A COMPARATIVE STUDY OF ACADEMIC PERFORMANCE AND LEISURE INTEREST IN SCIENCE OF GRADE 10 STUDENTS LEARNING THROUGH LABORATORY-BASED AND TEXTBOOK-BASED METHODS AT ST. JOSEPH HIGH SCHOOL, BARHALGANJ, INDIA

Poonam Yadav

I.D. No. 5929515

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF EDUCATION

in Curriculum and Instruction

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Field of Study: CURRICULUM AND INSTRUCTION

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ABSTRACT

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Key Words: SCIENCE EDUCATION, ACADEMIC PERFORMANCE, LEISURE INTEREST, LABORATORY-BASED METHOD, TEXTBOOK-BASED METHOD, SECONDARY SCHOOL

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Thesis Advisor: ASST. PROF. DR. ORLANDO RAFAEL GONZÁLEZ GONZÁLEZ

This study was conducted to determine whether there was a significant difference in the gain in academic performance in science, as well as in the gain in leisure interest in science, between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. For this purpose, the researcher designed a quantitative comparative study, and a quasi-experimental research design was implemented, using two conveniently-chosen groups of Grade 10 students from the target school: the 35 students in the experimental group were taught using laboratory-based method, while the 37 students in the control group were taught using the textbook-based method. The duration of the study was four weeks, with a 50-minute session every weekday for both the laboratory-based and textbook-based learning methods during June 2022. For the data collection, the Science academic performance test and the 10-item Students' Leisure Interest in Science Questionnaire were both administered as pre-tests and post-tests, in order to address this research's objectives and hypotheses. The collected data

were analyzed using descriptive statistics and independent samples *t*-tests. From performing descriptive statistics on the collected data, the level of academic performance in Science of Grade 10 students under both treatments, before and after the intervention, was good, while the level of participants' leisure interest in Science was moderate under both treatments, before and after the intervention. From a quantitative comparative analysis, there was no significant difference in the gain in either academic performance or leisure interest in Science between the experimental and the control groups. Based on the research findings, recommendations are provided for students, teachers, school administrators and future researchers.

Field of Study: Curriculum and Instruction **Student's Signature:** …….

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LIST OF ABBREVIATIONS

CBSE.....Central Board of Secondary Education

HBCSE.....Homi Bhabha Centre for Science Education

ICT .....Information and Communication Technology

IIT .....Indian Institute of Technology

INSA .....Indian National Science Academy

ISO .....International Science Olympiad

JEE .....Joint Entrance Examination

KVPY.....Kishore Vigyan Protsahan Yojana

NCERT .....National Council of Educational Research and Training

NEET .....National Eligibility Cum Entrance Test

NEP .....National Education Policy

NIIT.....National Institute of Information Technology

NSEJS .....National Standard Exam in Junior Science

SAI .....Scientific Attitude Inventory

SAI2 .....Scientific Attitude Inventory II

SCL .....Student-Centered Learning

SLISQ .....Students' Leisure Interest in Science Questionnaire

TOSRA .....Test of Science-Related Attitudes

CHAPTER I

INTRODUCTION

In this chapter, the researcher discusses the importance of science learning in India and the necessity of change science learning instruction in relation to both learning methods and strategies. This chapter includes the background of the study, statement of the problem, research questions, research objectives, research hypotheses, theoretical and conceptual frameworks, scope of the study, definitions of terms, and significance of the study.

Background of the Study

Science is an important subject in one's educational life because it generates solutions for everyday life and helps us to answer the great mysteries of the universe. It helps students to develop an understanding of the world, grounded on current scientific theories and it also contains practical inquiry activities such as laboratories and experiments (Das et al., 2014). Science is also very important in education worldwide, and particularly in India. Some of the best engineering colleges in the world, which requires knowledge of science, are the Indian Institute of Technology (IIT) and National Institute of Information Technology (NIIT).

Science education plays an essential role in life. Llewellyn (2002) reported that science is inquiry, art and imagination combined, where students use critical, logical, and creative thinking to explore areas of personal interest, and that inquiry inspires students to be lifelong learners and become independent thinkers. Cronin-James (2000) stated that for young students, hands-on science has a stronger effect on knowledge than on attitude. Students can conduct their own investigations and satisfy their curiosity which increases their engagement and supports their interest in science (Metz, 2008). Science also urges to

improve the people's and country's future, the use of eco-friendly water and energy, and the development of agriculture and sustainable growth (Mala, 2017).

In order to promote science learning in students, the Government of India encourages and supports students to join many science-related overseas competitions, such as the International Science Olympiad (ISO), in which students from different countries take part. Moreover, there are several competitive exams Indian students aim for after Grade 10, in which extensive knowledge of science is required. Some of them are the following:

- Kishore Vigyan Protsahan Yojana (KVPY): It is a national program of fellowship in basic sciences conducted by the Indian Department of Science and Technology.
- National Standard Exam in Junior Science (NSEJS): The NSEJS, which is organized by the Indian Association of Physics Teachers in collaboration with the Homi Bhabha Centre for Science Education (HBCSE), is widely regarded as the most difficult science exam at the higher secondary level in the world.
- National Eligibility Cum Entrance Test (NEET): The percentage of physics is 25%, chemistry is 25%, zoology is 23% and botany is 27%. The syllabus contains questions from the science field only.
- Joint Entrance Examination (JEE): The percentage of science in this entrance examination is 75%. The syllabus contains questions from physics and chemistry.

The practice of science requires facilities in which laboratories and experimentation can be conducted. With the introduction of laboratory-based method, the researcher has observed that students are more interested in performing experiments, which helps in the development of their scientific abilities and skills such as: posing scientifically-oriented questions, formulating and testing hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments (Krajcik et al., 2001). According to McWhorter and Hudson-

Ross (1996), without new and student-centered approaches such as performing experiments in science class to instruction that relate to students' learning needs, many young students would perform badly and drop out of school. According to prior research, a student-centered learning environment appears to provide higher-level learning results more effectively than a standard teacher-centered one (Tynjala, 1998), which indicates that a laboratory-based method environment seems to produce students' higher-level learning outcomes more efficiently than a traditional textbook-based learning environment (Adunola, 2011). Moreover, the flow of knowledge from the speaker to the student during a laboratory session is not centralized, and hence this teaching approach is considered more effective (Lindquist, 1995). In fact, most science instructors nowadays use a laboratory-based method to engage students in hands-on experiments, direct observation, and immersion into their environment, in order to encourage their curiosity, analytical investigation, critical thinking, enjoyment, scientific interest, and increased knowledge of science (Hesson & Shad, 2007; Sobel, 2004). The method is also particularly helpful in enhancing student interest in science, because it stimulates goal-oriented behavior among pupils (Slavin, 1996). Therefore, study in a laboratory is an integral and essential part of science courses (Odubunni & Balagun, 1991).

Science can be learned in a schoolyard, a classroom, a school garden, or a local park. Outdoor learning environments have been utilized to help students care about their local environments (Lakin, 2006). This increases the interest of the students towards science, which ultimately increases the students' academic performance.

There are mostly two learning methods used for teaching science in India: The laboratory-based and textbook-based methods. The laboratory-based method emphasizes more on interest and capability of students. Learning is student-centered. Within the laboratory; the teachers provide practical demonstrations of the concepts being studied. The students tend to recall more what they observe rather than what they hear. Çelik (2018)

describes the laboratory-based method as the implementation of series of activity-based learning activities with the purpose of improving students' academic performance and interest towards science activities. Practical work in the learning of academic concepts involves students' activities such as observing, counting, measuring, experimenting, recording, investigating, testing, analyzing and creating. Oyedeji (2000) determined that students taught science under the laboratory-based method academically perform higher than of those taught under the textbook-based method. Laboratory activities have been designed and conducted to engage students individually, in small groups and in large-group demonstration. Adeyegbe (2005, as cited in Yara, 2010) listed laboratory adequacy as one of the elements that affect the learning of the students in terms of academic achievement. Laboratory-based method also has been found to influence goal-orientated behavior in students; hence the method is very effective in improving student achievement (Slavin, 1996).

Textbook-based method is a teacher-based learning method which focuses on telling, memorizing and recalling information. Learners might be involved mostly in note-taking (Schreurs & Dumbraveanu, 2014). Under this strategy, students just obtain knowledge from the teacher, without increasing their level of connection with the subject being taught (Boud & Feletti, 1999). The textbook-based method is less practical, more theoretical, and requires mostly memorization (Teo & Wong, 2000). Textbook-based method does not use activity-based learning to motivate students to solve real-world problems using applicable knowledge because the instructor has influence over the transmission and sharing of knowledge, the lecturer may try to maximize information delivery while conserving time and effort. As a result, students' interest in science may decrease (Zakaria et al., 2010). In the textbook-based method, students learn by memorization and recitation, and hence do not build critical thinking, problem-solving, or decision-making skills, which results in a low academic

performance (Sunal et al., 1998).

This study investigated the academic performance and leisure interest in science of Grade 10 students of St. Joseph High School who were learning science by using either textbook-based learning method or laboratory-based learning method in the English program. Also, this study compared both methods in terms of these two variables, in order to identify the significance and importance of the methods in increasing the academic performance and leisure interest in science of the students at St. Joseph High School, India.

Statement of the Problem

St. Joseph High School is a private international school in Barhalganj, India, with approximately 40 teachers and around 730 students. The school provides the English Program (EP) for students to learn mathematics, science, social studies, and health, by using English as the medium of instruction. Despite Information and Communication Technology (ICT) classes, the learning method in St. Joseph High School is based on the traditional and teacher-centered learning approach called textbook-based method. This is in line with a report from the Indian National Science Academy (INSA, 2001), which states that the exploratory method of learning science (i.e., employing keen and careful observation, asking questions, challenging the answers, and making generalizations and discoveries) has not yet been adopted by the formal system of Indian science education.

Science laboratory activities allow students to gather first-hand learning experience by performing various experiments on their own. The textbook-based method is used highly throughout the school, which can be an issue in triggering students' academic performance and leisure interest in science (Fraser, 1981; Klopfer, 1971; Slavin, 1996). Laboratory-based method has been found to influence goal-oriented behavior in students, and hence the method is very effective in improving students' academic performance (Slavin, 1996). Obanya (2012)

stated that the average recall rate of learning by lecture-based approaches such as the textbook-based method is 5%, whereas that of practice by doing, like in the laboratory-based method, is approximately 75%. As a result, students learning science through memorization are prone to forgetting the contents shortly after having a quiz, test, or examination on it.

Furthermore, the researcher has observed that Grade 10 students at the target school who learn science by performing experiments in laboratory seems to be more confident to speak up their answers, whether correctly or wrongly, which seems to result in a better student academic performance than the one of those students who are learning science through the textbook-based method. Gilbert (1994) and Hodson (1996, in Yara, 2010) reported that students taught science by using laboratory-based method academically performed better than those who used the textbook-based method. According to Fallows and Ahmet (1999), education is at its finest when learners' collaboration, association with peers, and contribution are maximized. Through the use of the laboratory-based method, learners are able to participate in the educational process through demonstrating by doing, contrarily to the textbook-based method, and hence students' interest in science, cognitive skills, understanding of nature through science, curiosity, and problem-solving skills in science are improved, resulting in a better academic performance (McGrath & MacEwan, 2011).

Another issue that is worth raising is the academic performance of the Grade 10 students at the target school. The results revealed that, for the last five years, the mean academic performance in Science at the target school was 70%, which is less than the 85% in Mathematics. Even though there are differences in methodology and language between mathematics and science, the two disciplines are closely connected, since mathematics often works pretty much like science: in many areas of pure mathematics, such as in number theory, mathematicians gather data by computing multiple examples, then they search for a pattern, make a hypothesis, and test it against additional data, until new data matches our

hypothesis after some iterations (Silverman, 2012). Moreover, this mean academic performance in Science of 70% at the target school was even lower than other subjects like English, Computer Science, and Social Science.

The researcher believes that learning through the student-centered approach known as laboratory-based method would make the science learning process more efficient and productive. Therefore, in order to compare students' academic performance and leisure interest in Science under the two learning methods (i.e., laboratory-based method and textbook-based method), the current study was conducted. The researcher concentrated only on Grade 10 students enrolled in Grade 10 Class A and Grade 10 Class B at the target school in the Science program.

Research Questions

The following research questions were explored in this study.

1. What are the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India?
2. What are the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India?
3. What are the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India?
4. What are the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India?

5. Is there a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India?
6. Is there a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India?

Research Objectives

The following research objectives were explored in this study.

1. To determine the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.
2. To determine the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.
3. To determine the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.
4. To determine the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.
5. To determine if there is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High

School, Barhalganj, India.

6. To determine if there is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook- based method at St. Joseph High School, Barhalganj, India.

Research Hypotheses

The following research hypotheses were tested in this study.

1. There is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India, at a significance level of .05.
2. There is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India, at a significance level of .05.

Theoretical Framework

This study was carried out on the basis of three major theories: the behaviorist theory, the constructivist theory, and Klopfer's (1971) attitude to science scheme classification.

Behaviorist Theory

The behaviorist theory, also known as behaviorism, is concerned with observable changes in behavior caused by repetition and practice (Pandey, 2017). According to the behaviorist theory, learning happens when a proper response is demonstrated in response to the presentation of a specific environmental stimulus (Ertmer & Newby, 2013). Learning can

be seen in observable behaviors such as correct answers. In addition to correct responses, behaviorists place a strong emphasis on rewards and consequences for these behaviors, believing that this will influence the likelihood of correct responses in the future (Ertmer & Newby, 2013). Behaviorism is just involved with behavior and is uninterested in the feelings that underpin that behavior (McLeod, 2017). Due to the lack of attention paid to feelings and thoughts, behaviorism does not provide a method for teaching children to practice their learning to concepts and contexts outside of the classroom. It emphasizes in them giving the right answers, but it does not teach them how to be creative thinkers, critical thinkers, or independent thinkers.

The behaviorist method can still be used to memorize facts, recall steps, comprehend rules, and make generalizations (Ertmer & Newby, 2013). If the task being learned is as simple as memorizing a technique, procedure, set of rules, or system, and a behaviorist approach (e.g., the textbook-based method) could be used successfully.

Constructivist Theory

The constructivist theory, also known as constructivism or constructionism, is grounded on the assumption that learning is a mixture of previous knowledge, beliefs, and individual skills, all playing a role in the social process (Booth, 2011). Constructivist educators believe that, in order for learners to grasp and transfer knowledge effectively, the information must be presented in a way that allows them to interact with its real-world relevance and application. Constructivists believe that learning is a one-of-a-kind thing performed by a one-of-a-kind being (Booth, 2011).

