EFFECTIVENESS OF STATION ROTATION MODEL ON ACADEMIC ACHIEVEMENT IN SCIENCE AMONG HIGH SCHOOL STUDENTS

Dissertation submitted to N.V.K.S.D. College of Education (Autonomous), affiliated to Tamilnadu Teachers Education University, Chennai in partial fulfilment of the requirements for the award of the degree of

MASTER OF EDUCATION

by

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DECLARATION

I, JUHI JELUNA J (Reg No. 10124 MED0603) hereby declare that this dissertation entitled **"EFFECTIVENESS OF STATION ROTATION MODEL ON ACADEMIC ACHIEVEMENT IN SCIENCE AMONG HIGH SCHOOL STUDENTS"** submitted by me for the degree of Master of Education is the result of my original and independent research work carried during the academic year 2025 - 26 under the guidance and supervision of Dr. K. Gireesh Kumar, Assistant Professor in History, N.V.K.S.D. College of Education, Attoor. This dissertation has not been submitted elsewhere for the award of any degree, diploma, associateship, fellowship to any other University or Institution.

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CERTIFICATE

This is to certify that the dissertation entitled **“EFFECTIVENESS OF STATION ROTATION MODEL ON ACADEMIC ACHIEVEMENT IN SCIENCE AMONG HIGH SCHOOL STUDENTS”** submitted for the Master of Education degree by **JUHI JELUNA J** is an original record of research work carried by her under my guidance and supervision during the academic year 2025 - 26 under my guidance and supervision. This dissertation has not been submitted to any other university for the award of any other degree or diploma. It is further certified that the work is an original one free from any duplication.

Place: Attoor

Date: **Signature of the Supervisor**

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With great pleasure and privilege, I present here with full satisfaction of the dissertation entitled Effectiveness of Station Rotation Model on Academic Achievement in Science among High School Students. I immeasurably thank God for blessing me with good health and confidence to successfully complete this work

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Chapter - I

INTRODUCTION

Science is an essential and core subject at both school and higher education levels, as it supports the development of knowledge and understanding of the natural world. It helps individuals understand the fundamental rules and principles that govern the universe. Science is also considered a systematic approach adopted for the acquisition of knowledge in the search for truth (Mangal, 2022). Therefore, the effectiveness of teaching and learning science in schools plays a vital role in the overall educational programme. Over the years, science teaching has gradually shifted from viewing science merely as a body of established knowledge to understanding it as a human activity that emphasizes scientific processes and procedures (Lesha, 2019). Science should not be taught in a monotonous environment, as such an approach may reduce students' interest and engagement. Science education needs to be explored through innovative and learner-centred approaches. Traditional teaching methods often require students to acquire information through textbook-based learning, which may limit active participation and conceptual understanding.

In recent years, many schools have shifted from lecture-based teaching methods to activity-oriented instructional approaches. The teaching of science should develop students' skills and interest in learning through activities that provide varied experiences. Innovative teaching methods in science are essential for addressing the diverse learning needs of students and for improving their engagement, understanding, and application of complex concepts (Singh, 2026). To make science learning more effective, teachers should adopt new instructional approaches and methods in the classroom environment that actively engage students in understanding scientific concepts and achieving the desired educational objectives.

In the modern technological era, the integration of technology in education plays a crucial role in enhancing students' learning experiences. Modern academic environments are increasingly committed to using digital tools to deliver varied, accessible, and student-centred learning experiences (Vangara, 2026). The National Education Policy (NEP, 2020) also emphasizes the integration of technology and promotes online and blended learning models for effective instruction across disciplines. Technology integration in science education enables learners to analyse scientific concepts in an interactive and engaging manner through innovative instructional approaches (Kumar, 2025). Consequently, a range of modern instructional methods are now being adopted in educational settings to make students active participants in the teaching-learning process.

One such innovative approach is the Station Rotation Model, which emerged from the blended learning framework conceptualized and formalized by Heather Staker and Michael B. Horn (2012) in their work on classifying K–12 blended learning models. The Station Rotation Model is a hybrid form of learning that combines traditional instruction, online learning, and collaborative learning experiences. It is also known as the Classroom Rotation or In-Class Rotation Model, in which students rotate within a contained classroom environment (Staker & Horn, 2012). In this model, students rotate through stations according to a fixed schedule, and at least one station involves online learning.

The Station Rotation Model is student-centred, student-driven, and student-paced, making learning more meaningful, relevant, and engaging for learners (Tucker, 2021). Stacey and Gerbic described the Station Rotation Model as a combination of traditional classroom teaching approaches with a variety of online resources (Akinoso et al., 2021). The model allows instructors to differentiate instruction based on students' needs and interests (Komur, 2023). Typically, it consists of three or more stations within the classroom, incorporating online learning, teacher-led instruction, collaborative learning, and independent tasks. These stations are designed to accommodate diverse learning styles and encourage active participation.

Various teaching activities such as simulations, quizzes, gamified tasks, and collaborative work can be incorporated into the online station to enhance personalized learning and technology integration within the classroom. The Station Rotation Model can also help in developing specific skills among high school students. Teachers play a significant role in facilitating learning through various instructional modes and should possess adequate knowledge regarding the implementation of this model in classroom settings.

Need and Significance of the Study

The present educational system challenges teachers to employ innovative instructional methods that promote students' active understanding and retention of concepts. Learning science is often considered challenging for high school students. Science classrooms frequently struggle with low student engagement, passive content delivery, and insufficient opportunities for the development of critical thinking and collaborative skills. During the process of acquiring knowledge and understanding academic concepts, students commonly experience various challenges and setbacks. Therefore, high school students need opportunities to learn concepts meaningfully and apply them in real-life situations (Shaila, 2021).

Despite the growing emphasis on learner-centred education, some schools continue to follow conventional teaching methods and focus primarily on completing the syllabus within a limited time frame. In such classrooms, students often remain passive listeners and may hesitate to ask questions or clarify their doubts regarding scientific concepts. Conventional teaching methods generally provide uniform instruction, neglecting the diverse learning needs and readiness levels of students within the classroom. As a result, students tend to retain factual knowledge only for short periods and may lack the motivation to explore scientific concepts deeply.

In this context, the introduction of innovative teaching strategies for high school students becomes highly significant. Such strategies actively involve students in the learning process, move beyond monotonous lecture-based teaching, and foster essential competencies such as critical thinking, teamwork, and self-regulation. Science should be presented as an interconnected discipline that helps students understand the complexity of the world around them. According to the Teachers Institute (2025), science should be taught as interconnected ways of understanding a single and complex world.

Teaching science through innovative instructional approaches should impart knowledge and training to students while simultaneously improving the overall educational system (Kapur, 2019). The Station Rotation Model, which consists of a series of stations or learning activities through which students rotate (Tucker, 2021), and is considered one of the most effective innovative teaching strategies. It encourages students to remain active participants and work collaboratively with their peers. Learners explore scientific concepts through different activity centres involving collaboration, technology integration, and teacher interaction.

The Station Rotation Model is particularly useful for teaching scientific concepts that students may recognize but are unable to clearly define. Its flexible structure addresses the individual needs of students effectively (Othman, 2018). Students also feel more comfortable clarifying their doubts and actively engaging in science learning. A study conducted by Jeluna, J and Kumar, G (2026) revealed that the awareness level of the Station Rotation Model among prospective teachers is moderate. Hence, teachers need adequate awareness and careful planning for the successful implementation of this model. Furthermore, teachers can become more innovative in designing activities for each station based on the intended learning objectives. In the Station Rotation Model, students select and organize information received from online learning stations and teacher-led instruction, thereby actively connecting new knowledge with their prior experiences (Gheith, 2018). Since the model is student-centred, it provides individualized attention according to students' learning needs. It also promotes collaborative learning with peers and teachers by providing hands-on experiences, real-time feedback, and opportunities for peer learning (Unnathamani, 2024).

The Station Rotation Model is expected to benefit both teachers and students by helping them master scientific and technological knowledge through better understanding of complex concepts and their application in real-life situations. Students are likely to learn joyfully at every learning station through this model. Moreover, the Station Rotation Model transforms conventional classrooms into dynamic, inclusive, and adaptable learning environments for high school students. It also nurtures essential twenty-first-century skills such as adaptability, collaboration, communication, and self-direction. The primary feature of the Station Rotation Model is its integration of direct instruction and technology within the classroom environment. This model enhances students' autonomy by allowing them to learn through different activity centres, thereby increasing their interest and reducing distractions. Through the Station Rotation Model, teachers can closely monitor students' participation and engagement in each activity centre while incorporating diverse instructional activities and teacher-led interactions (Guerrero, 2024).

Several research studies have highlighted the effectiveness of the Station Rotation Model in various subjects. A study conducted by Ramadan et al. (2025) revealed that the Station Rotation Model had a positive and significant effect on students' learning outcomes, with a moderate to high level of influence. Similarly, Kaur (2024) reported that the model effectively improved students' critical thinking and academic achievement. Osuji et al. (2024) found that the Station Rotation Model provided learners with opportunities to broaden the scope of their learning, thereby improving their academic performance and retention levels. Likewise, Tabassum et al. (2024) observed significant improvement in academic performance among students engaged in blended learning environments compared to those in traditional classrooms. Research on the Station Rotation Model has been widely conducted in developed countries due to advancements in digital infrastructure and educational technology. However, in developing countries such as India, research related to the Station Rotation Model in science education remains limited. Therefore, the present study focuses on examining the academic outcomes of high school students learning science through the Station Rotation Model.

Research Question

1. To what extent is the Station Rotation Model of teaching effective in enhancing the academic achievement of high school students?

Statement of the Problem

In the modern educational scenario, innovative instructional methods are increasingly required to promote student-centred learning, where learners play a central role in the teaching-learning process. Greater emphasis is now being placed on the integration of technology and the implementation of modern teaching practices to improve student engagement and academic achievement. In order to enhance students' engagement and participation, the Station Rotation Model enables students to develop digital skills and remain actively involved in various modes of learning within the classroom. In the context of Class IX instruction, it is essential to determine whether this shift towards the Station Rotation Model results in significant academic benefits when compared to conventional teaching methods. The present investigation seeks to provide empirical evidence regarding the effectiveness of the Station Rotation Model in enhancing students' academic achievement. Hence, the problem selected for the present study is entitled: ***Effectiveness of the Station Rotation Model on Academic Achievement in Science among High School Students*.**

Operational Definitions of the Key Terms

a) Effectiveness

Effectiveness refers to the extent to which the desired outcomes or results are achieved through teaching Science using the Station Rotation Model, resulting in intended improvements in the academic achievement of high school students.

b) Station Rotation Model

The Station Rotation Model refers to an instructional approach in which students rotate through different activity centres at fixed time intervals that promotes communication, collaboration, critical thinking, and problem-solving skills in Science among high school students.

c) Academic Achievement in Science

Academic achievement in Science refers to the measurable outcomes of students' performance in Science, demonstrated through the attainment of learning objectives and mastery of content. In the present study, academic achievement is defined as the scores obtained by Class IX students in academic assessments conducted after the educational intervention using the Station Rotation Model of teaching.

d) High School Students

High school students refer to learners belonging to the age group of 14–15 years who are enrolled at the secondary education level. In the present study, high school students refer to students studying in Class IX at Yettacode Higher Secondary School, Yettacode, under the Tamil Nadu State Board of Education during the academic year 2025–26.

In the present study, the phrase *"Effectiveness of the Station Rotation Model on Academic Achievement in Science among High School Students"* refers to the preparation and evaluation of an instructional design consisting of lesson transcripts, based on the Station Rotation Model and its impact on the Science achievement of Class IX students.

Objectives of the Study

The objectives framed for the present study are as follows

1) To prepare and validate instructional design based on Station Rotation Model for teaching Science for Class IX students.
2) To construct and validate an achievement test in Science for Class IX students.
3) To test the effectiveness of Station Rotation Model by comparing the mean pre-test and post-test scores in Science of Class IX students in the experimental group.
4) To compare the mean pre-test score of achievement in Science among Class IX students in the experimental group and control group.
5) To compare the mean post-test score of achievement in Science among Class IX students in the experimental group and control group.
6) To find out the significant differences in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate.

Hypotheses

In pursuit of the above stated objectives, following hypotheses were formulated.

1) There exists no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and control group.
2) There exists no significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group.
3) There exists no significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group.

4) There exists no significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate.

Methodology in Brief

Method adopted

Experimental method was adopted for conducting the present study

Experimental Design

Pre-test, Post-test non-equivalent group design was used for the present study. The present study employed a two-group experimental design.

Population

Population for the present study consists of all the high school students of Kanniyakumari district in Tamil Nadu following State board syllabus during the academic year 2025 – 26.

Sample

The sample size for the present investigation consists of 90 students studying Class IX from Yettacode Higher Secondary School, Yettacode, Kanniyakumari district. They were divided into experimental group consisted of 46 students and control group consisted of 44 students

Variables of the study

- Independent Variable – Station Rotation Model
- Dependent Variable – Academic Achievement

Tools used

The following tools were used for collecting the data

a) Instructional design on Station Rotation Model in Science subject of Class IX prepared and validated by the investigator.

b) Achievement test on selected concepts in Science for Class IX prepared by the investigator.

Statistical Technique used

In the present study, the following statistical techniques were used for the analysis and interpretation of the collected data

1) ‘t’- test (test of significance)
    - Independent t-test
    - Paired t-test
2) ANCOVA (Analysis of Co-variance)

Delimitation of the Study

The following are the delimitations of the study:

1. The study was limited to one school in Kanniyakumari District.
2. The study was limited to Class IX students only.
3. The sample was limited to 90 students only.
4. The experimental study was conducted only among English-medium students.
5. The study was conducted for a period of three weeks only.

Organization of the Report

The present study is organized into five chapters.

Chapter I deals with the Introduction, Need and Significance of the Study, Statement of the Problem, Operational Definitions of the Key Terms, Objectives of the Study, Hypotheses of the Study, Methodology in Brief, and Delimitation of the Study.

Chapter II deals with the Review of Related Literature, which contains two sections:

- **Section A** contains the theoretical overview of the study.
- **Section B** contains the review of related literature, including Indian and foreign studies, along with a critical review of the study.

Chapter III deals with the methodology adopted for the study, which contains two sections:

- **Section A** – Development of the Instructional Design and Achievement Test in Science for class IX.
- **Section B** – Method adopted for the study, including the research design, variables of the study, experimental procedure, tools used, administration of tools, sample selected for the study, and statistical techniques used for the study.

Chapter IV includes the details regarding the analysis of data, results, and interpretation of the data.

Chapter V deals with the study in retrospect, major findings of the study, conclusions, educational implications, and suggestions for further research in this area of study.

Chapter –II

REVIEW OF RELATED LITERATURE

- Theoretical Overview
- Review of Related Literature
- Critical Review

Chapter – II

REVIEW OF RELATED LITERATURE

Review of related literature is a significant aspect of any research work. It is an inclusive contemplative survey of previous writings referring to problems or issues. The term 'review' means to organize the knowledge of the specific areas of research to evolve a structure of knowledge to show that the study would be an additional to this field (Sharma, 2008). The review of related literature involves the systematic identification, location and analysis of documents containing information related to the research problem.

According to *W.R. Borg*, "The literature in any field forms the foundation upon which all future work will be built. If we fail to build the foundation of knowledge provided by the review of literature our work is likely to be shallow and naïve and will often duplicate work that has already been done better by some one else."

According to *John W. Best*, "A summary of the writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known and what is still unknown and untested. Since effective research is based upon past knowledge, this step helps to eliminate the duplication of what has been done and provide useful hypotheses and suggestions for significant investigation."

The review of related literature begins with the identification of the research problem, continues throughout the different stages of the research process, and extends up to the preparation of the final research report. Examining previous research studies helps in avoiding unnecessary duplication of work and provides valuable insights into the viewpoints, findings, and approaches adopted by other researchers related to the same area of study.

Purpose of Review of Literature

The review of literature services the following purpose in conducting a research work-

1) Review of related literature provides important theories, concepts, explanations, and hypotheses that may assist the researcher in identifying and formulating a new research problem.
2) It helps the investigator to determine whether the existing evidence is sufficient to address the problem, thereby reducing unnecessary repetition or duplication of previous studies.
3) It serves as a valuable source for developing research hypotheses. On the basis of earlier studies, the researcher can frame suitable and directional hypotheses for the investigation.
4) It offers guidance regarding appropriate research methods, procedures, sources of data, and statistical techniques required for solving the research problem effectively.
5) It provides comparative findings and relevant data that are useful in interpreting and discussing the results of the present study. The conclusions of earlier studies can also be compared with the findings of the current investigation.
6) It helps the investigator to develop deeper knowledge, competence, and scholarly understanding in the selected area of research.
7) It contributes to the development of accurate and comprehensive knowledge in the field of study, which becomes valuable for the researcher throughout academic and professional life, especially in research and higher educational settings.

As the present study was intended to find out the Effectiveness of Station Rotation Model on Academic Achievement in science among High School Students, an attempt was made to review available research literature in connection with Station Rotation Model. The investigator has gone through the studies related to the areas of Station Rotation Model and they were presented.

Review of Literature is given in two sections

Section A: Theoretical Overview

Section B: Review of Related Studies.

Section- A

Theoretical Overview

Blended Learning

Blended learning is the combination of active, engaged learning online combined with active, engaged learning offline to provide students with more control over the time, place, pace, and path of their learning. In other words, Blend of both offline and online learning.

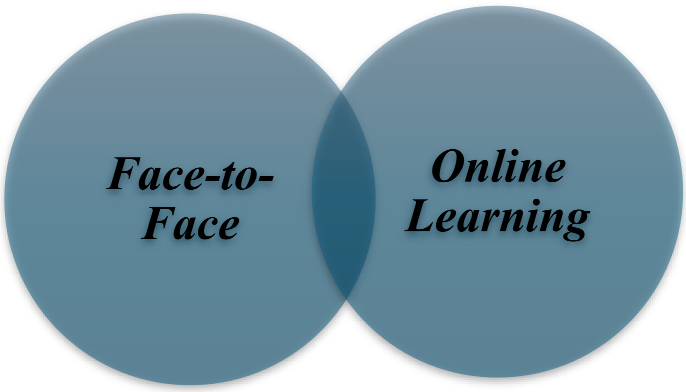

Figure 2.1: *Blended Learning*

The goal of blended learning is this fundamental shift in control from teacher to learner. A key aspect of this definition is positioning the students as “active agents” in the lesson or learning experience. The *students* should be doing the heavy cognitive lift of making meaning. In a blended learning environment, the students are doing the thinking, discussing, making, questioning, exploring, collaborating, and reflecting.

