CHEMISTRY LABORATORY COMPETENCE AMONG HIGHER SECONDARY SCHOOL STUDENTS IN RELATION TO THEIR GENDER, TYPE OF SCHOOL AND LOCATION OF SCHOOL

A

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ABBREVIATION USED

CLCT Chemistry Laboratory Competence Test

GOVT. Government

PVT. Private

S.D.Standard Deviation

TOSType of School

LOS Location of School

ABSTRACT

Laboratory work is considered essential in promoting students' learning of science and of scientificinquiry.Thechemistrylaboratorycompetenciesarefocusedonstudentsknowinganda pplying scientific methods and procedures to solve problems in familiarsettings andunderstandingtheirenvironmentinarationalway.Despiteallefforts made,thereisstillaneno rmousgapbetweenthecompetenciesthatstudentsshouldacquireandthewaytheyarebeingevalu ated.ChemistryLaboratoryCompetencehasgreatimpactondevelopingvariousskillsofhighers econdaryschoolstudents.RealisingtheimportanceofChemistryLaboratoryCompetenceindev elopingtheimportantskillsofhighersecondaryschoolstudentsandalso theinfluenceofitintheacademicachievementsofstudents,toinvestigatetheproblem byStandardizedtoolnamely*ChemistryLaboratoryCompetenceTest*developedbyRathodand Kotwale(2012)isused.Thesampleconsistsof192highersecondaryschoolstudents,96(male) and96(female)ofJammudistrictselectedbystratifiedrandom samplingtechnique.TheObjectivesofthestudyweretoassessthelevelofchemistrylaboratoryc ompetenceofhigherSecondaryschoolstudents.To studyinteractionexistsbetweentypeofschoolandLocationofschool,typeof schoolandgender,locationofschoolandgenderandamong gender,typeofschool and location ofschoolwith chemistrylaboratorycompetenceasthe dependent variableinhighersecondaryschoolstudents.Inthepresentstudy,percentageand3-wayANNOVAwerecalculatedtoachievetheobjectivesofthestudy.From theresults,itwasconcludedthatthehighersecondaryschoolstudentsstudying in privateschoolwerefound to havelow chemistrylaboratorycompetence than higher secondary school students studying in governmentschool.There was significantdifference oflocation ofschoolonchemistry laboratory competence of students studying in eleventh class.There was significantgenderdifferences at0.05 levelofsignificance in the chemistry laboratory competence of highersecondarystudents.Theresultalsoindicatedthatthereisnosignificantinteractionexists between type of schooland gender with chemistry laboratorycompetence as the dependentvariable among highersecondarystudentsstudyingineleventhclass.Theresultalsoindicatedthatsignificantinte ractionexistbetween location ofschooland genderwith chemistry laboratorycompetence as

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CHAPTER– I

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

How do we prepare students for practical skills they conduct in the laboratory?
Practical skills involve psychomotor development, as they typically involve handling chemicals, glassware, and instrumentation. But how do we prepare students for this work, and do we give them enough time to develop these skills? Farmer and Frazer analyzed 126 school experiments with a view to categorizing practical skills **(Farmer & Frazer,2016)**Science laboratories have been part of high school education for two centuries, yet a clear articulation of their role in student learning of science remains elusive. This report evaluates the evidence about the role of laboratories in helping students attain science learning goals and discusses factors that currently limit science learning in high school laboratories. In this chapter, the committee presents its charge, reviews the history of science laboratories in U.S. high schools, defines laboratories, and outlines the organization of the report.

In the National Science Foundation (NSF) Authorization Act of 2002, Congress called on NSF to launch a secondary school systemic initiative. The initiative was to "promote scientific and technological literacy" and to "meet the mathematics and science needs of students at risk of not achieving State student academic achievement standards." Congress directed NSF to provide grants for such activities as "laboratory improvement and provision of instrumentation as part of a comprehensive program to enhance the quality of mathematics, science, engineering, and technology instruction". At an early stage in its deliberations, the committee chose to focus primarily on "the role of high school laboratories in promoting the teaching and learning of science for all students."

The primary goal of these early high school laboratories was to prepare students for higher science education in college and university laboratories. The National Education Association produced an influential report noting the "absolute necessity of laboratory work" in the high school science curriculum (National Education Association, 1894) in order to prepare students for undergraduate science studies. As demand for secondary school teachers trained in laboratory methods grew, colleges and universities began offering summer laboratory courses for teachers. In 1895, a zoology professor at Brown University described "large and increasing attendance at our summer schools," which focused on the dissection of cats and other animals. (Bump, 1895).At that time, most educators and scientists believed that participating in laboratory experiments would help students learn methods of accurate observation and inductive reasoning. However, the focus on prescribing specific experiments and procedures, illustrated by the embrace of the Harvard list, limited the effectiveness of early laboratory education. In the rush to specify laboratory experiments, procedures, and equipment, little attention had been paid to how students might learn from these experiences. Students were expected to simply absorb the methods of inductive reasoning by carrying out experiments according to prescribed procedures (Rudolph, 2005).

In sum, the new approach of integrating laboratory experiences represented a marked change from earlier science education. In contrast to earlier curricula, which included laboratory experiences as secondary applications of concepts previously addressed by the teacher, the new curricula integrated laboratory activities into class routines in order to emphasize the nature and processes of science (Shymansky, Kyle & Alport, 1983). Large meta-analyses of evaluations of the post-Sputnik curricula (Shymansky, 1983; Shymansky, Hedges & Woodworth, 1990) found they were more effective than the traditional curriculum in boosting students' science achievement and interest in science.

Traditional practical classes for undergraduate chemistry students where they follow a prescribed experimental procedure over a set time are the backbone of most chemistry degree courses. These practical classes are designed to complement material dealt with in lectures and give students practical experience, which will be invaluable in their future careers as chemists. However, there is much discussion on the merits of such a system (Meester and Maskill, 1995, Johnstone and Al Shuaili, 2001).

Table 1.1

*Descriptors of the laboratory Instruction Styles***(**Domin, 1999).

Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student Generated
Discovery	Predetermined	Inductive	Given
Problem-Based	Predetermined	Deductive	Given

Hofstein and Lunette (2004) detailed some of the factors that inhibit students' learning. Among these are the following:

• The recipe-style laboratory practical's used in most institutions do not allow the student to think about the larger purpose of their investigation and the sequence of tasks they need to pursue to achieve those tasks.

• Assessment is seriously neglected, resulting in the impression that laboratory work does not need to be taken seriously.

• Educators are not informed about what is best practice.

• Resources for more appropriate laboratory teaching styles are limited.

1.1(a) SCIENCE EDUCATION

Science education is a key area of activity internationally. Science education is a major field of practice, with science (and individual science disciplines) being taught and learnt at various levels, both formally and through more informal approaches all around the world. In most countries, science is seen as a key component of schooling, and higher education in science subjects is usually considered of major importance for meeting societal needs such as ensuring the 'supply' of scientists, engineers and other professionals working in scientific fields and for ensuring sustainable economic development.

This major field of practice is supported and explored through the academic study of science education. Science education research (SER) is a well-established, major area of research (Fensham, 2004) that can inform the practice of science education.

Science is now an accepted, indeed often a core, part of the school curriculum around the world. However, no matter how much time is put aside for teaching science, there always has to be a severe selection of material as there is much more potential science content than could realistically be fitted within a pupil's school career. In selecting curriculum, we should always keep in minds our purposes for teaching science. There are a number of good reasons that might be suggested for teaching science. In particular, it is worth considering the following arguments:

• It is important to teach science because of the need for future scientists, engineers, technologists, and others who will need a strong science background for their work.

• It is important to teach science as it is an important aspect of modern culture and everyone should appreciate this aspect of culture.

• It is important to teach science because a knowledge of science is needed for citizenship in modern technological societies.

1.1(b) SCIENCE EDUCATION IN INDIA

During the years preceding India's independence on August 15, 1947, the Indian national congress focused considerable attention on the importance of science and technology, including scientific planning in an independent country Jawaharlal Nehru, the first prime minister of India was largely responsible for parliaments adoption of the 1958 national science policy resolution that envisaged the cultivation of science and scientific research in all its aspects. In 1968, Indian National Science was designated as the adhering organization in India to the International Council for science on behalf of the government of India.

The teaching of science as a part of general education was re-emphasized in the National Policy on Education- 1986 (Malhotra, 1998). The task of the developing curriculum and related instructional material in science was entrusted to the department of education in science, National Council for Educational Research and Training (NCERT). National Curriculum Framework Policy (NCF) 2005 of India recommends teaching science as a process/inquiry and value system. It talks about maintaining the cognitive validity, process validity, historical validity, environmental validity, and ethical validity in science textbooks.

National council of educational research and training (NCERT), 1961 has a separate department of science education which carries the following function - The Department of Education in Science and Mathematics (DESM) is a think tank for Science, Mathematics and Environmental Education at the school stage and is responsible for carrying out research, development, training, evaluation and extension activities in these areas. The Department conducts experiments with teaching-learning strategies involving new methods and technologies, and develops instructional material as well as material for training of teachers and teacher-educators in Science and Mathematics for the School Community. The DESM faculty comprises experts in Physics, Chemistry, Biology, Mathematics and Environmental Education. The department undertakes curriculum development in Science and Mathematics for all school stages starting from the upper primary to the higher secondary stage. The elements of environmental education and other aspects relevant to school education are interwoven throughout the entire school curriculum.

1.1(c) HISTORY OF SCIENCE EDUCATION

Roger Bacon was the first to lay emphasis on the value of experiments and inductive enquiry; it was Francis Bacon who brought them to the notice of the world. He advocated sense training as part of education and a real start in science teaching was mad through the inductive method. Galileo Galilei, William Harvey and Audreas Vesailus also have contributed significantly for the growth of science education. Science gained a place in the school curriculum by its introduction for the first time at Rugby school of England in 1849. Botany, Geology, Physics and Chemistry were started in that school. The most outstanding contribution to the teaching of science towards the close of the 19th century was that of H.E Amstrong. The Heuristic method of teaching was advocated by him. The 20th Century is the age of rapid propagation of science education all over the world.

LANDMARKS IN THE DEVELOPMENT OF SCIENCE EDUCATION IN INDIA:

Science education in India has been greatly accelerated after independence. The important landmarks in the development of science education are the following:

Report of the Secondary Education Commission (1953):

Science is the basic component of education and culture; so it should be made an integral part of school education. The present society is the science-based society. The present century has made tremendous advancement in scientific and technical knowledge as a result of explosion of knowledge. In such a situation one of the main functions of education is to keep pace with this advancement of knowledge. Another feature of modern society is the rapid social change. In the situation of change, the school must always be alert if it is to keep abreast of significant changes. An education system which does not renovate itself continuously becomes outdated and puts hindrance to progress.

Indian Education Commission (1964-66): This commission recommended compulsory science as part of general education and stressed that methods of teaching science should be modernized and that science teaching should be linked with agriculture and technology.

National Policy on Education (1986): This policy has given much stress on science education and has recommended that science education should be designed to enable the learner to acquire problem solving and decision making skills as well as the ability to correlate science with health, agriculture, industry and other aspects of daily life. It has also been stressed that concerted effort be made to extend science education to all those who had to remain outside the pale of formal education.

Science can be viewed as a continuing human effort to systematize knowledge for describing and understanding nature (Smith, 2012). For the sake of convenience science is sub-divided into various disciplines chemistry, physics, biology, geology etc.

1.1(d) BENEFITS OF SCIENCE EDUCATION

The main interest of imparting education is to turn out people able to appreciate and enjoy the beauty and wonder of Nature. They should be efficient in all walks of life and should take delight in the wealth of culture of past generations and civilizations. Hence, Science should form an essential part of the curriculum as it is the only subject which affords knowledge of certain facts and laws and helps in achieving the main object of education. Science almost revolutionaries' human life and proved indispensable for existence of man. Science instills a sense of intrigue and enables students to develop understanding and form questions based both on the knowledge they already have and the insight they wish to gain in the future. Students who excel in science lessons are likely to develop a strong ability to think critically**.**

The following are the arguments in favor of Science to be placed in School Curriculum:

OBSERVATION VALUE: Science provides unique training in observation and

Reasoning: Science students reason from definitely ascertained facts and form clear

Concepts: It makes one systematic and enables him/her to form an objective judgment.

SCIENTIFIC VALUE: Prof.H.E. Armstrong says that Science is taught to provide training in knowledge of Scientific method, which is useful in the life pursuits. Hence science processes develop scientific values among learners.

CULTURAL VALUE: Science has its cultural value. It has a literature of its own. The Scientific discoveries of Galileo, Newton, Faraday, Raman, Saha, Bose, Armstrong and others area treasures of mankind. So, Science has won the first rank of humanistic studies.

UTILITARIAN VALUE: Science has utilitarian value. It trains child to use his leisure time properly.

INTELLECTUAL VALUE: Modern knowledge of Science provides great intellectual pleasure. An educated person is under very great disadvantage if he is not familiar with that knowledge.

DISCIPLINARY VALUE: Science is found to be the most valuable element in the education of those who show special aptitude. Science provides discipline of mind.

1.1(e) PROBLEMS OF SCIENCE EDUCATION IN INDIA

National Council Education Research & Training (NCERT) Position Paper on science has recognized that our science textbooks are overloaded with scientific facts. It also mentions that science teaching in India suffers from the problems like (a) It is lagging behind in achieving enshrined values like humanism, scientific temper and social justice in our constitution.

(b) Science education, even at its best, does not encourage inventiveness and creativity.

(c) Overpowering examination system is the fundamental problems of science education.

1.1(f) SCIENCE LABORATORY

Laboratory activities have had a distinctive and central role in the science curriculum and science educators have suggested that many benefits mount up from engaging students in science laboratory activities. Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in laboratory. Unfortunately, the term laboratory or practical have been used, too often without precise definition, to embrace a wide array of activities. Lots of arguments have been raised in the past to give justification or rationale for its use. Even though laboratory sessions were generally taken as necessary and important, very little justification was given for their inclusion. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration setting.

Both the content and pedagogy of science learning and teaching are being analyzed, and new standards intended to shape and refresh science education are emerging. Teacher guidance and instructions have ranged from highly structured and teacher centered to open inquiry. The terms have sometimes been used to include investigations or projects that are pursued for several weeks, sometimes outside the school, while on other occasions they have referred to experiences lasting 20 minutes or less.

The National Science Education Standards and the 2061 project reaffirm the conviction that inquiry in general and inquiry in the context of practical work in science education is central to the achievement of scientific literacy. Inquiry-type laboratories have the potential to develop student's abilities and skills such as: posing scientifically oriented questions forming hypothesis, designing and conducting scientific investigations, formulating and revising scientific explanations and communicating and defending scientific arguments.

Chemistry is essentially a laboratory activity oriented subject. No course in chemistry can be considered as complete without including practical work in it. Laboratory activity, here, is used to describe the practical activities which students undertake using chemicals and equipment in a chemistry laboratory. The original reasons for the development of laboratory work in chemistry education lay in the need to produce skilled technicians for industry and highly competent workers for research laboratories.

Laboratories are one of the characteristic features in the sciences at all levels. It would be rare to find any science course in any institution of education without a substantial component of Laboratory activity. Even though the instructional potential of the laboratory is enormous. Most practical activities in higher secondary education are by nature illustrative or demonstrative. Too often they emphasize the acquisition of observational skills and allow students to see the concept dealt in action and relate theory more closely to reality. It is important to think about goals, aims and objectives in the context of laboratory work.

