Chapter 2:

Review of Related Literature

2.1 Introduction

Reviewing related literature is one of the major steps in any research study. It involves systematically examining previous studies, reports, scholarly articles, and theoretical contributions that relate to the current research topic. The purpose of a literature review is not merely to gather information but to critically analyze existing knowledge, identify gaps, and build a conceptual framework that justifies the need for the present study.

For the current research titled "A Study of Availability and Utilization of Science Laboratories for Teaching-Learning Science in Secondary Schools of Bhopal," the review of related literature serves multiple important purposes:

- It helps in understanding how science laboratories have been perceived, designed, and utilized across different educational systems.
- It provides a comparative context to evaluate the conditions in Bhopal against national and international scenarios.
- It guides the formulation of research questions, objectives, and methodology by identifying gaps in existing studies.
- It validates the relevance of the research problem by highlighting recurring challenges in science laboratory infrastructure, utilization, and pedagogy.

Education in science is laboratory-oriented, where students participate in intellectual and constructive work and are facilitated to construct knowledge through the execution of scientific practices.

This chapter is organized systematically to reflect the evolution and scope of prior research. First, international studies are reviewed to understand global perspectives on science laboratory availability and utilization. These studies, from countries such as Ethiopia, Kenya, Nigeria, and the UK, offer insights into how laboratory-based science education impacts student performance and learning engagement. Notable findings emphasize the correlation between hands-on laboratory experiences and conceptual understanding while also revealing issues such as underutilization and inadequate infrastructure.

Subsequently, Indian studies are examined to bring focus to the national context. From early works in the 1960s and 1970s to more recent studies in the 2010s and 2020s, literature reveals persistent challenges in India, especially in government-run schools. These include a

lack of dedicated laboratories, outdated teaching practices, poor equipment maintenance, and insufficient time or staffing for practical sessions. Despite the policy-level emphasis on practical learning—through initiatives like RMSA and NEP 2020—implementation continues to face systemic obstacles.

This comparative review not only enriches the background of the study but also demonstrates that while the importance of laboratory-based learning is well acknowledged, there remains a significant gap in actual implementation. Hence, this literature review solidifies the rationale and urgency for conducting a focused study on the availability and utilization of science laboratories in secondary schools of Bhopal, contributing meaningful insights for educational improvement.

2.2 Studies Conducted in Abroad

Akçayir et al. (2016) pointed out that the successful application of science laboratory equipment imparts students with the ability and knowledge to design scientifically based questions, plan experiments, perform experimental work, and defend scientific evidence. According to their research, science laboratories have a very considerable impact on science subject education and exert strong influences on students' learning outcomes if utilized successfully.

Geleta, K. (2018), in a study on science laboratory input availability and utilization in Ilu Abba Bora Zone high schools, Southwestern Ethiopia, confirmed that the absence and wastage of laboratory facilities negatively impacted the academic performance of the students. His study confirmed that most of the high schools lacked the necessary laboratory equipment, and mismanagement and wastage of existing facilities were factors leading to poor performance in standardized tests (Ethiopian General School Leaving Certificate Examination).

Glasson (1986) evaluated the effects of 'hands-on' and teacher demonstration instruction on science attainment. The findings confirmed that students who had hands-on work completed performed significantly higher than students who had teacher demonstration alone. This finding underscores the significance of interactive and experiential learning activities toward science learning.

Hodson (1990) evaluated the effectiveness of school practical work in several nations critically. He argued that, notwithstanding its intended high value, in most schools, the practical work was poorly conceived and implemented and led to wasteful outcomes that could not attain science education goals.

Konyango's (2011) study on the impact of the utilization of resources on physics performance in Kenyan public secondary schools concluded that despite having laboratories, they were not utilized, and hence there was low performance in physics. The study concluded that teacher and student attitudes towards the subject could influence the impact of utilization of the laboratory and hence the subsequent academic performance.

Lazarowitz and Tamir (1994) emphasized that laboratory experiments are student-centered, encouraging active student participation and a better understanding of scientific phenomena. Lack of availability and utilization of laboratory facilities negatively impacts students' learning achievements.

Malach Mogire Mogaka (2019) investigated the correlation between the availability and utilization of physics laboratory equipment and students' performance in public day secondary schools in Kisii County, Kenya. The study revealed a statistically significant correlation between the availability and utilization of physics laboratory equipment and students' performance. Specifically, it was found that approximately 30% of the variance in the academic performance of students was accounted for by the availability and utilization of physics laboratory equipment.