According to the constructivism, both the learner and the context are important to the learning processes and outcomes, and we all construct our own knowledge as learners based on personal perceptions and experiences (Booth, 2011). This means that teachers' lesson plans, teaching styles, and content would be adjusted to meet children’s ability,

developmental stage, or interest (Matthews, 2003). Constructivists believe that students create meaning rather than acquiring it (Ertmer & Newby, 2013). They believe that each learner interprets and comprehends the world around them in a particular and unique way, depending on their own unique life experiences, and that there is no single universal meaning or comprehension for all students.

Klopfer's (1971) Attitude to Science Scheme Classification

Klopfer (1971) developed a theoretical classification for the affective domain in relation to science education, by categorizing a set of affective behaviors such as the manifestation of favorable attitudes toward science and scientists; the acceptance of scientific enquiry as a way of thought; the adoption of scientific attitudes; the enjoyment of science learning experiences; and the development of interests in science and science-related activities. This theoretical classification is comprised of six major affective behaviors: manifestation of favorable attitudes towards science and scientists; acceptance of scientific inquiry as a way of thought; adoption of scientific attitudes; enjoyment of science learning experiences; development of interest in science and science-related activities; and development of interest in pursuing a career in science. Several existing tests, such as the Scientific Attitude Inventory (SAI), the Scientific Attitude Inventory II (SAI2) and the Test of Science-Related Attitudes (TOSRA) evaluate scientific attitudes and attitudes towards science. The TOSRA's subscale "leisure interest in science" belongs to the category of "development of interest in science and science-related activities" in Klopfer's (1971) classification.

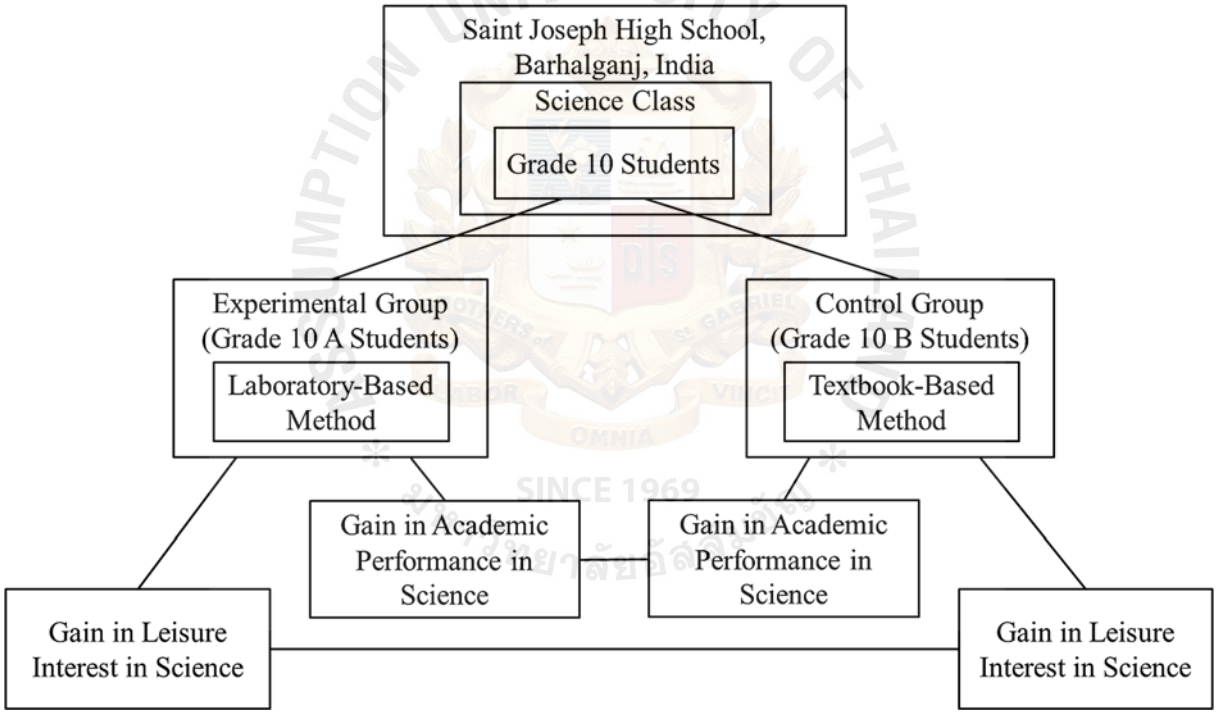
Conceptual Framework

The purpose of this study was to determine the students' academic performance and leisure interest in science held by students learning through laboratory-based method and

textbook-based method at St. Joseph High School, Barhalganj, India. The study was conducted on two Grade 10 classes through two different methods: one class was comprised of students learning through laboratory-based method (i.e., the experimental group), while the other class was comprised of students learning through the textbook-based method (i.e., the control group). The researcher used Grade 10 Class A, where laboratory-based method was used, and Grade 10 Class B, where textbook-based method was applied. Figure 1 shows the relationship among the variables addressed in this study.

Figure 1

Conceptual Framework of This Study



Scope of the Study

In this section, the boundaries of this study are clearly described, in relation to five different aspects: theoretical scope, variable scope, research design scope, demographic scope, and instrumental scope.

Theoretical Scope of This Study

This research was guided by three theories. Firstly, the behaviorist theory, on whose

principles teacher-centered learning approaches, such as the textbook-based method, are largely based. Secondly, the constructivist theory, on whose principles student-centered learning approaches, such as the laboratory-based method, are largely based. Finally, leisure interest in science was explained in this study using Klopfer's (1971) attitude to science scheme classification, which explains variables on the affective domain in relation to the development of interest in science and science-related activities.

Variable Scope of This Study

This study addressed the following three research variables: Science teaching method (laboratory-based method and textbook-based method) served as the independent variable, and both the academic performance and the leisure interest in Science of Grade 10 students at the target school, served as the dependent variables.

Research Design Scope of This Study

The research used a quasi-experimental research design and employed a quantitative comparative survey research design to compare students' gain in academic performance and leisure interest in science through laboratory-based method and textbook-based method of Grade 10 students at St. Joseph High School, Barhalganj, India.

Demographic Scope of This Study

The study was conducted on two conveniently chosen Grade 10 Science classes from the target school, using two different teaching methods: laboratory-based method and textbook-based method. The study was focused on Grade 10 Science students of St. Joseph High School, Barhalganj, India, enrolled in the Term 2 of the academic year 2021-2022. The population consisted of 730 Grade 10 students, but the sample which was used for this thesis research project was limited to 72 students, distributed as follows: 35 from Grade 10 A (i.e., the experimental group), and 37 from Grade 10 B (i.e., the control group). The findings from this research are limited to explain the research variables at hand for the Grade 10 Science

class at the target school, and will be only generalizable to schools with similar characteristics and student population as the target school.

Instrumental Scope of This Study

The Grade 10 students' academic performance in Science was assessed through scores on the Science academic performance test, a research instrument that was created by the researcher for this study. This test was administered as a pre-test and post-test to collect data on participants' academic performance before and after the instructional intervention.

Students' leisure interest in science was measured using the Students' Leisure Interest in Science Questionnaire (SLISQ), whose items were adopted from one out of the seven dimensions comprising the Test of Science-Related Attitudes (TOSRA; Fraser, 1981). The SLISQ was administered to the participants before and after the instructional intervention, in order to collect data on their leisure interest in science.

Definitions of Terms

In order to assure a common understanding of the main terms used in this study, the following terms are defined to convey the sense in which they are used throughout this thesis.

Academic Performance in Science

This refers to the demonstration of understanding of the information learned in the Science class by Grade 10 science students at St. Joseph High School, Barhalganj, India. This variable was measured using participants' scores on the Science academic performance test, a research instrument that was created by the researcher for this study and was administered as a pre-test and post-test, before and after the instructional intervention.

Grade 10 Students

This refers to all the Grade 10 students who were enrolled in Term 2 of the academic year 2021-2022 at of St. Joseph High School, Barhalganj, India. The student population of

this school consisted of 730 students. However, the convenience sample used for this study was comprised of 72 students which were divided into two classes: 35 Grade 10 students from Grade 10 A class, which served as the experimental group, learning through the laboratory-based method; and 37 Grade 10 students from Grade 10 B class, which served as the control group, learning through the textbook-based method.

Laboratory-Based Method

The laboratory-based method is a student-centered instructional approach that involves practical experimentation in a laboratory setting. A laboratory is a special room or building dedicated to scientific experiments. Laboratories use specialized tools and equipment, known as apparatus, to perform scientific experiments. In the laboratory-based method, learning is available by performing experiments. In this method of learning, students are allowed to share their ideas and make decisions about their own learning.

Leisure Interest in Science

Students' leisure interest in science is the degree of concern or psychological involvement to which they engage and spend time in science-related activities in their leisure time. Therefore, leisure interest in science is understood as the degree to which science-related activities or science arouse students' curiosity during their leisure time. For this study, the participants' level of leisure interest in science was measured by administering the Students' Leisure Interest in Science Questionnaire (SLISQ), a 10-item instrument adopted from one of the seven measures included in the Test of Science-Related Attitudes (TOSRA; Fraser, 1981).

St. Joseph High School, Barhalganj, India

St. Joseph School is an educational institution located in Barhalganj, a town in Uttar Pradesh State, India. This school is an English medium institution from Grade 1 to Grade 12, affiliated to the Central Board of Secondary Education (CBSE) New Delhi, and following the

CBSE curriculum. The school was established in 2007, and now has 730 students and 40 teachers. Studying Science is compulsory for students up to Grade 10, grade after which it becomes optional to choose Science for further studies.

Textbook-Based Method

The textbook-based method is a teacher-centered instructional approach in which the teacher is the controller in the class using the textbook as mostly the only source of instruction and as a guide for students, while the students follow the instructions given by their teacher. In this method, textbooks are regarded as detailed sequences of teaching procedures that instruct students on what to do and when to do it. In this method, textbook instruction is rarely supplemented with hands-on activities, which often results in less engagement in the class from the students.

Significance of the Study

This study examined Grade 10 students' Science academic performance and leisure interest in Science under laboratory-based method and textbook-based method in learning Science. The findings of this study would benefit the school administrators, teachers, students, and future researchers.

Firstly, the information gained from this study would be beneficial to the school administrators by understanding the importance of laboratory-based method on students' learning and their academic performance and leisure interest in Science to further plan and develop future professional development programs for teachers' training and make changes and improvements that will benefit the students' learning.

Secondly, the information gained from this study will help teachers to rethink the improvement in learning science by using appropriate instructional strategies and learning methods.

Thirdly, this study examined if there was a significant difference in academic performance and leisure interest in science between students learning through laboratory-based method, which is student-centered approach, and textbook-based method, which is teacher-centered approach. This intervention, under which a group of participants studied through laboratory-based learning method in science, may help Grade 10 students at St. Joseph High School, India, to develop peer learning, team-working, reasoning, problem solving and critical thinking skills.

Lastly, the research findings can assist future researchers in designing new experiments with similar purpose.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter, the researcher reviewed the important theories and literature related to this research. There are seven sections in this chapter. The first section gives an overview of Science Education in India. The second section gives information about the behaviorist theory. The third section presents the constructivist theory. The next section focuses on Klopfer's (1971) attitude to science scheme classification. The fifth section reviews the previous studies on laboratory-based and textbook-based methods and their influence on academic performance. The sixth section reviews the previous studies on leisure interest in science. Lastly, the seventh section introduces the background of the target school in detail.

Science Education in India

Science has an important role in human life providing technological devices and products that make peoples' lives easier and better. Science subjects in schools help students think of different opportunities for their future career which are high pay and quality work. Basic science learning will enable people to become effective members of their society and help them reconstruct successful ways of thinking (United Nations Educational, Scientific and Cultural Organization, 2010). Through learning science, students will understand how the universe work, as well as the functioning of the human body system, space, and recent technologies, by performing experiments that will help them develop scientific skills such as posing scientifically-oriented questions, formulating and testing hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments (Krajcik et al., 2001).

Therefore, science contributes to students' development of decision making and problem-solving skills, curiosity, analytical investigation, critical thinking, enjoyment, scientific interest, and increased knowledge of science (Hesson & Shad, 2007; Sobel, 2004). Science answers students' inquiries and helps them reason out the phenomena around them and satisfies their curiosity. Students who are highly motivated to learn science and have a high science academic achievement have a powerful critical thinking ability (Redman, 2013).

The National Policy of Education (Government of India, 1986) reaffirmed the importance of science and mathematics as compulsory subjects in the first ten years of schooling in India. Because science syllabi and textbooks are prescribed by respective state curriculum organizations, the content and process of teaching science differs from state to state.

According to the National Curriculum Framework (NCF) from 2005 (National Council of Educational Research and Training [NCERT], 2005), when teaching science at the primary level, the child should be engaged in joyfully exploring the world around them. The goals at this stage are to foster the child's curiosity about the world, to engage the child in exploratory and hands-on activities, and to help the child acquire basic cognitive and psycho-motor skills through observation, classification, and inference.

Modern Indian Education System

Modern education system emphasizes subjects like science and math. Until July 2020, the schooling system in India was based on the 10+2 system, which rewarded Secondary School Certificate (SSC) on completing Grade 10 and Higher Secondary Certificate (HSC) by completing Grade 12. The new National Education Policy (NEP), this has been replaced with the 5+3+3+4 system.

The main focus in upper primary students is learning scientific principles through some hands-on activities to create simple technological units and modules, and continuing to

learn more about the environment and health through activities and surveys. Students learn scientific concepts primarily through activities and experiments.

At the secondary level, students are learning science as a composite discipline. Structured experimentation as a tool for discovering/verifying theoretical principles, as well as working on locally significant science and technology projects, are important components of the curriculum at this stage.

Science is introduced as a distinct discipline in the upper secondary stage, with an emphasis on experiments, technology, investigative projects, historical development of key scientific concepts, and awareness. According to the All India School Education Survey (AISES; National Council of Educational Research and Training, 2016), approximately 58% of secondary schools in the country have a science laboratory, and only approximately 38% have an adequate science laboratory.

Indian Students' Attitudes Toward Science Education

According to the National Science Survey (2004), mathematics remains the most preferred subject. Subjects like Physics, Chemistry, and Biology are rated as the top subjects in Grades 11 and 12 by about 30% of the students. This figure is triple that for students in Grades 6 to 8, suggesting that the appeal for science subjects increases dramatically in the higher classes in school.

At the Grade 6 to 8 level, 22% of the students said they would like to study pure science at higher levels of education. Yet, only 13.4% of the students in Grades 11 and 12 wanted to study pure science at the graduate/post-graduate level. The interest in all types of science education does not decline much. In fact, 60% of the students at the Grades 6 to 8 level said they wanted to pursue some science education.

The three most preferred professions for students turned out to be teacher, doctor and engineer. No decline in interest in the proportion of students who wished to study science was

found. A third of the students said they did not study science as they did not feel motivated enough and another 40% said the number of students in a class were too many for them to understand what was being taught (National Science Survey, 2004).