Horn and Staker's (2013) definition expresses that "blended learning is any time a student learns, at least in part, at a supervised brick-and-mortar location away from home and, at least in part, through online delivery with some element of student control over time, place, path, and/or pace. The modalities along each student are learning path within a course or subject connected to provide an integrated learning experience". The adaptation of Staker and Horn's definition is rooted in constructivist principles emphasizing the student's role as an active participant in the learning process.

Overview of Blended learning

a) The Why of Blended learning

The *why* driving shifts to blended learning has always been a desire to increase student engagement. The goal of the various blended learning models is to shift students to the center of learning and architect lessons that provide them with more control over their experience.

b) The How of Blended learning

"Blended learning" is an umbrella term. Many different models give students different degrees of control over time, place, pace, and path. On one end of the spectrum are the rotation models, like the station rotation and flipped classroom models, where the teachers are the drivers of instruction. On the other end of the spectrum are models, like the A La carte and enriched virtual models, that rely heavily on online learning as the driver of instruction and learning happens primarily online.

c) The What of Blended learning

Shifting from teacher-led, whole group instruction to blended learning models can positively impact student engagement because they have more control over their learning (Tucker, 2020).

Models of Blended Learning

The majority of blended-learning programs resemble one of four models such as

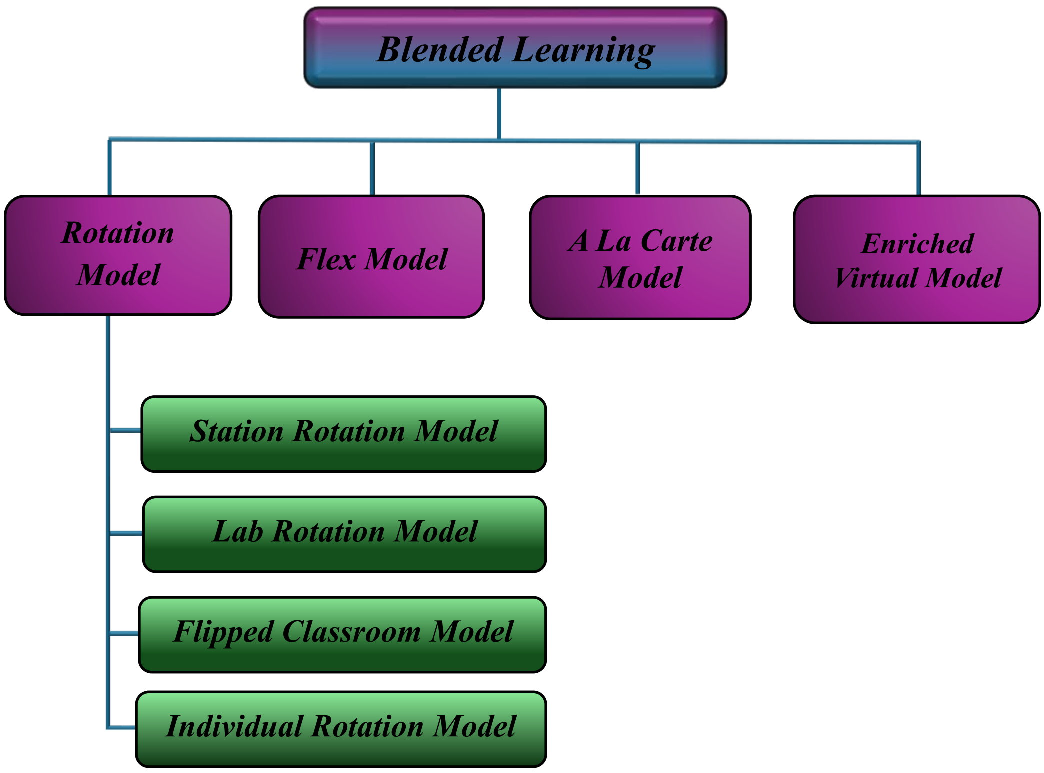

Figure 2.2: *Models of Blended Learning*

1) Rotation Model
2) Flex Model
3) A La Carte Model
4) Enriched Virtual Model

1) Rotation Model

The Rotation model in which students rotate on a fixed schedule or at the teacher's discretion between learning modalities, at least one or a full class of which is online learning. Other modalities might include activities such as small-group instruction, group projects, individual tutoring, and pencil-and-paper assignments. The students learn mostly on the brick-and-mortar campus, except for any homework assignments.

The rotation models work well in a physical classroom, on a hybrid/blended schedule, or in a remote learning situation (as long as offline learning activities are integrated into the student's remote learning lessons. The Rotation model includes four sub-models such as

a) Station Rotation Model
b) Lab Rotation Model
c) Flipped Classroom Model
d) Individual Rotation Model.

In the models of Blended learning, the Rotation Model and its sub-models such as Station Rotation Model, Lab Rotation Model and Flipped Classroom Model comes under the *Hybrid zone* of learning. Blended learning is emerging as a hybrid innovation that is a sustaining innovation relative to the traditional classroom. This hybrid form is an attempt to deliver "the best of both worlds"—that is, the advantages of online learning combined with all the benefits of the traditional classroom.

a) Station Rotation Model

Station Rotation Model in which the students experience the Rotation model within a contained classroom or group of classrooms. The Station Rotation model differs from the Individual Rotation model because students rotate through all of the stations, not only those on their custom schedules. The station rotation model is a series of stations, or learning activities, and students rotate through them. The total number of stations depends on various factors, the length of the class or the total number of students. This model is flexible and can be adapted for a variety of learning landscapes– in person, online, or a combination of the two.

b) Lab Rotation Model

Lab Rotation Model in which the students rotate to a computer lab for the online-learning station.

c) Flipped Classroom Model

Flipped Classroom Model in which the students participate in online learning off-site in place of traditional homework and then attend the brick-and-mortar school for face-to-face, teacher-guided practice or projects. The primary delivery of content and instruction at online, which differentiates a Flipped Classroom from students who are merely doing homework practice online at night.

d) Individual Rotation Model

Individual Rotation Model in which each student has an individualized Playlist and does not necessarily rotate to each available station or modality.

2) Flex Model

A program in which teaching and learning are mainly delivered through the Internet, where students learn through an individually customized and flexible schedule across different learning methods, while the teacher of record remains available on-site

3) A La Carte Model

The A La Carte Model refers to a blended learning in which students combine online learning with traditional classroom instruction. It allows learners to choose online courses based on their interests or needs in addition to the regular face-to-face courses offered at school.

4) Enriched Virtual Model

The Enriched Virtual Model is a type of blended learning in which students divide their time between online learning and attending a physical school campus. Learning mainly occurs through online instruction, while face-to-face sessions are conducted periodically to provide guidance, interaction, and support from teachers.

Origin and Development of Station Rotation Model

The Station Rotation Model was formalized by researchers at the *Clayton Christensen Institute* for Disruptive Innovation. This model was first systematically categorized as a blended learning model in a 2012 white paper by Heather Staker and Michael Horn, titled ***"Classifying K–12 Blended Learning".*** The model has been widely adopted in K-12 schools and is recognized as a common type of blended learning observed in these educational settings.

Station Rotation Model

Station Rotation Model is a popular K-12 blended learning model that rotates students through a series of stations or learning activities (Tucker, 2021). It transforms a traditional theory-oriented classroom into an engaging and interactive augmented learning environment. The Station Rotation Model takes place within a physical classroom or training environment, unlike other blended learning approaches. Station Rotation Model allows students to engage with content in various formats and at their own pace. The Station Rotation Model cycles students through learning stations on a fixed schedule, blending teacher-led, peer, and digital instruction in a single class period in which students move through various learning stations, with each station focusing on a specific learning activity. This method combines teacher-led instruction, group collaboration, and self-directed learning, thereby addressing different learning needs and preferences. Station Rotation is an active learning strategy. It allows for small-group differentiation and increases student engagement by varying the learning modality

According to *Eleanor et al (2020*), the criteria to define Station Rotation Model as

a) The class must be split into groups;
b) Students must rotate through two or more stations during a class period;
c) At least one station must incorporate the use of digital instruction;
d) Each rotation must last at least 10 minutes; and
e) Stations and rotations must be within a single classroom under the same teacher (Fulbeck et al, 2020).

Types of Stations in Station Rotation Model

The station rotation model is composed of a series of stations, or learning activities, that students rotate through. This model has three types of stations

a) Teacher-led Station
b) Online Station
c) Offline Station

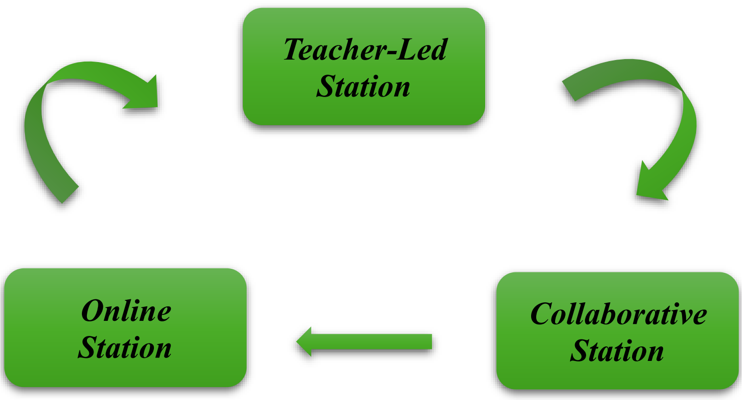

Figure 2.3: *Station Rotation Model*

a) Teacher-led Station

The teacher-led station makes it possible to differentiate instruction, modelling sessions, guided practice, and feedback to better meet the needs of small groups of learners. Teachers can also provide real-time feedback. Teachers should focus on two goals in this station such as differentiation and engagement.

Depending on the grouping strategy a teacher uses, they should consider how they can differentiate by adjusting their explanations, models, word choice, scaffolds, and supports to ensure every student can access the information or tasks presented. Teachers must be strategic about the level of academic rigor and complexity of the practice and application they are assigning to ensure that it is within their zone of possibility. In addition, teachers can strategically pair or group students within their stations for peer support.

According to **Tucker** (2022) teachers time and focus on Teacher-led station need to

- Provide differentiated instruction
- Lead interactive modelling sessions
- Guide practice and application
- Give feedback as students work
- Facilitate small group discussions

It possible for teachers to provide specific supports and scaffolds to aid comprehension and focus on texts, problems, or examples within each group's zone of possibility.

b) Online Station

The online stations allow students more control over the pace and path of their progress through learning activities. They may work individually or collaboratively at these stations, directing their learning and accessing peer support. The online station in the station rotation model should be designed to promote the anyone of the development of 21st-century learning skills, commonly referred to as the 4Cs such as critical thinking, communication, collaboration, and creativity. Activities that encourage critical thinking help students express their reasoning and problem-solving abilities. Communication skills can be enhanced through online interactive learning platforms that provide opportunities for all learners to participate in academic dialogue. Collaboration may be promoted through the use of digital tools and collaborative platforms that enable students to work together on shared tasks and projects. Creativity can be fostered by allowing students to use technological. Designing online learning stations with these elements increases student engagement and participation.

c) Offline Station

The offline station provides students with opportunities to engage in meaningful learning activities without the use of digital devices. This station is designed to promote student agency, collaboration, creativity, and active participation through tasks such as group discussions, concept mapping, sketch notes, problem-solving activities, experiments, and reflective writing. Since every learner is different, offline stations often provide students with simple choices, such as working individually or with peers, presenting ideas visually or in written form. These choices encourage learner autonomy and increase motivation and engagement. The offline station also helps students develop critical thinking, communication, and collaborative skills in an interactive and learner-centered environment

Theoretical foundations of Station Rotation Model

There are various educational theories that work under Station Rotation Model to enhance the learning of students in psychological and in pedagogical aspects.

a. Constructivism

According to constructivism, learning is a personal process that results from students' interaction with the teachers, peers, technology, and all the components of the learning environment. Each student has his own personal beliefs and prior knowledge which are always questioned when new knowledge is constructed (Nagy, 2018). Jean Piaget proposed the theory of cognitive constructivism, which explains that children actively construct knowledge through interaction with their environment. According to Piaget, learning occurs when learners connect new experiences with their existing knowledge structures, called schemata, through the processes of assimilation and accommodation. He also explained that children progress through different stages of cognitive development, and each stage influences their thinking and learning abilities. Piaget emphasized activity-based and learner-centered education, where students learn effectively through exploration, experimentation, discovery learning, and problem-solving. The role of the teacher is to provide meaningful learning experiences suited to the developmental level of learners. Therefore, teachers should provide meaningful learning experiences that match the developmental level and readiness of learners.

The Station Rotation Model is closely related to Piaget's cognitive constructivism because it encourages active participation, experiential learning, and knowledge construction. In this model, students rotate through different learning stations such as teacher-led instruction, collaborative activities, hands-on tasks, and technology-based learning. These varied experiences help learners actively engage with content, develop problem-solving skills, and build conceptual understanding through interaction and exploration. The model also supports individual learning pace and collaborative learning, while teachers act as facilitators who guide students in constructing knowledge independently. Thus, the Station Rotation Model reflects Piaget's constructivist principles by promoting a learner-centered and interactive classroom environment.

b. Zone of Proximal Development

Lev Vygotsky proposed the Social Cognition Theory, which emphasizes that social interaction and culture play an important role in cognitive development and learning. According to Vygotsky, children learn through interaction with parents, teachers, peers, and society. He believed that language is the primary tool for communication, thinking, and the development of knowledge. Learning takes place when children participate in problem-solving activities with the guidance and support of more knowledgeable individuals. Vygotsky also introduced the concept of internalisation, through which social learning gradually becomes individual understanding. One of the major concepts of his theory is the Zone of Proximal Development (ZPD), which refers to the difference between what a learner can do independently and what he or she can achieve with the guidance of teachers or peers. He also emphasized scaffolding, where support is gradually provided and reduced according to the learner's needs until independent learning is achieved.

The Station Rotation Model is closely related to Vygotsky's Social Cognition Theory, particularly the concept of the Zone of Proximal Development. In the Station Rotation Model, students rotate through different learning stations. These stations create opportunities for learners to receive guidance and support from teachers and peers while performing tasks that may be difficult to complete independently. Through teacher assistance, collaborative learning, and interactive activities, students are able to progress from their current level of understanding to higher levels of learning within their ZPD. The model also supports scaffolding, as teachers provide step-by-step guidance and gradually encourage students to learn independently. Therefore, the Station Rotation Model related with Vygotsky's theory by fostering social interaction, cooperative learning, guided instruction, and cognitive development in a learner-centred environment.

c. Differentiated Instruction Theory

Carol Ann Tomlinson developed the theory of Differentiated Instruction to address the diverse learning needs, abilities, interests, and learning styles of students in the classroom. According to Tomlinson, students differ in their readiness levels, interests, and learning profiles; therefore, a single method of teaching cannot effectively meet the needs of all learners. Differentiated Instruction is a pro-active and learner-centered approach in which teachers modify content, process, product, and learning environment according to students' individual differences.

Content refers to what students learn, ***Process*** refers to how students learn, ***Product*** refers to how students demonstrate learning, and ***Environment*** refers to the physical and emotional conditions of learning. The theory emphasizes flexible grouping, scaffolding, continuous assessment, and varied instructional strategies to ensure equitable learning opportunities for all students (Callens, 2026).

Tomlinson's theory also highlights the importance of pre-assessment and ongoing assessment to identify students' readiness and learning needs. Teachers are expected to provide multiple learning pathways and activities so that all learners can achieve the same learning goals through different methods suited to their abilities and preferences..

The Station Rotation Model is closely connected to Carol Ann Tomlinson's Differentiated Instruction theory because it provides varied learning experiences that address individual learner differences. In the Station Rotation Model, students rotate through different stations. These stations allow teachers to differentiate content, process, and learning activities according to students' readiness, interests, and learning profiles. For example learners receive additional scaffolding and teacher support at another station.

Students can learn through visual, auditory, kinesthetic, collaborative, or digital methods depending on their needs. Teachers can continuously assess student performance during station activities and modify instruction accordingly. The model also promotes active engagement, learner autonomy, and collaborative learning, making the classroom more inclusive and student-centered. Therefore, the Station Rotation Model effectively applies the principles of Differentiated Instruction by ensuring that all students receive meaningful and appropriate learning experiences based on their individual differences.

d. Cognitive Load theory

Cognitive Load Theory was proposed by John Sweller in 1988 and explains that learning becomes effective when instructional methods are designed according to the limitations of human working memory. The theory states that working memory has limited capacity and can process only a small amount of information at a time. When too much information is presented simultaneously, cognitive overload occurs, which negatively affects learning and understanding.

Cognitive Load Theory emphasizes reducing unnecessary information and distractions, organizing content meaningfully, and presenting information in manageable segments to improve learning efficiency. Sweller and colleagues (2011) highlighted that instructional designs based on cognitive load principles improve learning outcomes, while researchers such as Mayer and Moreno (2003) and Chandler and Sweller (1991) emphasized the importance of avoiding redundancy, split attention, and excessive information presentation. The theory also supports the use of scaffolding, worked examples, chunking of information, and gradual movement from guided learning to independent learning to help students transfer information effectively from working memory to long-term memory.

The Station Rotation Model organizes learning into smaller, manageable instructional stations that reduce cognitive overload and improve student understanding. In the Station Rotation Model, students rotate through various stations, allowing information to be presented in segmented and structured ways. This helps learners focus on one task at a time rather than processing excessive information simultaneously. Teacher-led stations provide scaffolding and step-by-step guidance for learners with low prior knowledge, while independent and digital stations allow advanced learners to progress at their own pace, reflecting the expert reversal effect explained in Cognitive Load Theory. The model also reduces split attention by integrating learning resources effectively and encourages chunking of content through short and focused activities. Therefore, the Station Rotation Model supports the principles of Cognitive Load Theory by enhancing attention, reduces overload, and promotes meaningful learning.

e. Connectivism Theory

Connectivism is defined as a learning theory that consists of several series of nodes which facilitate the process of connecting a huge number of networks in order to facilitate learning. Connectivism is a modern learning theory that emphasizes the role of technology, digital networks, and social connections in the learning process. The theory explains that learning occurs through connections formed between individuals, digital resources, information networks, and technological tools. In the digital age, knowledge is widely available through the internet, online platforms, multimedia resources, and collaborative environments. Therefore, learners are expected to access, evaluate, organize, and apply information from various digital sources. Teachers act as facilitators who guide students in selecting reliable resources and using technology effectively for meaningful learning experiences.

