1 Chapter 1: Introduction

1.1 Introduction-

Experiments are the hallmark of Physics. Scientific attitude and vision can be developed by allowing young minds to perform experiments in physics lab and observe and understand the scientific phenomena to happen. Learning through experiments encourages students to bring scientific thinking to the processes of strong, innovative and logical path between concept and phenomena.

In order to compete globally, students require a strong foundation in science, technology, engineering, and mathematics (STEM). To this end, the development and evaluation of educational innovations in science classes have become increasingly significant. One such educational innovation – virtual laboratories – is evaluated in this study.

Information and Communication Technology (ICT)-based education is a new trend in gathering knowledge in the current educational scenario. The growth of web-based learning has massively influenced the present learning pedagogy .The virtual laboratories focus on virtualizing. Web-lab techniques have added a new dimension to the classroom education in schools. This kind of educational technology supports an improved

individualized learning that met rural and urban educational needs with high level of flexibility and reduced the concerns regarding time and space.

1.2 Rationale of the study-

Physics is one of the most fundamental natural sciences which involve the study of universal law and the behaviors and relationship among a wide range of physical concepts and phenomena. Generally, physics teacher faces so many challenges while teaching physics because there are so many concepts in physics which are abstract in nature. When students are failed to visualize these abstract concepts then it results to their poor performance in physics.

Additionally, there are so many limitations with real labs. In most of the interior areas it is difficult to establish a planned laboratory. So, the students of these areas are left behind due to lack of facilities. Virtual labs can be helpful to make these students understand the concepts of physics.

There are so many software and applications which are designed to perform experiments and known as Virtual labs. In this way we need to check the effectiveness of virtual labs. This study will investigate the effectiveness of such virtual laboratories in terms of students' understanding of the some basic concepts of physics.

1.3 Title of the study-

A study of effect of virtual laboratory on achievement in science of class IX students of Government Inter Colleges of Kotdwara

1.4 Laboratory-

The laboratory has been a prominent feature of science education since the inception of teaching science systematically in the 19th century. A laboratory refers to "experiences in school settings in which students interact with equipment and materials or secondary sources of data to observe and understand the natural world" (Hofstein & Kind, 2012, p. 190). However, in the early years of science experimentation in school, laboratories were simply environments in which to practice or confirm information learned during lectures or from textbooks. Practical works either conventional or virtually are integral part in science curriculum and instruction since they are real demonstration and implementation of what students learn. However, the dramatic change and progress of digital technology started to change the nature of practical works and replace them with virtual lab applications. In fact, the significance of practical works was clearly evident in some research studies.

1.5 Integration of laboratory work with classroom-

How can one integrate the laboratory experiments with classroom teaching-learning experiences? The learning experiences in the laboratory should provide some challenge to the students to learn. They get interested if they understand the purpose of the experiment and are made to realize the application of it to their everyday life. Students can be involved in planning and organizing various works of laboratory. Following guidelines for planning and organizing experiments in physical science may be considered.

1. It should be ensured that students have a sound theoretical knowledge required for handling the apparatus and performing the experimental work.

For this, theory and practical teaching learning situations should be properly integrated and coordinated. Open-ended activities and experiments provide student's freedom to explore their ideas students should come prepared for the laboratory work.

2. They should be encouraged to refer laboratory manual and other supplementary materials.
3. They should be facilitated to find answers to their own questions.
4. Community resources and laboratory should be involved to provide enough apparatus to provide opportunity to all learners on hands-on activities. It should be checked that the apparatus are in proper working condition.
5. During the laboratory work, extensive and critical discussion on the theoretical aspects of the experiments with the students and continuous assessment of their performance are of utmost importance. This helps the teacher to know their misconceptions and naive concepts and she can then facilitate them in the construction and reconstruction of their knowledge.
6. A noticeboard to display safety rules of the laboratory, time- table, list of experiments, group patterns, etc. can be maintained and kept up to date. Good discipline is necessary for smooth functioning of the laboratory work.
7. Safety kits such as fire extinguishers, sand bucket, rubber gloves, separate dustbins for dry and wet waste materials, etc. should be kept handy. First-aid box must be kept ready and timely replenishment of medicines must be ensured. Remember that safety of the students and teachers is more important than the safety of the apparatus. Generally, in the beginning of the session, the teacher takes the students around the laboratory to familarize them with the general facilities, equipment, apparatus, chemicals, glassware, etc. available in the laboratory and informs them about certain do's and don'ts while working in the laboratory.