Oluwasegun et al. (2015) examined the effect of the availability of laboratory equipment in physics on students' performance in Ethiope West, Nigeria. Their study revealed a significant degree of improvement in students' performance in physics due to the availability of laboratory equipment. This confirms that high availability and utilization of laboratory equipment are directly related to students' academic performance. They emphasized that laboratory equipment reduces abstraction and enhances students' participation and comprehension of scientific principles.

Orehowsky and Walter (1999) conducted a study on the effect of laboratory instruction on the performance and attitude of chemistry students in high schools. The researchers established that laboratory instruction helped the students to better comprehend chemical principles and have good attitudes toward science.

Rahman et al. (2019) indicated that preparation rooms and storage rooms for chemicals and equipment are poorly equipped in most science laboratories in institutions. Such deficiencies may disrupt laboratory-based learning effectiveness and compromise safety. They proposed enhancing organizational practice and infrastructure to address these deficiencies.

Tamunoiyowuna, S. (2022), examined the use and availability of laboratory equipment among physics students in Nigeria. They established that the use and availability of laboratory equipment were low, which was not conducive to physics education. From their research, they established that students' unavailability of laboratory equipment hinders them from comprehending practical concepts, hence failing in academics.

Tekalign (2016) researched the provision of science laboratory facilities in secondary schools and determined that the majority of schools lacked even the most fundamental laboratory facilities. Secondary schools were well provided with the necessary materials for instruction in biology in just 16.67% of the schools, and the same shortage was also evident for chemistry and physics laboratories. The study identified the challenges for teachers and students in conducting practice activities, which are crucial for curriculum achievement and the establishment of fundamental scientific competencies.

Wahidah et al. (2021) demonstrated that although there was a lab and storage room within the school, the facilities should be enhanced, such as with a storage area and experiment preparation room. The research highlighted that proper lab facilities with full infrastructure enhance students' learning activity and observational capability greatly. They mentioned four main reasons why practical work is crucial in learning science: generating enthusiasm, enhancing experimental skills, giving a scientific learning approach, and facilitating the learning process. Their research highlighted the importance of practical work in enhancing students' scientific capability and knowledge.

Zenda (2016) examined the determinants of poor grades in physical science among secondary school students in Limpopo. The study found that insufficient learning and teaching materials, students' lack of motivation, large pupil-teacher ratio, and teachers' workload were key determinants of students' performance. The study emphasized the use of appropriate resources and quality teaching in improving learning in science subjects.

2.3 Studies Conducted in India

Bajracharya (1986) examined the status of science education in secondary schools in Nepal. As noted in the study, existing curricular objectives were inadequate as they did not take into consideration practical work. The curriculum contained more theory than practical work, and the methods of teaching used were outdated, centered around a chalk-and-blackboard approach. This approach was found to be a hindering factor to the interest and grasp students had toward science.

Chakrapani and Puroshottama (1975) looked into the scientific practical-work program in some selected 60 schools in the Madras district. They reported that about 50 percent of the schools had no laboratory at all. The private schools have better laboratory facilities as compared to those run by the government and municipality. Very small percentages of teachers have been trained in audio-visual education, and about 75 percent had in-service training in science teaching. About 79 percent of the schools had organized science clubs. Only 55 percent of the schools allow students to do practical work in laboratories.

Muddu (1978) investigated the problems faced by biology teachers in thirty selected schools in Hyderabad. Most of the school laboratories lacked adequate equipment and teaching materials for biology. The majority of the schools suffered poor library facilities, with 63 percent of school libraries lacking general biology textbooks.

Pareek (2023) documented that only 1 out of 21 surveyed schools had a functional science laboratory. Many of the surveyed schools did not possess stand-alone laboratories meant for science subjects, and a large number of teachers as well as students reported missing vital laboratory facilities. He noted many teachers had difficulties with performing laboratory exercises. Not having a specified block for laboratory sessions in the school timetable also made it harder for learners to participate in hands-on scientific endeavors.

Patole (1967) studied the teaching of science in rural primary schools and noted a serious lack of availability and utilization of science laboratories. The research underlined the reality of insufficient resources and the necessity of increasing practical work to better the teaching and learning of science.

Prerana H. Shelat (2012), an instructional strategy was formulated to enhance comprehension in science for class VII students. This study proved that appropriately scaffolded laboratory exercises could substantially improve students' mastery and retention of scientific principles.