Indian Higher Education in Science

The most common pattern for post-school (10+2) teaching programs in basic sciences across the country requires students to complete a 3-year B.Sc. course, followed by a 2-year M.Sc. course before enrolling in a Ph.D. program. The B.Sc. degree typically entails the study of a predetermined combination of three subjects over the course of four years. The three-subject combination at B.Sc. is divided into three major science streams, namely the "Bio" (or "Medical") group, the "Math" or "Physics" (also known as "non-Medical" or "Pure Science") groups. After completing the B.Sc. degree, the student applies for admission to the 2-year M.Sc. program.

According to National Council of Applied Economic Research (NCAER, 2004), about a quarter (22.3%) of the 39.2 million graduates had a science education background; about a fifth (19.4%) of the 9.3 million postgraduates and a third of the 0.3 million doctorates had a science education background. Science education is required for 29% of all professional, technical, and related jobs in India (NCAER, 2004).

According to Department of Science and Technology (2001), from the 1,54,827 Signal and Telecommunication (S&T) personnel engaged primarily in Research and Development (R&D) activities as on 1st April, 2005, 47.6% had an engineering and technology background, 29.8% had a background in natural sciences, 12.1% in agricultural sciences, 8.1% in medical sciences, and the remaining 2.4% in social sciences.

Indian Policy Recommended Resources and Opportunities in Science

There are different opportunities in India, in the form of institutions, programs and

research centers, for students who are willing to take science in future: the Improvement of Science Education in Schools Scheme, the Kishore Vaigyanik Protsahan Yojana (KVPY) Program, the Computer Literacy and Studies in Schools (CLASS) Program, the Jawaharlal Nehru National Science Exhibition, and the Exploratory Research Center.

Improvement of Science Education in Schools Scheme

A centrally sponsored scheme to improve the quality of science education and to promote scientific temper became operational in India in 1987. Under the scheme 100% assistance is provided to the States for provision of science kit s to upper primary schools, up gradation of science laboratories and library facilities in senior/secondary schools and training of science teachers. The scheme also provides for assistance to voluntary organizations for undertaking innovative projects in the field of science education

Kishore Vaigyanik Protsahan Yojana (KVPY) Program

The Department of Science and Technology (DST) launched a program in 1999 to encourage students of basic sciences, engineering, and medicine at the higher secondary, undergraduate, and graduate levels to pursue research careers in these fields. The program's goal is to identify and encourage talented students who have a strong interest in research.

Computer Literacy and Studies in Schools (CLASS) Program

From 1993, a pilot project initiated by the Department of Electronics in collaboration with the Ministry of Human Resource and Development (MHRD) was modified and converted into a centrally sponsored scheme. The projects' goals were as follows to provide students with an understanding of computers and their use to provide hands-on experiences to demystify computers for young students and to familiarize students with a variety of computer applications. The CLASS 2000 program was launched by the government with the goal of providing computer literacy in 10,000 schools, computer-assisted learning in 1,000 schools, and computer-based learning in 100 schools. These hundred schools were dubbed

SMART schools, and they were created to encourage the widespread use of computers in the teaching-learning process. According to the National University of Educational Planning and Administration (NUEPA, 2010), as of September 2008, 14% of the elementary schools in India have a computer.

Jawaharlal Nehru National Science Exhibition

The National Council of Educational Research and Training (NCERT) organizes an annual event in India. This event consists of a series of exhibitions at the school, district, regional, and state levels culminate in the national level science exhibition. The relevance of science and technology for development are criteria that are taken into account when determining the themes**.**

Exploratory Research Center

It is a science center established in Pune State, India, where students from elementary and secondary schools can explore and experiment, invent and innovate, and design and fabricate. Its vision is that even very young children want to be scientists. There are no teachers in the Exploratory Research Center, only highly experienced guides who explore basic scientific concepts with the students through carefully designed activities. The goal is for children to learn science by participating in the scientific process. The Exploratory Research Center encourages keen and careful observation, piques children's curiosity, encourages them to ask questions, challenge the answers, and allows them to generalize and discover. The exploratory method of learning science has not yet been adopted by the formal system of science education (Indian National Science Academy [INSA], 2001).

The main barriers to supporting diversity are a lack of basic infrastructure, insufficient support systems, and a lack of resources for disadvantaged students to receive a quality science education. As a result, curriculum designers and textbook writers create material that is aligned with the poor facilities, reinforcing the belief that space and practical work are not

necessary for science education. Another effect of poorly equipped or non-existent laboratories is that teachers overlook the opportunities provided by low-cost activities and experiments using locally and easily accessible materials. In terms of content and pedagogy, science curricula and textbooks do not adequately reflect the diversity of students across the country (Nature Conservation Foundation [NCF], 2005).

Behaviorist Theory

According to the behaviorist theory, learning happens when a proper response is demonstrated in response to the presentation of a specific environmental stimulus (Ertmer & Newby, 2013). Teachers who use a behaviorist approach would present lesson objectives in a linear manner. The teacher would use hints or cues to guide students to a desired behavior, and then use consequences to reinforce the desired behavior. Lower-level cognitive skills are introduced first by behaviorists. This is followed by the development of higher-level cognitive abilities. The issue with this type of instruction, which is primarily-centered, is that lessons are primarily engaged in learning skills in isolation (Ertmer & Newby, 2013; McLeod, 2017).

The behaviorist method can still be used to memorize facts, recall steps, comprehend rules, and make generalizations (Ertmer & Newby, 2013). If the task being learned is as simple as memorizing a technique, procedure, set of rules, or system, and a behaviorist approach (e.g., the textbook-based method) could be used successfully.

According to Donnelly (2014), learning can take place in both passive and active modes. Because students have different understandings, memorization and rote learning are also important for learning. For example, some students learn best through active engagement, pictures, memorization, hands-on experience, or reading. That is why textbook-based instruction is a classic example of using the behaviorist theory in education.

Textbook-Based Instruction

Textbook-based instruction is a teacher-based learning method which focuses on telling, memorizing and recalling information, under which learners might be involved mostly in note-taking (Schreurs & Dumbraveanu, 2014). Under this strategy, students just obtain knowledge from the teacher, without increasing their level of connection with the subject being taught (Boud & Feletti, 1999). The textbook-based method is less practical, more theoretical, and requires mostly memorization (Teo & Wong, 2000). Textbook-based method does not use activity-based learning to motivate students to solve real-world problems using applicable knowledge because the instructor has influence over the transmission and sharing of knowledge, the lecturer may try to maximize information delivery while conserving time and effort. As a result, students' interest in science may decrease (Zakaria et al., 2010). In the textbook-based method, students learn by memorization and recitation, and hence do not build critical thinking, problem-solving, or decision-making skills, which results in a low academic performance (Sunal et al., 1998).

Textbook-based instruction is typically characterized by a teacher-direct orientation, which has long been used as the primary method of instruction in India. This method of instruction places a strong emphasis on rote learning. Knowledge is passed down from teacher to student, with the teacher having complete control over what the students learn. According to Thamraksa (2011), many teachers are not open to new teaching approaches as they do not wish to move out of their comfort zones and do something new. Furthermore, teachers believe that their teaching methods are already the best and thus do not need to be changed. Some students see traditional instruction which is textbook-based as proof that they are being taught in school (Thamraksa, 2011).

Textbook-based instruction is often a situation where children function as parrots who repeat exactly what is taught. Depending on what is being taught and what is suitable for the

students, the teacher must use different teaching and learning strategies accordingly (Donnelly, 2014).

Constructivist Theory

The constructivist theory, also known as constructivism or constructionism, is grounded on the assumption that learning is a mixture of previous knowledge, beliefs, and individual skills, all playing a role in the social process (Booth, 2011). Constructivism is based on the idea that students actively construct knowledge, with learning being an active mental work, not a passive reception of teaching (Woolfolk, 1993). Students build their new experiences on top of their current understanding foundation.

There are four critical areas for the success of a constructivist classroom:

- The instructor functions as a facilitator rather than a director.
- The students and the instructor share equal authority and accountability.
- Instruction is given in small groups.
- The lecturer and the students both share their knowledge.

According to Brooks and Brooks (1999), constructivist classroom environments have existed for as long as humans have been asking each other questions. Constructivism, or the study of learning, is concerned with how we all make logical sense of our surroundings.

Jean Piaget (1970) is regarded as one of the founding constructivist theorists. According to his theory, humans gather data through the interaction of their experiences and ideas. Later, Piaget (1985) expanded on this theory to explain how new knowledge is formed to fit with the learner's existing knowledge, and how existing knowledge is modified to accommodate the new information. Piaget (1985) proposed that individuals construct new knowledge from their experiences through processes of accommodation and assimilation. Individuals assimilate by incorporating new experiences into pre-existing frameworks

without altering those frameworks.

Vygotsky (1978) focused on how relationships with others who are more capable, knowledgeable, or expert than the learner influence the learner's thinking. Vygotsky proposed that when learning a new skill or solving a new problem, a person can perform better when accompanied and assisted by an expert than when performing alone. Vygotsky (1978) also proposed the teaching pedagogy is more toward student centered.

Laboratory-Based Instruction

The laboratory-based instruction is a constructivist, student-centered learning method which consists of the implementation of a series of activity-based learning activities with the purpose of improving students' academic performance and interest towards science activities (Çelik, 2018). The major characteristics of the laboratory-based method include creating a learning environment where students take charge of their learning and get involved in it (Thamraksa, 2011).

According to Froyd and Simpson (2008), proper teaching methods like the laboratory-based method using student-centered learning (SCL) can increase student motivation to learn, in-depth understanding of content and an overall positive attitude for the subject. SCL provides students with an opportunity to discover and construct knowledge.

There are many reasons why laboratory-based instruction method, which is a SCL approach, should be adopted; firstly, it is a very enjoyable method for learners and secondly research has strongly indicated that this approach tends to improve student learning. Using SCL is not a way to cut out teacher roles, but an approach to bring a change in teaching techniques which improves learning and knowledge of the learners (Froyd & Simpson, 2008).

According to Asoodeh et al. (2012), the main aim of today's education is not to give information to students directly but to allow them to research for it themselves. Laboratory-based learning method is a student-centered instruction that creates active learning in several

ways, such as cooperative learning, problem-solving exercises and critical thinking exercises. Working in groups not only improves students' participation in class activities, but also it is a way to increase students' self-confidence and making the work less stressful. It helps to take away the feeling of learners being bored in class (Asoodeh et al., 2012).

Klopfer's (1971) Attitude to Science Scheme Classification

Klopfer (1971) presented a useful general framework for organizing the evaluation of affective behaviors related to science education. Klopfer's (1971) attitude to science scheme classification is a model for the affective domain that is related to science education. Klopfer (1971) classification of attitudes toward science includes six affective domains: manifestation of favorable attitudes toward science and scientists, acceptance of scientific inquiry as a way of thinking, adoption of scientific attitudes, enjoyment of science learning experiences, development of interest in science and science related activities, and development of interest in pursuing a career in science.

Fraser (1981) then devised the Test of Science-Related Attitudes (TOSRA) to measure secondary students' attitudes toward science and science-related issues, based on Klopfer's (1971) classification. Klopfer's (1971) first category, manifestation of favorable attitudes toward science and scientists, was split into the first two TOSRA scales. The rest of the TOSRA scales each correspond to the remaining five TOSRA scales. For instance, in this study, the TOSRA scale named "leisure interest in science" corresponds to Klopfer's (1971) development of interest in science and science-related activities.

Fraser (1981) subdivided Klopfer's (1971) original classification into the Social Implications of Science Scale and the Scientists' Normalcy Scale.

The Social Implications of Science scale comprises the demonstration of favorable attitudes toward learning science (Fraser, 1981). This includes attitudes toward the social

benefits of scientific development and research, as well as problems associated with technological discovery and research.

The Scientists' Normalcy Scale assesses students' perceptions of scientists as individuals as well as their perceptions of scientists as having a normal lifestyle. This scale also assesses students' enjoyment of science learning experiences. This includes both participation in science labs and attendance at science classes.

The Leisure Interest in Science scale assesses the growth of interest in science and science-related activities. Fraser's (1981) category is intended to reflect students' interests in science-related hobbies and extracurricular activities outside of the classroom. This is a modification of Klopfer's (1971) original classification, which included two aspects (Klopfer, 1971): the student's interests in activities that he or she can carry out himself or herself (voluntary participation); and the attention the student pays to ongoing events in science and the societal interactions of science (Fraser, 1981). Klopfer (1971) considered the growth of a student's interest in finding a career in science to be a genuine and meaningful part of his scientific learning.

Previous Studies on Laboratory-Based and Textbook-Based/Traditional Methods

Olubu (2015) conducted a study to determine the influence of laboratory learning environment on students' performance in secondary school. The study's population included all Senior Secondary School III (SSS III) science students from all public secondary schools in Ondo State, Nigeria. The study's sample included 690 students from the schools chosen for the study. For data collection, two research instruments were used: the Questionnaire on Chemistry Laboratory Learning Environment (QCLLE) and the Chemistry Practical Achievement Test (CPAT). Analysis of variance (ANOVA) and multiple regression were used to analyze the data collected. The findings revealed a significant relationship between

the five dimensions of the laboratory learning environment and student performance. It is recommended that the government provide secondary schools with resources, teaching materials, models, equipment, and adequate laboratories for the teaching and learning of Science in order to improve teaching and learning.

In Mulinge's (2017) study, the objective was to determine the impact of laboratory equipment on students' academic performance in science subjects in Machakos Sub-County, Kenya's public secondary schools. The study's objectives were to determine the availability of laboratory facilities and equipment in public secondary schools, the extent to which science teachers use laboratory facilities in teaching science subjects, and the correlation between laboratory equipment and students' academic performance in science. The descriptive survey design was used by the researcher. The study's sample population included 450 students. According to the findings of the study, there is a significant relationship between laboratory facilities and students' academic performance in science subjects. The use of laboratory facilities by teachers when teaching science subjects had an impact on students' performance in science subjects.

Yadav and Mishra (2013) conducted a study of the Effects of a Laboratory Approach on Science Achievement and Process Skills in Is Standard Students The goal of this study was to compare the effects of laboratory approach on the development of science process skills and academic achievement in university students. The sample for this study consisted of 81 university students enrolled in the General Physics Laboratory-I- course at Devi Ahilya Vishwavidyalaya (DAVV) Indore, India. Students from the B.Sc. class (43) were chosen as the experimental group. Students from the BCA class (38) were chosen as the control group. The current study's researchers came to the conclusion that the achievement of students studied using the laboratory approach was significantly higher than the traditional approach. Students who studied in a laboratory setting performed better.