Chemistry laboratory activities have a distinctive and central role in the science curriculum and science educators have suggested that there are many benefits from engaging students in chemistry laboratory activities. More specifically, when properly developed, inquiry centered laboratories have the potential to enhance students constructive learning, conceptual understanding and understanding of the nature of science.

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Unfortunately, the term laboratory or practical have been used, too often without precise definition. Lots of arguments have been raised in the pastto give justification or rationale for its use. Even though laboratory sessions were generally taken as necessary and important. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration setting.

The study of classroom, laboratory and school learning environments and their effects on students' learning has been going on for more than a century. Past efforts in the study of the laboratory competence indicated that it plays a major role in improving and learning in higher secondary education. The laboratory experiment is an important part of science teaching. Many studies show that experiments in laboratory influence students to have better attitudes toward chemistry. Furthermore, laboratory experiments can help students to understand abstract concepts in chemistry. Practical work in chemistry laboratories is also fun and interesting for the students. As the result, they are motivated which is related to the topics in the classroom. According to Swain 2000, as cited in Parkinson, 2004, there are mainly four aims of practical work in the chemistry laboratory which is encouraging students to 1) Laboratory practice seeing problems and solve it. 2) Find the facts and new principles. 3) Develop ability to co-operate 4) Develop critical attitude. However, there are some criticisms against the practical work in the chemistry laboratory. There are several weaknesses of practical work in laboratory – 1) Noise influences students to be confused. 2) Some students either girls or boys don't like practical work. 3) Time consuming. 4) Lack of facilities.

TYPE OF PRACTICAL WORK:

Scholars identify three distinct types of practical work:

1. *Experiences*, which are intended to give students a 'feel' for observable fact;
2. *Exercises*, which are designed to develop practical skills and techniques; and
3. *Investigations*, which give students the opportunity to tackle more open-ended tasks like a problem-solving.

Some also classify practical works in to four major types: exercises, experiences,demonstrations and investigations. Each of these types of practical has its own place in science.

Exercise	To develop practical skills
Experience	To gain experiences of a phenomenon
Demonstration	To develop a scientific argument or cause an impression
Investigation	Hypothesis – testing: to reinforce theoretical understanding. Problem solving: to learn the ways of working as a problem solving scientist.

A number of researchers, analyzed different types of laboratory investigations based on the level of openness and the demand for inquiry skills. Through a revised form, typical laboratory lesson was compared with that of a typical investigation carried out by a scientist in terms of who does what and he concludes that what students are actually doing in a typical laboratory is like technicians and not like scientists. It was suggested that this openness can occur at different stages of an investigation: in the problem to be solved; in the planning and operation ofthe investigation; and in the possible solutions to the problems. Based on this, some produce a four-way classification of investigations, depending on whether each stage is open – that is left to the students to decide or closed.At level zero all the problems, procedures, and conclusions are given and hence there is no experience of scientific inquiry. At this level, one may find exercises involving practices in some techniques and/or confirmation where the answer is already provided to the students. They may provide opportunities for students to learn accuracy in the process of trying to replicate a known answer. In level one, both problems and procedures are given and they have to collect data and draw the conclusions. In level two, only the problem is given and the student has to design the procedure, collect the data and draw conclusions. These are called investigative practical. In level three, the student has to do everything beginning with problem formulation up to drawing of conclusions.

1.1(g) LABORATORY COMPETENCE

Laboratories have been purported to promote a number of goals for students, most of which are also the goals of science education in general (Lunetta, 1998; Hofstein and Lunetta, 1982). To examine the definition and goals of laboratory experiences and research reviews on laboratory education that have identified and discussed learning goals (Anderson, 1976; Hofstein and Lunetta, 1982; Lazarowitz and Tamir, 1994; Shulman and Tamir, 1973).A comprehensive list of goals set for desired outcomes of laboratory experiences:

i. *Enhancing mastery of subject matter*: Laboratory experiences may enhance student understanding of specific scientific facts and concepts and of the way in which these facts and concepts are organized in the scientific disciplines.

ii. *Developing scientific reasoning*: Laboratory experiences may promote a student's ability to identify questions and concepts that guide scientific.

iii. *Understanding the complexity and ambiguity of empirical work*: Interacting with the unconstrained environment of the material world in laboratory experiences may help students concretely understand the inherent complexity and ambiguity of natural phenomena. Laboratory experiences may help students learn to address the challenges inherent in directly observing and manipulating the material world, including troubleshooting equipment used to make observations, understanding measurement error, and interpreting and aggregating the resulting data.

iv. *Developing practical skills*: In laboratory experiences, students may learn to use the tools and conventions of science. For example, they may develop skills in using scientific equipment correctly and safely, making observations, taking measurements, and carrying out well-defined scientific procedures.

v. *Understanding of the nature of science*: Laboratory experiences may help students to understand the values and assumptions inherent in the development and interpretation of scientific knowledge, such as the idea that science is a human endeavor that seeks to understand the material world and that scientific theories, models, and explanations change over time on the basis of new evidence.

vi. *Cultivating interest in science and interest in learning science*: As a result of laboratory experiences that make science "come alive," students may become interested in learning more about science and see it as relevant to everyday life.

vii. *Developing teamwork abilities*: Laboratory experiences may also promote a student's ability to collaborate effectively with others in carrying out complex tasks, to share the work of the task, to assume different roles at different times, and to contribute and respond to ideas.

1.1(h) CHEMISTRY AS A BRANCH OF SCIENCE:

Chemistry is the branch of science that studies the composition, properties and interaction of matter. Chemistry plays central role in science and is often intertwined with other branches of science like physics, biology, geology etc. Chemistry also plays an important role in daily life. Chemical principles are important in diverse areas such as weather patterns, functioning of brain and operation of a computer.

Chemical industries manufacturing fertilizers, acids and other organic and inorganic chemicals including new materials contribute in a big way to the national economy. Chemistry plays an important role in meeting human needs for food, health care products and other materials aimed at improving the quality of life. Chemistry is the science of molecules and their transformation. It is the science not so much of the one hundred elements but of the infinite variety of molecules that may be built from them (Hoffman, 1963).

Chemistry is the study of matter and its interactions with other matter and energy. The crucial role that Chemistry plays in modern scientific technological development is well accepted. Chemistry has to play a pivotal role in technology using Chemistry students, Engineers and Researchers, who in turn will contribute to the running of vast technological structure that are building up. If we want to turn out the experts and technologies in the area of Chemistry, it is imperative that we should develop a sound system of scientific education, with proper accent given to the instruction in Chemistry. The New Encyclopedia Britannica (1997) stated that' Chemistry is the science that deals with the properties, composition and structure of substances, the transformations that may undergo and the energy that is released or absorbed during these processes'. In the Chamber's Dictionary (1959) it is stated that Chemistry is the science that deals with the nature of substances and the ways in which the act on or combine with each other.

Chemistry as a science studies the composition and properties of matter. It also studies the reactions between various chemicals known as chemical reactions. Basic chemical reactions are always going on around us. Chemists try to understand how the composition of substances affects the substance`s properties. They seek to understand why and how substances change within chemical reactions. Chemists try to understand and observe the underlying structure of matter and attempt to understand why the properties that we observe with our senses occur in matter.

The division of Chemistry into Organic and Inorganic domains has its origin in earliest antiquity. Many Organic compounds like alcohol, sugar, fats, soap, vinegar, indigo and starch were known to prehistoric people. In the 18th century many Organic compounds were isolated from natural sources .Organic Chemistry as its often said is the Chemistry of the carbon Compounds. Throughout our lives, Chemistry plays a key role in keeping us healthy. Innovations in Chemistry have enabled the improvement of longevity of people.

Chemistry finds a lot of applications in the field of health care. Chemotherapy and other drugs now are delivered more accurately on plastic patches and dissolving discs. Vaccines have eradicated once rippling diseases. Medical devices such as pace makers and blood bags save lives. Lifesaving medicines help us to combat disease and live longer. Chemistry plays an important role in ensuring our food supply. Food growers use Chemistry to apply fertilizers that deliver essential nutrients to soil resulting in a wholesome, abundant food supply. Without fertilizers the world food supply would shrink by one-third Food growers use chemicals as pesticides and weedicides. Chlorine Chemistry is the most effective weapon against waterborne bacteria and viruses. Chemistry finds a lot of applications in sports and games.

1.1(i) CHEMISTRY LABORATORY COMPETENCE AMONG HIGHER SECONDARY SCHOOL STUDENTS

The aim of a competency-based educational model is to integrate knowledge with the development of the skills, attitudes and values that comprise a competency. The key question we need to ask ourselves as teachers is, how can we ensure that students will acquire the competencies defined for a specific course? The first step in answering this question is to find a congruent line between the activities students carry out in class and the way in which they are being evaluated. Practical laboratory classes that correspond to science courses are essential because students perform in a real context and with an established problem. The classes I teach, Matter and the Environment and Matter and Sustainability, include laboratory activities in which students put into practice the theory studied in class, such as: measuring pH, cleaning product generation, gas laws, polymer creation, chemical reactions and renewable energy sources, among others. To reflect students' progress in the acquisition of competencies in the laboratory, we use an analytical rubric to define what is expected of them. With the same rubric, the teacher can provide assertive, personalized feedback on the students' performance. In this way, teachers work together with students to assure the development of autonomy and self-regulation in relation to the disciplinary competencies in the area of science, which include: formulating scientific questions, producing hypotheses, obtaining, recording and systematizing information, applying safety standards, waste management, data collection, comparing results obtained in an experiment, communicating conclusions and documenting information sources.

Laboratory activities have long had a distinctive and central role in the science curriculum and science educators have suggested that many benefits accrue from engaging students in science laboratory activities (Pickering, 1980; Hofstein & Lunetta, 1982; Garnet et al., 1995; Lunetta, 1998; Tobin, 1990; Hofstein & Lunetta, 2004). Since the end of the 19th century, when schools began to teach science systematically, the science laboratory has become a distinctive feature of science education.

During the major curriculum reforms in science education in the early 1960s, practical work in science education was used to engage students in investigations, discoveries, inquiries, and problem-solving activities. In other words, the laboratory became (at least in the minds of science educators and curriculum developers) the center of science teaching and learning. For example, George Pimentel editor of the CHEMStudy (Merril & Ridgway, 1969) suggested that the laboratory was designed to help students gain a better idea of the nature of science and scientific investigation by emphasizing the discovery approach. In addition, he suggested that it gives students an opportunity to observe chemical systems and to gather data useful for the development of principles subsequently discussed in the textbook and in class. However, when it came to assessing and evaluating the effectiveness of the laboratory, the situation was less simplistic and less clear. For example, as early as 1969, Ramsey and Howe, on the basis of an extensive review of the literature regarding instruction in the science laboratory concluded that the experience possible for students in the laboratory situation should be an integral part of any science course has come to have a wide acceptance in science teaching. What the best kinds of experiences are, and how these may be blended with more conventional class work has not been objectively evaluated to the extent that clear direction based on research is available for teachers.

Both the content and pedagogy of science learning and teaching are being scrutinized, and new standards intended to shape meaningful science education are emerging. The National Science Education Standards (National Research Council, 1996) and other science education literature (Lunetta, 1998; Bybee, 2000; Hofstein & Lunetta, 2004) emphasize the importance of rethinking the role and practice of laboratory work in science teaching in general and in the context of chemistry education in particular. It is true that very often research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning science. However, sufficient data do exist to suggest that the laboratory instruction is an effective and efficient teaching medium to attain some of the goals for teaching and learning science. Appropriate laboratory activities can be effective in helping students construct their knowledge (Tobin, 1990 & Gunstone, 1991), develop logical and inquiry-type skills, as well as problem-solving abilities. They can also assist in the development of psychomotor skills (manipulative and observational skills). In addition, they have a great potential in promoting positive attitudes and in providing students with opportunities to develop skills regarding cooperation and communication. In this respect the science laboratory is a unique learning environment. Thus, it has the potential to provide science teachers with opportunities to vary their instructional techniques and to avoid a monotonous classroom learning environment.

Thirty years of experience in researching the chemistry laboratory

The review of research on the laboratory is based on more than 30 years of experience with all facets of the chemistry curriculum in the upper secondary schools in Israel. This included chemistry curriculum development, implementation, evaluation, and research. Throughout the years an attempt has been made to cover most of the domains that characterize practical work in the context of the chemistry laboratory. Among these are studies focusing on the following aspects:

1. The chemistry laboratory: A unique mode of learning, instruction, and assessment.
2. Assessing students' performance and achievement using different modes of presentation in the chemistry laboratory.
3. Students' attitude towards and interest in school chemistry laboratory work.
4. Students' perceptions of the laboratory classroom learning environment

1.1(j) THE CHEMISTRY LABORATORY: A UNIQUE MODE OF LEARNING, INSTRUCTION AND ASSESSMENT

Kelly and Lister (1965), based on comprehensive research findings, suggested that the science laboratory is a unique mode of teaching and learning and that the abilities of students in the laboratory are only slightly correlated with their abilities in other non-practical learning experiences. Support for this was provided at a later stage by Tamir (1972) and more recently by Yeany, Larossa and

Hale (1989). A study on modes of learning and teaching in the context of chemistry was conducted by Ben-Zvi, Hofstein, Samuel& Kempa (1977). The main goal of this study was to identify relationships between modes of learning in the chemistry laboratory and other modes of learning that prevail in high school chemistry. The study was undertaken in the context of a laboratory centered program: Chemistry for High School (1972), developed at the Weizmann Institute of Science. This program was developed and implemented in the Israeli education system to replace the adopted version of the CHEMSudy program. Correlation of the results followed by factor analytic investigation revealed the following:

• Cognitive achievement in chemistry measured by written paper and pencil tests and achievement in the chemistry laboratory constitute independent modes.

• Factor analytic investigation of the various variables showed that the practical domain can be subdivided into three distinct modes: -

-Problem-solving abilities

-Skills in performing routine laboratory tasks

-The ability to observe.

Overall achievement in chemistry is therefore a combination of all these various modes that have to be taken into consideration when assessing students' ability in chemistry. Although this study was conducted in the mid-seventies, it is still in alignment with more recent reforms in science, claiming that if we truly value the development of knowledge, skills, and attitudes that are unique to practical work in science laboratories, appropriate assessment of these outcomes must be developed and implemented continuously by teachers in their own laboratory-classrooms. The National Science Education Standards (National Research Council, 1996) indicate that the entire student's learning experiences THE LABORATORY IN CHEMISTRY EDUCATION should be assessed and that the assessment should be authentic. Attention to such standards, however, has promoted testing that has generally not incorporated the assessment of performance and inquiry, although there have been a few noteworthy efforts to do so. Researchers, teachers, and testing jurisdictions, whose goal is to assess comprehensively the learning that takes place in school science generally, or in school laboratories more specifically, should use appropriate assessment tools and methodologies to identify what the students are learning (conceptual as well as procedural).