1.6 Limitations of traditional labs-

There are lots of limitations to successfully carry out traditional labs mostly in developing countries. Time constrains, shortage of equipment and reagents, insufficient laboratory protocol, issues in personal safety, inadequate technical support etc are the most common reasons of setting up a proper laboratory condition in most rural and government schools of India. Traditional lab doesn't promote self-learning and it needs high maintenance. Online labs may be an asset to many schools which confront economic issues in maintaining equipment and other necessary conditions that need to be met for a good laboratory practice (Diwakar et al., submitted).

1.7 Importance of laboratory work experience

While learning science, students use so different process skills to understand the concept of science. Students learn while handling, manipulating and innovating different types of equipment. Laboratory provides an environment to learners for exhibiting their qualities such as resourcefulness, initiativeness, orderliness, cooperation, and team spirit. Students enjoy working together with their peers with some freedom of action, having a feel of the excitement of the unknown and achieving a sense of discovery. Of course, learners cannot rediscover all of science; however, encouraging them to observe, investigate and think critically on a laboratory activity can facilitate them to construct some abstract concepts and principles of science, to awaken curiosity about the world around them and to gain a feel and appreciation of science. Thus, laboratory work facilitates development of-

(i) **Cognitive abilities**, i.e. principles and laws discussed in the classroom may precede or follow the laboratory work or it may be carried out during discussion; Pedagogy of Science.

(ii) process skills of science;

(iii) scientific attitude; and

(iv) Understanding nature of science.

Use of laboratory must be focused towards achieving these objectives. Process skills, understanding nature of science, scientific attitude, cognitive abilities, Laboratory work facilitates development of objectives of laboratory work. The kind of experience that is provided by the laboratory cannot be replaced by any other exercise. Well-planned laboratory experiences have great potential to attract our young generation into science courses. Performing experiments in prescribed fashion and just involving students in hands-on activities do not result in development of inquiry skills in science. Skills of inquiry play an important role in science. Development of inquiry skills cannot be taken for granted as the by-product of the process skills of science. Opportunities to raise question, involving the learners in critical discussion, investigating their own questions and being flexible in the work should be facilitated in the laboratory. Inquiry can be broadly planned considering limited availability of time and crowded classrooms. It is to be kept in mind that emphasis should be given to the first five letters of LABORATORY rather than the last seven letters.

Generally three types of approaches are used while doing laboratory work. One is deductive approach and another one is inductive approach. **Deductive approach**: It is perhaps the most common approach and used for the verification of concepts, laws and principles of science. The theoretical aspect of the concept is first discussed (e.g. Ohm's law,

Archimedes principle) and it is followed by first-hand experience. Students can get time to organise their abstract ideas (using mathematics, wherever required) and can acquire meaning of the concepts and find relevance of the laboratory work with their previous understanding.

Inductive approach: Students are provided opportunity to develop concepts, principles and laws through first-hand experience before these ideas are discussed in the class. Students search for patterns, relationship between different quantities and applications of the concepts while engaged in the laboratory work. Their ideas are reinforced during discussion after the laboratory work. This work is immediately followed by discussion for strengthening of their understanding.

Problem solving approach: Learners can be provided opportunities to do open-ended activities and experiments of exploratory nature where they have freedom to explore their ideas. By the time students reach higher secondary stage; they acquire basic technical and inquiry skills. They should be encouraged to identify their own problem, develop hypothesis, design investigation and experiment to solve the problem, collect and organise the data and report their findings. It gives them opportunity to become independent learners, organise their own learning and develop self-confidence. For example, a group of students are interested in knowing, do oils of higher density have larger value of refractive index? Or what factors may be responsible for variation of the result in Ohm's law experiments and to what extent? They should be encouraged to work on their problem. It is important to mention here that it is not central to reach a concluding result, getting students engaged in the process of inquiry is more important.