The Station Rotation Model integrates technology-based learning with traditional classroom instruction. The technology-based stations allow learners to access digital content, online resources, videos, simulations, and interactive learning platforms, which support the principles of Connectivism. Students learn by interacting with digital information networks and by connecting with peers and teachers through collaborative activities. The model also encourages self-directed learning, critical thinking, and the ability to evaluate digital resources effectively. Through online stations, learners develop digital literacy skills and gain opportunities to explore knowledge beyond textbooks and classroom boundaries. Teachers guide students in navigating digital resources and selecting appropriate learning materials, which reflects the role of facilitators emphasized in Connectivism.

Implementation and Management of Station Rotation Model

1) Key Principles of Station Rotation Model

a) Structured Rotation on a Fixed Schedule

Students move through stations according to a teacher-set timer, not self-directed choice. This predictability reduces cognitive overhead for students

b) At least One Online Learning Station

The model requires digital learning as a structural component, not an optional supplement. The online station commonly features an adaptive practice platform. This generates data the teacher can use before the next class to adjust grouping or re-teach specific concepts.

c) Teacher-Led Small Group Instruction

The teacher can hear individual student thinking, catch misconceptions in real time, and differentiate explanation and questioning in ways that are impossible with the full class. The small group station is where the model earns its instructional return.

d) ***Multiple Learning Stations***

Each station focuses on a specific activity or type of learning, such as online station, teacher-led station and collaborative station.

e) ***Direct Instruction***

A teacher-led session where students receive information directly.

f) ***Collaborative Work***

Group activities that encourage teamwork and peer learning.

g) ***Time Management***

Each station is allocated a specific time frame, ensuring that students engage with all activities within a designated period.

h) Clear Procedures and Transitions

The model fails without established routines. Students need explicit procedures for what to do when they arrive at each station, how to signal they need help without interrupting the teacher's small group, what to do if they finish early, and how to transition between stations efficiently.

2) **Tools and Materials needed for Station Rotation Model**

a) Timer

Timers are an essential component of smooth transitions from station to station. When station rotation is fully implemented, it should take students about 60 seconds to transition. This should provide students enough time to pack up, move to another station, and get materials ready for the new station.

b) Colour-Coded Systems

Use colour-coded cards or folders to signify different groups of stations. Each group receives folders indicating their must-do stations at the beginning of class.

c) Exit Ticket

Exit tickets are a quick and sustainable strategy for encouraging students to reflect on their learning and provide feedback about the learning experience. Teachers can include some questions designed to check for understanding to gauge the effectiveness of the lesson and identify students who need additional instruction and support.

d) Formative Assessment Data

Regular formative assessments can provide immediate feedback on student understanding and mastery of specific skills. These formative assessments can take the form of quizzes, short written responses, and graphic organizers.

e) Summative Assessment Data

When students complete a summative assessment, that data often reveals that the class is in different places in terms of their concept knowledge and skill set.

Benefits of the Station Rotation Model

a) Enhanced Engagement

Students are more likely to stay engaged when they can switch between different activities. This variety keeps the learning experience fresh and exciting, reducing the likelihood of boredom.

b) Personalized Learning

By allowing students to work at their own pace and choose activities that resonate with them, station rotation supports personalized learning. Educators can tailor instruction to meet individual needs, ensuring that all students can succeed.

c) Development of Critical Skills

Station rotation encourages collaboration, communication, and problem-solving skills. As students work together in groups, they learn to articulate their thoughts, listen to others, and navigate challenges collectively.

d) Improved teacher-student interaction

The station rotation model improves teacher–student interaction by reducing the number of students in each group at a given time. Smaller group sizes allow teachers to pay closer attention to individual learners and better understand their learning needs and difficulties. Teachers can provide immediate guidance, clarification, and constructive feedback during activities, which helps students improve their understanding and performance.

e) Efficient Use of Resources

Teachers can utilize classroom resources more effectively by dividing students into smaller groups. This approach allows for more targeted instruction and support, maximizing the impact of teaching efforts (Mary, 2025).

- Create smaller learning communities within the larger class.
- Spend time working directly with small groups of students.
- Differentiate learning (e.g., instruction, scaffolds, practice, assignments).
- Balance online and offline work to give students a break from the screen. (Tucker, 2020)

Challenges of Station Rotation Model

a) Classroom Management

Managing the classroom effectively can become difficult when students are divided into different stations and engaged in various activities simultaneously.

Teachers may find it challenging to monitor all groups at the same time, maintain discipline, and ensure that students remain focused on their assigned tasks. Noise levels and frequent movement between stations may also create distractions and reduce the effectiveness of learning if proper routines are not established.

b) Time Constraints

Implementing station rotation within a limited class period can be challenging for teachers. Sufficient time is needed for explanation, transitions between stations, completion of activities, and discussion of learning outcomes. If time is not managed properly, students may be unable to complete tasks effectively, and important concepts may not receive adequate attention.

c) Resource Availability

The successful implementation of the station rotation model often requires adequate learning materials, technological devices, internet access, and sufficient classroom space. Station rotation allows for the effective integration of technology, such as online learning platforms and educational software. In many schools, especially those with limited facilities, teachers may face difficulties in arranging enough resources for each station. A lack of materials or technological support can reduce the effectiveness of activities and limit student participation.

Section B

Review of Related Studies

Yilmaz and Fırat (2026) conducted a study to examine the implementation of the Station Rotation Blended Learning Model in science education in rural classrooms. The main objective of the study was to explore the learning experiences of students using the Station Rotation Model in a rural educational setting. The sample consisted of eight fifth-grade students, including five girls and three boys aged between 10 and 11 years. A case study approach was adopted for the investigation. The instructional process involved three stations, namely teacher-led instruction, online learning, and independent work, through which students rotated. Data were collected using focus group interviews, open-ended questionnaires, reflective diaries, and researcher observations. The results of the study revealed that students had positive learning experiences, reporting better understanding, increased interest, enjoyment in learning, and the development of independent learning, peer teaching, and collaboration skills. It was also found that students considered the online station the most engaging, the teacher-led station the most informative, and the independent station the most challenging. The study further proposed two models for the effective implementation of the Station Rotation Model in both small and large classrooms.

Anagnostopoulou et al. (2025) conducted a study to examine the effectiveness of the Station Rotation Model in blended learning. The main objective of the study was to systematically review existing research to understand the impact of the Station Rotation Model on students' learning outcomes and skills. The sample for the study consisted of 30 research studies selected based on specific inclusion and exclusion criteria following PRISMA guidelines. A systematic review method was adopted, and data were collected through a comprehensive analysis of relevant literature. The analysis focused on evaluating the effectiveness, benefits, and challenges associated with the implementation of the Station Rotation Model. The results of the study revealed that the Station Rotation Model has a significant positive impact on students' collaboration, motivation, satisfaction, and overall learning experience. It was also found that the model promotes personalized learning, autonomy, and the development of critical and higher-order thinking skills. Additionally, the study highlighted the adaptability of the model across different learning environments and modalities. The study concluded that the Station Rotation Model is a promising approach for enhancing learning outcomes and 21st-century skills in blended learning environments.

Elizondo and Rodriguez (2025) conducted a study to examine the use of the Station Rotation Model in enhancing science achievement in secondary education. The main objective of the study was to identify the essential characteristics of the Station Rotation Model that facilitate the development of scientific and digital competencies among secondary school students. The sample consisted of 21 research studies selected for analysis based on their relevance to the Station Rotation Model. A systematic review method was adopted, and data were collected through an extensive review of existing literature. The analysis focused on identifying key features, implementation strategies, and outcomes associated with the model. The results of the study revealed that the Station Rotation Model significantly enhances science learning and supports the development of scientific and digital competencies. It was also found that effective implementation requires strong organizational, pedagogical, and technological planning to create an interactive, engaging, and personalized learning environment. The study concluded that the Station Rotation Model is a relevant and effective instructional approach for promoting competency-based education in secondary science classrooms.

Lidya et al. (2025) conducted a study to examine the effectiveness of the Station Rotation Learning Model in improving student learning outcomes. The main objective of the study was to evaluate the impact of the Station Rotation Model on students' academic performance. The sample consisted of 60 students from SMP Negeri 2 Palembang, with 30 students in the experimental group and 30 students in the control group. A quantitative approach with a true experimental design (posttest-only control group design) was adopted. The experimental group was taught using the Station Rotation Model, which involved independent, collaborative, and technology-based learning stations, while the control group was taught through traditional methods. Data were collected using tests, observations, and documentation and were analyzed using statistical techniques such as the paired-samples t test and N-gain analysis. The results of the study revealed a significant improvement in the academic achievement of students in the experimental group compared to the control group. The experimental group achieved a higher mean score (83.50) than the control group (64.17), and the improvement level was also higher (63.97% moderate gain) compared to the control group (21.14% low gain). The study concluded that the Station Rotation Model is an effective instructional strategy for enhancing student learning outcomes.

Oledan (2025) conducted a study to explore students' perceptions and experiences of the Station Rotation Model in blended mathematics learning. The main objective of the study was to examine how students perceive the effectiveness of the Station Rotation Model and how these perceptions influence their engagement, motivation, and satisfaction, as well as to develop a thematic framework of their learning experiences. The sample consisted of 126 Grade 10 students from a laboratory high school in Iligan City, Philippines. A descriptive-correlational mixed-method design was adopted for the study. Data were collected using surveys and student reflections and were analyzed using descriptive statistics, simple linear regression, and thematic analysis. The results of the study revealed that students had moderately high perceptions of learning effectiveness, engagement, motivation, and satisfaction. It was also found that perceived learning effectiveness significantly predicted students' engagement and satisfaction. Further, thematic analysis indicated that the Station Rotation Model promoted peer collaboration, independent problem-solving, and deeper understanding of concepts through structured learning activities. The study concluded that the Station Rotation Model is an effective blended learning approach that enhances student engagement, motivation, collaboration, critical thinking, and overall learning outcomes.

Ramadan et al. (2025) conducted a study to evaluate the effectiveness of the blended learning Station Rotation Model on students' learning outcomes. The main objective of the study was to synthesize existing research findings through a meta-analysis to determine the overall impact of the Station Rotation Model on academic achievement. The sample consisted of research studies selected from indexed international journals based on specific inclusion criteria following PRISMA guidelines. A meta-analytical method was adopted, involving stages such as identification, screening, eligibility, and inclusion of relevant studies. Quantitative data were extracted and analyzed to determine the overall effect size and the influence of various moderating factors. The results of the study revealed that the Station Rotation Model has a positive and significant effect on students' learning outcomes, with a moderate-to-high level of impact. It was also found that factors such as educational level, subject matter, duration of intervention, and research location influenced the magnitude of the effect. The study concluded that the Station Rotation Model is an effective instructional strategy for improving academic achievement, especially when supported by adaptive instructional design and appropriate digital tools, and it recommended further research including non-cognitive variables such as motivation and engagement.

Seitova and Khalmatova (2025) conducted a study to explore the implementer's opinions on the use of the Station Rotation Model in EFL (English as a Foreign Language) teaching. The main objective of the study was to examine the features, challenges, effectiveness, and suggestions for further implementation of the Station Rotation Model. The sample consisted of an English language teacher who acted as the implementer of the model. A mixed-method research approach was adopted, combining qualitative data analysis within a quantitative framework. Data were collected using a semi-structured interview to gather detailed feedback on the implementation of the model. The results of the study revealed that the implementer identified engaging and interest-based activities as a key feature of the model. It was also found that students faced more challenges in the group-working station, while the pair-working station was considered the most effective. It was concluded that the Station Rotation Model is a useful instructional strategy in EFL teaching, though careful planning is required to address challenges and enhance its effectiveness.

Shanmugham (2025) conducted a study to find out the effectiveness of the Station Rotation Model of blended learning in learning English grammar among undergraduate students. The main objectives of the study were to apply the Station Rotation Model of blended learning in teaching English at the undergraduate level and to measure its effectiveness among B.A. students. The sample consisted of two matched groups of B.A. students, each group comprising above-average, average, and below-average students. An experimental method was adopted in which the control group was taught through the traditional lecture method and the experimental group was taught using the Station Rotation Model of blended learning. Achievement in English grammar was measured using appropriate instructional tools. The results of the study revealed that the Station Rotation Model of blended learning was more effective than the traditional lecture method for learning English at the undergraduate level. It was also found that the model helped below-average students improve and perform closer to average students, while above-average students also showed considerable progress.

Yuliaristiawan (2025) conducted a study to examine the implementation of the Student-Centered Approach (SCA) with the Station Rotation Learning Model to support 21st-century learning. The main objective of the study was to analyze the impact of the Station Rotation Model in promoting student-centered learning and developing 21st-century skills. The sample consisted of research studies selected for systematic review based on their relevance to the Student-Centered Approach and Station Rotation Model. A systematic review method was adopted, and data were collected through analysis of existing literature. The results of the study revealed that the Station Rotation Model positively influences students' cognitive achievement, critical thinking skills, collaboration, and learning motivation. It was also found that the model can be effectively applied across different educational levels. The study concluded that the Station Rotation Model is an effective approach for supporting student-centered and 21st-century learning.

Guerrero and Benavides (2024) conducted a study to examine the effect of the Station Rotation Model on learning Physics among Grade X students. The main objective of the study was to determine the effectiveness of the Station Rotation Model in improving students' performance in Physics, particularly in topics such as reflection and refraction. A quasi-experimental method was adopted for the study. The instructional process involved the use of the Station Rotation Model, integrating diverse learning activities, while students' performance was measured using achievement tests. The results of the study revealed that students initially had average mastery of Physics concepts, but their performance improved significantly after the implementation of the Station Rotation Model. It was also found that the model enhanced students' understanding, motivation, creative and critical thinking, time management, and collaborative skills. The study concluded that the Station Rotation Model is an effective instructional strategy for improving academic achievement and developing essential skills in Physics learning.

Kaur (2024) conducted a study to examine the effect of the Station Rotation Model on critical thinking and academic achievement among learners. The main objective of the study was to explore how the Station Rotation Model, as a blended learning approach, contributes to the development of critical thinking skills and improvement in academic achievement. The study adopted a qualitative research approach based on a comprehensive literature review. Data were collected through extensive searches of academic databases and digital libraries, focusing on relevant studies related to blended learning and the Station Rotation Model. The results of the study revealed that the Station Rotation Model is an effective instructional strategy that enhances both critical thinking and academic achievement among students, highlighting its relevance in the digital era of education.

Latif (2024) conducted a study to examine the effectiveness of the Station Rotation Model in mastering fractions among students. The main objective of the study was to evaluate the impact of the Station Rotation Model on students' performance in adding and subtracting fractions. The sample consisted of 31 students selected through convenience sampling. A mixed-method research design was adopted for the study. Quantitative data were collected, while qualitative data were gathered through online questionnaires with Likert-scale items, open-ended questions, and structured interviews with selected students. A non-parametric test, specifically the Wilcoxon signed-rank test, was used to analyze the achievement scores. The results of the study revealed a significant improvement in students' performance and positive perceptions of the Station Rotation Model, highlighting that the use of manipulatives made learning enjoyable, group work enhanced engagement, and certain challenges were faced during implementation. The study concluded that the Station Rotation Model is an effective approach for improving mathematical learning and student engagement.

Mikawati and Susianna (2024) conducted a study to examine the application of the Station Rotation Model in improving the mastery of concepts and skills in English subjects among Grade III students. The main objective of the study was to evaluate the effectiveness of the Station Rotation Model in enhancing students' conceptual understanding and communication skills. The sample consisted of Grade III students. The results of the study revealed that the application of the Station Rotation Model significantly improved students' understanding of concepts and communication skills. It was also found that there was a progressive increase in students' competency scores from the first cycle to the third cycle. The study concluded that the Station Rotation Model is an effective instructional strategy for enhancing collaboration skills and conceptual understanding, although proper support and resources are necessary for optimal implementation.

Osuji and Abraham (2024) conducted a study to examine the effect of the Station Rotation Model on Biology students' academic performance and retention in secondary schools. The main objective of the study was to determine the impact of the Station Rotation Model on students' achievement and retention in Biology. The sample consisted of 110 SS1 Biology students selected through purposive sampling from a population of 4,800 students. A quasi-experimental design was adopted for the study. The instruments used for data collection were the Biology Students Academic Performance Test (BSAPT) and Biology Students Retention Test (BSRT). The results of the study revealed that students exposed to the Station Rotation Model performed significantly better and showed higher retention compared to those taught through traditional methods. The study concluded that the Station Rotation Model is an effective instructional strategy for improving academic performance and retention in Biology and recommended its adoption in secondary school classrooms along with the integration of 21st-century learning skills.

Pandya (2024) conducted a study to examine the integration of the Rotation Model of blended learning in teaching students with different abilities in the post-COVID situation. The main objective of the study was to explore how the Rotation Model can be effectively implemented to address the diverse learning needs of students and improve their academic achievement. The study adopted a qualitative approach based on conceptual analysis and review of existing practices related to blended learning. The data were derived from discussions on teaching strategies, planning techniques, and implementation practices suitable for diverse classrooms. The analysis focused on identifying effective methods for applying the Rotation Model in real classroom settings. The results of the study indicated that the Rotation Model of blended learning is beneficial in managing students of varying abilities, improving their academic performance, and providing personalized learning opportunities. It was also found that proper planning, collaboration among teachers, students, parents, and institutions, as well as systematic implementation, can significantly enhance the effectiveness of the model and reduce teachers' workload while supporting better learning outcomes.

Tabassum et al. (2024) conducted a study to examine the impact of blended learning on student performance. The main objective of the study was to determine the effectiveness of blended learning in enhancing academic performance, engagement, and satisfaction among university students. The sample consisted of 319 students drawn from diverse academic backgrounds. Data were collected using a structured questionnaire, which was validated through a pilot study involving 50 students. Pre- and post-intervention assessments were also conducted over a semester to measure changes in student performance. The results of the study revealed a significant improvement in academic performance among students who were exposed to blended learning compared to those in traditional learning environments. It was also found that blended learning enhanced students' engagement and satisfaction. The study concluded that blended learning is an effective instructional approach and recommended its adoption in educational institutions to improve student performance.

Tayyeh and Hassan (2024) conducted a study to examine the impact of the Rotation Model of blended learning stations on mathematical intuition among students. The main objective of the study was to determine the effect of the Rotation Model on developing mathematical intuition among third-year middle school female students. The sample consisted of 60 female students, with 29 in the experimental group and 31 in the control group. A quasi-experimental design with a post-test was adopted for the study. The tools used for data collection included a mathematical information test, an intelligence test, and a mathematical intuition test. The results of the study revealed that students in the experimental group significantly outperformed those in the control group in terms of mathematical intuition. It was also found that the Rotation Model contributed to enhancing students' intuitive thinking in mathematics. The study concluded that the Rotation Model of blended learning stations is an effective instructional strategy for improving mathematical intuition and recommended its use in mathematics teaching, along with proper teacher training and integration into educational programs.