Previous Studies on Leisure Interest in Science

Zandstra (2012) conducted a study on “The Impact of an Informal Science Program on Students' Science Knowledge and Interest in the local GEAR UP Project” on the students enrolled in 14 different Grade 11 science classes in three high schools at Texas, United States, who participated in this project for six years. In this study, quantitative and qualitative data were used to assess the impact of an informal science program on the science knowledge and interest of eleventh grade students. This sample included 122 eleventh grade students. In the quantitative survey, participants' scientific knowledge and interest were assessed using state standardized test scores and a modified version of the Test of Science-Related Attitudes (TOSRA) were used to assess participants' scientific knowledge and interest. The quantitative phase findings revealed a weak but significant correlation between students' attendance and science interest at program elements (in total number of hours) and their science knowledge. The participants’ level of academic performance in Science was found to be very good, and their level of leisure interest in science was found to be moderate. The comparisons between attendance and interest were highlighted by the fact that students had the opportunity to see interesting areas of science and interact with real scientists during field trips. Grade 11 students who had higher attendance at the GEAR UP program elements (i.e., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, communicating findings, mathematics workshops and summer camp) had a higher level of science interest than students with lower attendance. Leisure interest in science was found to be not significantly correlated to attendance at any of the GEAR UP program elements. However, science academic performance (knowledge) was found to be significantly, positively and weakly correlated to attendance at science-related

program elements.

Darlington (2017) conducted research on the topic of “Understanding and Developing Student Interest”, on Science students aged 14 to 16 in four secondary schools in England. The participants were asked about what they thought the purpose of learning science was between the14-16 years old, how interested they were, and what they believed could pique their interest in science lessons A questionnaire was distributed and completed in the summer before the students by 475 students and 11 teachers from four state-maintained schools in England. The participants began their General Certificate of Secondary Education (GCSE) studies. The findings indicated that students in all schools agreed that learning from others and their perception of choice and control in learning increase their interest in science lessons, whereas students in all schools appeared to be ambivalent about the role of exploring science in increasing their science interest levels. Moreover, there was a significant, moderately strong and positive correlation between a student’s strength of agreement with being more interested if more effort is put into the lesson and their science interest level. This implies that students are aware of the link between their input into their learning and their interest in the subject. This conclusion is further supported by the significant, moderately strong and negative correlation between students’ strength of agreement with teachers should make the lessons interesting and their level of interest in science. However, this negative correlation could be interpreted as the students who have a higher level of interest in science believing that the teachers already make lessons interesting. Also, after administering the questionnaires, two classes were chosen for putting in place manageable interventions focused on supporting the development of student interest in Science based on our understanding of the research literature and the results of Student Questionnaire and the Teacher Questionnaire previously administered, with practical work being a key component of science lessons enacted in the classroom. The quantitative data collected from students in

Classes 1 and 2 showed that, even though there was a numerical increase in the students' overall level of interest in science for students in both classes, no significant impact on the students' interest in science was found as a result of the trialed interventions.

Background of the Target School

The target school is an English medium School that offers program from nursery to Grade 10. The school was founded in 2007, and has been well known for its prominent curriculum, especially English Program. The school is medium sized school with students across primary, middle up to Grade 10. The school now has a total of 730 students across primary, middle and high school.

The target school is affiliated to the Central Board of Secondary Education (CBSE) board provides CBSE curriculum which the core subjects are integrated and taught in English medium. Students spend approximately 75% of the school day in an English environment, 25% in a Hindi environment. The science immersion classes are from Grade 1 to Grade 10, which means students learn academic subjects through those means of instructions. The science curriculum for Grade 10 students is based on the Central Board of Secondary Education (CBSE) where one of its visions is to provide quality laboratory-based education for everyone. Science classes held in St. Joseph High School is based on textbook-based learning method where teacher is the main focus, rote learning is used and lots of homework are given.

Most students indicated that they have rarely conducted any experiments in the class. Although a few students indicated that they sometimes conduct simple experiments in the class, most of them relied on the textbook-based method. Few students were engaged in hands-on activities because of the absence of laboratory facilities. Teachers' views emphasized that science courses were mainly based on the use of textbooks. Even though

laboratory rooms are there but since Teachers are no using so materials and resources are also not available in the laboratory to perform experiments. sometimes, although rare, they were performed in the classroom environment. It is also noteworthy that these experiments were not performed at the end of a topics or chapters, but instead they are strictly dependent on the book.

Science class in Grade 10 has 5 periods per week. While studying the unit of study of Science, students in Grade 10 will learn about the chemical reactions and equations, acids bases and salt, metals and nonmetals, carbon and its compounds, periodic classification of elements, life process, control and coordination, how organisms reproduce, heredity and evolution, light-reflection and refraction, the human eye and the colorful world, electricity, magnetic effects of electric current, sources of energy, our environment, and sustainable management of natural resources.

CHAPTER III

RESEARCH METHODOLOGY

In this chapter, the researcher describes the methods and procedures to be used to collect and analyze the data on academic performance and leisure interest in Science from Grade 10 students at the target school, learning through laboratory-based and textbook-based methods. This chapter introduces the research design, population and sample, research instruments, data collection, data analysis, and summary of the research process.

Research Design

The purpose of this study was twofold: to determine whether there was a significant difference in the gain in academic performance in Science, as well as in the gain in leisure interest in Science, between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. For this purpose, the researcher designed a quantitative comparative study, and a quasi-experimental research design was implemented, using two conveniently-chosen groups of Grade 10 students from the target school. The experimental group was taught using laboratory-based learning method, while the control group was taught using the textbook-based learning method.

For the data collection, the 10-item Students' Leisure Interest in Science Questionnaire (SLISQ) was used to measure participants' leisure interest in Science, on a 5-point Likert scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *not sure*, 4 = *agree*, 5 = *strongly agree*). This instrument was developed by adopting one of the seven subscales comprising the Test of Science-Related Attitudes (TOSRA; Fraser, 1981). Participants' academic

performance in Science was measured using the Science academic performance test, a research instrument that was created by the researcher for this study, based on the instructional contents to be studied during the intervention period. Both the SLISQ and the Science academic performance test were administered as pre-tests and post-tests, in order to address this research's objectives and hypotheses.

For the data analysis, descriptive statistics (means and standard deviations) and statistical hypothesis testing (independent samples *t*-tests) were employed, in order to analyze the collected quantitative data.

Population

The total population of this study consisted of all the 730 students currently enrolled in the Grade 10 Science at St. Joseph High School, Barhalganj, India, during the Term 2 of the academic year 2021-2022. Grade 10 students were organized in 20 classes, within which the researcher taught two of them.

Sample

From the population, the researcher conveniently chose for this study two Grade 10 classes, Grade 10 Class A (hereafter Grade 10 A), comprised of 35 students, and Grade 10 Class B (hereafter Grade 10 B), comprised of 37 students. These two classes were selected because the researcher was teaching them Science at the target school by the time of conducting the study.

In order to determine whether the participants' academic performance in Science was homogenous between the groups, the researcher used the scores from a summative Science test, common to both classes, administered to the participants during the Term 2 before the administration of any pre-test related to the current study. Then, the researcher conducted a

preliminary statistical hypothesis test (independent samples *t*-test) to make sure that the students were all on the same level of academic performance in Science before the beginning of the intervention. The results of the test (see Table 1) show that there was no significant difference in academic performance in Science, before the intervention, between the selected classes.

Table 1

Results of the Comparison of the Academic Performance in Science Between Grade 10 A and Grade 10 B Students at St. Joseph High School, Barhalganj, India

Grade 10 class	*N*	*M*	*SD*	*df*	*t*	*p*
Grade 10 A	35	7.70	1.73	70	.26	.794
Grade 10 B	37	7.60	1.69			

Note. The scores were obtained on a scale from 0 (poorest academic performance) to 10 (best possible academic performance).

As shown in Table 1, the results of the independent samples *t*-test indicate that there was no significant difference in academic performance in Science between Grades 10 A and Grade 10 B students at the target school, before starting the intervention; $t(70) = .26$, $p = .794$. Table 2 shows the details of the sample chosen for this study.

Table 2

Sample Details of the Grade 10 Science Students Participating in This Study

Grade 10 class	*N*	Group	Teaching method to be used
Grade 10 A	35	Experimental group	Laboratory-based method
Grade 10 B	37	Control group	Textbook-based method

As it can be observed in Table 2, the researcher randomly selected Grade 10 A class ($N = 35$) to be the experimental group, while Grade 10 B class ($N = 37$) was randomly selected to be the control group.

Research Instruments

This study was conducted based on the following research instruments: the Science academic performance test, and the Students' Leisure Interest in Science Questionnaire. Both instruments were administered as pre-tests and post-tests, in order to address this research's objectives and hypotheses.

Science Academic Performance Test

The researcher designed and administered the Science academic performance test to measure the level of academic performance in Science held by the Grade 10 students at St. Joseph High School, Barhalganj, India, who participated in this study during the Term 2 of the academic year 2021-2022. This test was created by the researcher to collect information on participants' academic performance in relation to the instructional content that was reinforced during the intervention period. Therefore, the test assessed factual and conceptual knowledge of the Science subject, mainly designed on the Chapter 10 (Light-Reflection and Refraction) and Chapter 13 (Magnetic Effects and Electric Current) of the Grade 10 Science textbook used by the participants, developed by the National Council of Educational Research and Training (NCERT). The grading of the collected tests was carried out by the researcher herself.

The Science academic performance test consisted of 30 questions, all of them compulsory, organized into three sections: Sections A, B and C.

- **Section A**. Questions 1 to 15, which are either multiple choice questions (MCQ), very short answer type questions (VSA), or assertion-reason type questions, worth 1 mark each. Answers to these questions should be given in one word, one sentence, or selecting one choice.
- **Section B**. Questions 16 to 20, which are short answer type questions, worth 2 marks each. Answers to these questions should not exceed 50 to 60 words.

- **Section C**. Questions 21 to 22, which are long answer type questions, worth 2.5 marks each. Answers to these questions should not exceed 80 to 90 words.

On these 22 questions, the students were expected to score at least 15 points out of 30 points, with a score lower than 15 points being regarded as a failure, while scoring more than 28 points was regarded as an excellent level of academic performance in Science.

Table 3 explains the interpretation of the Grade 10 students' Science academic performance test scores in Term 2, academic year 2021-2022, at St. Joseph High School, Barhalganj, India.

Table 3

Interpretation of the Science Academic Performance Test Scores

Score scale	Interpretation of the academic performance in Science
28-30	Excellent
24-27	Very good
20-23	Good
15-19	Satisfactory
< 15	Failed

Students' Leisure Interest in Science Questionnaire

The Students' Leisure Interest in Science Questionnaire (SLISQ) was used to measure the levels of leisure interest in science held by the Grade 10 students participating in this study. The SLISQ has 10 items, which were adopted from the "leisure interest in Science" subscale from the Test of Science-Related Attitudes (TOSRA), originally developed by Fraser (1981), based on Klopfer's (1971) attitude to science scheme classification. The items were measured on a 5-point Likert-type scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *not sure*, 4 = *agree*, 5 = *strongly agree*), asking students to express their degree of agreement to each item statement. Five of the items were positively worded (i.e., Items 1, 3, 5, 7, and 9), and five were negatively worded (i.e., Items 2, 4, 6, 8, and 10). For the purpose of data

analysis, all negatively-worded items were reverse coded, in order to standardize the directionality of the interpretation.

Table 4 presents the interpretation of the 5-point Likert scale used for the Students' Leisure Interest in Science Questionnaire.

Table 4

Interpretation of the 5-Point Likert Scale for the Students' Leisure Interest in Science Questionnaire

Agreement level	Anchor	Mean score	Interpretation of the leisure interest in science
Strongly agree	5	4.50-5.00	Very high
Agree	4	3.50-4.49	High
Not sure	3	2.50-3.49	Moderate (neither interested nor uninterested)
Disagree	2	1.50-2.49	Low
Strongly disagree	1	1.00-1.49	Very low

Validity and Reliability of the Research Instruments

The following sections describe the validity and reliability of the Students' Leisure Interest in Science Questionnaire (SLISQ), and the Science academic performance test, which were administered to Grade 10 students in Term 2, academic year 2021-2022, at St. Joseph High School, Barhalganj, India, before and after the intervention period of the present study.

Validity and Reliability of the Students' Leisure Interest in Science Questionnaire

In this section, the validity and reliability of the SLISQ are discussed in depth.

Validity of the SLISQ. The items comprising the Student' Leisure interest in Science Questionnaire were adopted from the Leisure Interest in Science dimension from the Test of Science-Related Attitudes (TOSRA; Fraser, 1981). The TOSRA has been extensively validated through different studies. In fact, the validity of all the subscales included in the original TOSRA was pilot tested and validated using samples of students at all four junior high school grades (Years 7-10) in Australia (Fraser, 1981). Moreover, the discriminant

validity of the TOSRA on a sample of 1337 Australian middle school students was found to be consistent with the scale structure (Fraser, 1981).

Reliability of the SLISQ. In terms of reliability, the Leisure Interest in Science subscale was found to have a good internal consistency by Zandstra (2012), with a Cronbach's alpha of .84, on a sample of 122 American Grade 11 students. Moreover, the Leisure Interest in Science subscale was also found to have a good internal consistency by Fraser (1981), with Cronbach's alphas ranging from .85 to .89 on samples of Australian students from Year 7 to Year 10. The internal consistency reliabilities observed in different research projects using the employing the Leisure Interest in Science subscale (Fraser, 1981), as well as in the current study, are shown in Table 5.

Table 5

Reliability of the Students' Leisure Interest in Science Questionnaire

Variable	Cronbach's alpha			
	Fraser (1981)	Zandstra (2012)	Current study	
			Before the intervention	After the intervention
Leisure interest in Science	.85 ~ .89	.83	.71	.74

Validity and Reliability of the Science Academic Performance Test

In this section, the validity and reliability of the Science academic performance test are discussed in depth.

Validity of the Science Academic Performance Test. The items comprising this test were designed based on the knowledge the participants already had on Science before the implementation of the intervention. After the test was designed, it was checked by the head of Science department and three Science co-teachers from the target school, in order to establish content validity. The head of the Science department, as well as the three Science teachers who checked the test, have at least 10 years of experience in teaching Science at high school

level in India.

Reliability of the Science Academic Performance Test. Regarding the test reliability, the questions comprising the test were the exact same questions between administrations (i.e., between the pre-test and the post-test administration), but they were shuffled, in order to minimize participant recall, avoid possible memorized answers and reduce the monotony of questions. Moreover, the test questions included in this instrument had the same format that the target school had been using for many years, so it can be assumed that this test structure is considered reliable by the target school.

Experimental Process

The duration of the study was a period of 4 weeks, with a 50-minute session every day for both laboratory-based and textbook-based learning methods during June 2022. The data were collected by the researcher herself, who served as the Science teacher for both groups. During the experimental period, the same topics were taught to both groups, according to the school Science curriculum, but with the only difference being the teaching method used to deliver the instruction.