1.2 SIGNIFICANCE OF THE STUDY

Chemistry laboratory teaching has become an integral part of education in Indian schools. However, experts agree that the quality of chemistry teaching requires to be improved considerably so as to achieve its purpose and objectives i.e. to understand the basic principles, to develop problem solving, analytical skills and ability to apply them to the problems of everyday life besides promoting the spirit of enquiry and experimentation. This study is aimed at identifying differences in terms of the practical implementation of practical chemistry in laboratories based on gender, type and location of schools. The utilization of laboratory facilities in chemistry teaching enables learners to develop problem solving skills and positive attitude, interest towards science learning. Laboratory work is considered essential in promoting students' learning of science and of scientific inquiry. Chemistry practical in laboratory helps the students to increase the ability to apply chemistry knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature and also competence in the planning, design and execution of research investigations, from the problem recognition stage through to the evaluation and appraisal of results and findings this also will increase the ability to select appropriate techniques and procedures. This study would help to find the level of competence in chemistry laboratory of higher secondary school students in relation to their gender, type of school and location of school.

1.3 STATEMENT OF THE PROBLEM

CHEMISTRY LABORATORY COMPETENCE OF HIGHER SECONDARY SCHOOL STUDENTS IN RELATION TO THEIR GENDER, TYPE OF SCHOOL AND LOCATION OF SCHOOL

1.4 OPERATIONAL DEFINITIONS OF THE KEY-TERMS

CHEMISTRY LABORATORY COMPETENCE

It refers to the ability to carry out chemistry laboratory work successfully or efficiently as assessed by *Chemistry Laboratory Competence Test* by Rathod and Kotwale.

HIGHER SECONDARY SCHOOL STUDENTS

Higher secondary school students refer to students of 11^{th} and 12^{th} classes studying in high secondary schools affiliated to JKBOSE (Jammu and Kashmir Board of School Education).

GENDER

Gender refers to male or female.

TYPE OF SCHOOL

In the proposed study, type of school refers to government or private higher secondary school students.

Government schools refer to the schools managed by directorate of school education, J&K government.

Private school refers to the school which is managed by private management and which is not supported financially by the government.

LOCATION OF SCHOOL

Location of school refers to the place in which the school is located 1.such as urban or rural.

1.5 OBJECTIVES OF THE STUDY

The following objectives will be considered for the present study

1)To assess the level of the chemistry laboratory competence of higher secondary school students

2) To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

1.6 HYPOTHESES

Keeping in view of the objectives the following hypotheses will be considered:

1) There is no significant difference of Chemistry laboratory competence among higher secondary school students

2) There is no significant interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

1.7 VARIABLES OF THE STUDY

Independent Variables

- Gender
- Location of School
- Type of School

Dependent Variable

- Chemistry Laboratory Competence

1.9 DELIMITATIONS OF THE STUDY

1) The present study has been delimited to 192 Higher Secondary School students only.

2) The present study has been delimited to the 12 Higher Secondary Schools located in Jammu district only.

3) The study is delimited to *Chemistry Laboratory Competence Test*(CLCT) developed by Rathod and Kotwale (2012)

CHAPTER-II

REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

In essence, a literature review identifies, evaluates and synthesizes the relevant literature within a particular field of research. It illuminates how knowledge has evolved within the field, highlighting what has already been done, what is generally accepted, what is emerging and what is the current state of thinking on the topic. Literature refers to a collection of published information/materials on a particular area of research or topic, such as books and journal articles of academic value.

To review the literature means to be able to identify:

- what has been established, discredited and accepted in your field
- areas of controversy or conflict among different schools of thought
- problems or issues that remain unsolved
- emerging trends and new approaches
- how your research extends, builds upon, and departs from previous research.

A review of literature presents much more than a summary of relevant sources. The act of reviewing involves evaluating individual sources as well as synthesizing these sources in order to gain a broad view of the field. A literature review should not include every single source that you have read. It's important to be selective about the sources you choose to address. Ensure the sources you analyze are directly relevant to your research question(s) and topic. It's important also that you think critically about the credibility and reliability of sources.

A literature review uses as its database reports of primary or original scholarship and does not report new primary scholarship itself (Cooper, 1998). According to Brog, "Literature in any field forms the foundation upon which all the future work will be build". A review of related literature gives the scholar an understanding of previous work that has been done in his or her field of research and what still remain to be done.

It is also provided an opportunity of gaining insight into the method measures, subject and approaches employed by other research workers. A careful review of research, journals, books, dissertations, thesis and other sources of information about the problems to be investigated is one of the important step in the planning of any research study.

In the present study, the investigator reviewed the researches done in the field of Chemistry Laboratory Competence among higher secondary school students.

2.2 REVIEW OF RELATED LITERATURE

Freedman (1997) investigated the use of hands on laboratory program as a means of improving student attitude toward science and increasing student achievement levels in science knowledge. Using a post-test-only control group design, curriculum referenced objective examinations were used to measure student achievement in science knowledge, and a post-test survey was used to measure student attitude toward science. One-Way Analysis of Variance compared the groups' differences in achievement and attitude toward science. Analysis of covariance was used to determine the effect of the laboratory treatment on the dependent achievement variable with attitude toward science as the co-variable. The findings showed that students who had regular laboratory instruction scored significantly higher ($p < .01$) on the objective examination of achievement in science knowledge than those who had no laboratory experiences.

Santoniono (2004) examined the factors affecting the attitudes of young female students towards chemistry at the high school level. This study investigated whether self confidence towards chemistry, the influence of role-models and knowledge about the usefulness of chemistry, were affecting the attitudes towards chemistry, of 183 high school young females. Data were obtained using Chemistry Attitude Influencing factors (CAIF instruments). It has indicated that attitudes towards science education differ between males and females. A declining interest in chemistry among females was found.

Adeyemi (2008) examined chemistry laboratories and the quality of output from secondary schools in Ondo state, Nigeria. The design was made along the lines of a descriptive survey while the study population comprised all the 257 secondary schools drawn randomly from the study population. The instrument used to collect data for the study was an inventory while the data collected were analyzed using the one-way analysis of variance and least significant difference test semi- structured interviews were conducted. The findings showed that the quality of output was best in schools having chemistry laboratories.

Gomathi (2010) conducted study on the availability and utility of chemistry laboratory facilities and the achievement of higher secondary students in chemistry practical. Survey method of research had been used. The data were collected from 250 students. *t*-test and F-test were used for data analysis. The significant positive correlation was found between the availability and utilization of chemistry laboratory facilities in the secondary schools.

Ali and Awan (2013) conducted study to examine the relationship of attitude of higher secondary school students towards science with achievement in the subject chemistry. Data was collected from 1885 students. Simple correlation, multiple regressions analyze (R) and standard regression coefficients were used to investigate the relationships between attitude towards science and achievement in science. The results of the study indicated that attitude towards science has significantly positive relationship with the achievement of science students at higher secondary level.

Oginni, Awobodu, Alaka and Saibu (2013) examined school factors of higher secondary school students' achievement in chemistry. Ex-post facto research type with a survey design way adopted for the study. The sample used consisted of senior secondary school chemistry students from 37 local governments. Instruments were developed and validated for the study. Three research questions were raised and answered in the study Pearson Product Moment Co-relation and Multiple Regression Statistics were used to analyse the data collected. Findings from the study showed that the conditions accrued to school factors improve the performance of students in chemistry.

Tatli and Ayas (2013) examined the effect of a virtual chemistry laboratory (VCL) on student achievement among 90 students from three different ninth-grade classrooms (an experimental group and two control groups). Study data were gathered with pre and post Chemical Changes Unit Achievement (CCUA) Test, Laboratory Equipment Test (LET) and unstructured observations. The collected data were analyzed using SPSS (version 16.0). Comparisons were made within and between groups. It was concluded that the developed virtual chemistry laboratory software is least effective as the real laboratory, both in terms of student achievement in the unit and students' ability to recognize laboratory equipment.

Akani (2015) investigated the roles of the laboratory in students' academic achievement in chemistry in higher secondary schools in Ebony State of Nigeria. Four research questions and two hypotheses guided the study. A sample of 240 students selected through simple random sampling from the higher secondary schools in three education zones was used for the study. A questionnaire instrument developed by the researcher was used for data collection. The instrument was validated by three experts one from measurement and evaluation and the other two from chemistry evaluation. The data collected were analyzed using mean and standard deviation statistics t- Test was used in testing the hypotheses. The results showed that the use of laboratory helps to develop scientific attitudes in the students towards practical of chemistry, develop scientific skills for problem solving in students among others.

Choota, Halim, Zakaria and Mokhtar (2015) explored the study chemical safety in school laboratories located in Urban and Rural areas. Two higher secondary schools in Pahang which located in urban and rural areas were selected. Respondents of the survey were science students from both schools. The survey was carried out using a multiple – choice questionnaire method. The survey questionnaire was administered during the teaching and learning activities. This study revealed that they were not so sure about the safety aspects in school laboratory. The findings from this study provide learning to enhance the knowledge and practical of chemical safety in school laboratories.

Mukami (2015) explored the study on establishing the extent of utilization of chemistry laboratories in teaching and learning the subject. The survey which was a descriptive survey was conducted in Meni South District. It targeted a population of 40 public higher secondary schools from which eight sampling procedures. Questionnaires, interview schedule were used to collect the data which was analyzed using descriptive statistics. The study found that the absence, lack of training and over-writing of technicians was a problem encountered in the district under study. Some students were not conversant with use of some apparatus. This could be the major reason why performance in chemistry in district is low.

Neji and Amba (2015) investigate the study on utilization of laboratory facilities and their relationship with students' academic performance in Calabar. A total of three hundred and fifty students drawn from fourteen public secondary schools were used for this study. The data were analyzed using two instruments which include; Questionnaire on Utilization (QULF), Chemistry and Achievement Test (CAT). The data collected were analyzed using population *t*-Test and Pearson's Product Moment Co-relation. However, it was observed from the data analyzed that laboratory facilities are not adequately utilized in secondary schools for teaching Chemistry. It was also noticed that laboratory facilities do not significantly contribute to the variance in students' academic performance in Chemistry.

Obaya (2015) conducted study on competency based approach to evaluate high school laboratory skills during a chemistry course. An assessment tool where students, level of achievements was created. This assessment tool describes the level of achievement of competency which was developed according to the course curriculum and the graduate profile of the third semester of high school students taking the subject "Matter& Environment". A sample of 24 students, 12 males and 12 females with an average age of 16 years old was randomly chosen. Results indicated that by having a consistent evaluation plan and by providing students' with effective feedback, the students competency levels addressed in laboratory practical's can be improved significantly.

Olubu (2015) determined the effects of laboratory Learning environment on students' learning outcome in higher secondary school chemistry. The study adopted the pre-test, post-test, quasi-experimental control group design. The sample consisted 293 senior secondary chemistry students in their intact classes from six schools purposively selected from six local government areas of Ondo state. Two research instruments were used for the collection of data namely Chemistry Practical Achievement (CPAT) and Chemistry Attitude Scale (CAS). Data collection was analyzed using Analysis of Covariance (ANCOVA). Results showed that integration dimension of chemistry laboratory learning environment has the most significant effect on the leaner's performance.0

Mumangi (2016) investigated the effect of chemistry practicalon students' performance in chemistry of higher secondary schools. The main objective of the study was to establish if there is any significant difference in academic achievement in chemistry between exposed to chemistry practical and those not so exposed. Students' Achievement Tests (SAT) used to determine learners' performance. The computer package SPSS (Statistical Package for Social Scientists) was to analyze the data. Descriptive statistics such as mean, frequency, percentages and standard deviation was used to analyze the research findings. The study also used inferential statistics such as ANOVA, ANCOVA, t-Test. Multi-stage cluster sampling and purposive sampling were used to obtain a sample of 24 out of 272 higher secondary school students. There was a difference between the mean scores in the post-test of the students. The mean score for experimental group was (15.73) where as it was (14.18) for the control group that is the students exposed to chemistry practical scored significantly higher in the achievement test than those not exposed.

Ajayiand Ogbeba (2017) examined the effects of gender on students' achievement using hands-on activities. A sample of 292 students from eight purposively selected higher secondary schools out of a population of 8,381 students from zone C of Benue state was used for the study. The study adopted a quasi-permanently research design. Stoichiometry Achievement Test (SAT) was used for data collection. Reliability coefficient of 0.92 was established using Pearson correlation moment coefficient. Two research questions and two hypotheses guided the study. The research questions were answered using mean and Standard Deviation while hypotheses were tested at 0.05 level of significance using ANCOVA (Analysis of Covariance). The study revealed that there is no significant difference in the mean achievement scores between male and female students taught using hands-on activities.

Anwar (2018) examined chemical laboratory skills measurement high school students. The sample selected by purposive stratified random sampling. Development of laboratory skills worksheet is adapted from four development stages: define, design, develop and disseminate. The result showed that the average of initial skills laboratory of students at school was 45.20 in medium category.

Irwanto and Anti Prodjosantoso (2018) conducted study on students to have the scientific skills and attitudes. The research aims to investigate the Science Process Skills (SPS) and Chemistry Attitude (CA) and analyze the correlation between those two variables. Convenience sampling was executed to select 152 chemistry students at the Yogyakarta State University in the academic year 2017/2018. This survey involved quantitative method and co-relational design. The descriptive statistic, *t*-Test, Pearson's Product Moment Co-relation and Regression Analysis were used at significance level .05. Students' SPS and CA were classified low and moderate respectively. There was a significant difference between SPS and CA scores based on gender in favor of female students. It can be concluded that students who have high SPS score tend to have positive attitudes toward chemistry.

Busolo (2019) investigated gender differences in chemistry achievement levels of students and to provide more and more equal opportunities for studying chemistry and science in general to both boys and girls. The study was a cross-sectional descriptive survey employing correlation methods to investigate gender differences in chemistry achievement levels of boys and girls. The study comprised 12 stratified selected public higher secondary schools in Kakamega district. A total of 386 students responded to a five-item, Chemistry achievement Test comprising descriptive, mathematical and spatial ability items. A reliability coefficient of at least 0.8 was acceptable for the study. Quantitative data obtained from Chemistry Achievement Test were analyzed during Statistical Package for social science (SPSS). It includes mean, Standard Deviation, *t*-Test, ANOVA. The study revealed that boys performed better than girls. Boys had a stronger affinity and interest towards chemistry.

The review of related literature can be concluded that the experiments conducted in chemistry laboratories proved in improving students' attitude towards chemistry and increasing students' achievement in scientific knowledge. These studies have shown that laboratory experiments helped in creating interest in various aspects of science and enhanced their learning ability. However, very few research studies have been conducted to assess the level of Chemistry Laboratory Competence in relation to gender, type of school and location of school. These studies research on utilization of laboratory facilities and their relationship with students' academic performance. In most of the studies it is found that the students who have regular laboratory instructions have significantly higher scores than those who have not regular laboratory instructions. Also, these studies examined the factors of declining interest in chemistry among females. It has been noticed that laboratory facilities do not significantly contribute to the variance in students, academic performance in chemistry. In addition, it has been reported that the developed Virtual Chemistry Laboratory Software is least effective as real laboratory.

CHAPTER-III

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter explains the research methodology used in the present study. Research methods play a vital role in research method. Research methods are the various procedures, schemes and algorithms used in research. All the methods used by a researcher during a research study are termed as research methods. They are essentially planned, scientific and value-neutral. They include theoretical procedures, experimental studies, numerical schemes, statistical approaches, etc. Research methods help us collect samples, data and find a solution to a problem. Particularly, scientific research methods call for explanations based on collected facts, measurements and observations and not on reasoning alone. They accept only those explanations which can be verified by experiments.