1.8 Virtual lab

Web tools have immensely influenced the current teaching and learning process. Virtual labs offer diverse analysis of a concept through different components such as a close emulation of a real laboratory 'experience' through animations. In current education prospect, computer-aided technologies provide special advantages for designing innovative science course materials and developing highly interactive student-teacher relationship. Modern web-based educational systems are distinct from the traditional educational models. Adapting to the web based educational systems requires certain qualities and different learning pedagogies. With this change in the education trend, many educational and research institutions widely employed such innovative technologies for teaching and learning purposes.

Virtual laboratories simulate a real laboratory environment and processes, and are defined as learning environments in which students convert their theoretical knowledge into practical knowledge by conducting experiments (Woodfield, 2005).

A virtual laboratory is an on-screen simulator or calculator that helps test ideas and observe results. Learners use advanced technology to perform a series of experiments that yield authentic results. In short we can say that virtual labs are like online games in which output is provided according to our input.

1.9 Objectives of virtual lab-

1. To provide clear visual images in science that can be viewed from different angles of the learner.
2. To extend an individual opportunity in each and every step of the experimental process rather than with a group of learners as common in traditional lab.

3. To provide numerous, self-paced practice opportunities.
4. To give opportunity for self-scheduled testing.
5. To give the learners a sense of control orders their learning.
6. To facilitate independent learning. To foster the development of self-motivation.

1.10 Advantages of Virtual Labs-

The self -regulated, instructor guided module in virtual lab facilitates effective learning. A major goal of virtual lab is to increase scientific literacy by using interactive multimedia to teach the fundamental concepts of science and to share those resources via the internet some the advantages of virtual labs are as follows:

1. The virtual lab strives to make learning science a fun.
2. It allows the learners to review and repeat experiments.
3. It enables the learners to work at home.
4. It permits the learners to quiz themselves.
5. It develops independent learning.
6. It nurtures self-motivation.
7. It provides an opportunity for various self-paced practical exercises.
8. It ensures better understanding of concept.
9. The simulation technique used in virtual labs can bring the learner nearer to the real life.
10. The virtual lab creates interests among the learners.

1.11 O- Labs-

The O- Labs is based on the idea that lab experiments can be taught using the Internet, more efficiently and less expensively. The labs can also be made available to students with no access to physical labs or where equipment is not available owing to being scarce or costly. This helps them

compete with students in better equipped schools and bridges the digital divide and geographical distances. The experiments can be accessed anytime and anywhere, overcoming the constraints on time felt when having access to the physical lab for only a short period of time.

The features include:

1. Content aligned to NCERT/CBSE and State Board Syllabus.
2. Physics, Chemistry, Biology Labs from Class 9 to Class 12. English and Maths lessons for Class 9 and 10.
3. Interactive simulations, animations and lab videos.
4. The concepts and understanding of the experiment.
5. The ability to perform, record and learn experiments - anywhere, anytime, and individualized practice in all areas of experimentation.

The 'learning-enabled assessment' through O-Labs facilitates in the assessment of; the procedural and manipulative skills of the experiment, the concepts and understanding of the experiment and a student's reporting and interpreting skills.

The development of O-Labs includes the study and use of mathematical techniques to demonstrate the various complex functions in diverse areas of science. The labs make use of cutting edge simulation technology to create real world lab environments. Thorough study and research is done by research personnel for better understanding of the experimental procedures. Real lab scenarios are captured through live demonstration of the

experiment so as to assimilate information on the procedures and lab equipment. Visualization and development of the graphical symbols are done based on realistic situations and compared with the respective real equipment. Simulations are made interactive using various authoring tools, thus recreating and simulating a real lab environment.

The O-Labs are hosted at www.olabs.edu.in. Access to O-Labs is free for Schools upon registration.

Now this is the era of technology, students are not getting chance to present themselves in physical laboratory due to this pandemic. But it is important to integrate the theoretical knowledge with practical knowledge otherwise students will have only theoretical concepts in imagination and they will face difficulty in relating it with real world.