Unnathamani and Sumanjari (2024) conducted a study to examine the impact of the Station Rotation Model on enhancing writing skills and academic performance among primary school children. The objective of the study was to evaluate the effectiveness of technology-integrated English language instruction using a blended learning approach for improving the writing skills of primary school students from socioeconomically disadvantaged backgrounds. The sample consisted of primary school children with limited exposure to English language learning outside the classroom. An experimental approach was adopted, wherein technology-integrated instructional strategies based on the Station Rotation Model were implemented. Tools such as interactive multimedia resources, online platforms, and language learning applications were used to support instruction. The results of the study revealed that the Station Rotation Model significantly enhanced students' writing skills and overall academic performance. It was also found that technology-integrated blended learning provided personalized and engaging learning experiences, helping students overcome limitations related to socioeconomic disadvantages and improving their proficiency in English.

Yukhymenko et al. (2024) conducted a study to examine the effectiveness of the Station Rotation Model of blended learning in higher education. The main objective of the study was to empirically test the effectiveness of the model in achieving a balance between online and in-person instruction. Data were collected using questionnaires and interviews from teachers who had implemented the Station Rotation Model. The results of the study revealed that teachers had a positive perception of the Station Rotation Model, indicating a high level of acceptance of its effectiveness. It was also found that the model promotes individualized learning and enhances digital competence among learners. The study concluded that the Station Rotation Model is an effective approach in higher education for balancing online and face-to-face instruction, and it provided practical recommendations for its successful implementation.

Elangovan (2023) conducted a study to examine the effectiveness of the Station Rotation Model of blended learning in learning English grammar among students of Standard VIII. The main objective of the study was to determine the impact of the Station Rotation Model on students' achievement in English grammar. The sample consisted of Standard VIII students who were divided into experimental and control groups. An experimental method with a pretest-posttest control group design was adopted. The experimental group was taught using the Station Rotation Model, which included teacher-led instruction, online learning, and collaborative activities, while the control group was taught through traditional teaching methods. An achievement test in English grammar was used for data collection, and statistical techniques such as mean, standard deviation, and t test were employed for analysis. The results of the study revealed that students in the experimental group showed significantly higher achievement compared to the control group. It was also found that the Station Rotation Model improved students' engagement, participation, and understanding of grammatical concepts. The study concluded that the Station Rotation Model is an effective instructional strategy for teaching English grammar at the secondary level.

Kumar et al. (2023) conducted a study to examine the effectiveness of the blended learning approach on the academic achievement of learners. The main objective of the study was to carry out a meta-analysis of previous research studies to determine the overall impact of blended learning on students' academic success. The sample of the study consisted of 20 research articles selected through purposive sampling from studies published between 2015 and 2021, which were identified through Google

Search. A meta-analytical method was adopted, and quantitative data were extracted from the selected studies and converted into effect sizes using Meta Essentials software. The analysis involved calculating the average effect size to determine the overall impact. The results of the study revealed that the average effect size was 1.46, indicating a large effect. It was concluded that blended learning approaches have a significant positive impact on students' academic achievement.

Xiangze and Abdullah (2023) conducted a study to examine the effectiveness of the Station Rotation Model integrated with a gamification approach in enhancing students' engagement in online English learning. The main objective of the study was to identify the integration of Station Rotation and gamification features within a learning management system that improves students' cognitive, emotional, and behavioural engagement in English vocabulary learning. The sample consisted of students from a non-native English-speaking context engaged in online learning. A qualitative research approach was adopted, and data were collected through observation, self-reports, and interviews using triangulation methods. The results of the study revealed that the integration of the Station Rotation Model with gamification significantly enhanced students' engagement across cognitive, emotional, and behavioural dimensions. It was also found that the approach increased students' interest, motivation, and active participation in learning English. The study concluded that combining Station Rotation with gamification is an effective strategy for improving student engagement in online language learning and provided practical recommendations for its implementation.

Varghese and Ranjith (2022) conducted a study to examine the effectiveness of the Station Rotation Blended Learning Model in an inclusive school setting. The objective of the study was to evaluate and analyse the impact of the Station Rotation Model on the learning outcomes of students, including those with diverse learning needs. The sample consisted of two Grade IV classrooms with 30 students, in which one group was taught using the traditional method and the other group was taught using the Station Rotation Model. An experimental method was adopted to compare the effectiveness of the two approaches. The instructional process in the experimental group involved rotation through different learning stations, enabling personalized attention and inclusion of all learners. The results of the study revealed that students in the Station Rotation Model group showed significantly higher learning outcomes compared to those in the traditional group. It was also found that students were less distracted and more engaged in learning. The study concluded that the Station Rotation Model is effective in promoting inclusive education, enhancing student interest, and improving overall academic performance.

Akinoso et al. (2021) conducted a study to examine the effect of the Station Rotation Model of instructional delivery on students' achievement and attitude in Mathematics. The main objective of the study was to determine whether the use of the Station Rotation Model improves students' academic achievement and attitude towards Mathematics compared to the conventional method. The sample consisted of senior secondary school students selected from two schools, which were purposively selected and randomly assigned to experimental and control groups. A pretest-posttest control group quasi-experimental design was adopted for the study. The instruments used for data collection were the Mathematics Achievement Test (MAT) and the Attitude towards Mathematics Inventory (ATMI). The results of the study revealed that there was a significant improvement in the academic achievement of students taught using the Station Rotation Model compared to those taught through the conventional method. However, no significant difference was found in students' attitudes towards

Mathematics. The study concluded that the Station Rotation Model is effective in improving achievement in Mathematics and recommended its adoption in instructional practices.

Ayob et al. (2021) conducted a study to examine the effect of blended learning using the Station Rotation Model on students' achievement in learning Chemistry. The main objective of the study was to determine the effectiveness of the Station Rotation Model in improving students' academic performance in Chemistry. A quantitative research design with a pre-experimental one-group pretest-posttest design was adopted for the study. The tools used for data collection were pretests and posttests developed to assess students' achievement in Chemistry. The results of the study revealed that there was a significant improvement in students' achievement after the implementation of the Station Rotation Model. It was also found that the model had a positive influence on students' learning through engaging activities. The study concluded that the Station Rotation Model is an effective instructional strategy for teaching Chemistry and recommended its use in designing blended learning environments.

Roach (2020) conducted a study to examine the effect of blended learning using the Rotation Model on fourth- and fifth-grade students' achievement in Mathematics. The main objective of the study was to determine whether the Rotation Model of blended learning improves students' mathematics achievement compared to traditional classroom instruction. A quantitative quasi-experimental comparative design was adopted for the study. Data were collected using a descriptive survey, and students' performance was measured through the Northwest Evaluation Association (NWEA) MAP Growth Mathematics assessment scores. An independent-samples t test was used for data analysis. The results of the study revealed that there was no statistically significant difference in mathematics achievement between students who were taught using the Rotation Model and those who were taught through traditional methods. The study concluded that, although blended learning using the Rotation Model is widely implemented, its impact on mathematics achievement in this context was not significant, highlighting the need for careful implementation and further research.

Christina (2019) conducted a study to examine the application of the Station Rotation Method of blended learning in elementary school science education to improve higher-order thinking skills. The main objective of the study was to determine the effectiveness of the Station Rotation Method in enhancing students' higher-order thinking skills and meeting diverse learning needs. The sample consisted of elementary school students selected for the study. A classroom action research design with a one-group pretest-posttest design was adopted. Data were collected through observation, interviews, teachers' journals, and assessment of students' learning outcomes. The results of the study revealed that the Station Rotation Method significantly improved students' problem-solving ability, critical thinking, and creativity in completing tasks. It was also found that the method effectively promoted higher-order thinking skills among students. The study concluded that the Station Rotation Model is an effective instructional strategy for enhancing higher-order thinking skills in science education.

Fazal and Bryant (2019) conducted a study to examine the effectiveness of blended learning using the Station Rotation Model in middle school mathematics. The main objective of the study was to determine the impact of blended learning on students' mathematics achievement compared to traditional face-to-face instruction. The sample consisted of 413 sixth-grade students. Data were collected using standardized assessment scores, namely the State of Texas Assessments of Academic Readiness

(STAAR) and the Measure of Academic Progress (MAP). An independent-samples t test was used to analyse the differences between students taught through blended learning and those taught through traditional methods. The results of the study revealed that students in the blended learning group performed better on the MAP assessment, indicating higher academic growth, whereas students in the traditional group scored higher on the STAAR assessment, which measures grade-level proficiency. The study concluded that blended learning using the Station Rotation Model is effective in promoting academic growth in mathematics, particularly for students who require additional support, although its impact on meeting grade-level standards may vary.

Mahalli et al. (2019) conducted a study to examine the implementation of the Station Rotation and Flipped Classroom models of blended learning in EFL learning. The main objective of the study was to analyse how these blended learning models are applied in teaching academic writing in an English Education Study Program. A qualitative research approach was adopted for the study. Data were collected through observation and interviews focusing on the implementation process of both models. The analysis highlighted that the Station Rotation Model was implemented through three rotations, namely teacher-led instruction, independent or collaborative activities, and online learning, while the Flipped Classroom model involved online assignments followed by face-to-face classroom sessions. The results of the study revealed that blended learning facilitated flexibility in learning, increased student activity, and enhanced curiosity. The study concluded that the use of Station Rotation and Flipped Classroom models is effective in promoting active learning and engagement in EFL classrooms.

Nagy (2018) conducted a study to examine the effect of the Station Rotation Model on preparatory students' writing performance. The main objective of the study was to determine the effectiveness of the Station Rotation Model in improving writing skills among first-year preparatory students. A quasi-experimental design was adopted for the study. The participants were selected and taught using the Station Rotation Model as a single-group intervention. Data were collected using both quantitative and qualitative tools, including a pre- and post-writing test, an analytical writing scoring rubric, a writing performance reflective checklist, and students’ writing samples. The results of the study revealed that students showed significant improvement in writing performance, particularly in relevance of ideas, reflection, organization, accuracy, fluency, and vocabulary acquisition. The study concluded that the Station Rotation Model is an effective instructional strategy for enhancing preparatory students’ writing performance.

Govindaraj and Silverajah (2017) conducted a study to examine the blending of Flipped Classroom and Station Rotation Models in enhancing students’ learning of Physics. The main objective of the study was to understand students’ perceptions of a blended learning approach using flipped and station rotation models in Physics learning. Data were collected using a survey questionnaire consisting of a five-point Likert scale and open-ended questions. The analysis focused on students’ perceptions across five domains: access, interaction, response, results, and facilitation. The results of the study revealed that students had generally positive perceptions of the blended learning approach in all measured domains. It was also found that the approach enhanced student involvement and satisfaction in Physics learning, although some areas for improvement were identified. The study concluded that the combination of Flipped Classroom and Station Rotation Models is an effective blended learning strategy for supporting Physics education.

Critical Review

The investigator reviewed 31 studies from various sources related to the Station Rotation Model of teaching. The related studies revealed that the Station Rotation Model promotes meaningful learning experiences by improving academic achievement, retention, critical thinking, creativity, communication skills, collaboration, motivation, engagement, and higher-order thinking skills among learners. The reviewed studies further revealed that the Station Rotation Model supports personalized and student-centered learning by integrating teacher-led instruction, online learning, collaborative activities, and independent learning tasks. Several studies, such as those by Yilmaz and Fırat (2026), Oledan (2025), Guerrero and Benavides (2024), and Christina (2019), indicated that students experienced greater enjoyment, participation, and conceptual understanding through rotational learning activities. Systematic reviews and meta-analyses conducted by Anagnostopoulou et al. (2025), Ramadan et al. (2025), and Kumar et al. (2023) confirmed the overall positive impact of blended learning and the Station Rotation Model on students' learning outcomes and 21st-century skills. The reviewed studies adopted various research methodologies, including experimental, quasi-experimental, mixed-method, qualitative, systematic review, classroom action research, and meta-analytical approaches.

The review of related literature helped the investigator gain a proper perspective on the problem selected for the present investigation. After a careful review of all the studies, it was found that although many studies have examined the effectiveness of the Station Rotation Model in different subjects and educational contexts, only limited studies were found in relation to its effectiveness in developing specific learning outcomes in Science. Therefore, to fill this research gap, the investigator conducted a study on the "Effectiveness of the Station Rotation Model on Academic Achievement in Science among High School Students."

Chapter – III

METHODOLOGY

Section – A

- Development of Instructional Design on Station Rotation Model
- Development of Achievement Test in Science

Section – B

- Method Adopted
- Experimental Design Selected
- Experimental Procedure
- Statistical Techniques used

Chapter-III

METHODOLOGY

Educational research involves application of scientific methods to the solution of educational problems. The ultimate aim of educational research is to provide knowledge that helps the researcher to achieve his goal by the most effective method. According to Best and Kahn (2002), "Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of events".

Research methodology is a style of conducting a research work, which is determined by the nature of the problem. Methodology is the philosophical framework within which the research is conducted or the foundation upon which the research is based" (Brown, 2006). Research methodology involves the systematic procedures by which the researcher starts from the initial identification of the problem to its final conclusions.

According to *Kothari* (2009), "Research methodology, is a strategy to systematically answer the research challenges." It might be considered a Science that studies how scientific research is conducted. The role of the methodology is to carry on the research work in a scientific and valid manner. The methodology consists of procedures and techniques for conducting a study.

The scope of research methodology is wider than that of research methods. Thus, research methodology not only consider the research methods but also consider the logic behind the methods that used in the context of a research study and explain why a particular method or technique are chosen for this study and why not using other methods. Hence the success depends on the suitability of the method adopted of the study. For the present study, the investigator has chosen the experimental method.

Research methodology involves various activities. They include problem identification, literature research, hypothesis development, data collection, data analysis, result interpretation, and conclusion. It is a method for solving research problems systematically. Methodology is just as vital to any kind of research as the validity and reliability of the results.

Research design is a significant component of research methodology, as it serves as a framework or blueprint for conducting the study systematically. Research methodology not only ensures academic rigor but also establishes the reliability and validity of the research findings. The primary aim of research is not merely to solve problems, but also to generate new knowledge and understanding. A well-structured methodology supports the systematic, ethical, and meaningful pursuit of knowledge. Thus, research methodology can be understood as a carefully organized process that transforms inquiry and curiosity into reliable, useful, and ethically sound findings that contribute to informed decision-making and the advancement of knowledge.

The methodology of the present investigation has been presented under two sections. Section A deals with the development and validation of the tools and Section B with the details of research design

Section - A

This section deals with development of the tools.

1. Development of Instructional Design on Station Rotation Model

2. Development of Achievement Test in Science

Tool: 1

DEVELOPMENT OF INSTRUCTIONAL DESIGN ON STATION ROTATION MODEL

An instructional Design on the Station Rotation Model was prepared by the investigator for Class IX students to assess their academic performance by using an experimental design. The Station Rotation Model contains various activities for enhancing learners in various modes, giving importance to students' active engagement in the learning process. This design includes a set of instructional materials such as the lesson transcript on Station Rotation Model, various activities conducted in the stations and the assessment tools used. By using this package, the effectiveness of Station Rotation Model is assessed. The Station Rotation Instructional Design promotes differentiated instruction with teachers and collaborative discussion among peers.

Steps of Station Rotation Model

The development of Station Rotation Model was prepared based on the rules and principles given by Horn and Staker (2012), The Steps adopted for the preparation of Station Rotation Model as suggested by **Rebecca Hite, Heather Greenhalgh-Spencer**, and **Gina Childers (2022)** in their work on ***Differentiation using station rotations in science education.***

Development of Steps for Instructional Design on Station Rotation Model has the following steps

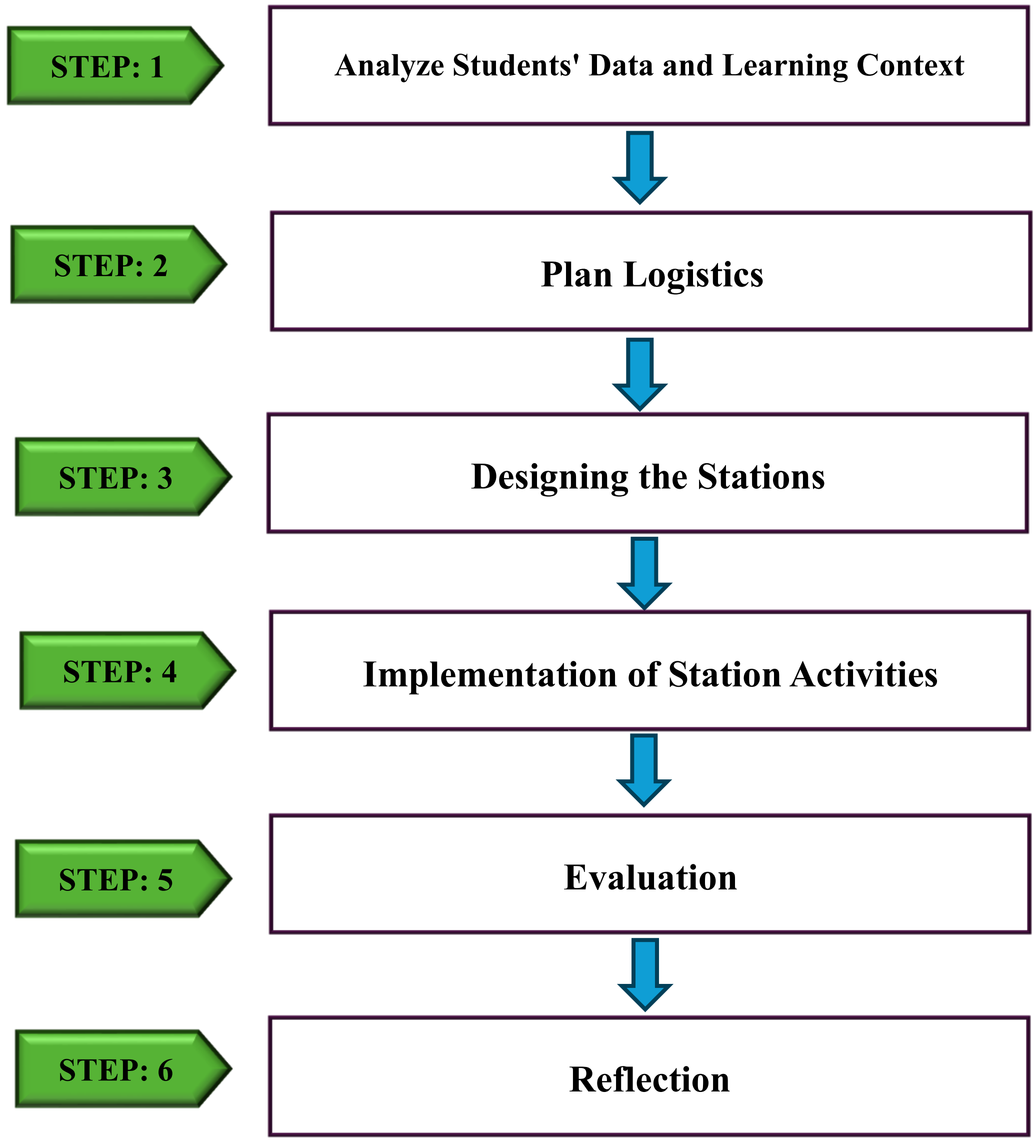

Figure 3.1 *Development of Steps for Instructional Design on Station Rotation Model*

The details of the steps for preparing the lesson transcripts are given below.