Research is a systematic investigation and scientific method of analysis. Research is a logical and systematic search for new and useful information on a particular topic. Research is not confined to science and technology only. There are vast areas of research in other disciplines such as languages, literature, history and sociology. Whatever might be the subject, research has to be an active, diligent and systematic process of inquiry in order to discover, interpret or revise facts, events, behaviors and theories. Applying the outcome of research for the refinement of knowledge in other subjects, or in enhancing the quality of human life also becomes a kind of research and development. Research can be defined as "an activity that involves finding out, in a more or less systematic way, things you did not know" (Walliman and Walliman, 2011).

3.2 DESIGN OF STUDY

The design of the research is actual blue print of the procedure for the completion of various researches for valid conclusion as well as conceived, adequately, planned, and executed design helps greatly in permitting to reply both on observation and tool used in research methodology.

3.2(a) METHODOLOGY

To achieve the objectives of the present study, proper methodology is required to select an appropriate sample and a tool to get the information from the higher secondary school students. It must be appropriate, feasible, objectiveand reliable well planned and well understood. The Descriptive survey method has been used for the present study.

3.2(b) POPULATION

The population of the present study comprised of 36,903higher secondary school students studying in 1067 higher secondary schools in Jammu district.

3.2(c) SAMPLE OF THE STUDY

A simple random sampling technique was employed for selection of the sample. The twelve schools were selected randomly and from each school higher secondary school students were selected randomly. Thus the total sample comprised of 192 students. Out of which 96 were male students and 96 were female students.

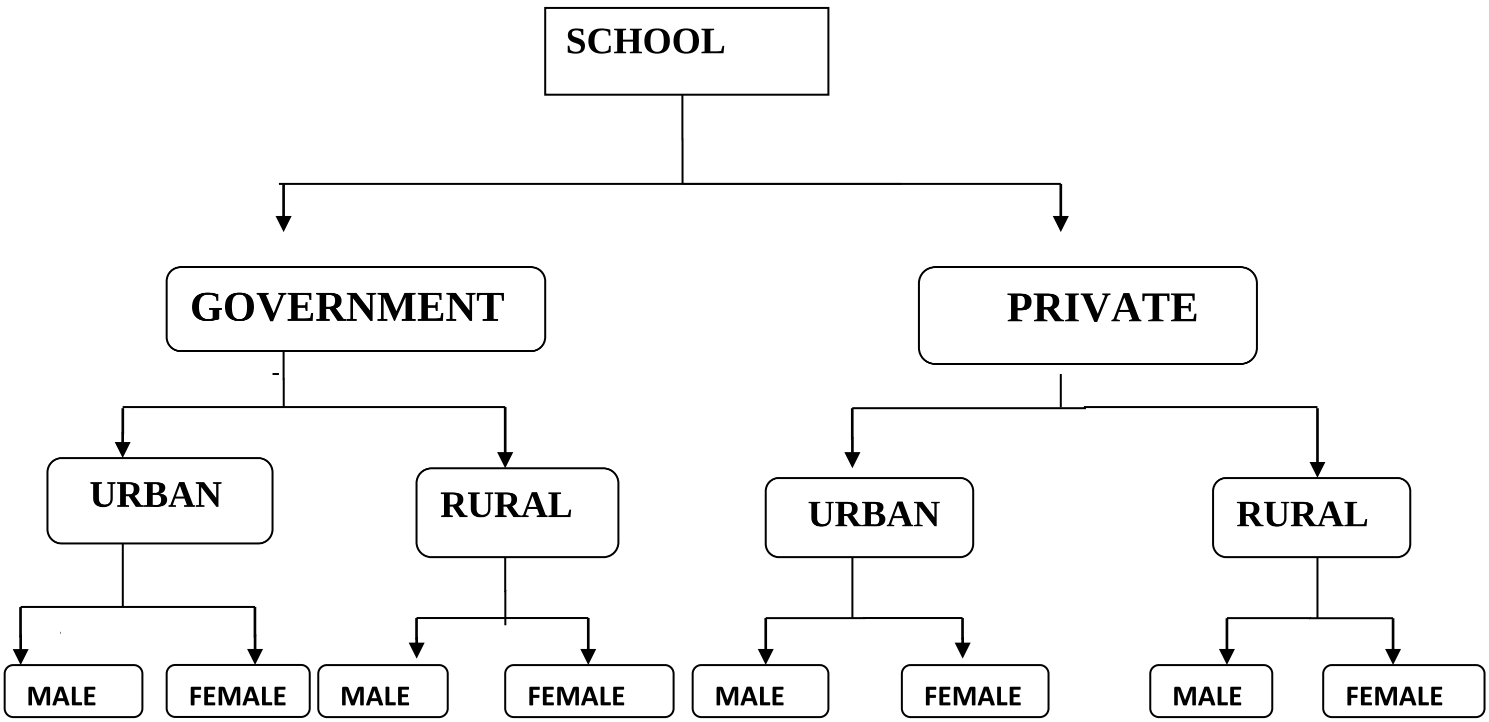

*Figure 3.1*Distribution of Sample

The details of the sample selected from twelve schools (Private and Government) affiliated to Jammu and Kashmir State Board of School Education have been given in the table 3.1 and 3.2.

Table 3.1

Distribution of Sample from Rural Area

S.No.	Name of School	Type of School	No. of Students		Total
			Male	Female	
1	Govt. Higher Secondary School, Dablahar	Government	8	8	16
2	Govt. Higher Secondary School, Salehar	Government	8	8	16
3	Govt. Higher Secondary School, Bishnah	Government	8	8	16
4	Fatima Convent High School	Private	8	8	16
5	Bal Bharti Shiksha high school	Private	8	8	16
6	New Model High School	Private	8	8	16
			48	48	96

Table 3.2

Distribution of Sample from Urban Area

S.No.	Name of School	Type of School	No. of Students		Total
			Male	Female	
1	Govt. Higher secondary school.	Government	8	8	16
2	Govt. Higher secondary school.	Government	8	8	16
3	Govt. Higher secondary school.	Government	8	8	16
4	Neel Kamal higher secondary school.	Private	8	8	16
5	Tiny Tots Higher secondary school.	Private	8	8	16
6	Dewan Devi Higher secondary school.	Private	8	8	16
			48	48	96

3.2(d) VARIABLES OF THE STUDY

Variables are those which may vary from person to person or situation to situation. In the present study:

A) Independent variables:

1. Gender (Male and Female)
2. Type of school (Private and Government)
3. Area (Rural and Urban)

B) Dependent variable

Chemistry Laboratory Competence

3.3 TOOL EMPLOYED

In the proposed study, *Chemistry Laboratory Competence Test* (CLCT) by Rathod and Kotwale shall be used by investigator. It is a performance test to assess laboratory competence. It is meant to measure laboratory competence for the secondary and higher secondary school students. The test is comprised of 27 items. This includes six sub-sections consisting of alternative type, match the column, one-word answerand fill the blanks and short answer type questions.

The basis of item selection was Experimental skills, Classification, Measurement, following correct laboratory procedures, analyzing situation, selecting hypothesis, Handling instrument, implying safety rules and problem solving. Keeping in mind, the above facts present that the test has been prepared with the hope that it may facilitate to measure laboratory competence.

Section A. Measure the skill of handling apparatus in the chemistry laboratory. It represents the student ability of abstraction, discrimination and also measure cognitive ability to perform correctly, the laboratory procedure by handling apparatus safely and in the appropriate manner.

Section B. Measures the skill of investigation. It represents the students' ability of observation, in perceiving cause and effect relationship in chemistry experiments under different conditions. This becomes the basis of processing and retrieval of information at the abstract level.

Section C. Measure the skills of drawing inference and reporting results. It represents the student's ability of hypothesizing and drawing best solution through previous experiential learning. This becomes the basis of systematic writing of results.

Section D. Measures the skills of computation and measurement. It represents the student's ability of mathematical calculation, to observe the authentic procedure for reporting reading of commonly used laboratory procedures. This ascertains accuracy in observation and thus in results too.

Section E. Measure the skills of using and differentiating commonly used laboratory apparatus. It represents the ability of students' awareness about laboratory apparatus and use in different required laboratory procedures.

Section F. Measure the skill of using measures while performing laboratory work. It represents the ability of students' awareness about safety measures and precautions to be followed in the chemistry laboratory.

The questions are framed in simple English, according to the level of sample students and easy scientific terms to enable the testees to answer them. This test is helpful in judging an individual's performance in chemistry laboratory.

3.4 STANDARDIZATION OF THE TEST

The CLCT was standardized by following the objective principle of item analysis and establishing reliability and validity.

Procedure of Item Analysis

Item analysis was accomplished in the following five steps given below:

1.Item Selection - The items representing the six selected areas were constructed. These prepared items were given to the Chemistry and Education subject experts for review and criticism. The objective was to choose items which would serve the purpose of assessing Chemistry Laboratory Competence. On the basis of experts' opinions and suggestions items were selected and categorized in different sections.

2. Item try out – The selected items were tried out on a small sample of thirty-five students of XI standard from Chemistry subject. Some of the items were modified and some were cancelled. The number of items varied in different sections. After the items were selected for the second draft of six sections, the draft was again tried out on a sample of 75 students studying in high school and 150 higher secondary standards.The feedbackfrom the try out and experts' suggestions were considered in drafting the third draft. The objective was to scrutinize each item for laboratory competence test in light of the data available. The third draft was administered on a sample of 357 students. Thus, the final draft of chemistry Laboratory Competence Test (CLCT) was prepared.

3. Item Difficulty- The third step was to find out the index of item difficulty. Davis and Harper method of item analysis and for dichotomy of items. Kelley's count off 27% high scores and 27% low scores responses was considered. In Davis and Harper method of item analysis right responses were considered for characterization of item. The range of selection of difficulty index was 0.30-0.70. Thus the final draft of *Chemistry Laboratory Competence* (CLCT) was prepared.

4. Reliability of the Test- Test- Retest reliability was established by re-administering the test to 357 students of class XI after a gap of 20 days. The correlation Coefficient was calculating between the scores of two tests. The Correlation Coefficient was found to be 0.92 which is significant at 0.01 level of significance. For finding out the reliability coefficient Pearson and Split half method have been used. The reliability coefficient comes to 0.92 and 0.62-0.94 respectively which is very high and the result of the test should be relied upon. It is evident from high reliability that the test is reliable.

5. Validity of the Test- For calculating the validity coefficient of the present test the content validity and the face validity have been used. Although the items of the test have been used were found to discriminate between high, average and low scores and also most of the items revealed positive and high correlation with the total test scores. So the test is comprised of homogenous items and has the capability to discriminate among laboratory competence.

3.5 ADMINISTRATION OF THE TOOL

The user of the test should read the whole test booklet, scoring key and manual thoroughly. The answers are to be given on the test paper itself. The present test may be administered to a group or to an individual.

In an admiration of the test, the administrator should ensure adequate seating arrangement and writing facility for an individual.

The administrator should introduce the test by forming a good rapport with the students. A brief description about the purpose of testing and implying test should be narrated. After the distribution of the test booklet the testee should be told not to open the test booklet and ask them to fill the entries given at the top of the test booklet.

There are six sections in the tests-booklet. The instructions should be read out by the administrator while the testee should read them silently. Administrator should make sure that the testee follows instructions clearly. To make sure the administrator should ask about the doubts and remove these doubts. After understanding the questions ask them to get ready for work and instruct them to write the test. Necessary instructions of marking the answers are given. Read the given directions carefully. Write your responses in space provided in test booklet. Administrator should collect the test booklets approximately in 45 minutes.

Scores on test are commonly interpreted by reference to norms which refers to the test performance of the standardized sample. Norms are empirically established by deciding what the person in a representative group actually performs in the test. Norms are relative measures. it means that raw scores of an individual are referred to the distribution of the scores of the achieved by the standardizedsample, to find out in which category one’s performance falls. Thus it helps to determine the individual’s exact position in reference to the standardized sample i.e., in reference to other person in a group. It also helps in comparing performance of an individual in different tests. An individual’s raw score is the sum o9f his scores for the separate items. This test is meant for science students of secondary and higher secondary classes of age 15 to 18 years. Present test is standardized on 617 students of M.P Board Schools and CBSE School of both rural and urban residential areas. Scores on CLC are interpreted in terms of standard score (z-Scores) and grade equivalents. Grade norms are statistically analyzed within group norms of standard score. Thus the raw score obtained are converted into weighted scores.

CLCT is employed within academic settings and can be easy to use for interpretations. Norms for the five groups (N 617, M 39 S, D 15). For the interpretation of the level of Chemistry Laboratory Competence, the z-score Norms (Table 1) are to be read for status in Table 2. The competence Status has been categorized in 7 points, viz., (a) Extremely High Competence, (b) Very High

Competence, (c) High Competence, (d) Average Competence, (e) Low Competence, (f) Very Low Competence, (g) Extremely Low Competence.

Table 3.3

Z-score Norms for Chemistry Laboratory Competence Test

M = 39, SD = 15, N = 617

Raw Scores	**Z-Score**	**Raw Score**	**Z-Score**	**Raw Scores**	**Z-Score**	**Raw Scores**	**Z-Score**
01	-2.53	19	-1.33	37	-0.13	55	+1.06
02	-2.46	20	-1.26	38	-0.06	56	+1.13
03	-2.40	21	-1.20	39	+0.00	57	+1.20
04	-2.33	22	-1.13	40	+0.06	58	+1.26
05	-2.26	23	-1.06	41	+0.13	59	+1.33
06	-2.20	24	-1.00	42	+0.02	60	+1.40
07	-2.13	25	-0.93	43	+0.26	61	+1.46
08	-2.06	26	-0.86	44	+0.33	62	+1.53
09	-2.00	27	-0.80	45	+0.40	63	+1.60
10	-1.93	28	-0.73	46	+0.46	64	+1.66
11	-1.86	29	-0.66	47	+0.53	65	+1.73
12	-1.80	30	-0.60	48	+0.60	66	+1.80
13	-1.73	31	-0.53	49	+0.66	67	+1.86
14	-1.66	32	-0.46	50	+0.73	68	+1.93
15	-1.60	33	-0.40	51	+0.80	69	+2.00
16	-1.53	34	-0.33	52	+0.86	70	+2.06
17	-1.46	35	-0.26	53	+0.93		
18	-1.40	36	-0.20	54	+1.00		

Table 3.4

Interpretation of Status of Chemistry Laboratory Competence

S.No.	**Raw Score Range**	**Z- Score Range**	**Category**	**Chemistry Laboratory Competence**
1	70	+2.01 and above	A	Extremely High Competence
2	58-69	+1.26 to +2.00	B	Very High Competence
3	47-57	+0.51 to +1.25	C	High Competence
4	32-46	-0.50 to +0.50	D	Average Competence
5	21-31	-0.51 to -1.25	E	Low

				Competence
6	09-20	-1.26 to -2.00	F	Low Competence
7	00-08	-2.01 and below	G	Extremely Low Competence

3.6 SCORING PROCEDURE

Each item of the **C**hemistry Laboratory Competence Test (CLCT) has to be scored separately as per the instructions given in scoring key. Doubtful and incomplete response has to be given zero. The score of each area has to be counted and entered into the table given on the first page of the teat booklet. Scores obtained must be entered into individual test-booklet as it is.