The materials used in the lessons were aligned to the Indian Science curriculum and planned out to deliver the same instructional content as in the other Grade 10 Science classes, by using knowledge from the Grade 10 Science textbook developed by the National Council of Educational Research and Training (NCERT). The intervention was designed to deliver knowledge on Grade 10 Science textbook's Chapter 10 (Light-Reflection and Refraction) and Chapter 13 (Magnetic Effects and Electric Current). In addition to using the textbook as instructional material, the researcher used laboratory activities with the experimental group.

Table 6 below explains how the instruction for both the control and experimental groups were organized, according to the weeks, periods and lesson topics.

Table 6

Lesson Schedule for the Experimental Group and Control Group During the Experimental Period

Week	Date	Lesson contents	
		Experimental group	Control group
1	June 6, 2022	Students' Leisure Interest in Science Questionnaire, and the Science academic performance test (administered as pre-tests)	Students' Leisure Interest in Science Questionnaire, and the Science academic performance test (administered as pre-tests)
1	June 7, 2022	Lesson 10-1: Vocabulary; Reflection of light	Lesson 10-1: Vocabulary; Reflection of light
1	June 8, 2022	Lesson 10-2: Spherical mirrors	Lesson 10-2: Spherical mirrors
1	June 9, 2022	Lesson 10-3: Image formation by spherical mirrors	Lesson 10-3: Image formation by spherical mirrors
1	June 10, 2022	Lesson 10-4: Refraction of light	Lesson 10-4: Refraction of light
2	June 13, 2022	Lesson 10-5: The refractive index	Lesson 10-5: The refractive index
2	June 14, 2022	Lesson 10-6: Image formation in lenses using ray diagrams	Lesson 9-6: Image formation in lenses using ray diagrams
2	June 15, 2022	Lesson 10-7: Lens formula and magnification. Review; Laboratory activity	Lesson 10-7: Lens formula and magnification. Review; Activity Book; Worksheet
2	June 16, 2022	Lesson 10-8: Refraction by spherical mirrors	Lesson 10-8: Refraction by spherical mirrors
2	June 17, 2022	Lesson 10-9: Review; Laboratory activity	Lesson 10-9: Review; Activity Book; Worksheet, Exercises
3	June 20, 2022	Lesson 13-1: Magnetic field and field lines. Conductor in a magnetic field	Lesson 13-1: Magnetic field and field lines. Conductor in a magnetic field
3	June 21, 2022	Lesson 13-4: Magnetic field due to a current-carrying conductor	Lesson 13-4: Magnetic field due to a current-carrying conductor
3	June 22, 2022	Lesson 13-5: Force on a current carrying conductor in a magnetic field	Lesson 13-5: Force on a current carrying conductor in a magnetic field
3	June 23, 2022	Lesson 13-6: Electric motor and electric generator	Lesson 13-6: Electric motor and electric generator

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Week	Date	Lesson contents	
		Experimental group	Control group
3	June 24, 2022	Lesson 13-7: Laboratory activity	Lesson 13-7: Activity Book; Worksheet, Exercises
4	June 27, 2022	Lesson 13-8: Review	Lesson 13-8: Review
4	June 28, 2022	Students' Leisure Interest in Science Questionnaire, and the Science academic performance test (administered as post-tests)	Students' Leisure Interest in Science Questionnaire, and the Science academic performance test (administered as post-tests)

The researcher followed three main steps to conduct the study, which are described below.

1. The Science academic performance test and the Students' Leisure Interest in Science Questionnaire were given to all the students in both groups before the first class session of the current intervention.
2. Different instruction methods were used to teach each of the groups: the experimental group was taught by laboratory-based method, while the control group was taught by textbook-based method.

    In the experimental group, the researcher divided the students in groups of 4-5 persons after the lesson content was delivered and reviewed, and a laboratory session was conducted. Students were given objects that are reflected, absorbed and allowed light or electrical current to pass through. Students were asked to look for similarities amongst the objects and sort them into categories. Students discussed what words would be used to name those categories of light; to explain reflection of light; to make predictions of the law of reflection from experiments with sheet and pins and discuss their observations; and to visualize and predict magnetic field lines due to a current-carrying electric conductor.

    In the control group, students were not be grouped in Science class. The

teacher only used the textbook and the activity book for teaching, and most of the students focused on reading and explanation the lesson contents using worksheets.

3. The Science academic performance test and the Students' Leisure Interest in Science Questionnaire were given to all the students in both groups after the last class session of the current intervention.

In order to illustrate the instructional intervention conducted in this study, Table 7 shows the steps taken to implement the lesson to be taught on June 17, 2022 (Lesson 10-9; see Table 6). For this lesson plan, both the experimental group and control group share the same learning objectives (i.e., "Students should be able to master the names of objects" [Objective 1], "Students should be able to explain all the vocabularies related with the topics" [Objective 2], "Students should be able to explain reflection, its uses and image formation by different glass" [Objective 3], "Students should be able to explain refraction and its practical uses" [Objective 4]) and same homework (i.e., students should be able to complete exercises and questions related to the topics). The difference was the teaching method: in the experimental group, students performed experiments on reflection and refraction, while the control group was taught by textbook only.

Table 7

Comparison of the Implementation of a Sample Lesson Plan with the Experimental and Control Groups

Group	
Experimental	Control
Warm up (5 minutes)	
• The teacher shows pictures of the objects related to the previous lessons, discusses them with the students, and asks if they know which topic they had last class (5 minutes)	• The teacher shows pictures of the objects related to the previous lessons, discusses them with the students, and asks if they know which topic they had last class (5 minutes)

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Group	
Experimental	Control
Learning (35 minutes)	
• The teacher explains light and properties of light. The teacher describes the properties of light (5 minutes) • Students are given objects that are able to reflect and absorb light, and allow light to pass through. Students are asked to look for similarities among the objects and sort them into categories. Students discuss what words would be used to name those categories of light (10 minutes) • The teacher explains reflection of light. Students make prediction of the law of reflection from diagrams and discuss their observations (10 minutes) • Students perform the laws of reflection on a sheet of paper with all label, diagrams and explanation. Students submit the results to the teacher (10 minutes)	• The teacher explains light and properties of light. The teacher describes the properties of light (5 minutes) • The teacher explains reflection of light. The teacher explains the law of reflection and application of reflection of light with diagrams (10 minutes) • The teacher explains refraction of light. The teacher demonstrates the refraction of light in daily life contexts (5 minutes) • The teacher explains light and colors. The teacher explains the dispersion of light through a prism (5 minutes) • The teacher explains the uses of lights (5 minutes)
Conclusion (10 minutes)	
• Students have to show refraction of light through concave lens, convex lens and glass slabs • The teacher distributes a worksheet and use a rubric to evaluate students' progress	• Students are asked to do the exercise in the book and the teacher collects the workbooks

Collection of Data

The researcher requested permission from the school administrators of St. Joseph High School, Barhalganj, India, to conduct the research with the Grade10 students enrolled in the target school. Before starting the intervention, the researcher used the scores from a Science test common to both classes, scored on a scale from 0 to 10, in order to determine whether the participants' academic performance in Science was homogenous between the

groups. Then, after the researcher conducted a preliminary statistical hypothesis test (independent samples *t*-test) on the collected data, it was found that the students were all on the same level of academic performance in Science, and there was no significant difference in academic performance in Science, before the intervention, between the selected classes.

The experiment was implemented over 4 weeks, with five 50-minute lessons per class every week. The time allocated to this experiment was from June 6 to June 28, 2022. The data were collected by the researcher herself, after being granted permission from the school administrators and checking the test validity by experienced teachers in the Science department of the target school. The data collection included two stages: the administration of the Science academic performance test and the Students' Leisure Interest in Science Questionnaire to both groups as pre- and the post-tests (i.e., before and after the implementation of the intervention designed for this study). After the data collection process ended, the researcher proceeded to analyze the data using a statistical software package. After analyzing the data, the researcher worked on the development of her thesis' Chapters IV and V. Finally, the researcher was able to defend the final version of her thesis by October 2022. The research timeline for this study is shown in Table 8.

Table 8

Research Process Timeline for This Study

Date	Task
November 2021	To get the permission from the target school's authorities
December 2021- May 2022	To write the first three chapters of the Master thesis
March 2022	To conduct a preliminary comparative study to determine whether the students from the experimental and control groups were all on the same level of academic performance in Science, before starting the intervention
May 2022	To do the thesis proposal defense
June 6, 2022	To administer the research instruments to the target sample before starting the intervention

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Date	Task
June 7-27, 2022	To introduce Science contents related to light and electrical current to both the experimental and control groups (intervention period)
June 28, 2022	To administer the research instruments to the target sample after completing the intervention
June-September 2022	To finish Chapters IV and V
October 2022	To do the final thesis defense

Data Analysis

Based on the research objectives, data analysis was performed using the statistical methods indicated below.

1. To determine the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

   Method. In order to address this objective, frequencies, percentages, means and standard deviations were used to measure the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

2. To determine the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.

   Method. In order to address this objective, frequencies, percentages, means and standard deviations were used to measure the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.

3. To determine the levels of leisure interest in Science of Grade 10 students before

and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

Method. In order to address this objective, means and standard deviations were used to measure the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

4. To determine the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.

   Method. In order to address this objective, means and standard deviations were used to measure the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.

5. To determine if there is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

   Method. In order to address this objective, an independent samples *t*-test was used to determine if there was a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

6. To determine if there is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School,

Barhalganj, India.

Method. In order to address this objective, an independent samples *t*-test was used to determine if there was a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

Summary of the Research Process

In this section, a summary of the whole research process is presented, including the research objectives, sample details, data collection method, and data analysis methods. Table 9 shows the summary of the research process for the current study.

Table 9

Summary of the Research Process

	Research objective	Source of data or sample	Data collection method or research instrument	Method of data analysis
1.	To determine the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 35 students from Grade 10 A studying Science class at St. Joseph High School, Barhalganj, India	Science academic performance test (administered as pre-test and post-test)	Descriptive statistics (frequencies, percentages, means and standard deviations)
2.	To determine the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 37 students from Grade 10 B studying Science at St. Joseph High School, Barhalganj, India	Science academic performance test (administered as pre-test and post-test)	Descriptive statistics (frequencies, percentages, means and standard deviations)

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	Research objective	Source of data or sample	Data collection method or research instrument	Method of data analysis
3.	To determine the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 35 students from Grade 10 A studying Science class at St. Joseph High School, Barhalganj, India	Students' Leisure Interest in Science Questionnaire (administered as pre-test and post-test)	Descriptive statistics (means and standard deviations)
4.	To determine the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 37 students from Grade 10 B studying Science at St. Joseph High School, Barhalganj, India	Students' Leisure Interest in Science Questionnaire (administered as pre-test and post-test)	Descriptive statistics (means and standard deviations)
5.	To determine if there is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 35 students from Grade 10 A and 37 students from Grade 10 B studying Science at St. Joseph High School, Barhalganj, India	Science academic performance test (administered as pre-test and post-test)	Independent samples *t*-test
6.	To determine if there is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India	A convenience sample of 35 students from Grade 10 A and 37 students from Grade 10 B studying Science at St. Joseph High School, Barhalganj, India	Students' Leisure Interest in Science Questionnaire (administered as pre-test and post-test)	Independent samples *t*-test

CHAPTER IV

RESEARCH FINDINGS

In the previous chapters, the researcher explained the purpose and importance of the study, provided a literature review and discussed how this study was carried out. In this chapter, the researcher provides the findings from the statistical analysis on the data collected from 35 students of Grade 10 A and 37 students of Grade 10 B at St. Joseph High School in India, in the academic year of 2021-2022. This quantitative research was carried out to compare Grades 10 A and Grade 10 B classes (one under the laboratory-based method and the other under the textbook-based method), in terms of Science academic performance and leisure interest in Science.

Main Findings

In the following sections, the main findings of this study are presented in detail, according to the research objectives.

Findings From Research Objective 1

Research Objective 1 of the study was to determine the levels of academic performance in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India. In order to achieve Research Objective 1, the researcher used the Science academic performance test for Grade 10 students, as pre- and post-test. The exam consisted of 22 questions, of which Questions 1 to 15, which were either multiple choice questions (MCQ), very short answer type questions (VSA), or assertion-reason type questions, worth 1 point each. Questions 16 to 20, which were short answer type questions, worth 2 marks each. Questions 21 to 22, which were long

answer type questions, worth 2.5 marks each.

Table 10 displays the descriptive statistics summarizing the Science academic performance test scores obtained by the Grade 10 students participating in this study as part of the experimental group.

Table 10

Frequency Distribution and Overall Mean Score, Standard Deviation, and Interpretation of Grades 10 Students' Science Academic Performance Before and After Learning Through Laboratory-Based Method at St. Joseph High School, Barhalganj, India

Science academic performance interpretation	Score range	Before learning through laboratory-based method		After learning through laboratory-based method	
		f	%	*f*	%
Excellent	28-30	3	8.60	2	5.60
Very good	24-27	5	14.30	10	28.60
Good	20-23	15	42.90	22	62.90
Satisfactory	15-19	12	34.40	1	2.90
Failed	< 15	0	0	0	0
Descriptive statistics					
Minimum		15		19	
Maximum		29		29	
M		21.29		23.46	
SD		3.68		2.32	

Note. See Table 3 (p. 39) for the interpretation table.

As shown in Table 10, before learning through laboratory-based method, the level of Science academic performance was excellent for three students (8.60% of the study sample) participating in this study. Moreover, 5 students (14.30% of the study sample) performed at a very good level of Science academic performance, 15 students (42.90% of the study sample) exhibited a good level of science academic performance, 12 students (34.40% of the study sample) performed at a satisfactory level of Science academic performance, and no student (0% of the study sample) exhibited a failing level of Science academic performance.

Furthermore, Table 10 also shows that, before learning through laboratory-based

method, the overall mean score obtained by the participants in the Science academic performance test of Grade 10 at St. Joseph High School, Barhalganj, India, was *M* = 21.29 points, which was interpreted as a good level of science academic performance. The overall standard deviation of such scores was *SD* = 3.68 points, which means that, on average, participants' scores fluctuated 3.68 points from the mean. The Science academic performance test scores obtained by the Grade 10 students in the experimental group at St. Joseph High School, Barhalganj, India, participating in this study ranged from 15 to 29 points.

After learning through laboratory-based method, the level of science academic performance was excellent for two students (5.60% of the study sample) participating in this study. Moreover, 10 students (28.60% of the study sample) performed at a very good level of science academic performance, 22 students (62.90% of the study sample) exhibited a good level of science academic performance, 1 student (2.90% of the study sample) performed at a satisfactory level of science academic performance, and no student (0% of the study sample) exhibited a level of science academic performance that failed.

