 9.68 d f = (r-1). (c-1)

χ^2 (Cal) > χ^2 (0.01) & (0.05) = (2-1). (5-1)

χ^2 (Cal) > χ^2(13.277)& (9.488) = (1). (4) = 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

38.46% student teachers found that the tasks given by the researcher were appropriate most of the time while 38.46% student teachers found that the tasks given by the researcher were appropriate sometimes and only 23.07% student teachers found that the tasks given by the researcher were appropriate always. Hence the researcher found that majority of the student teachers were believed that the task given by the researcher were appropriate.

Statement 10

The instructions given by the researcher were appropriate.

Response to statement 10

	Not at All	Rarely	Sometime	Most of the Time	Always
f_o (Percentage)	0 (0%)	0 (0%)	6 (46.15%)	5 (38.46%)	2 (15.38%)
f_e	2.6	2.6	2.6	2.6	2.6

χ^2cal = 11.98

χ^2 (Cal) >χ^2 (0.01) & (0.05)

χ^2 (Cal)>χ^2 (13.277)& (9.288)

d f = (r-1). (c-1)

= (2-1). (5-1)

= (1). (4)= 4

Therefore Null hypothesisis rejected.

There is a significant difference between f_o and f_e.

Interpretation

46.15% student teachers found that the instructions given by the researcher were appropriate sometimes while 38.46% student teachers found that the

instructions given by the researcher were appropriateand only 15.38% student teachers found that the instruction given by the researcher were appropriate always. Hence the researcher found that the majority of the student teachers believed that the instruction given by the researcher were appropriate.

Thus from the above data analysis it is evident that the students held positive views about the course. The students found the tasks to be useful.

Thus the qualitative and quantitative data analysis i.e. feedback of student teachers, pre-test and post-test scores, chi-square indicate the usefulness of the tasks.

The following chapter presents findings and conclusions of the study.

Chapter 6

Suggestions, Implications and Conclusion

6.1 Introduction

The researcher conducted this study on management of the laboratory for science with the intention of providing ways and options to improve the present scenario.

This Chapter includes suggestions, implications and conclusion. The chapter also presents the outcomes of the study and scope for future researches.

6.2 Discussion and Findings

Laboratory is a very important component of Science teaching. It is a place where students get first-hand information. Moreover, the laboratory method demands planning and systematic arrangement of practical exposure through demonstrations, experiments and discussions.

The researcher made attempts to provide mock situations in laboratory vis-à-vis laboratory sessions, experiments and demonstration cum discussion sessions.

From the data analysis of the pre-test, it is evident that the student teachers were aware of basic concepts and practices related to the laboratory. The researcher could conclude that the student teachers were clear about the theoretical concepts of the laboratory. Moreover, some of the student teachers who had experiences organizing laboratory sessions could state the features of laboratory management. The student teachers also showed readiness to learn about both the theoretical and practical components of laboratory management. However, The qualitative analysis of the post-test indicated that the conceptual understanding of the student teachers had enhanced and they were able to conduct laboratory sessions within their groups comfortably. Moreover, student teachers planned laboratory tasks and prepared materials for laboratory. The student teachers also conducted discussions and linked theory to practice. The reactions of student teachers indicated a favorable view towards the tasks. The findings of the study are indicated below.

- Student teachers were aware of their roles in the laboratory and the tasks further enabled them to develop a clear conceptual understanding of the teacher's role in the laboratory.
- The mock situations and mock laboratory sessions enabled the student teachers to develop their laboratory skills.
- Student teachers expressed that the task enabled them to be clear of their role in the laboratory and create materials for students.
- Student teachers could link the theory and practical in science through laboratory sessions.
- The tasks and demonstrations provided clarity about record keeping and stock management to student teachers.
- The quantitative data analysis indicated that the student teachers had positive and favourable views towards the tasks.
- All student teachers were able to conduct laboratory sessions and made attempts to perform in laboratory vis-à-vis the inputs of the course.

6.3 Suggestions

The researcher has provided some suggestions based on her experience gained during this study.Suggestions are given for teachers as well as for students.

Suggestions for Teachers

- Design the schedule for laboratory activities for the class
- Organize the laboratory activities in a planned manner.
- Arrange the laboratory instruments in a systematic manner.
- Update the instrumentation.
- Display the important happenings in the lab.
- Provide equal opportunities to all the students.
- Manage the students by using different techniques.
- Manage the time schedule as well as the curriculum.
- Maintain the records in respective laboratory files.
- Teachers should take care that all the students are able to see the demonstration done.
- Teachers should give proper and clear instructions to the class.

- Remain vigilant when experiment is going on.
- Take care of the students' and your safety.

Suggestions for Students

- Maintain discipline in the lab.
- Keep control on the noise level when the teachers are explaining and demonstrating
- Be on time to reach the lab.
- Do not destroy or damage the instruments and the property of the lab.
- Replace the things taken from the lab in a proper condition
- Use lab for the purpose of learning.
- Maintain your record books and lab activity note.
- Remain safe and take care of others' safety.

6.4 Implications of the Study and Scope for Future Researchers

It can be concluded that the present study was a fruitful endeavor and helped the researcher develop a course for pre-service students.

The researcher would like to suggest the following topics for future studies.

- A survey on laboratory courses offered at various colleges can be studied.
- Course for PTC, B.Ed. can be developed with additional components of laboratory management in real laboratory settings.

Thus the researcher would like to state that the study was a learning experience for the researcher and gave insights into the procedure of laboratory management to numerous student teachers.

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