For finding the laboratory competence, the total score of corrected answers of an individual should be counted. On the basis of following table, the testee's scores can be classified. Scoring key has been given in Table 3.

Scoring procedure of this test is very simple. For scoring please consider the scoring key and marks distribution provided with this manual.

Table 3.5

Scoring Key

Section	**Item No.**	**Answer**	**Marks**	**Max. Marks**
Section A	1	B	01	13
	2	B	01	
	3	C	01	
	4	i) safe ii) unsafe	02	
	5	i) unsafe ii) safe	02	
	6	i) unsafe ii) safe	02	
	7	i) safe ii) unsafe	02	
	8	i) unsafe ii) safe	02	
Section B	9	B	01	
	10	C	01	
	11	C	01	
	12	B	01	
	13	D	01	
	14	D	01	
	15	D	01	07
Section C	16	More rate of stirring = More collisions among reactants = More rate of reaction hence rate of reaction would	02	

		be double in second case.		
	17	Laboratory assistant used tap water instead of distilled water.	02	
	18	Barium Chloride detects sulphate ions Sodium hydroxide detects iron ions	02	
	19	A. distilled water B. Chlorine gas C. Hydrochloric acid D. sodium chloride	04	
Section D	20	Initial weight = 23.5g Final weight = 23.74g Final weight – Initial weight = weight of magnesium: 23.74-23.5 = .24g	01 01 02	
	21	Initial reading = 1.1ml Final reading = 18.4ml Final reading – initial reading = Volume of acid used 18.4 – 1.1 = 17.3ml	01 01 02	
	22	Initial reading = 24.5 Final reading = 29 Final reading – initial reading = Difference in temperature 29-24.5 = 4.5C	01 01 02	12
Section E	23	1. Name – Fire	01	

		extinguisher, Used in case of accidental fire, operation of apparatus – point the nozzle towards fire, pull out the safety pin and squeeze the lever.	01 02	
	24	2. Name – fume – cupboard, Used for experiment and preparation in which evolution of large quantities of poisonous gases or vapors.	01 01 02	
	25	3. Name – Kipp's apparatus, Used for the supply of H2S gas, Operation of apparatus – Open the clamp to pass the gas in the solution.	01 01 02	
	26	a. beaker, b. pipette, c. test-tube, d. tong, e. test-tube, f. test-tube stand g. burette stands, h. tripod stand, i. wire-gauze, j. Bunsen's burner, k. tong, l. conical jar, m. graduating cylinder, n. weighing bottle, o. measuring flask, p. crucible with lid, q. mortar with pestle, r. burette, s. analytical	½ marks each (Total 10 marks)	

		weight box, t. analytical balance.		
	27.	A-B I-3 II-6 III-5 IV-2 V-1 VI-4	1Mark Each (Total 6 marks)	28
				Total Maximum marks 70

3.7 STATISTICAL TECHINQUES USED

In order to arrive at certain conclusions, it was necessary to analyze the success of subjects obtained from the test. After tabulation of the scores, following statistical techniques were applied to analyze the scores.

In this study, the investigators employed the following statistical techniques:

- Percentage
- 3-way ANOVA

CHAPTER-IV

ANALYSIS AND INTERPRETATION OF DATA

4.1 INTRODUCTION

Analysis of data means studying the organized material in order to bring out information useful for decision-making. The purpose of analysis is to find out the relationship between variables, which leads to the verification of hypothesis. Analysis of data is the process of bringing order, structure and meaning to the mass of collected data. Analysis of the data can be done in the light of the objectives of the study. The analysis and interpretation of data collected for study is important to draw out significant conclusion. Collection of data has no meaning unless it is tackled properly analyzed and interpreted by sophisticated techniques.

In this study, data have been collected from one-hundred and ninety-two higher secondary school students studying in both Government and Private schools in Rural and Urban areas of Jammu district. Data have been collected by administering *Chemistry Laboratory Competence Test* (CLCT) developed and standardized by Rathod and Kotwale (2012). The analysis of the results and their interpretation has been given in the following sections

4.2 RESULTS ANDFINDINGS

The resulting data have been analyzed using statistical techniques namely t-Test, Percentage and 3-way ANOVA.

4.2.1 Research Objective1

To assess the level of the chemistry laboratory competence of higher secondary school students

To assess the levels of the chemistry laboratory competence of higher secondary school students; Number, percentage and status have been computed and presented in the table 4.1.

Table 4.1

S. No.	**Score**	**Chemistry Laboratory Competence Status**	**Number & Percentage**
1	70	Extremely High	0 (0.0)
2	58-69	Very High	0 (0.0)
3	47-57	High	0 (0.0)

4	32-46	Average	54 (28.1)
5	21-31	Low	73 (38)
6	09-20	Very Low	64 (33.3)
7	00-08	Extremely Low	1 (0.01)

Table 4.1 indicates that no student has obtained score 47 and above. 28.1 % students were having average chemistry laboratory competence, 38% students were fall under the low chemistry laboratory competence status, and 33.3% of students were having very low competence of chemistry laboratory and 0.01% student fall under extremely low chemistry laboratory competence. So Hypothesis No. 2 stating that there is no significant difference of chemistry laboratory competence among higher secondary school students has been rejected.

4.2.2Research Objective2

To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary schoolstudents

Table 4.2

Source	**Sum of Squares**	**df**	**Mean Squares**	**F**	**Sig.**
TYPE OF SCHOOL	1645.02	1	1645.02	31.03	S
LOCATION OF SCHOOL	1131.02	1	1131.02	21.33	S
GENDER	247.52	1	247.52	4.67	S
TYPEOFSCHOOL * LOCATIONOFSCHOOL	616.33	1	616.33	11.62	S
TYPEOFSCHOOL * GENDER	33.33	1	33.33	0.63	NS
LOCATIONOFSCHOOL* GENDER	444.08	1	444.08	8.78	S

TYPEOFSCHOOL * LOCATIONOFSCHOOL * GENDER	4.69	1	4.69	0.09	NS
ERROR	9754.00	184	53.01		
TOTAL	141184.00	192			
CORRECTED TOTAL	13876.00	191			

Main Effects:

- TYPEOFSCHOOL(A):ThecomputedvalueofFforthemaineffectoftypeof school of higher secondary school students, irrespective of their gender and locationofschool,hascomeouttobe31.03,fordf1and184,whichisgreater than the table value of F (3.89) at 0.05 level and (6.76) at 0.01 level of significance.Thisresultindicatesthatthereissignificanteffectoftypeofschool onchemistrylaboratorycompetenceofhighersecondarystudentsasshownin table 4.2. The mean value (29.40) of male students studying in government schools is greater than the mean value (24.38) of male students studying in private schools as shown in table 4.3. Therefore, male students studying in governmenthighersecondaryschoolshavefoundtobemorecompetentthan malestudentsstudyinginprivatehighersecondaryschool.Also,themeanvalue (27.96)ingovernmenthighersecondaryschoolsis greaterthanthemeanvalue(21.27)offemalestudentsstudyinginprivatehigher secondary schools. Therefore, female students studying in government higher secondary schools have found to be more competent than female students studyinginprivate higher secondary schools.

Table 4.3

Mean Values on Chemistry Laboratory Competence of Higher SecondarySchool Students from Government and Private Higher Secondary Schools.

GENDER	GOVERNMENT	PRIVATE	TOTAL
MALE	29.40	24.38	26.89
FEMALE	27.96	21.27	24.61

TOTAL	28.68	22.82	25.75

- LOCATION OF SCHOOL (B): The obtained value of F for the main effect of location of school on chemistry laboratory competence of higher secondary schoolstudentsirrespectiveoftheirgenderandtypeofschoolhascomeoutto be21.33,fordf1and184,whichisfargreaterthanthetablevalueofF(3.89)at 0.05leveland(6.76)at0.01levelofsignificance.Thisresultindicatesthatthere exists significant difference of location of school on chemistry laboratory competenceofstudentsstudyingin11thclass.Themeanvalue(22.94)ofmale students studying in higher secondary schools of rural areas is lesser thanthe mean value (30.83) of male students studying in higher secondary schools of urbanareas.Alsothemeanvalue(23.71)offemalestudentsstudyinginhigher secondaryschoolsofruralareasislesserthanthemeanvalue(25.52)offemale studentsstudyinginhighersecondaryschoolsofurbanareasasshownintable4.4. Therefore, the male and female higher secondary school students in rural areas have found to be less competent than the male and female higher secondary students in urban areas.

Table 4.4

Mean values on Chemistry Laboratory Competence of Higher Secondary School Students from Higher Secondary Schools Located in Urban and Rural Areas.

GENDER	RURAL	URBAN	TOTAL
MALE	22.94	30.83	26.89
FEMALE	23.71	25.52	24.61
TOTAL	23.32	28.18.	25.75

- GENDER(C):ThecomputedvalueofFforthemaineffectofgenderonchemistry laboratory competence of higher secondary students, irrespective of type of schoolandlocationofschool,hascomeouttobe4.67,fordf1and184,whichis greaterthanthetablevalueofF(3.89)at0.05levelandlessthanthetablevalue of F (6.76) at 0.01 level of significance. This result indicates that there exist significant gender differences at 0.05 level of significance in the chemistry laboratorycompetenceofhighersecondarystudents.Themeanvalue(26.89)of male students studying in higher secondary schools is greater than the mean value(24.61)offemalestudentsstudyinginhighersecondaryschools.Therefore, malehighersecondaryschoolstudentshavefoundtobemorecompetentthan femalehighersecondaryschoolstudents.

Table 4.5

Mean Values on Chemistry Laboratory Competence of Higher Secondary School Students

GENDER	**TOTAL**
MALE	26.89
FEMALE	24.61
TOTAL	25.75

Interaction (A*B) Type of School*Location of School: The obtained value of F for double interaction between variable type of school and location of school withchemistrylaboratorycompetenceasthedependentvariableis11.62which is more than the table value of F (3.89) at 0.05 level and 0.01 level of significance for df1 and 184. This result indicates that significant interaction exist between type of school and location of school with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The mean value (28.04) of students studying in governmenthighersecondaryschoolslocatedinurbanareasisfargreaterthan themeanvalue(18.60)ofstudentsstudyinginprivateschoolslocatedinurban areas as shown in table 4.6. Therefore, the students of government higher secondaryschoolslocatedinurbanareashavebettercompetenceincomparison locatedinurbanareas.Also, from the mean values of students studying in government higher secondary schools (29.31) and private higher secondary schools (27.04), there exists no significant differencewithchemistrylaboratorycompetenceasthedependent variableamonghighersecondaryschoolstudentsstudyingineleventhclass.

Table 4.6

*Values of Mean, S.D., SE_M, df and t or Type of Sc*hool *differences in Location of School of Higher Secondary Students with respect to their Chemistry Laboratory Competence*.

Location of School	**Type of School**	**N**	**Mean**	**S.D.**	**$S.E_M$**	**df**	**t**	**Sig.**
Urban	Govt.	48	28.04	9.46	1.37	94	6.19	Sig.
	Pvt.	48	18.60	0.68	0.68			
Rural	Govt.	48	29.31	1.19	1.19	94	1.49	NS
	Pvt.	48	27.04	0.94	0.94			

InteractionA*C(TypeofSchool*Gender):TheobtainedvalueofFforthedouble interaction between variables type of school and gender with chemistry laboratorycompetenceasthedependentvariableis0.63whichhasfailedtoreach table value of F (3.89) at 0.05 level of significance for df 1 and 184. This result indicates that no significant interaction exists between type of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class.

Interaction B*C (Location of school*Gender):The obtained value of F for the double interaction between variable location of school and gender with chemistry laboratorycompetenceasthedependentvariableis8.78whichismorethanthe table valueofF (3.89)at0.05leveland0.01levelofsignificancefordf1and184.Thisresult indicates that significant interaction exist between location of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The mean value (22.94) of male students studying in higher secondary schools located in rural areas is much lesser than the mean value (30.83) of male students studying in higher secondary schools located in urban areas as shown in table 4.7. Therefore, the male students studying in higher secondary schools located in rural areas have found to be less competent than the male students studying in higher secondary schools located in urban areas. From the mean value (23.71) of female students studying in higher secondary schools located in rural areas andmeanvalue(25.52)offemalestudentsstudyinginhighersecondaryschoolslocated in urban areas, there exists no significant difference among female students studying in higher secondary schools located in urban and rural areas with chemistry laboratory competenceasthedependentvariable.

Table 4.7

Values of Mean, S.D., S.E$_M$, df and t for Location of Schooldifferences in Male and Female Higher Secondary Students with respect to their Chemistry Laboratory Competence.

Gender	**Location of School**	**N**	**Mean**	**S.D.**	**S.E$_M$**	**df**	**t**	**Sig.**
Male	Rural	48	22.94	8.11	1.17	94	5.12	0.01.
	Urban	48	30.83	6.96	1.01			
Female	Rural	48	23.71	9.54	1. 38	94	1.05	NS
	Urban	48	25.52	7.14	1.03			

Interaction A*B*C (Type of School*Location of School*Gender): Theobtained valueofFforthetripleinteractionbetweenvariablestypeofschool,locationof school and gender with chemistry laboratory competence as the dependent variableis0.09whichislessthanthetablevalueofF(3.89)at0.05leveland (6.76)0.01levelofsignificancefordf1and184.Thisresultindicatesthatno significantinteractionexistbetweenvariablestypeofschool,locationofschool and gender with chemistry laboratory competence as the dependent variable amonghighersecondaryschoolstudentsstudyingineleventh class.

CHAPTER-V

FINDINGS, CONCLUSION AND DISCUSSIONS, EDUCATIONAL IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

5.1 INTRODUCTION

In this chapter V, an attempt is made to summarize the findings of the study on the basis of analysis and interpretation made in chapter IV. In this chapter the researcher gave some suggestions in the light of the present study for carrying out further research study in this area.

After processing the data, obtaining and interpreting the results in previous chapter, the findings have been delimited and discussed in present chapter. These findings can be generalized to the extent of representatives of the sample and methodology employed in the study. In this chapter, the results are discussed to show how these findings are concurrent with some of the studies already conducted in the field. Keeping the major findings in view, the educational implications of the study have been worked out. But these findings and implications do not fit in all the concerns of the study.

As such some suggestions have been given for the further research. This chapter is therefore devoted to focusing the findings, conclusions, discussions of results of the study and for indications their implications and suggestions for further studies or research. These are presented below in the same sequence.

- Main Findings
- Conclusion and Discussion
- Educational Implications
- Suggestions for Further Research

5.2 MAIN FINDINGS OF THE STUDY

The main findings of the present study are reported in the following subsections:

5.2.1 RESEARCH OBJECTIVE 1

To assess the level of the Chemistry Laboratory Competence of higher secondary school students

In order to study the chemistry laboratory competence, percentage of different dimensions of chemistry laboratory competence has been calculated and higher secondary school students are classified accordingly. It is found that out of 192 students, 28.1% students were having average chemistry laboratory competence, 38% students were fall under the low chemistry laboratory competence status, 33.3% of students were having very low competence of chemistry laboratory and 0.01% students fall under extremely low chemistry laboratory competence.