STEP: 1 ***ANALYZE STUDENTS' DATA AND LEARNING CONTEXT***

In this step, students data are systematically collected and analyzed to establish a strong foundation for instructional planning. The teacher collects students' previous achievement scores to understand their performance level. The students' prior knowledge is also assessed through guiding statements administered before the lesson to determine their existing understanding of the topic.

Based on this data, station activities are carefully planned, and students are grouped strategically to promote effective learning. The insights gained from both academic records and prior knowledge assessment, support the design of differentiated station activities that address the learners need and enhance overall instructional effectiveness.

STEP: 2 ***PLAN LOGISTICS***

Plan Logistics refers to operational planning to ensure the smooth functioning of station rotations.

The main **components** of Plan Logistics are

i) Grouping

ii) Timing

iii) Direction

i) Grouping

In grouping, the total number of students in the experimental group is divided into separate groups using the strategy called "*mirror stations*". This strategy makes it possible to keep the total number of students at each station lower. From each group, two leaders are selected. The role of the first leader is to keep the Colour coded Folder consisting of required materials to carry out the station activities. The role of the second leader is to maintain the discipline of the respective.

Each group consist of a mixed - ability of students, such as high, moderate and emerging readiness levels to promote peer learning and cooperation.

ii) Timing

Timing for single station is eight minutes. Each station will be allotted eight minutes. The timing begins with a whole-group instruction lasting for 10 minutes. This is followed by station rotation activities, with a total rotation time of 24 minutes and an additional three minutes allotted for transitions between stations, making 27 minutes in total. Finally, the session was concluded with an evaluation of eight minutes. Thus, the entire lesson is planned to be completed within a total duration of 45 minutes.

iii) Direction

The direction for this plan logistics is that each group begins at their assigned station. After eight minutes, the teacher rings an alarm, to implement the transition to the next station and the students move quietly to the next station.

The instructions will be provided to each station. Students read and do their activities assigned in the particular station. All group members must participate in the allotted activities.

STEP: 3 ***DESIGNING THE STATIONS***

The students are divided into three groups, and three types of stations are planned. Each group will be allotted to their respective stations, such as

1. Teacher-led Station
2. Online Station
3. Offline Collaborative Station

In each of these three stations, the students will rotate according to a fixed schedule to engage in structured learning activities designed to promote conceptual understanding and collaborative learning.

1. ***Teacher-Led Station*** that focuses on concept explanation and guided discussion.
2. ***Online Station*** that emphasizes interactive digital learning.
3. ***Offline collaborative Station*** that involves hands-on group activity.

STEP: 4 ***IMPLEMENTATION OF STATION ACTIVITIES***

The implementation of station activities are systematically structured to ensure effective student engagement and optimal use of instructional time within the Station Rotation Model. The instructional sequence for this step is

1) **Whole - Group Instruction**
2) **Station Rotation Activities**

1) Whole - Group instruction (10 minutes)

The whole group instruction began with a brief mini lesson lasting approximately for 10 minutes. In this step, the teacher facilitates an introductory discussion to activate students' prior knowledge, clearly states the learning objectives, and explains the rotation procedures. This serves to provide conceptual orientation and ensure students cognitive preparation for independent and collaborative learning experiences.

2) **Station Rotation Activities**

Students' are rotated through three structured stations as given below based on prior assessment data and learning needs.

Figure 3.2 *Three Stations in Station Rotation Model*

Each station addresses the learning objective through varied instructional approaches. The table below illustrates the structured rotation plan adopted for the Station Rotation Model, in which six groups rotate through the teacher-led, online, and offline stations at 8-minute intervals to facilitate balanced and active learning.

Table 3.1
Station Rotation Chart

Stations	Rotation 1	Rotation 2	Rotation 3
 **Teacher-Led Station**	Group 1	Group 2	Group 3
 **Online Station**	Group 3	Group 1	Group 2
 **Collaborative Station**	Group 2	Group 3	Group 1

a) Teacher-Led Station (8 minutes)

At the teacher-led station, the teacher provides focused instruction and guided practice to a small group of students. The teacher plays an active facilitative role, while students engaged in questioning and in discussion.

Activities in Teacher-Led Station

Activities are designed to clarify key concepts, address misconceptions identified through prior assessments and offer immediate feedback.

i) Pair Activities

Think–Pair–Share, and Question Exchange are some of the pair activities conducted in the teacher-led station. In *Think–Pair–Share*, students first think individually about a question, discuss their ideas with the partner, and share their responses with the group. *Question Exchange* encourage students to answer questions with their partners, promoting active participation and collaborative learning.

ii) Group Activities

Group activities such as Group Discussion, Concept Mapping, and Problem-Solving Tasks are conducted in the teacher-led station. In *a Group discussion*, students work together to share opinions and arrive at a common understanding of the topic. *Concept Mapping* help students organize ideas visually and connect important concepts. Problem-Solving tasks encourage students to analyze situations collectively, discuss possible solutions, and develop critical thinking and teamwork skills.

iii) Role Play

Role Play activities are conducted to help students understand real-life situations and improve their communication skills. Students are given short situations or scenarios and are allowed two to three minutes to discuss and prepare their roles. They then perform the role play in front of their station members, which helps in developing confidence, creativity, and collaborative learning. Role play also enables students to apply theoretical knowledge in practical contexts and enhances active participation in the classroom.

Materials included in teacher-led station are

- Textbooks
- Charts
- Visual presentation

Assessment at this station is formative in nature using oral questioning

b) Online Learning Station (8 minutes)

The online station was designed to promote self-paced and individualized learning through digital resources selected by the teacher. The teacher supervises, ensuring appropriate engagement and technical support when necessary, while students work independently.

Materials included ***digital devices, internet access,*** and ***curated online content***.

Activities in Online Station

i) Video

Videos from YouTube and other online learning platforms are used to enhance students' visual understanding of concepts. These videos helped students to observe the processes, examples, and demonstrations in an engaging manner, thereby improving conceptual clarity and retention of learning. The use of audio-visual content also increased students' attention and participation during the learning process.

ii) Simulations

Simulations are conducted through PhET Interactive Simulations and through virtual labs to provide students with experiential learning opportunities. These simulations enabled students to perform experiments and observe scientific processes virtually, helping them understand abstract concepts in a practical way. Through simulations, students could visualize transfer of heat interactively, which enhanced their learning through online station.

iii) Gamified Assessments

Gamified assessments are conducted using Google Forms, Kahoot!, Wordwall, and Educaplay to assess students' understanding in an engaging manner. *Google Forms* are used to evaluate students' grasping and understanding of concepts through quizzes and interactive questions. *Kahoot!* provided a game-based quiz environment that encouraged active participation, competition, and motivation among students.

Wordwall includes various gamified activities such as matching words, drag-and-drop challenges, grouping activities, and image matching tasks, which made learning enjoyable and interactive for students. *Educaplay* was also used for gamified learning activities such as froggy jump quizzes, matching exercises, and line up activities that supported reinforcement of concepts through play-based learning.

iv) Collaborative Online Activity – Padlet

Padlet is used as a collaborative online learning platform where students could share their thoughts, ideas, and reflections related to the lesson. Students also created

AI-generated images based on the impact of plastics and uploaded them to Padlet for discussion and interaction.

Assessment is conducted through ***auto-graded quizzes*** or ***digital task completion records***.

c) Collaborative Station (8 minutes)

The offline station emphasizes peer interaction and application of knowledge. Students work collaboratively to apply concepts and construct understanding through dialogue and shared problem-solving.

Materials included ***activity sheets, charts,*** and ***manipulatives***.

Activities in Offline Station

i) Worksheet-Based Activities

The offline station mainly focused on worksheet-based learning activities that encouraged collaborative among students. Activities such as *Sorting Challenges* were used to help students classify and organize concepts based on their characteristics, thereby improving analytical and critical thinking skills. *Graphic Organizers* were also used to enable students to visually arrange information, identify relationships between concepts, and summarize their learning effectively.

ii) Visual Artifacts and Image-Based Worksheets

Visual artifacts and Image-based worksheets were used. Through pictures, diagrams, and visual representations, students were encouraged to identify concepts, analyze features, and differentiate between various categories. These activities supported visual learning and enhanced students’ understanding through concrete representations of concepts.

iii) Crossword Puzzles

Crossword puzzles and other worksheet activities are conducted to reinforce subject knowledge in an engaging manner. These activities encouraged students to recall concepts, and strengthen conceptual understanding through problem-solving tasks.

Assessment involved peer interaction and review of completed tasks.

STEP: 5 ***EVALUATION***

After completing all Station Rotation Activities, the investigator summarizes and reinforces key concepts to enhance students' understanding. ***Exit slips*** are then administered as a final formative assessment to evaluate students' understanding, identify remaining misconceptions, and assess the overall effectiveness of the instructional process.

STEP: 6 ***REFLECTION***

In the final step, reflection are carried out by the investigator to evaluate the effectiveness of the station rotation facilitation and overall instructional practices. The teacher analyses the factors such as student engagement, station effectiveness, time management, classroom management, and alignment with learning objectives to identify strengths and areas requiring improvement. These reflections informs necessary instructional adjustments and provides insights for improving future implementation of the Station Rotation Model.

Tool: 2

DEVELOPMENT OF ACHIEVEMENT TEST IN SCIENCE

Construction and Validity of the Tool on achievement test

Achievement test in Science (draft) was prepared by the investigator Juhi Jeluna. J with the help of the supervisor Dr. K. Gireesh Kumar, aimed to measure the achievement of Class IX students. It was based on the content selected for preparation of Station Rotation Model for teaching science from Tamilnadu State board syllabus. The questions prepared were objective type and carries one mark each. This section of questions consists of choose the correct answer. The time allotted for the test was 80 minutes and the mark allotted for the test was 70 marks. (The Achievement test in Science (draft) prepared by the investigator is given in Appendix C)

Achievement test in Science was constructed by following the systematic procedure. The investigator adopted the following major steps in the construction of the test

1. Planning of the Test
2. Preparation of the test
3. Item Writing
4. Item Editing
5. Arrangement of Items
6. Draft of the Test
7. Preliminary Try-out
8. Pilot Study
9. Scoring
10. Item Analysis

11. Item Selection
12. Final Test

1. **Planning of the Test**

The achievement test in Science, prepared by the investigator Juhi Jeluna. J and by the research supervisor Dr. K. Gireesh Kumar, aimed to measure the achievement in Science of Class IX students. While planning the test, due importance was given to the content of the Science textbook of Class IX. The investigator constructed the tool based on the level of attainment of the students who were selected as the sample for the study. A total of 70 items were included, and the maximum score allotted was 70. The time duration of the test was fixed as 80 minutes.

2. Preparation of the test

1) Weightage to Objective

The purpose of the test was mainly to assess the achievement of class IX students. The categories of objectives selected for the preparation of the achievement test were

- Understanding
- Applying
- Analyzing
- Evaluating
- Creating

Out of the 70 questions, 20 questions were understanding level, 26 questions were Applying level, 14 questions were Analyzing level, 4 questions were Evaluating level and 6 questions were Creating level, the details are shown below in the tabular column

Table 3.2

Weightage to Objectives

S.No.	Objectives	Marks	Percentage
1.	Understanding	20	28.57
2.	Applying	26	37.14
3.	Analyzing	14	20
4.	Evaluating	4	5.72
5.	Creating	6	8.57
Total		**70**	**100**

The table above shows the distribution of marks across different cognitive levels. Applying level with 26 marks (37.14%), followed by Understanding with 20 marks (28.57%). Analyzing accounts for 14 marks (20%), while Creating and Evaluating are allotted 6 marks (8.57%) and 4 marks (5.72%) respectively. This distribution prioritizes application and comprehension skills while also incorporating higher order thinking skills, with a total of 70 marks representing 100%.

2) Weightage to Content

The chapter "Heat" and "Carbon and its Compound" were selected from class IX science textbook and adequate weightage was given to each unit. The details are presented in Table 3.3

Table 3.3

Weightage to Content

S.No.	Content	Marks	Percentage
1.	Heat	35	50
2.	Carbon and its Compound	35	50
Total		**70**	**100**

The table above shows the content-wise distribution of marks for the achievement test. The units Heat and Carbon and Its Compounds are allotted equal weightage of 35 marks each, constituting 50% of the total marks. The total marks for the test are 70, with the overall percentage being 100%. This balanced distribution ensures equal emphasis on both physics and chemistry concepts, providing a comprehensive assessment of students' understanding of the prescribed syllabus.

3) Weightage to level of difficulty

Based on the level of difficulty questions, the items in the test were classified into Easy, Average and Difficult. Proper weightage was given to each level, in the achievement test. The details are shown in Table 3.4

Table 3.4

Weightage to Difficulty level

S.No.	Difficulty level	Marks	Percentage
1.	Easy	10	14.28
2.	Average	36	51.43
3.	Difficulty	24	34.29
Total		**70**	**100**

The table above shows the distribution of marks according to the level of difficulty in the achievement test. The average level of questions carries the highest weightage with 36 marks (51.43%), followed by the difficult level with 24 marks (34.29%). The easy level was allotted with 10 marks (14.28%).

Blue Print of an Achievement Test

The blue print is a three-dimensional chart showing the weightage given to objectives, content and form of questions in the achievement test. It gives in summary form, all necessary information about the design of the test. The figures outside the bracket indicate the marks and those with in the bracket indicates the number of questions. In this test, among the three forms of questions, the objective type question was used for strict objectivity in the evaluation procedure. The blue print was prepared for the Achievement test in Science for the Chapter "Heat" and "Carbon and its Compound" is given in table below

Table 3.5

Blue Print of an Achievement Test (Draft)

Objectives	Understanding			Applying			Analyzing			Evaluating			Creating			Total
Form of question	Objective			Objective			Objective			Objective			Objective			
Difficulty level / Content	E	A	D	E	A	D	E	A	D	E	A	D	E	A	D	
Heat	$(4)^1$	$(5)^1$			$(14)^1$				$(7)^1$			$(2)^1$			$(3)^1$	**35**
Carbon and its Compounds	$(7)^1$	$(4)^1$			$(12)^1$				$(7)^1$			$(2)^1$			$(3)^1$	**35**
Total	**20**			**26**			**14**			**4**			**6**			**70**
Figures outside the brackets indicate the marks and within the brackets indicate number of questions E – Easy; A – Average; D - Difficult																

2. Item Writing

Item writing is one of the most important steps in the construction of any research tool. Items of the Achievement in Science was written after reviewing a thorough study of related literature on achievement test in Science. The investigator collected relevant materials and constructed 70 number of questions for preparing the achievement test in Science of class IX. All items in the test was based on the syllabus of Tamilnadu State Board. All the questions were framed in multiple-choice format and each item was given equal priority. The respondents were instructed to answer all the questions carefully according to the instruction provided in the question paper. The prepared items were given for item editing

3. Item Editing

Item Editing is an important process for checking the quality of the prepared items. It requires careful review and thorough knowledge of the concerned subject. In Item Editing, the investigator examines the relevance, clarity and appropriateness of each item included in the test. After the initial editing, the test was submitted to experts, including teacher educators and school teachers who taught Science subject. Based on their suggestions and feedback, irrelevant and unclear items were removed or modified. Finally, all items were rewritten in simple, clear, and meaningful language to ensure better understanding by the respondents.

4. Arrangement of Items

The investigator carefully arranged all the edited items in a systematic order to increase the interest of the respondents and maintain the attention and readiness for responding.

5. Draft of the Test

The draft achievement test in Science was prepared by printing all the items along with their corresponding alternatives. The items were printed in English that consisted of 70 items in total. The general data sheet and necessary instructions were also provided to guide the respondents on how to mark their answers. A separate response sheet was also provided along with general data sheet. The draft from of the test and general data sheet along with response sheet is enclosed in the Appendix.

6. Preliminary Try-out

The test was tried out on a sample of class IX students in order to find out the accuracy and relevancy of each item. The test was administered to examine the practicability of the tool, including the time required for completion, the difficulty level of the items and the clarity of instructions. After the administration of test, the investigator reviewed the responses to evaluate the time taken by the students, identify any vague or confusing items and determine whether any further modifications were required.

7. Pilot Study

A pilot study is a scaled-down prototype of the final data collection process started from 24-11-2025 to 26-11-2025. The investigator conducted the pilot study for the draft version of the Achievement Test in Science for Class IX students. The investigator visited the various schools in the Kanyakumari District. After seeking permission from the head of the school, the investigator met the students of class IX and gave the brief self-introduction and purpose of conducting the test. The Achievement Test in Science was administered individually to Class IX students after providing clear instructions regarding the nature of the items, the method of selecting the correct answer and the time allotted for the test. After completing the responses, the investigator collected the response sheet from the students. The data was selected from the sample of 130 students by using simple random sampling technique for the purpose of item analysis and preparation of the final draft.

8. Scoring

The scoring key was prepared for each item with its corresponding marks. The collected response sheet was scored with the help of a key prepared by the investigator. For each correct response a score of **one** was assigned and for wrong response a score of **zero** was given. After completion of scoring, the data were organized and tabulated for analysis and interpretation. The scoring key is enclosed in the Appendix - E.

9. Item Analysis

Items were analyzed in order to compute the difficulty level and discriminative power of each item for conclusion in the final test. The investigator used the method suggested by **Ebel and Fresbie** (1991) for item analysis. For this, the answer sheets of respondents were arranged in the descending order, from high to low. Then the upper 27% of the answer scripts from the top was considered as 'Upper Group' and the lower 27% of the answer scripts from the bottom were considered as 'Lower Group' respectively.

The difficulty Index and discriminative power of each item was calculated by using the formula,

Difficulty Index

$$\boldsymbol{DI = \frac{R_H + R_L}{N_1 + N_2}}$$

Discriminative Power,

$$\boldsymbol{DP = \frac{R_H - R_L}{N}}$$

Where,

R_H - Number of correct responses in the Upper Group

R_L - Number of correct responses in the Lower Group

N_1 - Number of students in the Upper Group

N_2 - Number of students in the Lower Group

N - Number of students in the Upper or Lower Group

10. Item Selection

The investigator analyzed the items from the collected responses from the students. After item analysis, the investigator select the items based on the values obtained in both difficulty index and discriminative power. Items having difficulty level between 0.30 and 0.70 and the discriminating power 0.3 and above are selected for the final test. After Item analysis, a total of 36 items were selected from 70 items.