Moreover, Table 10 also shows that, after learning through laboratory-based method, the overall mean score obtained by the participants in the Science academic performance test of Grade 10 at St. Joseph High School, Barhalganj, India, was *M* = 23.46 points, which was interpreted as a very good level of science academic performance. The overall standard deviation of such scores was *SD* = 2.32 points, which means that, on average, participants' scores fluctuated 2.32 points from the mean. The Science academic performance test scores obtained by the Grade 10 students in the experimental group at St. Joseph High School, Barhalganj, India, participating in this study ranged from 19 to 29 points.

Findings From Research Objective 2

Research Objective 2 was to determine the levels of academic performance in Science

of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India. In order to achieve Research Objective 2, the researcher used the Science academic performance test for Grade 10 students, as pre- and post-test. The exam consisted of 22 questions, of which Questions 1 to 15, which were either multiple choice questions (MCQ), very short answer type questions (VSA), or assertion-reason type questions, worth 1 point each. Questions 16 to 20, which were short answer type questions, worth 2 marks each. Questions 21 to 22, which were long answer type questions, worth 2.5 marks each.

Table 11 displays the descriptive statistics summarizing the Science academic performance test scores obtained by the Grade 10 students participating in this study as part of the control group.

Table 11

Frequency Distribution and Overall Mean Score, Standard Deviation, and Interpretation of Grades 10 Students' Science Academic Performance Before and After Learning Through Textbook-Based Method at the St. Joseph High School

Science academic performance interpretation	Score range	Before learning through textbook-based method		After learning through textbook-based method	
		f	%	*f*	%
Excellent	28-30	0	0	2	5.40
Very good	24-27	6	16.20	5	13.50
Good	20-23	13	35.10	13	35.10
Satisfactory	15-19	16	43.20	16	43.30
Failed	< 15	2	5.4	1	2.70
		Descriptive statistics			
Minimum		11		11	
Maximum		27		29	
M		20.14		20.78	
SD		3.41		3.62	

Note. See Table 3 (p. 39) for the interpretation table

As shown in Table 11, before learning through textbook-based method, the level of Science academic performance was excellent for no students (0% of the study sample)

participating in this study. Moreover, 6 students (16.20% of the study sample) performed at a very good level of Science academic performance, 13 students (35.10% of the study sample) exhibited a good level of Science academic performance, 16 students (43.30 % of the study sample) performed at a satisfactory level of Science academic performance, and 2 students (5.40% of the study sample) exhibited a level of science academic achievement that failed.

Furthermore, Table 11 also shows that, before learning through textbook-based method, the overall mean score obtained by the participants in the Science academic performance test of Grade 10 at the St. Joseph High School, India was $M = 20.14$ points, which was interpreted as a good level of science academic performance. The overall standard deviation of such scores was $SD = 3.41$ points, which means that, on average, participants' scores fluctuated 3.41 points from the mean. The Science academic performance test scores obtained by the Grade 10 students in the control group at the St. Joseph High School, India, participating in this study ranged from 11 to 27 points.

After learning through textbook-based method, the level of science academic performance was excellent for two students (5.4% of the study sample) participating in this study. Moreover, 5 students (13.50% of the study sample) performed at a very good level of Science academic performance, 13 students (35.10% of the study sample) exhibited a good level of Science academic performance, 16 students (43.20% of the study sample) performed at a satisfactory level of science academic performance, and 1 student (2.7% of the study sample) exhibited a level of Science academic performance that failed.

Moreover, Table 11 also shows that, after learning through textbook-based method, the overall mean score obtained by the participants in the Science academic performance test of Grade 10 at the St. Joseph High School, India, was $M = 20.78$ points, which was interpreted as a good level of science academic performance. The overall standard deviation of such scores was $SD = 3.62$ points, which means that, on average, participants' scores

fluctuated 3.62 points from the mean. The Science academic performance test scores obtained by the Grade 10 students in the control group at the St. Joseph High School, India, participating in this study ranged from 11 to 29 points.

Findings From Research Objective 3

Research Objective 3 was to determine the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India. In order to address Research Objective 3, the researcher administered, as pre-test and post-test, the Students' Leisure Interest in Science Questionnaire (SLISQ), a 10-item instrument adopted from one of the seven measures included in the Test of Science-Related Attitudes (TOSRA; Fraser, 1981). The instrument consisted of 10 items, five of them positively worded (i.e., Items 1, 3, 5, 7, and 9), and the other five negatively worded (i.e., Items 2, 4, 6, 8, and 10). All the items were rated on a 5-point Likert scale ranging from 1 to 5 (1 = *strongly disagree*; 2 = *disagree*; 3 = *neutral*; 4 = *agree*; 5 = *strongly agree*).

Table 12 displays the overall mean scores, standard deviations and interpretations of levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India. For the purpose of data analysis, all negatively-worded items were reverse coded, in order to standardize the directionality of the interpretation.

Table 12

Mean Scores, Standard Deviations and Interpretations of Levels of Leisure Interest in Science of Grade 10 Students Before and After Learning Through Laboratory-Based Method at St. Joseph High School, Barhalganj, India

Experimental stage	*N*	*M*	*SD*	Interpretation
Before the experiment	35	3.13	1.06	Moderate
After the experiment	35	3.34	1.14	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

On average, the students' levels of leisure interest in Science of Grade 10 students before laboratory-based method in the experimental group was $M = 3.13$ ($SD = 1.06$), the students' levels of leisure interest in Science after the laboratory-based method was $M = 3.34$ ($SD = 1.14$). The difference between the means showed an increase in mean outcome of 3.34 – 3.13 = 0.21 units. On average, students' level of leisure interest in Science under laboratory-based method in the experimental group was numerically higher than the level exhibited before using the method.

Findings regarding Research Objective 3 are presented in detail in the following sections.

Before Using the Laboratory-Based Learning Method

Table 13 displays the overall mean scores, standard deviations and interpretations of the level of leisure interest in Science of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

Table 13

Mean Scores, Standard Deviations and Interpretations of the Level of Leisure Interest in Science of Grade 10 Students Before Learning Through Laboratory-Based Method at St. Joseph High School, Barhalganj, India

Item No.	Statement	*M*	*SD*	Interpretation
1	I would like to belong to a science club	3.60	.69	High
2	I get bored when watching science programs on TV at home	3.66	.93	High
3	I would like to be given a science book or a piece of scientific equipment as a present	3.06	1.16	Moderate
4	I dislike reading books about science during my holidays	2.89	1.08	Moderate
5	I would like to do science experiments at home	2.80	1.11	Moderate
6	Talking to friends about science after school would be boring	3.00	1.37	Moderate
7	I would enjoy having a job in a science laboratory during my school holidays	3.23	.84	Moderate
8	Listening to talk about science on the radio or the internet would be boring	2.77	1.03	Moderate
9	I would enjoy visiting a science museum at the weekend	3.77	.73	High
10	I dislike reading newspapers or web articles about science	2.54	1.44	Moderate
Overall (Leisure interest in science class)		3.13	1.06	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

As shown in Table 13, Grade 10 students from the experimental group expressed, before using the laboratory-based learning method, a moderate level of leisure interest in Science class regarding the statements made in Items 3, 4, 5, 6, 7, 8 and 10 (e.g., “I dislike reading books about science during my holidays” [Item 4], “I would like to do science experiments at home” [Item 5]). Moreover, before using the laboratory-based learning method, participants from the experimental group were found to have a high level of leisure interest in Science in relation to the aspects stated in Items 1, 2, and 9 (e.g., “I get bored when watching science programs on TV at home” [Item 2]; “I would enjoy visiting a science museum at the weekend” [Item 9]).

As presented in Table 13, the overall mean score of Grade 10 students' level of leisure interest in Science before learning through the laboratory-based method at St. Joseph High School, Barhalganj, India, was $M = 3.13$, which was interpreted as moderate. In other words, the Grade 10 students of St. Joseph High School, Barhalganj, India, hold a moderate level of the leisure interest in Science before learning through laboratory-based method.

After Using the Laboratory-Based Learning Method

Table 14 displays the overall mean scores, standard deviations and interpretations of the level of leisure interest in Science of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

Table 14

Mean Scores, Standard Deviations and Interpretation of the Level of Leisure Interest in Science of Grade 10 Students After Learning Through Laboratory-Based Method at St. Joseph High School, Barhalganj, India

Item No.	Statement	*M*	*SD*	Interpretation
1	I would like to belong to a science club	3.88	.76	High
2	I get bored when watching science programs on TV at home	3.82	.82	High
3	I would like to be given a science book or a piece of scientific equipment as a present	3.14	1.22	Moderate
4	I dislike reading books about science during my holidays	2.94	1.11	Moderate
5	I would like to do science experiments at home	3.05	1.30	Moderate
6	Talking to friends about science after school would be boring	3.25	1.54	Moderate
7	I would enjoy having a job in a science laboratory during my school holidays	3.71	.86	High
8	Listening to talk about science on the radio or the internet would be boring	2.8	1.23	Moderate
9	I would enjoy visiting a science museum at the weekend	3.77	.84	High
10	I dislike reading newspapers or web articles about science	3.00	1.45	Moderate
Overall (Leisure interest in science class)		3.34	1.14	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

As presented in Table 14, Grade 10 students from the experimental group expressed, after using the laboratory-based learning method, a moderate level of leisure interest in science regarding the statements made in Items 3, 4, 5, 6, 8 and 10 (e.g., “I dislike reading books about science during my holidays” [Item 4], “I would like to do science experiments at home” [Item 5]). Moreover, after using the laboratory-based learning method, participants from the experimental group were found to have a high level of leisure interest in science in relation to the aspects stated in Items 1, 2, 7 and 9 (e.g., “I would enjoy having a job in a science laboratory during my school holidays” [Item 7]; “I would enjoy visiting a science museum at the weekend” [Item 9]).

As presented in Table 14, the overall mean score of Grade 10 students’ levels of leisure interest in science after learning through the laboratory-based method at St. Joseph High School, Barhalganj, India, was $M = 3.34$, which was interpreted as moderate. In other words, the Grade 10 students of St. Joseph High School, Barhalganj, India, hold a moderate level of leisure interest in science after learning through laboratory-based method.

Findings From Research Objective 4

Research Objective 4 was to determine the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India. In order to address Research Objective 4, the researcher administered, as pre-test and post-test, the Students’ Leisure Interest in Science Questionnaire (SLISQ), a 10-item instrument adopted from one of the seven measures included in the Test of Science-Related Attitudes (TOSRA; Fraser, 1981), to collect data on attitude toward the learning situation from participants in control group, before and after the learning through textbook-based method. The instrument consisted of 10 items, five of them positively worded (i.e., Items 1, 3, 5, 7, and 9), and the other five negatively worded (i.e., Items 2, 4, 6, 8, and

10). All the items were rated on a 5-point Likert scale ranging from 1 to 5 (1 = *strongly disagree*; 2 = *disagree*; 3 = *neutral*; 4 = *agree*; 5 = *strongly agree*).

Table 15 displays the overall mean scores, standard deviations and interpretations of levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India. For the purpose of data analysis, all negatively-worded items were reverse coded, in order to standardize the directionality of the interpretation.

Table 15

Mean Scores, Standard Deviations and Interpretations of the Levels of Leisure Interest in Science of Grade 10 Students Before and After Learning Through Textbook-Based Method at St. Joseph High School, Barhalganj, India

Experimental stage	*N*	*M*	*SD*	Interpretation
Before the experiment	37	3.05	1.23	Moderate
After the experiment	37	3.12	1.18	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

On average, the students' levels of leisure interest in Science of Grade 10 students in the control group before learning through the textbook-based method was $M = 3.05$ ($SD = 1.23$), the students' levels of leisure interest in science after learning with the textbook-based method was $M = 3.12$ ($SD = 1.18$). The difference between the means showed an increase in mean outcome of 3.12 – 3.05 = 0.07 units. On average, the students' level of leisure interest in science under textbook-based method in the control group was, from a numerical point of view, slightly higher than the one before using the method.

Findings regarding Research Objective 4 are presented in detail in the following sections.

Before Using the Textbook-Based Learning Method

Table 16 displays the overall mean scores, standard deviations and interpretations of

the level of leisure interest in Science of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India.

Table 16

Mean Scores, Standard Deviations and Interpretations of the Level of Leisure Interest in Science of Grade 10 Students Before Learning Through Laboratory-Based Method at St. Joseph High School, Barhalganj, India

Item No.	Statement	*M*	*SD*	Interpretation
1	I would like to belong to a science club	3.65	1.01	High
2	I get bored when watching science programs on TV at home	2.84	1.30	Moderate
3	I would like to be given a science book or a piece of scientific equipment as a present	2.62	1.18	Moderate
4	I dislike reading books about science during my holidays	2.35	1.27	Low
5	I would like to do science experiments at home	3.30	1.45	Moderate
6	Talking to friends about science after school would be boring	2.68	1.27	Moderate
7	I would enjoy having a job in a science laboratory during my school holidays	3.27	1.46	Moderate
8	Listening to talk about science on the radio or the internet would be boring	3.24	1.16	Moderate
9	I would enjoy visiting a science museum at the weekend	3.40	.76	Moderate
10	I dislike reading newspapers or web articles about science	3.19	1.31	Moderate
Overall (Leisure interest in science class)		3.05	1.23	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

As presented in Table 16, Grade 10 students from the control group expressed, before using the textbook-based learning method, a moderate level of leisure interest in science regarding the statements made in Items 2, 3, 5, 6, 7, 8, 9 and 10 (e.g., “I get bored when watching science programs on TV at home” [Item 2], “I would like to do science experiments at home” [Item 5]). Moreover, after using the textbook-based learning method, participants from the control group were found to have a high level of leisure interest in science in relation to the aspect stated in Item 1 (“I would like to belong to a science club”), and a low

level of leisure interest in science in relation to the aspect stated in Item 4 (“I dislike reading books about science during my holidays”).

As presented in Table 16, the overall mean score of Grade 10 students’ levels of leisure interest in science class before learning through the laboratory-based method at St. Joseph High School, Barhalganj, India, was $M = 3.05$, which was interpreted as moderate. In other words, the Grade 10 students of St. Joseph High School, Barhalganj, India, hold a moderate level of leisure interest in science before learning through textbook-based method.

After Using the Textbook-Based Learning Method

Table 17 displays the overall mean scores, standard deviations and interpretations of level of leisure interest in Science of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India.