5.2.2 RESEARCH OBJECTIVE 2

To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

In this study, the result indicates that there is significant effect of type of school on chemistry laboratory competence of higher secondary students where as thecomputedvalueofFforthemaineffectoftypeof school of higher secondary school students, irrespective of their gender and locationofschool,hascomeouttobe31.03,fordf1and184,whichisgreater than the table value of F (3.89) at 0.05 level and (6.76) at 0.01 level of significance. The mean value (29.40) of male students studying in government schools is greater than the mean value (24.38) of male students studying in private schools as shown in table 4.3. Therefore, male students studying in governmenthighersecondaryschoolshavefoundtobemorecompetentthan malestudentsstudyinginprivatehighersecondaryschool.Also,themeanvalue (27.96)offemalestudentsstudyingingovernmenthighersecondaryschoolsis greaterthanthemeanvalue(21.27)offemalestudentsstudyinginprivatehigher secondary schools. Therefore, female students studying in government higher secondary schools have found to be more competent than female students studyinginprivatehighersecondaryschools.

In this study, theresultindicatesthatthere exists significant difference of location of school on chemistry laboratory competenceofstudentsstudyingin11thclass. The obtained value of F for the main effect of location of school on chemistry laboratory competence of higher secondary schoolstudentsirrespectiveoftheirgenderandtypeofschoolhascomeoutto be21.33,fordf1and184,whichisfargreaterthanthetablevalueofF(3.89)at 0.05leveland(6.76)at0.01levelof significance. Value(22.94)ofmale students studying in higher secondary schools of rural areas is lesser thanthe mean value (30.83) of male students studying in higher secondary schools of urbanareas.Alsothemeanvalue(23.71)offemalestudentsstudyinginhigher secondaryschoolsofruralareasislesserthanthemeanvalue(25.52)offemale studentsstudyinginhighersecondaryschoolsofurbanareasasshownintable4.4. Therefore, the male and female higher secondary school students in rural areas have found to be less competent than the male and female higher secondary students in urban areas.

In this study, the result indicates that there exist significant gender differences at 0.05 level of significance in the chemistry laboratorycompetenceofhighersecondarystudents. ThecomputedvalueofFforthemaineffectofgenderonchemistry laboratory competence of higher secondary students, irrespective of type of schoolandlocationofschool,hascomeouttobe4.67,fordf 1 and184,whichis greaterthanthetablevalueofF(3.89)at0.05levelandlessthanthetablevalue of F (6.76) at 0.01 level of significance. Themeanvalue(26.89)of male students studying in higher secondary schools is greater than the mean value(24.61)offemalestudentsstudyinginhighersecondaryschools.Therefore, malehighersecondaryschoolstudentshavefoundtobemorecompetentthan femalehighersecondaryschoolstudents.

In this study, the result indicates that significant interaction exist between type of school and location of school with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The obtained value of F between variable type of school and location of school withchemistrylaboratorycompetenceasthedependentvariableis11.62which is more than the Table value of F (3.89) at 0.05 level and 0.01 level of significance for df 1 and 184. The mean value (28.04) of students studying in governmenthighersecondaryschoolslocatedinurbanareasisfargreaterthan themeanvalue(18.60)ofstudentsstudyinginprivateschoolslocatedinurban areas as shown in table 4.6. Therefore, the students of government higher secondaryschoolslocatedinurbanareashavebettercompetenceincomparison tothestudentsofprivatehighersecondaryschoolslocatedinurbanareas.Also, from the mean values of students studying in government higher secondary schools (29.31) and private higher secondary schools (27.04), there exist no significantdifferencewithchemistrylaboratorycompetenceasthedependent variableamonghighersecondaryschoolstudentsstudyingineleventhclass.

In this study, the result indicates that no significant interaction exists between type of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class.TheobtainedvalueofFforthedouble interaction between variables type of school and gender with chemistry laboratorycompetenceasthedependent variable is 0.63 which has failed to reach table value of F (3.89) at 0.05 level of significance for df 1 and 184.

In this study, theresult shows that significant interaction exist between location of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The obtained value of F for the double interaction between variable location of school and gender with chemistry laboratorycompetenceasthedependentvariableis8.78whichismorethanthe table valueofF(3.89)at0.05leveland0.01levelofsignificancefordf1and184.The mean value (22.94) of male students studying in higher secondary schools located in rural areas is much lesser than the mean value (30.83) of male students studying in higher secondary schools located in urban areas as shown in table 4.7. Therefore, the male students studying in higher secondary schools located in rural areas have found to be less competent than the male students studying in higher secondary schools located in urban areas. From the mean value (23.71) of female students studying in higher secondary schools located in rural areas andmeanvalue(25.52)offemalestudentsstudyinginhighersecondaryschoolslocated in urban areas, there exists no significant difference among female students studying in higher secondary schools located in urban and rural areas with chemistry laboratory competenceasthedependentvariable.

In this study, theresultindicatesthatno significantinteractionexistbetweenvariablestypeofschool,locationofschool and gender with chemistry laboratory competence as the dependent variable studyingineleventhclass. Theobtained valueofFforthetripleinteractionbetweenvariablestypeofschool,locationof school and gender with chemistry laboratory competence as the dependent variableis0.09whichislessthanthetablevalueofF(3.89)at0.05leveland (6.76)0.01levelofsignificancefordf1and184.

5.3 CONCLUSION AND DISCUSSIONS

After analyzing the determined objectives of the present study, it is concluded that there is significant difference in chemistry laboratory competence among higher secondary school students in relation to their gender, type of school and location of school.

The present study verifies the findings of Belay (2012); Donnel, Connor & Serry (2017); Mokhtar (2007); Santoniono (2004); Lath & Mohaiedeen (2012); Jesubalan (2007); Seempala (2016); Gambari (2018) which also found significant difference in chemistry laboratory competence among higher secondary school students in relation to their gender, type of school and location of school.

The present study determined the competence of Chemistry laboratory among higher secondary students and the findings of the study showed that the higher secondary schools surveyed in Jammu city agreed that the use of chemistry laboratory develops competence and scientific attitude among higher secondary school students and also enhance the interest of students towards learning in chemistry. The general purpose of the study was how to find out how practical chemistry exercises triggered interest and hence promoted more academic achievement in senior secondary schools chemistry. Good competence in chemistry laboratory makes the students to learn about the nature of chemical science and technology in order to foster the knowledge of chemistry and thus enhance the aesthetic and intellectual understanding of the child. The students having better competence in chemistry laboratory can identify cause and effect relationships and in this process, develop important skills which are very important for the students at higher secondary level of education. According to Hancy (2007), aspects of laboratory competence exist all of which can be nurtured in the chemistry laboratory in the school.

Considering many factors, well-equipped chemistry laboratories along with well qualified and well trained teachers helps the students to develop better competence and improve academic performance in different examinations at higher secondary school stage. The variables like gender, type of school and location of school all have impacts on chemistry laboratory competence of the students at higher secondary stage.

In this study, it was found that most of the students have low to average chemistry laboratory competence in class eleventh in Jammu city during the study period. Considering gender, the mean value of male students have found to be higher than the mean value of female students studying in eleventh class. It was observed that type of school and location of school has impact on the chemistry laboratory competence of higher secondary school students as most of the students studying in government schools have been found to be more competent that students studying in private schools. On the other hand, the students studying in higher secondary schools located in rural areas have been found to be less competent in chemistry laboratory that students studying in higher secondary schools located in urban areas.

5.4 EDUCATIONAL IMPLICATIONS

Present study shows that students should learn to address the challenges inherent in directly observing and manipulating the material world including troubleshooting equipment used to make observations, understanding measurement error and interpreting and aggregating the resulting data. This study also shows that students at higher secondary level of education who engage in well-designed laboratory experiences develop problem-solving and critical-thinking skills, as well as gain exposure to reactions, materials, and equipment in a lab setting. Sustained investments in hands-on experiences in chemistry laboratory help inspire students to further their education and prepare them for high-technology careers by fostering skills sought by potential employers.

Moreover, hands-on experiences significantly advance learning at all levels of science education when appropriately designed and guided by qualified educators. During hands-on chemistry activities, higher secondary school students directly and safely investigate chemical properties and reactions, utilizing laboratory apparatus and instruments. These activities are essential for learning chemistry and improving science literacy.

"A laboratory is always considered as a relevant and essential part so far as the teaching of Science and Computer is concerned."Every school has laboratories where students can perform researches, experiments or even learn new things with the help of internet facility. This helps students to remember the studies in a better way by conducting their own experiments. It gives students first-hand experience and offers better opportunities for learning (Leblond, 2019).

Planning and implementation of strategies by higher secondary schools that help students to develop background of good laboratory skill experience.

Workshops and seminars should be conducted to realize the importance of laboratory in chemistry subject among students of higher secondary schools.

Skills such as proper handling of apparatus, observational skills, analysis of results and preventive measures should be developed by higher school students.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

From the study of related literature, it is found that no such studies on the matter have been conducted in any part of the country. So, the investigator hopes that there is still much scope for research in this field and put forward some suggestions for further research.

The present study was limited to only higher secondary school students who adopted chemistry subject. Therefore, similar studies can be carried out on students who adopted subjects like physics, biology.

A comparative study among the different districts may be concluded to get a clear picture about chemistry laboratory competence among higher secondary school students in relation to their gender, type of school and location of school.

A study may be done among students of other educational boards such as CBSE, ICSE.

A study may be browned to determine the relationship between chemistry laboratory competence and academic scores in chemistry subject of higher secondary school students.

A study may be ready to know the effects of chemistry laboratory competence on academic performance of higher secondary school students.

A comparative study may be ready to know the ability of developing laboratory skills among higher secondary school students and under-graduate students.

The report of the study has been concluded with the above suggestions, keeping a hope in the mind that the present study will help the teachers, researchers, policy makers and students to develop required laboratory skills and attitude for better laboratory competence at higher secondary level of education.

SUMMARY

TITLE: CHEMISTRY LABOATORY COMPETENCE AMONG HIGHER SECONDARY SCHOOL STUDENTS INRELATION TO THEIR GENDER, TYPE OF SCHOOL AND LOCATION OF SCHOOL.

SUPERVISOR **INVESTIGATOR**

Dr. Nishta Rana **Priyanka Sharma**

THE PROBLEM

Higher Secondary education occupies a prominent place in the development of education of a country. The progress of a country largely depends on expansion and improvement of higher secondary education. Educational development leads transformation of social structure from one pattern to another, which can be conceived as a process of social changes. Educational development is measure by different dimensions. Laboratory competence is one of them. There are many factors that are responsible for the performance of the students. Among them laboratory competence are most important. Therefore, the basic problem undertaken for investigation in the present study is, **"CHEMISTRY LABORATORY COMPETENCE AMONG HIGHER SECONDARY SCHOOL STUDENTS INRELATION TO THEIR GENDER, TYPE OF SCHOOL AND LOCATION OF SCHOOL."**

SCIENCE LABORATORY

Laboratory activities have had a distinctive and central role in the science curriculum and science educators have suggested that many benefits mount up from engaging students in science laboratory activities. Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in laboratory. Unfortunately, the term laboratory or practical have been used, too often without precise definition, to embrace a wide array of activities. Lots of arguments have been raised in the past to give justification or rationale for its use. Even though laboratory sessions were generally taken as necessary and important, very little justification was given for their inclusion. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration setting.

Both the content and pedagogy of science learning and teaching are being analyzed, and new standards intended to shape and refresh science education are emerging.Teacher guidance and instructions have ranged from highly structured and teacher centered to open inquiry. The terms have sometimes been used to include investigations or projects that are pursued for several weeks, sometimes outside the school, while on other occasions they have referred to experiences lasting 20 minutes or less.

The National Science Education Standards and the 2061 project reaffirm the conviction that inquiry in general and inquiry in the context of practical work in science education is central to the achievement of scientific literacy. Inquiry-type laboratories have the potential to develop student's abilities and skills such as: posing scientifically oriented questions forming hypothesis, designing and conducting scientific investigations, formulating and revising scientific explanations and communicating and defending scientific arguments.

Chemistry is essentially a laboratory activity oriented subject. No course in chemistry can be considered as complete without including practical work in it. Laboratory activity, here, is used to describe the practical activities which students undertake using chemicals and equipment in a chemistry laboratory. The original reasons for the development of laboratory work in chemistry education lay in the need to produce skilled technicians for industry and highly competent workers for research laboratories.

Laboratories are one of the characteristic features in the sciences at all levels. It would be rare to find any science course in any institution of education without a substantial component of Laboratory activity. Even though the instructional potential of the laboratory is enormous. Most practical activities in higher secondary education are by nature illustrative or demonstrative. Too often they emphasize the acquisition of observational skills and allow students to see the concept dealt in action and relate theory more closely to reality. It is important to think about goals, aims and objectives in the context of laboratory work.

Chemistry laboratory activities have a distinctive and central role in the science curriculum and science educators have suggested that there are many benefits from engaging students in chemistry laboratory activities. More specifically, when properly developed, inquiry centered laboratories have the potential to enhance students constructive learning, conceptual understanding and understanding of the nature of science.

Laboratory activities have had a distinctive and central role in the science curriculum and Science educators have suggested that many benefits mount up from engaging students in science laboratory activities. Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences in laboratory.

Unfortunately, the term laboratory or practical have been used, too often without precise definition. Lots of arguments have been raised in the pastto give justification or rationale for its use. Even though laboratory sessions were generally taken as necessary and important. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration setting.

The study of classroom, laboratory and school learning environments and their effects on students' learning has been going on for more than a century. Past efforts in the study of the laboratory competence indicated that it plays a major role in improving and learning in higher secondary education. The laboratory experiment is an important part of science teaching. Many studies show that experiments in laboratory influence students to have better attitudes toward chemistry. Furthermore, laboratory experiments can help students to understand abstract concepts in chemistry. Practical work in chemistry laboratories is also fun and interesting for the students. As the result, they are motivated which is related to the topics in the classroom. According to Swain 2000, as cited in Parkinson, 2004, there are mainly four aims of practical work in the chemistry laboratory which is encouraging students to 1) Laboratory practice seeing problems and solve it. 2) Find the facts and new principles. 3) Develop ability to co-operate 4) Develop critical attitude. However, there are some criticisms against the practical work in the chemistry laboratory. There are several weaknesses of practical work in laboratory – 1) The noise influences students to be confused 2) Some students either girls or boys don't like practical work 3) Time consuming 4) Lack of facilities

TYPE OF PRACTICAL WORK:

Scholars identify three distinct types of practical work:
1. *Experiences*, which are intended to give students a 'feel' for observable fact;
2. *Exercises*, which are designed to develop practical skills and techniques; and
3. *Investigations*, which give students the opportunity to tackle more open-ended tasks like a problem-solving.
Some also classify practical works in to four major types: exercises, experiences,demonstrations and investigations. Each of these types of practical has its own place in science.

Exercise	To develop practical skills
Experience	To gain experiences of a phenomenon
Demonstration	To develop a scientific argument or cause an impression
Investigation	Hypothesis – testing: to reinforce theoretical understanding. Problem solving: to learn the ways of working as a problem solving scientist.