Table 3.6

Details of Items selected for the Achievement Test in Science

Item Number	Discriminative Power	Difficulty Index	Selected Item
1	0.26	0.87	**-**
2	0.6	0.7	**Selected**
3	0.23	0.2	**-**
4	0.51	0.63	**Selected**
5	0.31	0.36	**Selected**
6	0.54	0.73	**Selected**
7	0.14	0.44	**-**
8	0.03	0.47	**-**
9	0.11	0.2	**-**
10	-0.03	0.21	**-**
11	0.17	0.51	**-**
12	0.54	0.67	**Selected**
13	-0.14	0.1	**-**
14	-0.11	0.14	**-**
15	0.57	0.51	**Selected**

16	0.4	0.71	**Selected**
17	0.14	0.3	**-**
18	0.37	0.56	**Selected**
19	0.57	0.51	**Selected**
20	-0.11	0.23	**-**
21	0.63	0.51	**Selected**
22	0.66	0.47	**Selected**
23	0.54	0.64	**Selected**
24	0.4	0.48	**Selected**
25	0.17	0.31	**-**
26	0.66	0.53	**Selected**
27	0.34	0.34	**Selected**
28	0.77	0.58	**Selected**
29	0.2	0.41	**-**
30	0.11	0.2	**-**
31	0.17	0.28	**-**
32	0.77	0.47	**Selected**
33	0.4	0.34	**Selected**
34	0.89	0.53	**Selected**
35	-0.09	0.21	**-**
36	0.28	0.34	**-**
37	0.51	0.63	**Selected**
38	0.06	0.43	**-**
39	0.48	0.44	**Selected**
40	0.4	0.31	**Selected**
41	0.68	0.63	**Selected**
42	0.66	0.56	**Selected**
43	0.37	0.44	**Selected**
44	0.74	0.51	**Selected**
45	0.08	0.21	**-**
46	0.6	0.56	**Selected**
47	0.14	0.33	**-**
48	0.31	0.41	**Selected**

49	0.28	0.4	**-**
50	0.6	0.41	**Selected**
51	0.4	0.37	**Selected**
52	0.26	0.38	**-**
53	0	0.28	**-**
54	0.28	0.4	**-**
55	0.43	0.47	**Selected**
56	0.17	0.31	**-**
57	0.43	0.36	**Selected**
58	-0.06	0.31	**-**
59	0.28	0.26	**-**
60	0.06	0.23	**-**
61	0.4	0.48	**Selected**
62	0.28	0.37	**-**
63	0	0.23	**-**
64	0.26	0.33	**-**
65	0.4	0.54	**Selected**
66	0.2	0.33	**-**
67	0.11	0.4	**-**
68	0.48	0.47	**Selected**
69	0.03	0.3	**-**
70	0.48	0.47	**Selected**

Total number of items selected = 36

11. Final Test

The investigator selected the items after the data analysis to form the final test. It consists of a total of 36 items from 70 items were selected for the final test based on the values of difficulty index and discriminating power. The test items were prepared based on the blue print, by giving due weightage to content, objectives and difficulty level. The maximum marks of the test were 36 and the time allotted was 40 minutes. The final form of the Achievement test is enclosed in the Appendix – F.

Table 3.7

Blue Print of an Achievement Test (Final)

Objectives / Form of question / Difficulty level / Content	Understanding			Applying			Analyzing			Evaluating			Creating			Total
	Objective			Objective			Objective			Objective			Objective			
	E	A	D	E	A	D	E	A	D	E	A	D	E	A	D	
Heat		$(4)^1$			$(10)^1$				$(3)^1$						$(2)^1$	**19**
Carbon and its Compounds	$(6)^1$				$(4)^1$				$(3)^1$			$(2)^1$			$(2)^1$	**17**
Total	**10**			**14**			**6**			**2**			**4**			**36**
Figures outside the brackets indicate the marks and within the brackets indicate number of questions E – Easy; A – Average; D - Difficult																

Establishing Validity and Reliability

Reliability and validity are essential to the effectiveness of any data gathering procedure.

Reliability

Reliability refers to the consistency and stability of a measuring instrument, indicating that it produces similar results whenever it is administered under similar conditions.

In the present study, the reliability coefficient was found by a spilt-half method. For the calculation of spilt-half reliability of a scale, the score obtained by a sample of 130 students are used. The score of odd items and even items were taken separately and the correlation was calculated. The coefficient of correlation indicates the reliability of the half scale. The correlation coefficient of the whole scale is then estimated by using Spearman Prophecy formula.

Table 3.8

Reliability analysis of the Achievement Test in Science

Contents	Count
Number of Sample	130
Number of Items	70
Correlation between odd half and even half items	0.78
Reliability Coefficient	0.88

From Table 3.1, it shows that correlation between odd half and even half items has 0.78 reliability. The reliability coefficient of the Academic Achievement Test in Science was found to be 0.88

Validity

Validity of the test answers the question what a test measure and how well it measures it whatever it designed to measure for. Best (1978) clarifies, “A test possesses validity to the extent that it measures what it claims to measure".

Face and content validity of the tool were ensured through expert review. The tool was examined by experts in the fields of education to determine whether the items appropriately represented the intended objectives and variables of the study. Based on their suggestions and evaluation, necessary modifications were made, and the experts confirmed that the tool had adequate content coverage and was suitable for measuring the required aspects of the study.

SECTION-B

THE RESEARCH DESIGN: PLAN AND PROCEDURE

The various aspects of the method followed in the present investigation are discussed such as the method adopted, research design, variables of the study, experimental procedure, tools used, administration of tools and statistical techniques used.

a) Method Adopted

The present study is an attempt to determine the effectiveness of Station Rotation Model on Academic Achievement in Science of class IX students. Therefore, the investigator followed an experimental method for the study.

b) Experimental Design Selected

To conduct an experimental study, an appropriate experimental design has to be selected. An experimental design is a plan or strategy of a investigation conceived in order to solve the research problem. According to Best and Kahn (1999), an experimental design is the part of the procedure that enables the researchers to test the hypothesis by searching valid conclusion about relationship between independent and dependent variables.

An experimental design can be selected based on factors like the nature and purpose of the experiment, the type of the variables to be manipulated, the nature of the data, the facilities or conditions available for conducting the experiment and the competence of the experiment. Convenience sampling technique were used for the present study.

Pre-test, post-test, non-equivalent parallel group design was used for this study. It is administratively difficult for the investigator to arrange equivalent groups by managing students as it may disturb the daily routine class work. These difficulties can be overcome by conducting the experimental in normal class which are normally non-equivalent groups with the help of some statistical technique. It was thus decided by the investigator to conduct the experiment in non-equated classroom of two groups. The design that was adopted for the present study was the pre-test, post-test, non-equivalent parallel group design.

Characteristics of the Experimental Design

i. The effects of the treatment are judged by studying difference between the pre-test and post-test scores.

ii. As there is no control group in this design, all the work concerns the experimental group only.

Best and Kahn (2009) illustrated the Pre test-Post test Non-equivalent Group Experimental Design as,

$$O_1 \; X \; O_2$$

$$O_3 \; C \; O_4$$

Where

X - Experimental Group

C - Control Group

O_1 & O_3 – Pre-test

O_2 & O_4 - Post-test

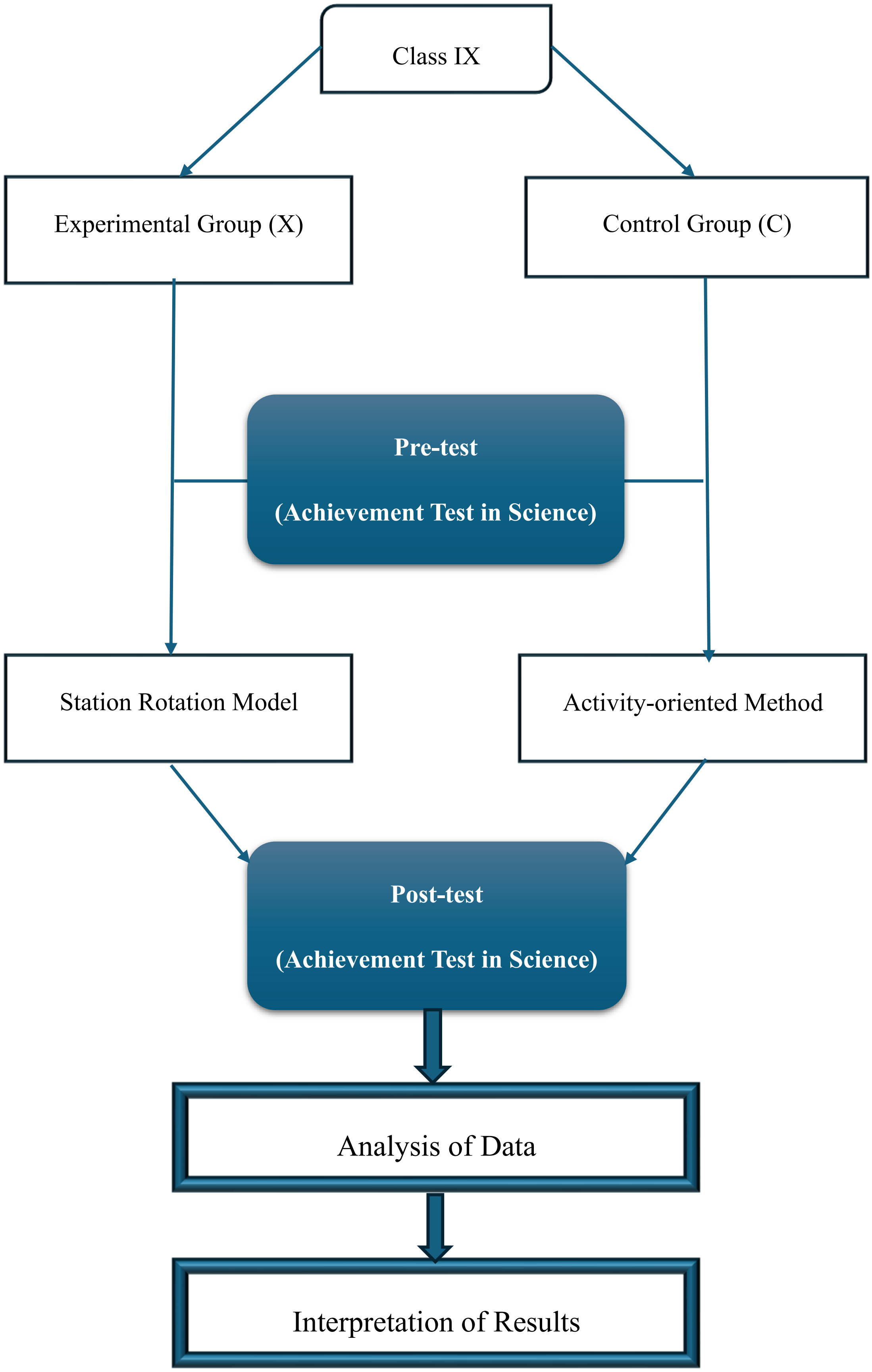

Figure 3.3 *Diagrammatic representation of Non-equivalent group design*

VARIABLES OF THE STUDY

Variables can be referred to as the condition or characteristics manipulated, controlled or observed by an experimenter. If the hypothesis and its deduced consequences are well conceived, two factors can be precisely identified they are,

a) Independent Variable

b) Dependent Variable

a) **Independent Variable**

The manipulated variable in the process of experimentation is known as independent variable. It is subjected to the direct control of the experimenter who can cause it to vary in any desire direction.

In this study, Method of teaching is the independent variable. The experimental group was treated with Station Rotation Model of teaching and the Control group was treated with Activity-Oriented Method. These are the two strategies adopted by the investigator for the independent variable.

b) **Dependent variable**

The basis on the effectiveness of experimental or independent variable studied is known as the dependent variable. The outcome (result) that is measured to see if it changes in response to the independent variable.

In this study, Achievement Test is a dependent variable. Both the groups were tested with the achievement test in Science.

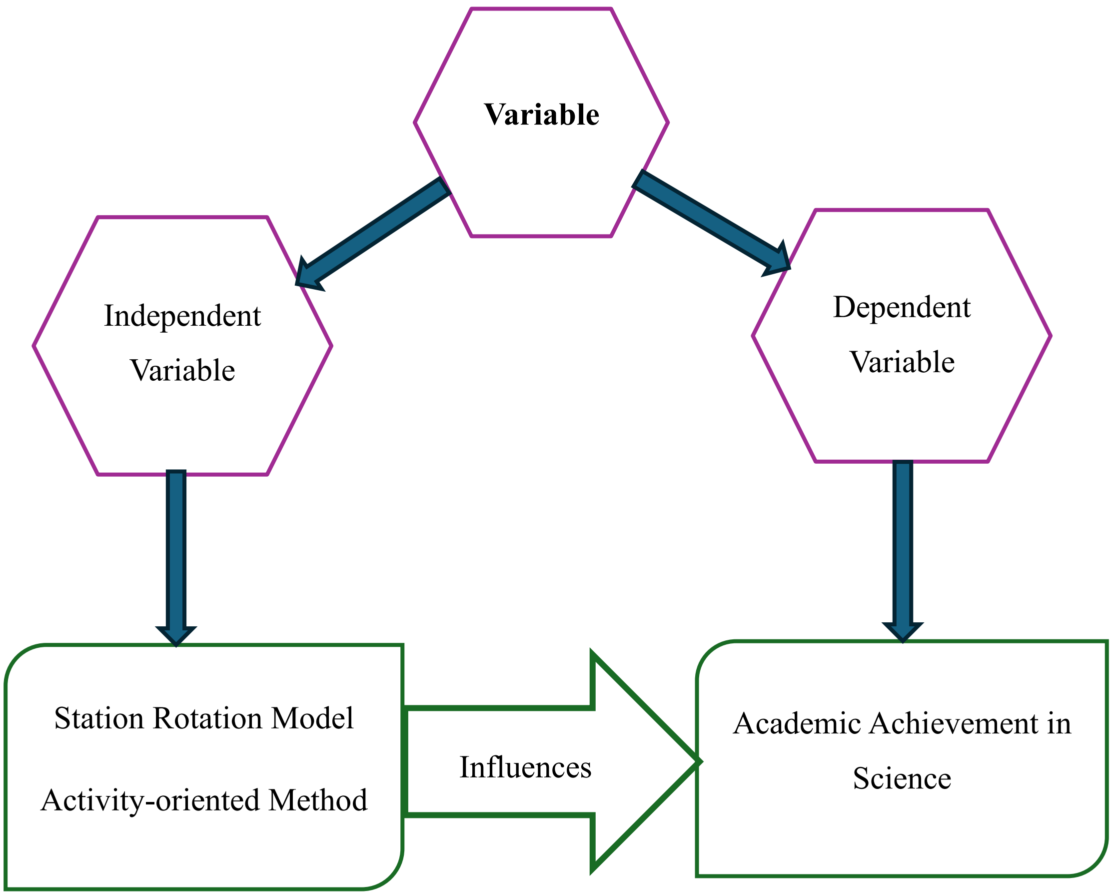

Figure 3.4 *Design of Experimental Study*

EXPERIMENTAL PROCEDURE

The steps involved in the experimental procedure are detailed below

1) **Administration of Pre-test**

   Achievement Test in Science

2) **Experimentation**

   a) Treatment with Station Rotation Model (Experimental Group)

   b) Activity- oriented Method (Control Group)

3) **Administration of Post-test**

   Achievement Test in Science

Administration of Pre-test

Achievement test in Science is based on the topic “Heat” and “ Carbon and its compounds” from class IX Science textbook. After having enough introduction about the purpose of the study, the investigator found a rapport with the students. The pre-test was administered to the students of two groups by the investigator before the commencement of the experiment. The filled response sheet on Achievement Test in Science was scored using the scoring key and the scores were subjected to statistical analysis

Experimentation

After the administration of the pre-test, the experimental group was given orientation and instruction on Station Rotation Model of teaching process were given. The experimental group was taught using the Station Rotation model of teaching for 15 days. The lesson transcripts are enclosed in the Appendix - A. The control group was taught using Activity-oriented method

Administration of post test

After teaching Science for both the experimental and control groups, the post-test was administered to measure the Achievement of the students in Science subject. It was aimed to access the effect of the treatment would be better in post-test compared to the pre-test. The same achievement test was used for the pre-test.

Sample selected for the study

A sample is a small proportion of a population selected for the observation and analysis. The careful observation of the sample enables the observer to draw inference about the population from which it was selected the following.

a) Selection of the Class

The investigator selected class IX students of Yettacode Higher Secondary School Yettacode for conducting the experimental study.

b) Selection of Group

The study was conducted on 90 students of class IX from Yettacode Higher Secondary School, Yettacode. Two divisions of class IX were selected for experiment one as experimental group and other as control group. The experimental group was taught through Station Rotation Model and control group was taught through Activity-oriented method routinely followed in the school.

STATISTICAL TECHNIQUES USED

The following Statistical techniques were used for analyzing the data

- t-test (test of significance)
- ANCOVA (Analysis of Co-variance)

Test of Significance (t-test)

The t-test was used to compare the mean scores obtained by two groups on a single variable (Garrett 2004). It is used to find out the significant level of difference between two groups of population. From the mean and the standard deviation, t values can be calculated. If the obtained t-value is 2.58 and above, then level of significance is at 0.01. If the t-value is between 1.96 and 2.58 significant levels and if the t value is below 1.96 the difference is not significant.

$$t = \frac{m_1 - m_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}$$

Where,

m_1 - mean of the first sample

m_2 - mean of the second sample

σ_1 - standard deviation of first sample

σ_2 - standard deviation of second sample

N_1 - Total number of frequency

N_2 - Total number of frequency of second sample

ANCOVA

ANCOVA or **Analysis of Covariance** is a statistical technique that compares group means while controlling for the effects of one or more continuous covariates. Garret (1981) stated that "through co-variance of analysis, one is able to effect adjustment in final of terminal scores which will allow difference in some initial variable. Analysis of covariance represents an extension of the method of analysis of variance to allow a correlation between initial and final scores". ANCOVA helps to found that the experimental group was better able to predict strong content from headlines after training than the control group. It also permits the investigator to statistically control for differences on the pretest so that post test differences would not be due to initial differences before the training.