Table 17

Mean Scores, Standard Deviations and Interpretation of the Level of Leisure Interest in Science of Grade 10 Students After Learning Through Textbook-Based Method at St. Joseph High School, Barhalganj, India

Item No.	Statement	*M*	*SD*	Interpretation
1	I would like to belong to a science club	3.65	.95	High
2	I get bored when watching science programs on TV at home	2.89	1.26	Moderate
3	I would like to be given a science book or a piece of scientific equipment as a present	2.70	1.08	Moderate
4	I dislike reading books about science during my holidays	2.46	1.24	Low
5	I would like to do science experiments at home	3.49	1.41	Moderate
6	Talking to friends about science after school would be boring	2.78	1.23	Moderate
7	I would enjoy having a job in a science laboratory during my school holidays	3.35	1.36	Moderate
8	Listening to talk about science on the radio or the internet would be boring	3.32	1.08	Moderate
9	I would enjoy visiting a science museum at the weekend	3.19	.81	Moderate

(continued)

(continued)

Item No.	Statement	*M*	*SD*	Interpretation
10	I dislike reading newspapers or web articles about science	3.38	1.23	Moderate
Overall (Leisure interest in science class)		3.12	1.18	Moderate

Note. See Table 4 (p. 40) for the interpretation table.

As presented in Table 17, Grade 10 students from the control group expressed, after using the textbook-based learning method, a moderate level of leisure interest in science regarding the statements made in Items 2, 3, 5, 6, 7, 8, 9 and 10 (e.g., "I get bored when watching science programs on TV at home" [Item 2], "I would like to do science experiments at home" [Item 5]). Moreover, after using the textbook-based learning method, participants from the control group were found to have a high level of leisure interest in science in relation to the aspect stated in Item 1 ("I would like to belong to a science club") and a low levels of leisure interest in science in relation to the aspect stated in Item 4 ("I dislike reading books about science during my holidays").

As shown in Table 17, the overall mean score of Grade 10 students' levels of leisure interest in science class after learning through the textbook-based method at St. Joseph High School, Barhalganj, India, was $M = 3.12$, which was interpreted as moderate. In other words, the Grade 10 students of St. Joseph High School, Barhalganj, India, hold a moderate level of leisure interest in science after learning through textbook-based method.

Findings From Research Objective 5

Research Objective 5 was to determine if there was a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. In order to address Research Objective 5, the researcher used the data collected before and after the experimental period using the pre-test scores and post-test

scores of Grade 10 students' academic performance in Science learning under laboratory-based method and those learning under textbook-based method, respectively, and conducted an independent samples *t*-test to compare the experimental group and the control group in their overall gains in academic performance in Science subject, from the pre-test to the post-test. The researcher used the independent samples *t*-test because this method allowed for a comparison between two unrelated, independent groups with respect to an average score for each group.

Table 18 shows the results of conducting an independent samples *t*-test comparing the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

Table 18

Results of the Independent Samples t-Test Comparing Grade 10 Students' Gain in Academic Performance in Science Learning Under Laboratory-Based Method and Those Learning Under Textbook-Based at St. Joseph High School, Barhalganj, India

Group	*N*	M_{before} (SD_{before})	M_{after} (SD_{after})	M_{gain} (SD_{gain})	*df*	*t*	*p*
Experimental group (Laboratory-based method)	35	21.29 (3.68)	23.46 (2.32)	2.17 (3.71)	70	1.52	.134
Control group (Textbook-based method)	37	20.14 (3.41)	20.78 (3.62)	0.65 (4.71)			

The analysis of the results from the independent samples *t*-test shown in Table 18 failed to reveal a significant difference in Grade 10 students' gain in academic performance in Science learning under laboratory-based method and those learning under textbook-based method, $t(70) = 1.52$, $p = .134$. Therefore, no significant difference was found in Grade 10 students' gain in academic performance in Science learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India

(for the experimental group, $M = 2.17$, $SD = 3.71$; for the control group, $M = 0.65$, $SD = 4.71$).

Findings From Research Objective 6

Research Objective 6 was to determine if there was a significant difference in the gain in leisure interest in science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. In order to address Research Objective 6, the researcher used the data collected before and after the experimental period using the pre-test scores and post-test scores in the Students' Leisure Interest in Science Questionnaire (SLISQ) obtained by Grade 10 students learning under laboratory-based method and those learning under textbook-based method, respectively, and conducted an independent samples *t*-test to compare the experimental group and the control group in their overall gains in leisure interest in science, from the pre-test to the post-test. The researcher used the independent samples *t*-test because this method allowed for a comparison between two unrelated, independent groups with respect to an average score for each group.

Table 19 shows the results of the independent samples *t*-test comparing the gain in leisure interest in science between Grade 10 students learning under laboratory-based method and those learning under textbook-based at St. Joseph High School, Barhalganj, India.

Table 19

Results of The Independent Samples t-Test Comparing Grade 10 Students' Gain in Leisure Interest in Science Learning Under Laboratory-Based Method and Those Learning Under Textbook-Based Method at St. Joseph High School, Barhalganj, India

Group	*N*	M_{before} (SD_{before})	M_{after} (SD_{after})	M_{gain} (SD_{gain})	*df*	*t*	*p*
Experimental group (Laboratory-based method)	35	3.13 (1.06)	3.34 (1.14)	.21 (.58)	70	1.18	.240
Control group (Textbook-based method)	37	3.05 (1.23)	3.12 (1.18)	.07 (.43)			

The analysis of the results of the independent samples *t*-test shown in Table 19 failed to reveal a significant difference in comparing Grade 10 students' gain in leisure interest in Science class learning under laboratory-based method and those learning under textbook-based method, $t(70) = 1.18$, $p = .240$. Therefore, no significant difference was found in the gain in leisure interest in science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India (for the experimental group, $M = .21$, $SD = .58$; for the control group, $M = 0.07$, $SD = .43$).

CHAPTER V

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

In the previous chapter, the researcher presented the findings of this quantitative study examining the academic performance and leisure interest in science held by Grade 10 students learning through laboratory-based method and textbook-based method at St. Joseph High School, Barhalganj, India. In this chapter, the researcher presents the summary of the study, summary of findings, conclusions from the researcher's perspective, a general discussion of the obtained results, and recommendations for students, teachers, school administrators, and future researchers.

Summary of the Study

The purpose of this study was twofold: to determine whether there was a significant difference in the gain in academic performance in science, as well as in the gain in leisure interest in science, between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. For this purpose, the researcher designed a quantitative comparative study, and a quasi-experimental research design was implemented, using two conveniently-chosen groups of Grade 10 students from the target school. The experimental group was taught using laboratory-based learning method, while the control group was taught using the textbook-based learning method.

The following were the research objectives guiding this study, in order to address the research purpose.

1. To determine the levels of academic performance in Science of Grade 10

students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.

2. To determine the levels of academic performance in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.
3. To determine the levels of leisure interest in Science of Grade 10 students before and after learning through laboratory-based method at St. Joseph High School, Barhalganj, India.
4. To determine the levels of leisure interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.
5. To determine if there is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.
6. To determine if there is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook- based method at St. Joseph High School, Barhalganj, India.

In order to address the aforementioned research objectives, a quasi-experimental study was conducted, in which 35 students from Grade 10 A were randomly assigned to the experimental group, learning under laboratory-based method, and 37 students from Grade 10 B were randomly assigned to the control group, learning under textbook-based method.

The duration of the study was a period of 4 weeks, with a 50-minute session every weekday for both the laboratory-based and textbook-based learning methods during June

2022. The data were collected by the researcher herself, who served as the Science teacher for both groups. During the experimental period, the same topics were taught to both groups, according to the school Science curriculum, but with the only difference being the teaching method used to deliver the instruction.

The materials used in the lessons were aligned to the Indian Science curriculum and planned out to deliver the same instructional content as in the other Grade 10 Science classes, by using knowledge from the Grade 10 Science textbook developed by the National Council of Educational Research and Training (NCERT). The intervention was designed to deliver knowledge on Grade 10 Science textbook's Chapter 10 (Light-Reflection and Refraction) and Chapter 13 (Magnetic Effects and Electric Current). In addition to using the textbook as instructional material, the researcher also used laboratory activities with the experimental group.

The variables were measured using two sets of instruments, which were he Science academic performance test and the Students' Leisure Interest in Science Questionnaire, respectively. The participants' responses to these two instruments were then collected and quantitatively analyzed through a statistical software package, using descriptive statistics (frequencies, percentages, means and standard deviations) to determine the level of each variable stated in Research Objectives 1-4. As for Research Objectives 5-6, the data were analyzed using comparative analysis (performing independent samples *t*-tests), in order to determine if there was a significant difference in gain in academic performance in Science and gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

Summary of the Findings

In this section the findings obtained from the quantitative analysis on the collected data are summarized. The findings are organized and presented by research objective.

Findings From Research Objective 1

Regarding to this research objective, the following findings were obtained after the researcher used the Science academic performance test for Grade 10 A students, as pre- and post-test, before and after they learned through laboratory-based method, and analyzed the collected data using descriptive statistics (frequencies, percentages, means and standard deviations).

- The level of academic performance in Science of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was excellent for three students, very good for five students, good for 15 students, and satisfactory for 12 students.
- The overall level of academic performance in Science of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.
- The level of academic performance in Science of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was excellent for two students, very good for 10 students, good for 22 students, and satisfactory for one student.
- The overall level of academic performance in Science of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.

Findings From Research Objective 2

Regarding to this research objective, the following findings were obtained after the researcher used the Science academic performance test for Grade 10 B students, as pre- and post-test, before and after they learned through textbook-based method, and analyzed the collected data using descriptive statistics (frequencies, percentages, means and standard deviations).

- The level of academic performance in Science of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was very good for six students, good for 13 students, satisfactory for 16 students, and failed for 2 students.
- The overall level of academic performance in Science of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.
- The level of academic performance in Science of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India, was excellent for two students, very good for five students, good for 13 students, satisfactory for 16 students, and failed for 1 student.
- The overall level of academic performance in Science of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.

Findings From Research Objective 3

Regarding to this research objective, the following findings were obtained after the researcher analyzed the data collected from the administration on the Grade 10 A students, as pre-test and post-test, of the Students' Leisure Interest in Science Questionnaire (SLISQ),

before and after they learned through laboratory-based method.

- The level of leisure interest in Science of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was moderate.
- The level of leisure interest in Science of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was moderate.

Findings From Research Objective 4

Regarding to this research objective, the following findings were obtained after the researcher analyzed the data collected from the administration on the Grade 10 B students, as pre-test and post-test, of the Students' Leisure Interest in Science Questionnaire (SLISQ), before and after they learned through textbook-based method.

- The level of leisure interest in Science of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was moderate.
- The level of leisure interest in Science of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India, was moderate.

Findings From Research Objective 5

Regarding to this research objective, the following finding was obtained after the researcher performed an independent samples *t*-test on the data collected from the administration on the experimental and control groups, as pre-test and post-test, of the Science academic performance test, before and after the intervention was conducted.

- There was no significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

Findings From Research Objective 6

Regarding to this research objective, the following finding was obtained after the researcher performed an independent samples *t*-test on the data collected from the administration on the experimental and control groups, as pre-test and post-test, of the Students' Leisure Interest in Science Questionnaire (SLISQ), before and after the intervention was conducted.

- There was no significant difference in the gain in leisure interest in science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.

Conclusions

In this section, the researcher presents the main conclusions drawn from the obtained results.

Conclusions From Research Objective 1

Regarding to this research objective, the following conclusions were drawn.

- The level of demonstration of understanding of the information learned in the Science class of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was excellent for three students, very good for five students, good for 15 students, and satisfactory for 12

students.

- The overall level of demonstration of understanding of the information learned in the Science class of Grade 10 students before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.
- The level of demonstration of understanding of the information learned in the Science class of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was excellent for two students, very good for 10 students, good for 22 students, and satisfactory for one student.
- The overall level of demonstration of understanding of the information learned in the Science class of Grade 10 students after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.

Conclusions From Research Objective 2

Regarding to this research objective, the following conclusions were drawn.

- The level of demonstration of understanding of the information learned in the Science class of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was very good for six students, good for 13 students, satisfactory for 16 students, and failed for 2 students.
- The overall level of demonstration of understanding of the information learned in the Science class of Grade 10 students before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.
- The level of demonstration of understanding of the information learned in the Science class of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India, was excellent for two students, very

good for five students, good for 13 students, satisfactory for 16 students, and failed for 1 student.

- The overall level of demonstration of understanding of the information learned in the Science class of Grade 10 students after learning through textbook-based method at St. Joseph High School, Barhalganj, India, was interpreted as good.

Conclusions From Research Objective 3

Regarding to this research objective, the following conclusions were drawn.

- The level of concern or psychological involvement to which Grade 10 students engage and spend time in science-related activities in their leisure time before learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was moderate.
- The level of concern or psychological involvement to which Grade 10 students engage and spend time in science-related activities in their leisure time after learning through laboratory-based method at St. Joseph High School, Barhalganj, India, was moderate.

Conclusions From Research Objective 4

Regarding to this research objective, the following conclusions were drawn.

- The level of concern or psychological involvement to which Grade 10 students engage and spend time in science-related activities in their leisure time before learning through textbook-based method at St. Joseph High School, Barhalganj, India, was moderate.
- The level of concern or psychological involvement to which Grade 10 students engage and spend time in science-related activities in their leisure time after

learning through textbook-based method at St. Joseph High School, Barhalganj, India, was moderate.

Conclusions From Research Objective 5

Regarding to this research objective, the following conclusion was drawn.

- There was no significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. Therefore, the teaching method under which Grade 10 students from the target school were learning Science appears to have no significant effect on their gain in academic performance in Science.

Conclusions From Research Objective 6

Regarding to this research objective, the following conclusion was drawn.

- There was no significant difference in the gain in leisure interest in science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. Therefore, the teaching method under which Grade 10 students from the target school were learning Science appears to have no significant effect on their gain in leisure interest in science.

Discussion

In the following sections, the researcher presents a discussion of the research findings obtained from conducting the current study, by relating them with the findings reported by previous research studies.

Academic Performance in Science

Regardless of the treatment under which the Grade 10 students from the target school were learning, the overall level of academic performance in Science before and after either treatment was found to be good. Therefore, the demonstration of understanding of the information learned in the Science class of Grade 10 students before and after learning through either of the methods at St. Joseph High School, Barhalganj, India, was consistently good. In other words, before and after learning through either of the methods, there was no statistical difference improvement in the overall level of academic performance in Science in the target group of Grade 10 students at St. Joseph High School, Barhalganj, India. This is not in line with the results reported by Olubu (2015) and Mulinge (2017), who found that teaching science using a laboratory learning environment had a significant effect on secondary school students' academic performance. Also, Yadav and Mishra (2013) reached to the same conclusion on a sample of Indian university students enrolled in the General Physics Laboratory-I course. The reason why the results of the current study are different to those reported by previous ones might be the level of attendance and participation at science-related program elements (e.g., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, and communicating findings) by the participants, which have been reported to be significantly, positively and weakly correlated to science academic performance of English Grade 11 students (Zandstra, 2012). In the case of Zandstra (2012), she conducted her study after the participants were involved in a science project for six years, and still found a weak correlation between science academic performance and attendance at science-related program elements. Therefore, a possible explanation for the findings obtained in the current study could be that a longer period of intervention might be needed, in order to be able to appreciate a significant effect of laboratory-based activities on the students' academic

performance in Science. Teaching science using a laboratory learning environment had a numerical effect on secondary school students' academic performance, but a longer period of intervention might be needed to appreciate a significant effect (Yadav & Mishra, 2013; Zandstra, 2012). Moreover, a poor academic performance in Science can be due to the lack of integration of experiments in Science class (McWhorter & Hudson-Ross, 1996).