A number of researchers, analyzed different types of laboratory investigations based on the level of openness and the demand for inquiry skills. Through a revised form, typical laboratory lesson was compared with that of a typical investigation carried out by a scientist in terms of who does what and he concludes that what students are actually doing in a typical laboratory is like technicians and not like scientists. It was suggested that this openness can occur at different stages of an investigation: in the problem to be solved; in the planning and operation ofthe investigation; and in the possible solutions to the problems. Based on this, some produce a four-way classification of investigations, depending on whether each stage is open – that is left to the students to decide or closed.At level zero all the problems, procedures, and conclusions are given and hence there is no experience of scientific inquiry. At this level, one may find exercises involving practices in some techniques and/or confirmation where the answer is already provided to the students. They may provide opportunities for students to learn accuracy in the process of trying to replicate a known answer. In level one, both problems and procedures are given and they have to collect data and draw the conclusions. In level two, only the problem is given and the student has to design the procedure, collect the data and draw conclusions. These are called investigative practical. In level three, the student has to do everything beginning with problem formulation up to drawing of conclusions.

LABORATORY COMPETENCE

Laboratories have been purported to promote a number of goals for students, most of which are also the goals of science education in general (Lunetta, 1998; Hofstein & Lunetta, 1982). To examine the definition and goals of laboratory experiences and research reviews on laboratory education that have identified and discussed learning goals (Anderson, 1976; Hofstein & Lunetta, 1982; Lazarowitz & Tamir, 1994; Shulman & Tamir, 1973).A comprehensive list of goals set for desired outcomes of laboratory experiences:

i. *Enhancing mastery of subject matter*: Laboratory experiences may enhance student understanding of specific scientific facts and concepts and of the way in which these facts and concepts are organized in the scientific disciplines.

ii. *Developing scientific reasoning*: Laboratory experiences may promote a student's ability to identify questions and concepts that guide scientific.

iii. *Understanding the complexity and ambiguity of empirical work*: Interacting with the unconstrained environment of the material world in laboratory experiences may help students concretely understand the inherent complexity and ambiguity of natural phenomena. Laboratory experiences may help students learn to address the challenges inherent in directly observing and manipulating the material world, including troubleshooting equipment used to make observations, understanding measurement error, and interpreting and aggregating the resulting data.

iv. *Developing practical skills*: In laboratory experiences, students may learn to use the tools and conventions of science. For example, they may develop skills in using scientific equipment correctly and safely, making observations, taking measurements, and carrying out well-defined scientific procedures.

v. *Understanding of the nature of science*: Laboratory experiences may help students to understand the values and assumptions inherent in the development and interpretation of scientific knowledge, such as the idea that science is a human endeavor that seeks to understand the material world and that scientific theories, models, and explanations change over time on the basis of new evidence.

vi. *Cultivating interest in science and interest in learning science*: As a result of laboratory experiences that make science "come alive," students may become interested in learning more about science and see it as relevant to everyday life.

vii. *Developing teamwork abilities*: Laboratory experiences may also promote a student's ability to collaborate effectively with others in carrying out complex tasks, to share the work of the task, to assume different roles at different times, and to contribute and respond to ideas.

CHEMISTRY AS A BRANCH OF SCIENCE:

Chemistry is the branch of science that studies the composition, properties and interaction of matter. Chemistry plays central role in science and is often intertwined with other branches of science like physics, biology, geology etc. Chemistry also plays an important role in daily life. Chemical principles are important in diverse areas such as weather patterns, functioning of brain and operation of a computer.

Chemical industries manufacturing fertilizers, acids and other organic and inorganic chemicals including new materials contribute in a big way to the national economy. Chemistry plays an important role in meeting human needs for food, health care products and other materials aimed at improving the quality of life. Chemistry is the science of molecules and their transformation. It is the science not so much of the one hundred elements but of the infinite variety of molecules that may be built from them (Hoffman, 1963**).**
Chemistry is the study of matter and its interactions with other matter and energy. The crucial role that Chemistry plays in modern scientific technological development is well accepted. Chemistry has to play a pivotal role in technology using Chemistry students, Engineers and Researchers, who in turn will contribute to the running of vast technological structure that are building up. If we want to turn out the experts and technologies in the area of Chemistry, it is imperative that we should develop a sound system of scientific education, with proper accent given to the instruction in Chemistry. The New Encyclopedia Britannica (1997) stated that' Chemistry is the science that deals with the properties, composition and structure of substances, the transformations that may undergo and the energy that is released or absorbed during these processes'. In the Chamber's Dictionary (1959) it is stated that Chemistry is the science that deals with the nature of substances and the ways in which the act on or combine with each other.

Chemistry as a science studies the composition and properties of matter. It also studies the reactions between various chemicals known as chemical reactions. Basic chemical reactions are always going on around us. Chemists try to understand how the composition of substances affects the substance`s properties. They seek to understand why and how substances change within chemical reactions. Chemists try to understand and observe the underlying structure of matter and attempt to understand why the properties that we observe with our senses occur in matter.

The division of Chemistry into Organic and Inorganic domains has its origin in earliest antiquity. Many Organic compounds like alcohol, sugar, fats, soap, vinegar, indigo and starch were known to prehistoric people. In the 18th century many Organic compounds were isolated from natural sources .Organic Chemistry as its often said is the Chemistry of the carbon Compounds. Throughout our lives, Chemistry plays a key role in keeping us healthy. Innovations in Chemistry have enabled the improvement of longevity of people.

Chemistry finds a lot of applications in the field of health care. Chemotherapy and other drugs now are delivered more accurately on plastic patches and dissolving discs. Vaccines have eradicated once rippling diseases. Medical devices such as pace makers and blood bags save lives. Lifesaving medicines help us to combat disease and live longer. Chemistry plays an important role in ensuring our food supply. Food growers use Chemistry to apply fertilizers that deliver essential nutrients to soil resulting in a wholesome, abundant food supply. Without fertilizers the world food supply would shrink by one-third Food growers use chemicals as pesticides and weedicides. Chlorine Chemistry is the most effective weapon against waterborne bacteria and viruses. Chemistry finds a lot of applications in sports and games.

CHEMISTRY LABORATORY COMPETENCE AMONG HIGHER SECONDARY SCHOOL STUDENT

The aim of a competency-based educational model is to integrate knowledge with the development of the skills, attitudes and values that comprise a competency. The key question we need to ask ourselves as teachers is, how can we ensure that students will acquire the competencies defined for a specific course? The first step in answering this question is to find a congruent line between the activities students carry out in class and the way in which they are being evaluated. Practical laboratory classes that correspond to science courses are essential because students perform in a real context and with an established problem. The classes I teach, Matter and the Environment and Matter and Sustainability, include laboratory activities in which students put into practice the theory studied in class, such as: measuring pH, cleaning product generation, gas laws, polymer creation, chemical reactions and renewable energy sources, among others. To reflect students' progress in the acquisition of competencies in the laboratory, we use an analytical rubric to define what is expected of them. With the same rubric, the teacher can provide assertive, personalized feedback on the students' performance. In this way, teachers work together with students to assure the development of autonomy and self-regulation in relation to the disciplinary competencies in the area of science, which include: formulating scientific questions, producing hypotheses, obtaining, recording and systematizing information, applying safety standards, waste management, data collection, comparing results obtained in an experiment, communicating conclusions and documenting information sources.

Laboratory activities have long had a distinctive and central role in the science curriculum and science educators have suggested that many benefits accrue from engaging students in science laboratory activities (Pickering, 1980; Hofstein & Lunetta, 1982; Garnet et al., 1995; Lunetta, 1998; Tobin, 1990; Hofstein & Lunetta, 2004). Since the end of the 19th century, when schools began to teach science systematically, the science laboratory has become a distinctive feature of science education.

During the major curriculum reforms in science education in the early 1960s, practical work in science education was used to engage students in investigations, discoveries, inquiries, and problem-solving activities. In other words, the laboratory became (at least in the minds of science educators and curriculum developers) the center of science teaching and learning. For example, George Pimentel editor of the CHEMStudy (Merril & Ridgway, 1969) suggested that the laboratory was designed to help students gain a better idea of the nature of science and scientific investigation by emphasizing the discovery approach. In addition, he suggested that it gives students an opportunity to observe chemical systems and to gather data useful for the development of principles subsequently discussed in the textbook and in class. However, when it came to assessing and evaluating the effectiveness of the laboratory, the situation was less simplistic and less clear. For example, as early as 1969, Ramsey and Howe, on the basis of an extensive review of the literature regarding instruction in the science laboratory concluded that the experience possible for students in the laboratory situation should be an integral part of any science course has come to have a wide acceptance in science teaching. What the best kinds of experiences are, and how these may be blended with more conventional class work has not been objectively evaluated to the extent that clear direction based on research is available for teachers.
Both the content and pedagogy of science learning and teaching are being scrutinized, and new standards intended to shape meaningful science education are emerging. The National Science Education Standards (National Research Council, 1996) and other science education literature (Lunetta, 1998; Bybee, 2000; Hofstein & Lunetta, 2004) emphasize the importance of rethinking the role and practice of laboratory work in science teaching in general and in the context of chemistry education in particular. It is true that very often research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning science. However, sufficient data do exist to suggest that the laboratory instruction is an effective and efficient teaching medium to attain some of the goals for teaching and learning science. Appropriate laboratory activities can be effective in helping students construct their knowledge (Tobin, 1990 & Gunstone, 1991), develop logical and inquiry-type skills, as well as problem-solving abilities. They can also assist in the development of psychomotor skills (manipulative and observational skills). In addition, they have a great potential in promoting positive attitudes and in providing students with opportunities to develop skills regarding cooperation and communication. In this respect the science laboratory is a unique learning environment. Thus, it has the potential to provide science teachers with opportunities to vary their instructional techniques and to avoid a monotonous classroom learning environment.

SIGNIFICANCE OF THE STUDY

Chemistry laboratory teaching has become an integral part of education in Indian schools. However, experts agree that the quality of chemistry teaching requires to be improved considerably so as to achieve its purpose and objectives i.e. to understand the basic principles, to develop problem solving, analytical skills and ability to apply them to the problems of everyday life besides promoting the spirit of enquiry and experimentation. This study is aimed at identifying differences in terms of the practical implementation of practical chemistry in laboratories based on gender, type and location of schools. The utilization of laboratory facilities in chemistry teaching enables learners to develop problem solving skills and positive attitude, interest towards science learning. Laboratory work is considered essential in promoting students' learning of science and of scientific inquiry. Chemistry practical in laboratory helps the students to increase the ability to apply chemistry knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature and also competence in the planning, design and execution of research investigations, from the problem recognition stage through to the evaluation and appraisal of results and findings this also will increase the ability to select appropriate techniques and procedures. This study would help to find the level of competence in chemistry laboratory of higher secondary school students in relation to their gender, type of school and location of school.

OBJECTIVES OF THE STUDY

The following objectives will be considered for the present study:

1)To assess the level of the chemistry laboratory competence of higher secondary school students

2) To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

HYPOTHESES

Keeping in view of the objectives the following hypotheses will be considered:

1) There is no significant difference of Chemistry laboratory competence among higher secondary school students

2) There is no significant interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

SAMPLE OF THE STUDY

A simple random sampling technique was employed for selection of the sample. The twelve schools were selected randomly and from each school higher secondary school students were selected randomly. Thus the total sample comprised of 192 students. Out of which 96 were male students and 96 were female students.

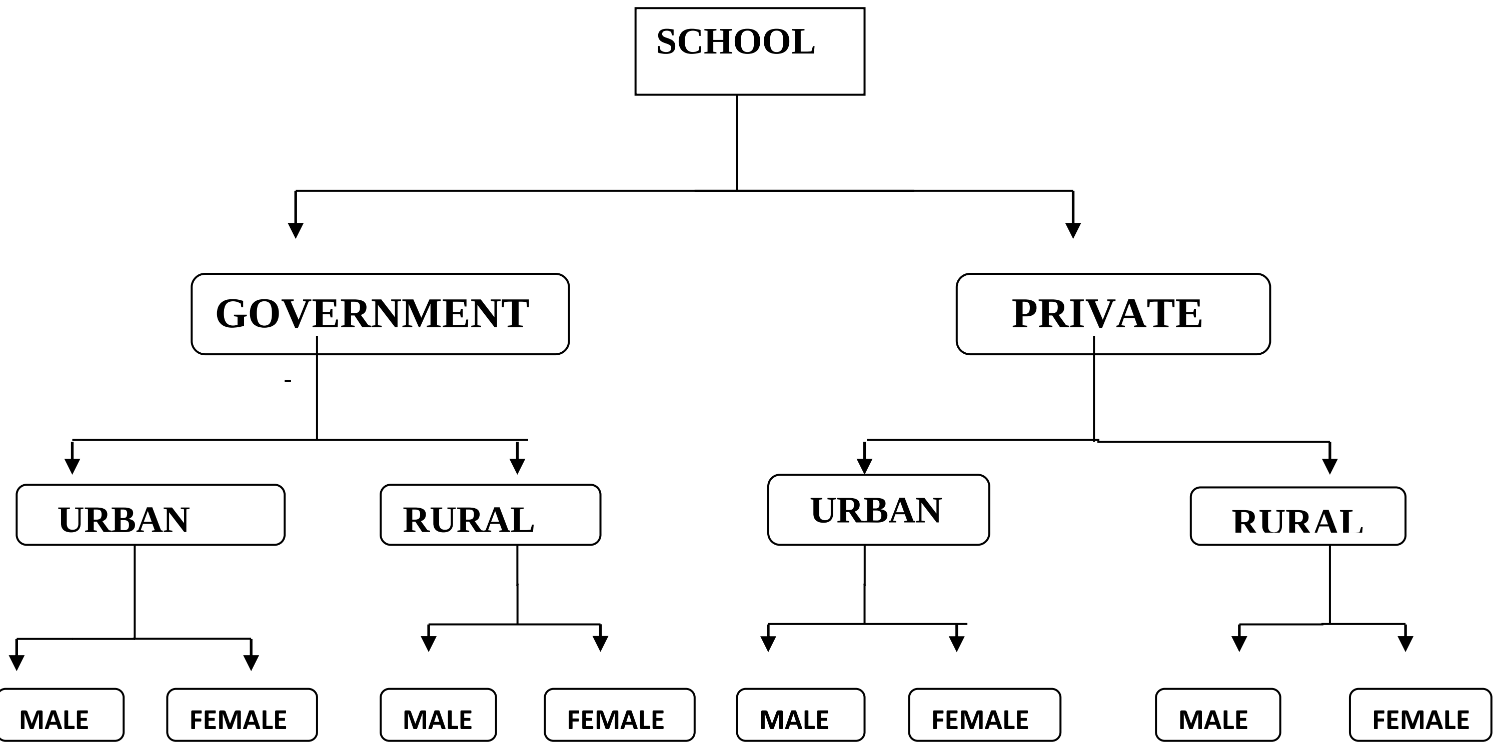

*Figure 3.1*Distribution of Sample

The details of the sample selected from twelve schools (Private and Government) affiliated to Jammu and Kashmir State Board of School Education have been given in the table 3.1 and 3.2.