Chapter – IV

ANALYSIS AND INTERPRETATION

- Test of Significance
- Analysis of Co-variance

Chapter - IV

ANALYSIS AND INTERPRETATION OF DATA

This chapter deals with the analysis and interpretation of the collected data. Analyzing the data involves looking at the tabulated information to identify the underlying truths or meanings. For interpretational purposes, it involves dissecting current complicated aspects into their most basic components and rearranging them. The purpose of analysis is to summarize the collected data in such a way that it provides answers to the questions that triggered the research.

Data analysis requires a researcher to have a deep and thorough level of knowledge because it is such a highly skilled and technical task. The purpose of data analysis is unique in and of itself. It is employed to give sense to the study's raw data and produce important findings. According to *Good, Barr and Scates* (1954), "Analysis is a process which enters into research in one form or another form the very beginning". Data interpretation is the process of identifying the inherent patterns and trends to draw inferences or conclusions from a completed data analysis. According to *C. William Emory*, "Interpretation has two major aspects namely establishing continuity in research through linking the results of a given study with those of another and the establishment of some relationship with the collected data"

Rummuel (2008) described "Data analysis and interpretation involve the objective material in the possession of the researcher and his subjective reactions and desires to drive from the data the inherent meaning in their relation to the problem". It is necessary to critically evaluate one analysis in light of all the constraints that were present at the time of data collection in order to interpret the data that has been examined. After the data collection, information must be processed, examined, and evaluated in conformity with the strategy that was established before the research was planned.

The major objective of this investigation was to test the effectiveness of Station Rotation Model on Academic achievement in Science among High School Students. This makes it clear that the experimental method was adopted for the present study by the investigator. Two parallel non-equivalent groups, one group as experimental group consisting of 46 students and another group as control group consisting of 44 students, were selected for this experimental study. A pre-test was conducted prior to the experimental study and then the experimental group was subjected to the Station Rotation Model of teaching for the interventional period of three weeks while the control group was subjected to activity-oriented teaching. After the intervention period, a post-test was administered to both the experimental and control groups. The scores obtained by the students in the pre-test and post-test were recorded and analyzed using the relevant statistical techniques.

In this study, the data was analyzed statistically using t-test and ANCOVA. The analysis of data for both groups was computed and done through the Jamovi software. Based on the pre-determined hypotheses, the results were carefully interpreted. The analysis of the data and the interpretation of the results are presented as follows

The data pertaining to the experimental and control groups were subjected to the following statistics.

1) **Test of Significance**
2) **Analysis of Co-variance**

1) Test of Significance

The study employed a test of significance for differences in means to determine whether there was any significant difference between the mean achievement scores of the samples of experimental group and control group.

2) Analysis of Covariance

Analysis of Covariance was applied for analyzing the data in order to effect the adjustment and calculate the terminal score to ascertain the relative superiority of the method adopted.

Details of the Analysis are stated below

1. Performance of Students in Experimental and Control Groups before Experimental Treatment.
2. Performance of Students in Experimental and Control Groups after Experimental Treatment.
3. Effectiveness of Station Rotation Model on Academic Achievement in Science for the Experimental Group.
4. Analysis of adjusted Post-test.

1. PERFORMANCE OF STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS BEFORE EXPERIMENTAL TREATMENT

Before the Experiment

The pre-test was conducted to both the experimental and control groups and the pre-test scores obtained by the students of both experimental and control groups were statistically analyzed.

For the obtained pre-test scores of the control and experimental group, mean, standard deviation and t-test were calculated. The values obtained for various statistical calculations were tabulated as follows.

Hypothesis 1

H_0 : There exists no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and the control group

To test the null hypothesis, t-test was used. The obtained p-value is compared with the table value at 0.05 level of significance.

Table 4.1

Comparison of the mean scores of Station Rotation Model and Activity-oriented method of Pre Test level for the Total sample

Group	N	Mean	SD	Mean Difference	t	p	Remarks
Experimental	46	9.80	3.95	1.30	1.92	0.058	Not Significant
Control	44	8.50	2.23				

From Table 4.1, it is clear that the calculated t-value is 1.92, p > 0.05 and it is not significant at any level. Hence the null hypothesis “There exists no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and the control group” is accepted. It means both experimental and control group do not differ significantly in the mean score in Science Achievement test. So, it is inferred that before the experimental treatment both groups were similar in their mean scores on their achievement test in Science Subject.

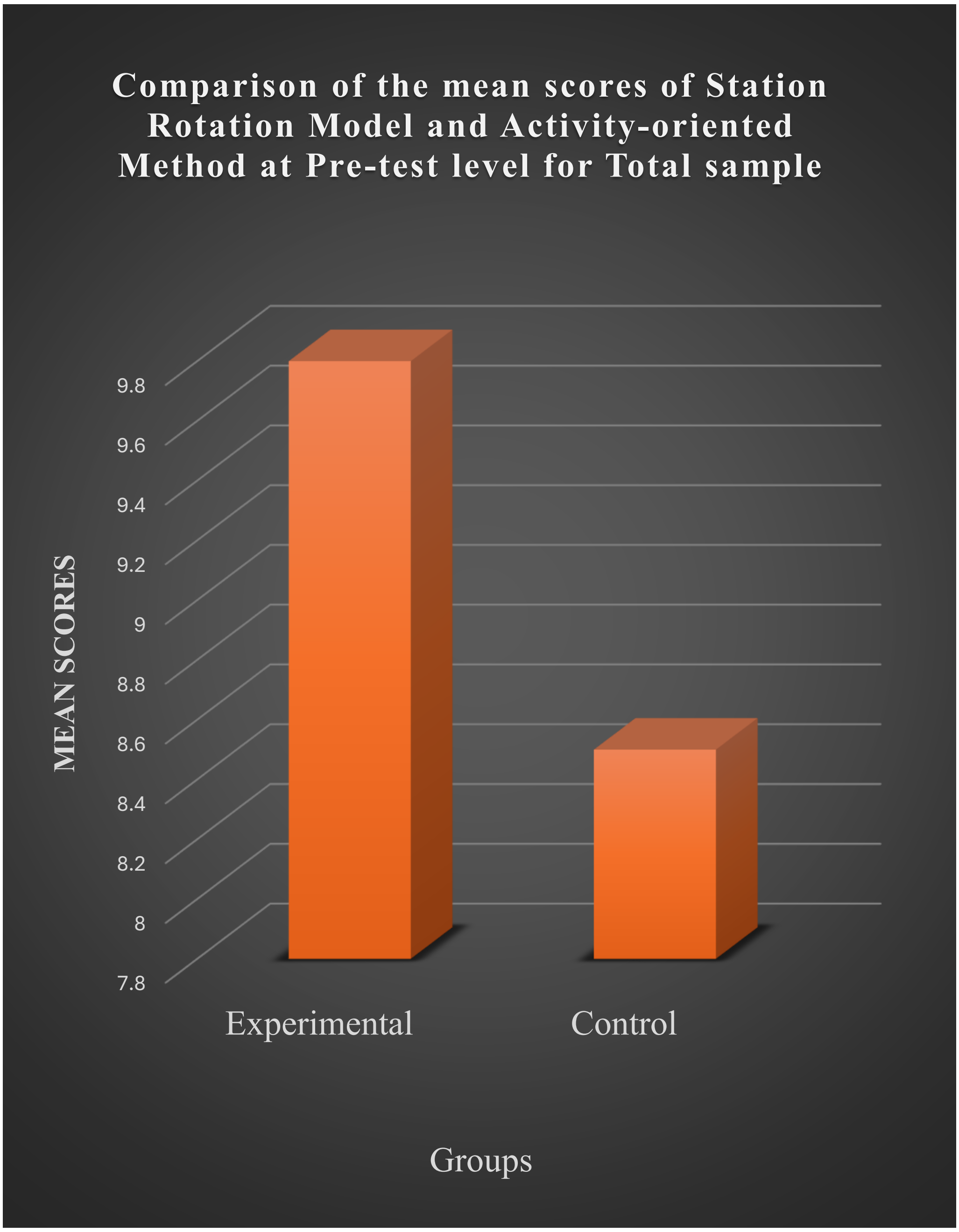

Figure 4.1 *Comparison of the mean scores of Station Rotation Model and Activity-oriented method of Pre Test level for the Total sample*

2. PERFORMANCE OF STUDENTS IN EXPERIMENTAL AND CONTROL GROUP AFTER EXPERIMENTAL TREATMENT

After the experimental treatment

The post test was conducted to both the experimental and control groups and the post-test scores obtained by the students of both experimental and control groups were statistically analyzed.

For the obtained post-test scores of the experimental and control groups, mean, standard deviation and t-test were calculated. The values obtained for various statistical calculations were tabulated as follows.

Hypothesis 2

H_0 : There exists no significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group

To test the null hypothesis, t-test was used. The obtained p-value is compared with the table value at 0.05 level of significance.

Table 4.2

Comparison of mean scores of Station Rotation Model-based Instructional and Activity-oriented Method of Post Test level for the Total Sample

Group	N	Mean	SD	Mean Difference	t	p	Remarks
Experimental	46	27.9	3.61	9.80	8.13	<0.001	Significant
Control	44	18.1	7.27				

From Table 4.2, it is clear that the calculated t-value is 8.13; $p < 0.05$ and it is significant at 0.05 level. Hence the null hypothesis "There exists no significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group" is rejected. It means that the scores in the Science achievement test are greater for the students in the experimental group than the control group. Therefore, it is inferred that Station Rotation Model treatment is effective in improving academic achievement in Science among High School students.

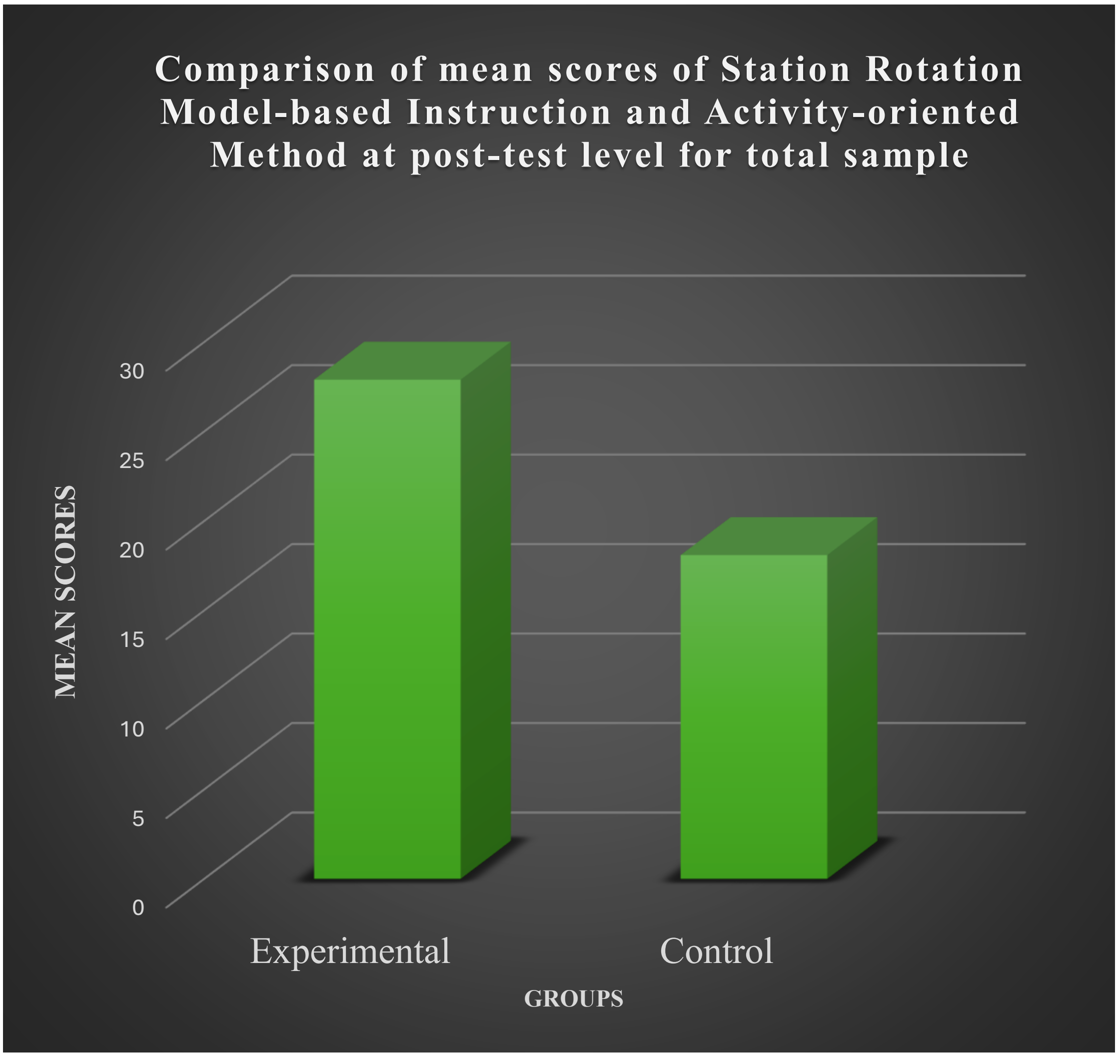

Figure 4.2 *Comparison of mean scores of Station Rotation Model-based Instruction and Activity-oriented Method at Post Test level for Total Sample*

3. EFFECTIVENESS OF STATION ROTATION MODEL-BASED INSTRUCTION ON ACHIEVEMENT TEST IN SCIENCE OF THE EXPERIMENTAL GROUP

Hypothesis 3

H_0 : There exists no significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group

To test the null hypothesis, t-test was used. The obtained p-value is compared with the table value at 0.05 level of significance

Table 4.3

Effectiveness of Station Rotation Model-based Instruction on Achievement Test in Science for the total sample

Test	N	Mean	SD	Mean Difference	t	p	Remarks
Pre	46	9.80	3.95	18.09	29.5	0.001	Significant
Post	46	27.89	3.61				

From Table 4.3, it is clear that the calculated t-value is 29.5, $p<0.05$ is significant at 0.05 level. Hence the null hypothesis "There exists no significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group" is rejected. Hence it is concluded that Station Rotation Model is effective in learning Science compared to that of Activity-oriented Method of learning Science.

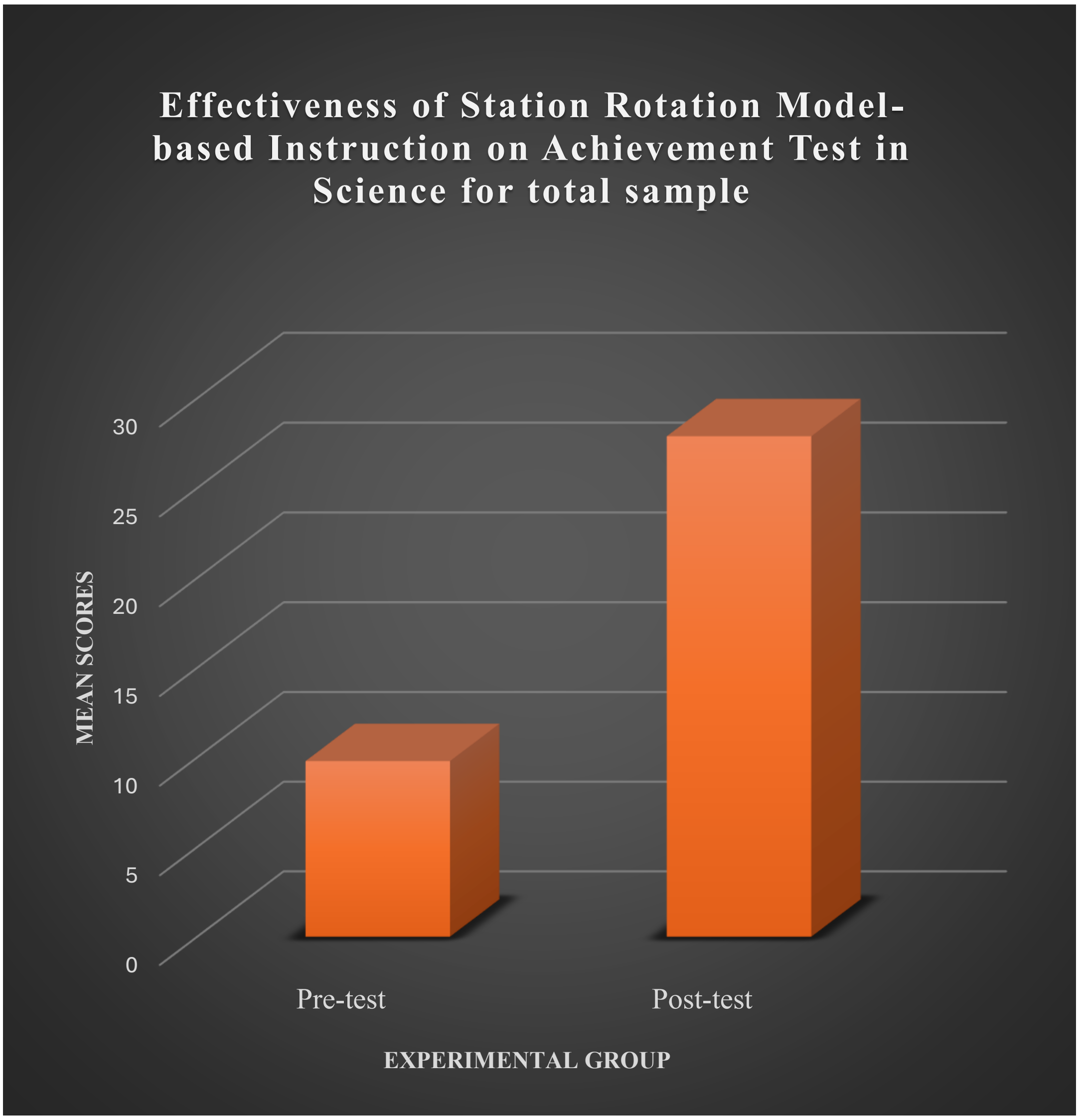

Figure 4.3 *Effectiveness of Station Rotation Model-based Instruction on Achievement Test in Science for total sample*

4. ANALYSIS OF ADJUSTED POST-TEST

Hypothesis 4

H_0 : There exists no significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate

The analysis of the pre-test scores of the experimental and control groups show that they do not differ significantly in their initial academic test. After the experiment, it was found that the experimental group was better than the control group in the achievement test. But it cannot conclude that the pupils of the two groups differed significantly in their achievement in the post-test by simply comparing the post-test scores. In this context, it became necessary to analyze the data using the statistical technique called Analysis of Covariance (ANCOVA). Here both the groups are equalized with respect to the control variable and then compared.