Leisure Interest in Science

In a similar fashion to that of the academic performance in Science, the results of the current study revealed that, regardless of the treatment under which the Grade 10 students from the target school were learning, the overall level of leisure interest in science before and after either treatment was found to be moderate. Therefore, the level of concern or psychological involvement to which Grade 10 students engage and spend time in science-related activities in their leisure time before and after learning through either of the methods at St. Joseph High School, Barhalganj, India, was consistently moderate. In other words, before and after learning through either of the methods, there was no statistical difference improvement in the overall level of leisure interest in Science in the target group of Grade 10 students at St. Joseph High School, Barhalganj, India. The reason for these results could be rooted on the nature of the effort put into the laboratory-based activities and textbook-based activities by the participants. According to Darlington (2017), there is a significant, moderately strong and positive correlation between a students' effort put into the science lesson and their science interest level. Thus, it is possible that the level of effort put into the activities under both approaches was not that different, and then no significant effect was seen on the participants' leisure interest in science. Also, the participants may have the perception that, regardless of being using laboratory-based activities, still the teacher should make the lessons more interesting. Darlington (2017) found a significant, moderately strong and negative correlation between English Grade 11 students' strength of agreement with

teachers should make the lessons interesting and their level of interest in science.

Another reason for the current results can be the level of attendance and participation in science program elements (i.e., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, and communicating findings) while learning under laboratory-based method. According to Zandstra (2012), there is a significant and positive correlation between students the attendance in science program elements (e.g., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, communicating findings) and the level of science interest than Grade 11 students exhibit.

Research has shown that science attitudes (e.g., leisure interest in science) are correlated with age. Sorge (2007) found that students' science attitude decreases slightly as age (9-14 years) increases. Moreover, George (2007) reported that children in primary levels have a more positive attitude and feelings toward science, which become less positive as their age increases.

Recommendations

Based on the findings of the current comparative study, the researcher would like to provide recommendations for students, teachers, school administrators and future researchers.

Recommendations for Students

The findings of this study revealed that, before and after the intervention, Grade 10 students under both treatments at St. Joseph High School, Barhalganj, India, had a good level of Science academic performance. Moreover, there was no significant increase in the gain in Science academic performance after the intervention, although a slight numerical increase occurred for both groups, being the most noticeable one the numerical increase in gain in

Science academic performance for the group learning under laboratory-based method. Therefore, in order for students to raise their academic performance in Science from good to very good or excellent, the researcher suggests that students should try to engage in science using the laboratory approach for a long term, especially outside the classroom, during their leisure time. In four weeks and 15 class sessions, the participants learning under laboratory-based method had a gain in Science academic performance of 2.17 units (see Table 18). It has been reported in the literature that long-term and consistent implementations over time of laboratory-based interventions in Science class will produce significant effects on learning (e.g., Mulinge, 2017; Yadav & Mishra, 2013).

The findings of this study also showed that, before and after the intervention, Grade 10 students learning under both laboratory-based and textbook-based methods at St. Joseph High School, Barhalganj, India, had a moderate level of leisure interest in science. Before and after the intervention, the items on the questionnaire that received the lowest overall mean score from participants learning under laboratory-based method were Items 4 (“I dislike reading books about science during my holidays”), 5 (“I would like to do science experiments at home”), 8 (“Listening to talk about science on the radio or the internet would be boring”), and 10 (“I dislike reading newspapers or web articles about science”). Before and after the intervention, participants learning under textbook-based method gave the lowest scores on the SLISQ to Items 2 (“I get bored when watching science programs on TV at home”), 3 (“I would like to be given a science book or a piece of scientific equipment as a present”), 4 (“I dislike reading books about science during my holidays”), and 10 (“I dislike reading newspapers or web articles about science”).

From these findings, the researcher suggests that students under both experimental conditions may engage in the behaviors stated in the items with lowest mean scores in the SLISQ, and hence try to read books, newspapers or web articles about science, do science

experiments, or listening to radio programs or web podcasts about science in their leisure time, in order to increase their level of leisure interest in science.

Recommendations for Teachers

In order to contribute with improvement of the students' academic performance and leisure in interest in Science, the researcher suggests that the teachers can modify their teaching and shift from a textbook-based method to a more laboratory-based one, by including instructional elements such as those indicated in the items on the SLISQ that received the lowest overall mean score from participants. Therefore, the researcher would like to suggest to the teachers to create learning environments that are more engaging in their Science classes, by incorporating more laboratory activities or work, which may ultimately boost students' academic performance and leisure interest in science (e.g., Mulinge, 2017; Yadav & Mishra, 2013; Zandstra, 2012). Teachers can achieve this by including instructional activities that require students to read books, newspapers or web articles about science, do experiments and laboratory work instead of using only the textbook in Science class, or asking students to listen to radio programs or web podcasts about science in their leisure time or as homework, in order to increase their level of leisure interest in science, which may have a positive impact on their academic performance in Science (Yadav & Mishra, 2013; Zandstra, 2012).

Recommendations for the School Administrators

The school administrators should encourage and prepare the teachers at the target school to use more laboratory activities or work in their Science classes. For that purpose, school administrators could organize training and professional development sessions for teachers to get them prepared to implement laboratory-based instructional methods in the Science classroom, as a complement of using the textbook. The administrators should encourage teachers to implement laboratory-based activities and

environment in their Science classrooms, so that students are not restricted to teacher-centered methods all the time.

Recommendations for Future Researchers

This research was conducted only with the Grade 10 students from St. Joseph High School, Barhalganj, India. Therefore, the findings of this study may not be generalized with other schools, and can be only guide actions on schools with a similar student profile to the target school. Then, for future researchers who are interested in examining the students' academic performance and leisure interest in science through laboratory-based and traditional teacher-centered approaches such as the textbook-based method, the researcher suggests them to conduct studies on different types of schools and on a wider range of grade levels (i.e., cross-sectional studies), in order to obtain more generalizable results, and also to be able to characterize and identify trends, across both grade levels and different types of schools, in the behavior of the variables addressed in this study.

Moreover, future researchers may consider conducting longitudinal studies to extend the results from the current study, and in so doing, it will be possible to investigate the change, development or the course over time of the variables addressed in this study.

Furthermore, in terms of the research variables considered in the present study, it was found that the teaching method under which Grade 10 students from the target school were learning Science appeared to have no significant effect on their gain in academic performance and leisure interest in science. Some previous studies (e.g., Zandstra, 2012) were carried out during an entire school year, while others (e.g., Mishra & Yadav, 2013) were completed in a duration of 10 days and found significant difference in academic performance and leisure interest in science between the experimental and control groups. Since the current study was conducted in four weeks, the researcher suggests that future researchers may consider to conduct the intervention for a longer period of time, in order to verify whether using either

laboratory-based or textbook-based method has a significant effect on secondary school students' gain in academic performance and leisure interest in science.

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APPENDIXES

APPENDIX A:

Science Academic Performance Test

Grade 10 Science Academic Performance Test

Students' Version Sample

St. Joseph High School, Barhalganj

Academic Year 2021-22

Subject: Science

Name:_____**Class:**_____

	Question Type	Number of Questions	Marks
Part I	**Multiple Choice /Very short answer questions**	**15**	**1 point each**
Part II	**Short answer questions**	**10**	**2 point each**
Part III	**Long answer questions**	**5**	**3 point each**
Total		**30**	**50**

Part I: Multiple choice / Very short answer questions (1-15).

Direction: Read the questions carefully and circle the correct the answers

1. When a plane mirror is rotated through a certain angle, the reflected ray turns through twice as much and the size of the image:

   (a) is doubled

   (b) is halved

   (c) becomes infinite

   (d) remains same

2. Focal length of a plane mirror is

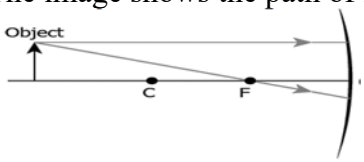
   (a) 0

   (b) infinite

   (c) 25 cm

   (d) -25 cm

3. The image shows the path of incident rays to a concave mirror.



   Where would the reflected rays meet for the image formation to take place?

   (a) behind the mirror

   (b) between F and O

   (c) between C and F

   (d) beyond C

4. A 10 mm long awl pin is placed vertically in front pin is formed at 30cm in front of the mirror. The focal length of this mirror is:

   (a) -30cm

   (b) -20cm

   (c) -40cm

   (d) -60cm

5. The swimming pool appears to be less deep than it actually is. Which phenomenon is responsible for this?

6. Which mirror can form a real image of an object?

7. A 3 cm high object is placed at a distance of 80 cm from a concave lens of focal length 20 cm. Find the size of the image formed?

8. Light travel fastest in
   (a) water

   (b) air

   (c) glass

   (d) diamond

9. When a straight conductor is carrying current:

   (a) There are circular magnetic field lines around it

   (b) There are magnetic field lines parallel to the conductor

   (c) There are no magnetic field lines

   (d) None of the above

10. Two magnetic field lines:

    (a) Intersect at neutral point

    (b) Never intersect each other

    (c) Intersect near north-pole or south pole

    (d) Intersect at the midpoint of the magnet.

11. Which of the following statements is incorrect regarding magnetic field lines?

    (a) The direction of the magnetic field at a point is taken to be the direction in which the north pole of a magnetic compass needle points.

    (b) Magnetic field lines are closed curves.

    (c) If magnetic field lines are parallel and equidistant, they represent zero field strength.

    (d) Relative strength of magnetic field is shown by the degree of closeness of the field lines.

12. Assertion (A): As the speed of the coil in the motor increases, there is reduction in the current flowing through it.

    Reason (R): During rotation in an electric motor, some induced current is produced.

    (a) (A) is incorrect and (R) is correct.

    (b) (A) is correct and (R) is incorrect.

    (c) Both (A) and (R) are correct but (R) is not the correct explanation of (A).

    (d) Both (A) and (R) are correct but (R) is the correct explanation of (A).

13. Choose the incorrect statement
    (a) Fleming's right-hand rule is a simple rule to know the direction of induced current.

    (b) The right-hand thumb rule is used to find the direction of magnetic fields due to current carrying conductors.

    (c) The difference between the direct and alternating currents is that the current always flows in one direction, whereas the alternating current reverses its direction periodically.

    (d) In India, the AC changes direction after every 1/50 second.

14. To avoid the risk of electric shock, which phenomenon is used?

15. Which rule determines the direction of the magnetic field due to a current carrying conductor?

PART 2 Short answer questions (16-25)

16. One student uses a lens of focal length +50 cm and another of −50 cm. State nature and find the power of each lens. Which of the two lenses will always give a virtual and diminished image irrespective of the position of the object?

17. State laws of reflection.

18. What are the values of angle of incidence ∠i and angle of reflection ∠r for normal incidence of light on a plane mirror?

19. Define the principal focus of a concave mirror.

20. Define relative refractive index of a medium.

21. Why does a compass needle deflect when brought near a bar magnet?

22. Write two ways to induce current in a coil?

23. Name and state rule used to determine the direction of magnetic field produced around a straight conductor carrying current?

24. What change will you notice in the compass needle if it is moved away from the conductor but the current through the conductor remains the same?

25. Two circular coils A and B are placed close to each other. If the current in the coil A is changed, will some current be induced in the coil B? Give reasons.

PART 3 Long answer questions (26-30)

26. The image of a candle flame placed at a distance of 30 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 60 cm from the optical center of the lens. Identify the type of lens and calculate its focal length.

27. Light is incident at an angle of
    (i) 30°
    (ii) 45°, on the same face of a given rectangular slab. If the angles of refraction at this face are r_1 and r_2 in the two cases. Obtain the relation between these two angles.

28. Explain the principle, construction and working of an electric motor with the help of a labeled diagram?

29. Explain the underlying principle and working of an electric generator by drawing a labeled diagram. What is the function of brushes?

30. Consider a circular wire lying in the plane of the table and the direction current in it is antilock wise.
    (i) Draw the magnetic field lines produced around it.
    (ii) Why does the magnetic field at the center of the current carrying circular loop appear straight? Explain with a diagram.

APPENDIX B:

Students' Leisure Interest in Science Questionnaire

Students' Leisure Interest in Science Questionnaire

One of your teachers is participating in a study on Grade 10 students' leisure interest in science. I would like to kindly ask for your participation in completing this questionnaire.

In this study, I would like you to complete the following questionnaire, which is related to your motivation for learning in basic science classes. Your participation in this questionnaire is voluntary; it will not in any way affect your grade and is only related to learning about your motivation for basic science.

Please read the statements carefully and circle whether you agree or disagree about them using the directions given below. There are no correct or wrong answers for answering this questionnaire. I thank you for taking the time to consider your responses and answer honestly.

Student Name: _____

Student Class: ☐ Grade 10 A ☐ Grade 10 B

Directions: This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no right or wrong answers, so please just try to think about how much you agree or disagree with each of the statements, and circle the number of the option that better represents your feelings. Your opinion is what is wanted.

Please use the scale below to answer the questions.

1. Strongly disagree
2. Disagree
3. Not sure
4. Agree
5. Strongly agree

Items	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1. I would like to belong to a science club.	1	2	3	4	5
2. I get bored when watching science programs on TV at home.	1	2	3	4	5
3. I would like to be given a science book or a piece of scientific equipment as a present.	1	2	3	4	5
4. I dislike reading books about science during my holidays.	1	2	3	4	5
5. I would like to do science experiments at home.	1	2	3	4	5
6. Talking to friends about science after school would be boring.	1	2	3	4	5
7. I would enjoy having a job in a science laboratory during my school holidays.	1	2	3	4	5
8. Listening to talk about science on the radio or the internet would be boring	1	2	3	4	5
9. I would enjoy visiting a science museum at the weekend.	1	2	3	4	5
10. I dislike reading newspaper or web articles about science.	1	2	3	4	5

BIOGRAPHY

Name Poonam Yadav

Gender Female

Nationality Indian

Date of Birth August 7, 1988

Educational Background

Master of Education (Curriculum and Instruction)

Assumption University, Bangkok, Thailand (2022)

Bachelor of Technology in Chemical Engineering

Indira Gandhi Institute of Technology, Odisha, India (2012)

Job Experience

St Joseph High School, India

High School Science Teacher (2020-2022)

Crescent International School, Thailand

IGCSE Physics Teacher (2018-2019)

Thai-Sikh International School, Thailand

IGCSE, AS and A Level Chemistry Teacher (2016-2018)