Table 3.1

Distribution of Sample from Rural Area

S. No.	**Name of School**	**Type of School**	**No. of Students**		**Total**
			Male	**Female**	
1	Govt. Higher Secondary School, Dablahar	Government	8	8	16
2	Govt. Higher Secondary School, Salehar	Government	8	8	16
3	Govt. Higher	Government	8	8	16

	Secondary School, Bishnah				
4	Fatima Convent High School	Private	8	8	16
5	Bal Bharti Shiksha high school	Private	8	8	16
6	New Model High School	Private	8	8	16
			48	48	96

Table 3.2

Distribution of Sample from Urban Area

S. No.	**Name of School**	**Type of School**	**No. of Students**		**Total**
			Male	**Female**	
1	Govt. Higher secondary school.	Government	8	8	16
2	Govt. Higher secondary school.	Government	8	8	16
3	Govt. Higher secondary school.	Government	8	8	16
4	Neel Kamal higher secondary school.	Private	8	8	16
5	Tiny Tots Higher secondary school.	Private	8	8	16
6	Dewan Devi Higher secondary school.	Private	8	8	16
			48	48	96

TOOL EMPLOYED

In the proposed study, *Chemistry Laboratory Competence Test* (CLCT) by Rathod and Kotwale shall be used by investigator. It is a performance test to assess laboratory competence. It is meant to measure laboratory competence for the secondary and higher secondary school students. The test is comprised of 27 items. This includes six sub-sections consisting of alternative type, match the column, one-word answer, fill the blanks and short answer type questions.

The basis of item selection was Experimental skills, Classification, Measurement, following correct laboratory procedures, analyzing situation, selecting hypothesis, Handling instrument, implying safety rules and problem solving. Keeping in mind, the above facts present that the test has been prepared with the hope that it may facilitate to measure laboratory competence.

Section A. Measure the skill of handling apparatus in the chemistry laboratory. It represents the student ability of abstraction, discrimination and also measure cognitive ability to perform correctly, the laboratory procedure by handling apparatus safely and in the appropriate manner.

Section B. Measures the skill of investigation. It represents the students' ability of observation, in perceiving cause and effect relationship in chemistry experiments under different conditions. This becomes the basis of processing and retrieval of information at the abstract level.

Section C. Measure the skills of drawing inference and reporting results. It represents the student's ability of hypothesizing and drawing best solution through previous experiential learning. This becomes the basis of systematic writing of results.

Section D. Measures the skills of computation and measurement. It represents the student's ability of mathematical calculation, to observe the authentic procedure for reporting reading of commonly used laboratory procedures. This ascertains accuracy in observation and thus in results too.

Section E. Measure the skills of using and differentiating commonly used laboratory apparatus. It represents the ability of students' awareness about laboratory apparatus and use in different required laboratory procedures.

Section F. Measure the skill of using measures while performing laboratory work. It represents the ability of students' awareness about safety measures and precautions to be followed in the chemistry laboratory.

The questions are framed in simple English, according to the level of sample students and easy scientific terms to enable the testees to answer them. This test is helpful in judging an individual's performance in chemistry.

RESULTS ANDFINDINGS

The resulting data have been analyzed using statistical techniques namely t-Test, Percentage and 3-way ANOVA.

Research Objective 1

To assess the level of the chemistry laboratory competence of higher secondary school students

To assess the levels of the Chemistry Laboratory Competence of Higher Secondary School Students;Number, Percentageand Status have been computedandpresentedin the table 4.1

Table 4.1

S.No.	Score	Chemistry Laboratory Competence Status	Number & Percentage
1	70	Extremely High	0 (0.0)
2	58-69	Very High	0 (0.0)
3	47-57	High	0 (0.0)
4	32-46	Average	54 (28.1)
5	21-31	Low	73 (38)
6	09-20	Very Low	64 (33.3)
7	00-08	Extremely Low	1 (0.01)

Research Objective 2

To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

Table 4.2

Source	Sum of Squares	df	Mean Squares	F	Sig.
TYPE OF SCHOOL	1645.02	1	1645.02	31.03	S
LOCATION OF SCHOOL	1131.02	1	1131.02	21.33	S
GENDER	247.52	1	247.52	4.67	S
TYPEOFSCHOOL * LOCATIONOFSCHOOL	616.33	1	616.33	11.62	S
TYPEOFSCHOOL * GENDER	33.33	1	33.33	0.63	NS
LOCATIONOFSCHOOL* GENDER	444.08	1	444.08	8.78	S
TYPEOFSCHOOL * LOCATIONOFSCHOOL * GENDER	4.69	1	4.69	0.09	NS
ERROR	9754.00	184	53.01		
TOTAL	141184.00	192			
CORRECTED TOTAL	13876.00	191			

Main Effects**:**

- Mean values on Chemistry Laboratory Competence of higher secondary school students from Government and Private Higher secondary schools

Table 4.3

GENDER	GOVERNMENT	PRIVATE	TOTAL
MALE	29.40	24.38	26.89
FEMALE	27.96	21.27	24.61

TOTAL	28.68	22.82	25.75

- Mean values on Chemistry Laboratory Competence of higher secondary school students from higher secondary schools located in Urban and Rural area

Table 4.4

GENDER	RURAL	URBAN	TOTAL
MALE	22.94	30.83	26.89
FEMALE	23.71	25.52	24.61
TOTAL	23.32	28.18.	25.75

- Mean values on Chemistry Laboratory Competence of higher secondary school students

Table 4.5

GENDER	TOTAL
MALE	26.89
FEMALE	24.61
TOTAL	25.75

Table 4.6

- *Values of Mean, S.D., SE_M, df and t or Type of School differences in Location of School of Higher Secondary Students with respect to their Chemistry Laboratory Competence.*

Location of School	**Type of School**	**N**	**Mean**	**S.D.**	**$S.E_M$**	***df***	***t***	**Sig.**
Urban	Govt.	48	28.04	9.46	1.37	94	6.19	Sig.
	Pvt.	48	18.60	0.68	0.68			
Rural	Govt.	48	29.31	1.19	1.19	94	1.49	NS
	Pvt.	48	27.04	0.94	0.94			

Gender	**Location of School**	**N**	**Mean**	**S.D.**	**$S.E_M$**	**df**	**t**	**Sig.**
Male	Rural	48	22.94	8.11	1.17	94	5.12	0.01.
	Urban	48	30.83	6.96	1.01			
Female	Rural	48	23.71	9.54	1. 38	94	1.05	NS
	Urban	48	25.52	7.14	1.03			

InteractionA*C(TypeofSchool*Gender):TheobtainedvalueofFforthedouble interaction between variables type of school and gender with chemistry laboratorycompetenceasthedependentvariableis0.63whichhasfailedtoreach table value of F (3.89) at 0.05 level of significance for df 1 and 184. This result indicates that no significant interaction exists between type of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class.

Table 4.7

Values of Mean, S.D., SE_M, df and t for location of school differences in Male and Female Higher secondary students with respect to their chemistry laboratory competence.

Gender	**Location of School**	**N**	**Mean**	**S.D.**	**$S.E_M$**	**df**	**t**	**Sig.**
Male	Rural	48	22.94	8.11	1.17	94	5.12	0.01.
	Urban	48	30.83	6.96	1.01			
Female	Rural	48	23.71	9.54	1. 38	94	1.05	NS
	Urban	48	25.52	7.14	1.03			

FINDINGS OF THE STUDY

To assess the level of the Chemistry Laboratory Competence of higher secondary school students

In order to study the chemistry laboratory competence, percentage of different dimensions of chemistry laboratory competence has been calculated and higher secondary school students are classified accordingly. It is found that out of 192 students, 28.1% students were having average chemistry laboratory competence, 38% students were fall under the low chemistry laboratory competence status, 33.3% of students were having very low competence of chemistry laboratory and 0.01% students fall under extremely low chemistry laboratory competence.

To study interaction exists between type of school and location of school, type of school and gender, location of school and gender and among gender, type of school and location of school with chemistry laboratory competence as the dependent variable in higher secondary school students

- In this study, the result indicates that there is significant effect of type of school on chemistry laboratory competence of higher secondary students where as thecomputedvalueofFforthemaineffectoftypeof school of higher secondary school students, irrespective of their gender and locationofschool,hascomeouttobe 31.03fordf1and184,whichisgreater than the table value of F (3.89) at 0.05 level and (6.76) at 0.01 level of significance. The mean value (29.40) of male students studying in government schools is greater than the mean value (24.38) of male students studying in private schools as shown in table 4.3. Therefore, male students studying in governmenthighersecondaryschoolshavefoundtobemorecompetentthan malestudentsstudyinginprivatehighersecondaryschool.Also,themeanvalue (27.96)offemalestudentsstudyingingovernmenthighersecondaryschoolsis greaterthanthemeanvalue(21.27)offemalestudentsstudyinginprivatehigher secondary schools. Therefore, female students studying in government higher secondary schools have found to be more competent than female students studyinginprivatehighersecondaryschools.

- In this study, theresultindicatesthatthere exists significant difference of location of school on chemistry laboratory competenceofstudentsstudyingin11thclass. The obtained value of F for the main effect of location of school on chemistry laboratory competence of higher secondary schoolstudentsirrespectiveoftheirgenderandtypeofschoolhascomeoutto be 21.33fordf1and184,whichisfargreaterthanthetablevalueofF(3.89)at 0.05leveland(6.76)at0.01levelofsignificance. Themeanvalue(22.94)ofmale students studying in higher secondary schools of rural areas is lesser thanthe mean value (30.83) of male students studying in higher secondary schools of urbanareas.Alsothemeanvalue(23.71)offemalestudentsstudyinginhigher secondaryschoolsofruralareasislesserthanthemeanvalue(25.52)offemale studentsstudyinginhighersecondaryschoolsofurbanareasasshownintable4.4. Therefore, the male and female higher secondary school students in rural areas have found to be less competent than the male and female higher secondary students in urban areas.

- In this study, the result indicates that there exist significant gender differences at 0.05 level of significance in the chemistrylaboratorycompetenceofhighersecondarystudents. ThecomputedvalueofFforthemaineffectofgenderonchemistry laboratory competence of higher secondary students, irrespective of type of schoolandlocationofschool,hascomeouttobe4.67 fordf1and184,whichis greaterthanthetablevalueofF(3.89)at0.05levelandlessthanthetablevalue of F (6.76) at 0.01 level of significance. Themeanvalue(26.89)of male students studying in higher secondary schools is greater than the mean value(24.61)offemalestudentsstudyinginhighersecondaryschools.Therefore, malehighersecondaryschoolstudentshavefoundtobemorecompetentthan femalehighersecondaryschoolstudents.

- In this study, the result indicates that significant interaction exist between type of school and location of school with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The obtained value of F between variable type of school and location of school withchemistrylaboratorycompetenceasthedependentvariableis11.62 which is more than the table value of F (3.89) at 0.05 level and 0.01 level of significance for df 1 and 184. The mean value (28.04) of students studying in governmenthighersecondaryschoolslocatedinurbanareasisfargreaterthan themeanvalue(18.60)ofstudentsstudyinginprivateschoolslocatedinurban areas as shown in table 4.6. Therefore, the students of government higher secondaryschoolslocatedinurbanareashavebettercompetenceincomparison to the studentsofprivatehighersecondaryschoolslocatedinurbanareas.Also, from the mean values of students studying in government higher secondary schools (29.31) and private higher secondary schools (27.04), there exist no significantdifferencewithchemistrylaboratorycompetenceasthedependent variableamonghighersecondaryschoolstudentsstudyingineleventhclass.

- In this study, the result indicates that no significant interaction exists between type of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class.TheobtainedvalueofFforthedouble interaction between variables type of school and gender with chemistry laboratorycompetenceasthedependent variable is 0.63 which has failed to reach table value of F (3.89) at 0.05 level of significance for df 1 and 184.

- In this study, theresult shows that significant interaction exist between location of school and gender with chemistry laboratory competence as the dependent variable among higher secondary students studying in eleventh class. The obtained value of F for the double interaction between variable location of school and gender with chemistry laboratorycompetenceasthedependentvariableis8.78whichismorethanthe table valueofF(3.89)at0.05leveland0.01levelofsignificancefordf1and184.The mean value (22.94) of male students studying in higher secondary schools located in rural areas is much lesser than the mean value (30.83) of male students studying in higher secondary schools located in urban areas as shown in table 4.7. Therefore, the male students studying in higher secondary schools located in rural areas have found to be less competent than the male students studying in higher secondary schools located in urban areas. From the mean value (23.71) of female students studying in higher secondary schools located in rural areas andmeanvalue(25.52)offemalestudentsstudyinginhighersecondaryschoolslocated in urban areas, there exists no significant difference among female students studying in higher secondary schools located in urban and ruralareas with chemistry laboratory competenceasthedependentvariable.
- In this study, theresultindicatesthatno significantinteractionexistbetweenvariablestypeofschool,locationofschool and gender with chemistry laboratory competence as the dependent variable amonghighersecondaryschoolstudentsstudyingineleventhclass. Theobtained

valueofFforthetripleinteractionbetweenvariablestypeofschool,locationof school and gender with chemistry laboratory competence as the dependent variableis0.09whichislessthanthetablevalueofF(3.89)at0.05leveland (6.76)0.01levelofsignificancefordf1and184.

EDUCATIONAL IMPLICATIONS

Present study shows that students should learn to address the challenges inherent in directly observing and manipulating the material world including troubleshooting equipment used to make observations, understanding measurement error and interpreting and aggregating the resulting data. This study also shows that students at higher secondary level of education who engage in well-designed laboratory experiences develop problem-solving and critical-thinking skills, as well as gain exposure to reactions, materials, and equipment in a lab setting. Sustained investments in hands-on experiences in chemistry laboratory help inspire students to further their education and prepare them for high-technology careers by fostering skills sought by potential employers.

Moreover, hands-on experiences significantly advance learning at all levels of science education when appropriately designed and guided by qualified educators. During hands-on chemistry activities, higher secondary school students directly and safely investigate chemical properties and reactions, utilizing laboratory apparatus and instruments. These activities are essential for learning chemistry and improving science literacy.

"A laboratory is always considered as a relevant and essential part so far as the teaching of Science and Computer is concerned." Every school has laboratories where students can perform researches, experiments or even learn new things with the help of internet facility. This helps students to remember the studies in a better way by conducting their own experiments. It gives students first-hand experience and offers better opportunities for learning (Leblond, 2019).

Planning and implementation of strategies by higher secondary schools that help students to develop background of good laboratory skill experience.

Workshops and seminars should be conducted to realize the importance of laboratory in chemistry subject among students of higher secondary schools.

Skills such as proper handling of apparatus, observational skills, analysis of results and preventive measures should be developed by higher school students.

SUGGESTIONS FOR FURTHER RESEARCH

From the study of related literature, it is found that no such studies on the matter have been conducted in any part of the country. So, the investigator hopes that there is still much scope for research in this field and put forward some suggestions for further research.

1. The present study was limited to only higher secondary school students who adopted chemistry subject. Therefore, similar studies can be carried out on students who adopted subjects like physics, biology.
2. A comparative study among the different districts may be concluded to get a clear picture about chemistry laboratory competence among higher secondary school students in relation to their gender, type of school and location of school.

3. A study may be done among students of other educational boards such as CBSE, ICSE.

4. A study may be browned to determine the relationship between chemistry laboratory competence and academic scores in chemistry subject of higher secondary school students.

5. A study may be ready to know the effects of chemistry laboratory competence on academic performance of higher secondary school students.

6. A comparative study may be ready to know the ability of developing laboratory skills among higher secondary school students and under-graduate students.

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