Rajput et al. (1978) surveyed the science laboratories of secondary schools in the western region of India. He found that more than 91.43 percent of Madhya Pradesh schools had no water, gas, or electricity supply in their laboratories. Their report said that 10 percent of the schools in Madhya Pradesh, Gujarat, and Maharashtra had no laboratories at all. Further, it has been reported that the teachers in these schools go through many problems while conducting laboratory work. Some of them lack a vacant period for practical work, a separate laboratory, a laboratory assistant, a big class size, and time constraints.

Thakur (2015) studied chemistry laboratory infrastructure in Delhi-NCR senior secondary schools. He pointed out that even though chemistry is an experimental science demanding active laboratory involvement, the majority of schools heavily depend on theoretical instruction. Laboratory facilities in numerous government and private schools were inadequate. Restrictions such as a large teacher-student ratio, non-availability of apparatus and chemicals, inadequacy of trained teachers, and overcrowded curricula demoralized the teachers and the students from conducting practical work with efficiency. Thakur concluded that nearly 50% of the laboratories studied were in atrocious condition, placing particular emphasis on the pressing need to enhance laboratory infrastructure, resource availability, and safety standards to enhance the quality of chemistry education.

Venkataraman (1976) did the study in an attempt to know the deficiencies in the teaching of science by visiting the classrooms of 46 science teachers of a few selected schools in Madras. He reported that the equipment available in the schools for science teaching was not sufficient to meet the requirements of the science syllabus. Lecture using a blackboard was the dominant method through which the classroom was utilized by the teachers. They were overloaded by teaching periods, and the classrooms were overcrowded. Audiovisuals such as film projectors and slide projectors were provided in some schools, but they were not put to use because of a lack of trained teachers. The library did not possess many science books. Botanical gardens were not there in any school.

Table 2: Summary of review of related literature.

S.No.	Research Title	Researcher Name (Year)	Major Findings
1.	Augmented Reality in Science Laboratories	Akçayir et al. (2016)	According to their research, science laboratories have a very considerable impact on science subject education and exert strong influences on students' learning outcomes if utilized successfully.
2.	Study of Science Education in the Secondary Schools of Nepal.	Bajracharya (1986)	Found that curricula emphasized theory over practical work; teaching methods were outdated, and this hindered student engagement and understanding of science.
3.	A study of practical works in the science program in the secondary schools.	Chakrapani & Puroshottama (1975)	About 50% of schools lacked labs; private schools had better resources. Many teachers lacked training in audiovisual tools, and only 55% allowed students to perform lab work.
4.	The Upshot of availability and utilization of Science laboratory inputs on students' academic achievement in high school Biology, Chemistry, and Physics in Ilu Abba Bora Zone, Southwestern Ethiopia	Geleta, K. (2018)	He confirmed that the absence and wastage of laboratory facilities negatively impacted the academic performance of the students. His study confirmed that most of the high schools lacked the necessary laboratory equipment, and mismanagement and wastage of existing facilities were factors leading to poor performance in standardized tests.

5.	A critical look at practical work in school science.	Hodson (1990)	Argued that practical work is often poorly implemented in schools, thus failing to achieve science education goals, despite its potential value.
6.	Impact of resource utilization on the performance of physics in KCSE in public secondary schools in Kenya	Konyango (2011)	Showed that underutilization of labs, regardless of their availability, correlated with low student performance in physics. Attitudes of teachers and students also influenced effective lab use.
7.	Research on using laboratory instruction in science.	Lazarowitz & Tamir (1994)	Emphasized the student-centered nature of labs that enhance understanding and active participation; lack of lab use negatively impacts achievement.
8.	Availability and Utilization of Physics Laboratory Equipment on Academic Achievement of Students in Public Day Secondary Schools.	Mogaka, M.M. (2019)	Found a strong correlation between the availability/utilization of physics equipment and student academic performance. About 30% of performance variance was linked to lab resources.
9.	A Study of Prevalent Status of Instructional Procedure in Biology in High Schools	Muddu (1978)	Found a shortage of biology lab equipment and poor library facilities. Teachers faced challenges in conducting practical work due to inadequate resources.
10.	The impact of physics laboratory on students' offering physics in Ethiopia.	Oluwasegun et al. (2015)	Showed that students in schools with better lab equipment performed significantly better; labs reduce abstraction and improve comprehension.