Before proceeding to ANCOVA, Analysis of Variance (ANOVA) was done. Total sum of squares, mean square and F-ratio of the pre-test and the post-test scores of the experimental and control group were computed. The summary of ANOVA of 'X' (pre-test) and Y (post-test) scores of pupils in the experimental and control group are given in the Table 4.4

Table 4.4

Summary of sum of the squares, mean squares and F-values of the pre-test and post-test scores in Science Achievement test of the Experimental and Control groups

Sources of variance	SS_x	SS_y	df	MS_x	MS_y	F_x	F_y
Between group	38.3	2150	1	38.3	2150		
Within group	916.2	2861	88	10.4	32.5	3.67	66.1
Total	954.5	5011	89				

From Table 4.4, it is clear that the calculated F_x is 3.67 which is less than the table value at 0.05 level. Hence, there is no significant difference between the pre-test scores of both experimental and control group.

Similarly the calculated value of F_y is 32.5 and it is greater than the table value of F at 0.05 level. Hence, there is significant difference between the post-test scores of both the experimental and control group.

Analysis of Co-variance

The final (Y) post-test scores were corrected for difference in initial (X) pre-test scores. Thus, SS_y has been adjusted for any variability in Y contributed by X. The adjusted sum of squares for Y,is SS_{yx} were computed and the F-ratio (F_{yx}) was calculated.

Table 4.5

Summary of sum of the squares, mean squares and F-values of the adjusted post-test scores in Science Achievement test of the Experimental and Control groups

Sources of variance	SS_x	SS_y	df	SS_{yx}	M_{yx}	F_{yx}
Between group	38.3	2150	1	1788	1787.9	
Within group	916.2	2861	87	2614	30.0	59.50
Total	954.5	5011	88	4402		

From Table 4.5, it is clear that the calculated F_{yx} is 59.50 and it is greater than the table value at 0.05 level of significance. The experimental and control group differs significantly after they have been adjusted for initial difference in the pre-test scores.

Table 4.6

Consolidated result of *mean, sum of the squares, mean squares and F-values of the adjusted post-test scores in Science Achievement test of the Experimental and Control groups*

Test	**Mean**		**Sources**	**Sum of Squares**	**df**	**Mean Squares**	**F**	**p**	**Remarks**
	Exp	Cont							
Pre test			Between	38.3	1	38.3			
(X)	9.80	8.50	Within	916.2	88	10.4	3.67	0.058	Not Significant
			Total	954.5	89				
Post test			Between	2150	1	2150			
(Y)	27.9	18.1	Within	2861	88	32.5	66.1	0.001	Significant
			Total	5011	89				
Adjusted			Between	1788	1	1787.9			
Post test	27.6	18.5	Within	2614	87	30.0	59.50	0.001	Significant
(Y)(X)			Total	4402	88				

From Table 4.6, it is clear that $p < 0.01$ and therefore it is significant at 0.05 level. It indicates that adjusted post-test mean scores of the students in experimental and control groups differ significantly after using the Station Rotation Model of teaching. Hence the null hypothesis "There exists no significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate" is rejected. So it can be concluded that the Station Rotation Model of teaching is significantly effective in improving the academic achievement for the students of class IX in Science.

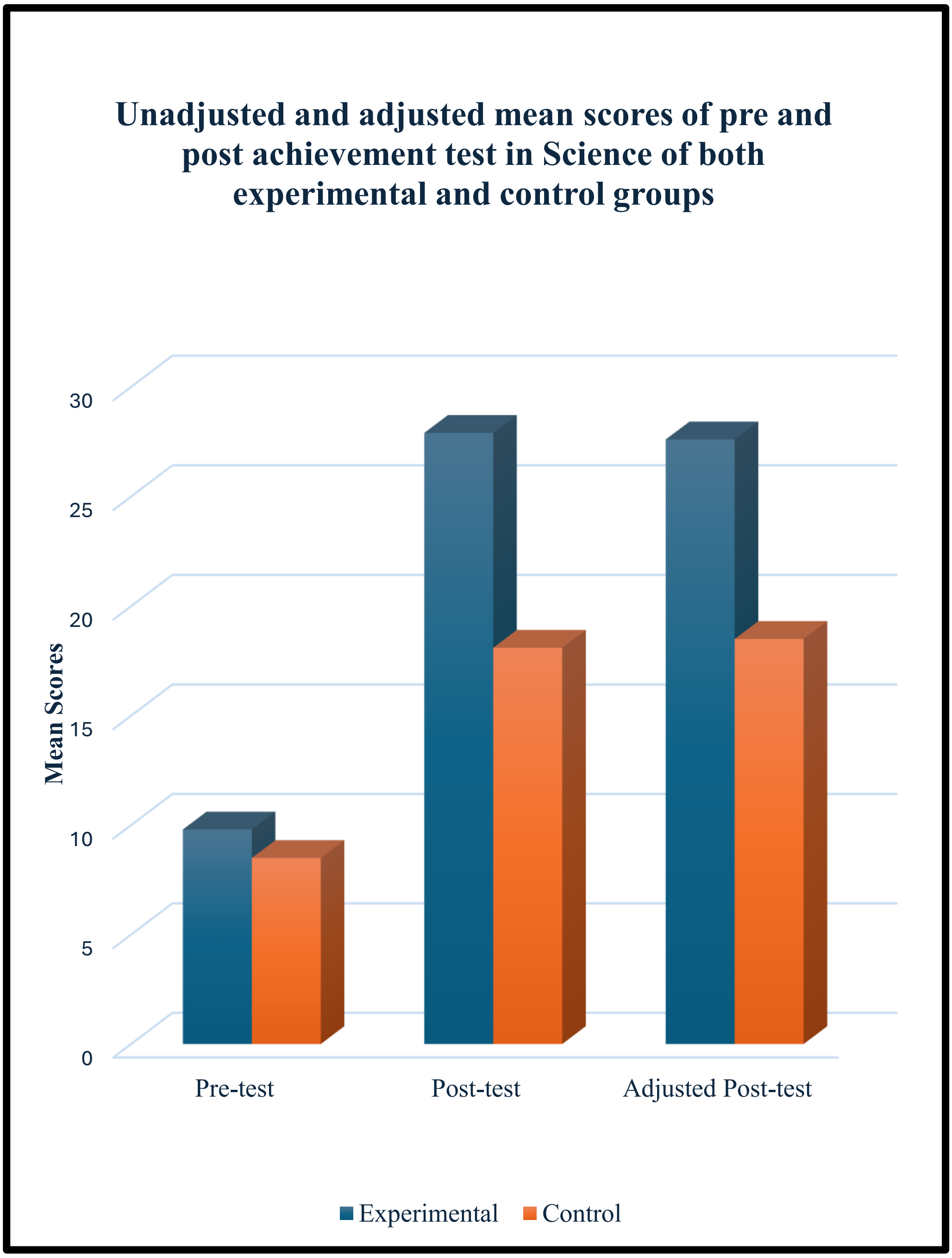

Figure 4.4 *Unadjusted and adjusted mean scores of pre and post achievement test in Science of both experimental and control groups*

Table 4.7

Significance of difference of Adjusted means for Station Rotation Model based Instruction and Activity-oriented Method for Total Sample

Adjusted post-test	Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Remarks
Experimental	27.6	5.48	1.15	7.71	0.001	Significant
Control	18.5					

A post- hoc test was applied for pair-wise comparison of the adjusted means scores in Science achievement test for experimental and control groups. Since, the obtained t-value is 7.71, P < 0.01 which is significant at 0.05 level. So it can be concluded that the Station Rotation Model based Instruction of teaching is significantly more effective than Activity-oriented method of teaching in improving Achievement test in Science among the students of Class IX.

TENABILITY OF HYPOTHESES

1. There exists no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and control group is accepted.
2. There exists no significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group is rejected.
3. There exists no significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group is rejected.
4. There exists no significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate is rejected.

Chapter –V

FINDINGS, CONCLUSION AND SUGGESTIONS

- The study in Retrospect
- Objectives of the Study
- Hypotheses framed for the Study
- Methodology in Brief
- Findings of the Study
- Educational Implications of the Study
- Conclusion
- Suggestion for further Research

Chapter - V

FINDINGS, CONCLUSIONS AND SUGGESTIONS

The Study in Retrospect

In this chapter, an attempt is made by the investigator to summarize all the findings based on the analysis and conclusion drawn from the investigation. The summary of the procedure adopted for the study is followed by a short description of the findings of the study. This chapter concludes with educational implications, recommendations based on the findings and suggestions for further research that have been derived from the present study in the field of education.

Statement of the Problem

This study aims to investigate the Effectiveness of Station Rotation Model on Academic Achievement in Science among High School Students.

Objectives of the Study

The Objectives framed for the present study are as follows.

1) To prepare and validate instructional design based on Station Rotation Model for teaching Science for Class IX students

2) To construct and validate an Achievement Test in Science for Class IX students

3) To compare the mean pre-test score of achievement in Science among Class IX students in the experimental group and control group

4) To compare the mean post-test score of achievement in Science among Class IX students in the experimental group and control group

5) To test the effectiveness of Station Rotation Model by comparing the mean pre-test and post-test scores in Science of Class IX students in the experimental group

6) To find out the significant differences in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate

Hypotheses Framed

1. There exists no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and control group

2. There exists no significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group

3. There exists no significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group

4. There exists no significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate

METHODOLOGY IN BRIEF

Method Adopted

Experimental method was adopted for conducting the present study

Experimental Design

Non-equivalent pre-test and post-test design was used for the present study. The present study employed two-group experimental design.

Sample

The present experimental study was conducted on sample size of 90 students studying in class IX in Yettacode Higher Secondary School, Yettacode, Kanniyakumari District. Two intact groups were selected. One section from Class IX was treated as the Experimental group consists of 46 students and another section treated as the Control group consists of 44 students. The experimental group was taught by Station Rotation Model-based instruction and the Control group was taught by Activity-oriented method.

Tools used for the study

The following tools were used for conducting the study.

a) Instructional design on Station Rotation Model in Science subject of Class IX prepared by the investigator.
b) Achievement test on selected concepts in Science for Class IX prepared by the investigator.

Data Collection Procedure

The pre-test was administered to both the Experimental and Control groups of students. At the end of the intervention period, the same Achievement test in Science was administered as a post-test to both the experimental and control groups of students.

Scoring

The investigator prepared a scoring key for correcting the response sheet of the achievement test. Each correct answer was given one mark and wrong answer with zero mark. The score of the achievement test is the total of the scores obtained for all the items.

STATISTICAL TECHNIQUE USED

In the present study the following statistical techniques were used.

1. test of Significance (t-test)
    - Independent t-test
    - Paired t-test
2. Analysis of Co-Variance (ANCOVA), followed by Bonferroni's Post hoc analysis.

FINDINGS OF THE STUDY

Findings of the experimental study emerged from the analysis of the enquired data collected are summarized as follows

1. The finding of the study revealed that there is no significant difference in the mean pre-test scores of achievement test in Science of Class IX students in the experimental and control group. The finding is supported by the obtained result ($t = 1.92$, $p > 0.058$).
2. There is significant difference in the mean post-test scores of achievement test in Science of Class IX students in the experimental and control group. The finding is supported by the obtained result ($t = 8.13$, $p < 0.001$).
3. There is significant difference in the mean pre-test and post-test scores of achievement test in Science of Class IX students in the experimental group. The finding is supported by the obtained result (paired $t = 29.5$, $p < 0.001$).
4. There is significant difference in the mean adjusted post-test scores of Science among class IX students in the experimental and control groups when pre-test is taken as covariate. The finding is supported by the obtained result. ($f_{yx} = 59.50$, $p < 0.001$ & $t = 7.71$, $p < 0.001$)

EDUCATIONAL IMPLICATIONS OF THE STUDY

The educational implications derived from the study based on the findings are as follows.

1. The premier implication of the study is that the lesson transcript based on Station Rotation Model prepared by the investigator serves as a valuable resource for Science teachers.
2. It is apparent from the results of the present study that the Station Rotation Model can be utilized for understanding and applying the concepts across various subjects.
3. Orientation and teacher training programmes should be implemented to help teachers design station activities and effectively organize and group the students.
4. The Science teachers should utilize Station Rotation Model of teaching to monitor and assess the improvement in students academic performance.
5. Station Rotation Model shall be integrated in school curriculum to provide students with opportunities to develop their critical thinking, problem-solving ability, and digital skills.
6. The teachers should be encouraged to adapt technological tools and collaborative platforms to foster active learning in Science.
7. The educational system should prioritize personalized learning, with teachers creating engaging and motivating environments across different learning modes.
8. Station Rotation Model could be beneficial for both the teachers and students in enhancing the classroom by active engagement to understand the specific concept using different activities at a set time.
9. Station Rotation Model enhances classroom efficiency by fostering students independence and providing a collaborative peer-to-peer environment.

10. Online Stations using gamified assessments can help analyze a students ability to grasp Science concepts while promoting an individualized learning experience.

CONCLUSION

Science is seen as an essential and core subject that supports the development of knowledge and understanding of the natural world. Today, most of the students struggle to learn science due to low engagement, passive content delivery, and insufficient development of critical thinking and collaboration skills. In this study, the students who were treated with Station Rotation Model achieved higher mean scores than those students who were taught through the conventional method. The results showed that Station Rotation Model of teaching improved the Achievement of class IX students in Science and also the students showed greater gains on assessments during Station Rotation Model of teaching. Moreover, Station Rotation Model increased the student engagement and motivation towards learning through various stations. The use of Station Rotation Model increases the students' achievement in learning Science. Hence, Station Rotation Model instructional design was effective in learning Science. By applying Station Rotation Model, the students enjoy learning actively by collaborating with peer members and exploring visually through online station. During the teaching-learning process based on Station Rotation Model, the students were more enthusiastic to complete their task in each stations that included videos, digital games, and group activities that made them think and explore the concepts. This research will be helpful to recommend Science teachers to adopt and implement the Station rotation Model of teaching Science. Proper classroom management should be ensured while teaching Science through Station Rotation Model to students across all educational level.

RECOMMENDATION

1. The study revealed that the Station Rotation Model was highly effective in learning Science. Hence the Station Rotation Model can be used for teaching different subjects at different levels of education such as Primary, Secondary and Higher Secondary.
2. Curriculum planning committee and policy makers can suggest the adoption of Station Rotation model for learning Science in classroom through interactive and student-centred approach.
3. For Science teachers, Faculty Development Programmes such as in-service training, seminars and workshops should be organized to help teachers to master the practical skills and face the challenges of implementing the model.
4. More research may be conducted to explore the effectiveness of different aspects of Station Rotation Model of teaching on students in various disciplines.
5. Awareness programmes on Station Rotation Model shall be organized for teachers to develop the knowledge and adaptability of practical skills on Station Rotation Model of teaching in the classroom.
6. Seminars and workshops on various aspects of Station Rotation Model shall be organized for the teachers to improve their knowledge and to face the challenges while implementing Station Rotation Model.

SUGGESTIONS FOR FURTHER RESEARCH

The present study is limited to two units in Science from Class IX. It is not a comprehensive study as many desirable areas have been left out. It requires modification by further research. Therefore, the investigator offers the following suggestions for the active consideration of the researchers in the field.

1. The present study has been conducted in Kanniyakumari district only. Further studies should cover various districts beyond Kanniyakumari to provide a more comprehensive picture.
2. The effectiveness of Station Rotation Model has been tested with the selected unit of Class IX standard. Other topics can be added for associate result.
3. The present study has been conducted only for school education and it may be extended to higher education also.
4. The present study has been conducted for Class IX students only. Effectiveness of Station Rotation Model across different grade levels can be conducted.
5. A comparative study of Station Rotation Model with other models of Blended learning can be conducted.
6. The present study has been conducted for two groups only. More than two groups can be compared for the effectiveness of Station Rotation Model at different schools.
7. The effect of Station Rotation Model to develop 21st Century skills in Higher Education can be studied.
8. A comparative analysis of the awareness and attitudes towards the Station Rotation Model between teachers and prospective teachers can be studied.
9. A comparative study of the effect of Station Rotation Model on both English and Tamil Medium students can be undertaken.
10. Impact of Station Rotation Model of teaching on the cognitive, affective and psychomotor domains can be studied extensively.

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APPENDICES

Appendix - A

N.V.K.S.D. COLLEGE OF EDUCATION, (AUTONOMOUS) ATTOOR

STATION ROTATION MODEL FOR TEACHING SCIENCE

(Standard - IX)

Prepared by

Juhi Jeluna. J

M.Ed. Scholar

Supervised by

Dr. K. Gireesh Kumar

Research Supervisor

STATION ROTATION MODEL

Station Rotation Model is an innovative teaching strategy designed to allow students to rotate through stations on a fixed time slot, where at least one of the stations is an online learning station. Station Rotation Model help students to develop their digital skills, communication and collaboration. Stations in this model often incorporate a combination of online learning, teacher-led instruction, and collaborative tasks, to encourage active involvement of students in the learning process. Various teaching activities can be adopted in online station such as simulation, quizzes, gamification and collaborative work. The teacher will be more innovative in framing the activities for each station. Station Rotation Model of teaching allows students to explore different modes of learning. Station Rotation Model of teaching helps the students to learn Science by experiencing both the mix of teacher-led guided direction to clarify the misconceptions and online learning effectively. Students are given necessary instruction to complete their task in each station.

This section (Appendix A) consists of six lesson transcripts based on Station Rotation Model prepared by the investigator based on the principles of Station Rotation Model for teaching Science for class IX. The topic from Science text book such as “Heat” and “Carbon and its compounds” of class IX from Tamilnadu State Board Syllabus were selected for the Station Rotation Model of teaching. Station Rotation Model prepared on Science topics are given in the following pages as lesson transcript 1 to 6.

LESSON TRANSCRIPT 1

<table>
<tr><td>Name of the Teacher</td><td colspan="4">Juhi Jeluna.J</td></tr>
<tr><td>Name of the School</td><td colspan="4">Yettacode Higher Secondary School, Yettacode</td></tr>
<tr><td>Subject</td><td>Science</td><td colspan="2">Date: 24-02-2026</td><td>Class: IX</td></tr>
<tr><td>Topic</td><td colspan="4">Heat – Effect of Heat</td></tr>
<tr><td>Book Reference</td><td colspan="2">IX Class Science Textbook</td><td colspan="2">No. of Students: 46</td></tr>
</table>

Learning Outcome

The pupil,

1. Defines heat as the transfer of internal energy.
2. Explains the transfer of internal energy from a hotter body to a colder body
3. Identifies the effects of heat such as expansion, change in state, Change in temperature and Chemical Change
4. Applies the concept of heat effects to real-life situations such as cooking food
5. Differentiates expansion in solids, liquids, and gases.
6. Analyses the situation based on effect of heat on real life situation
7. List out various examples that effect the expansion of heat

Content Analysis

- **Heat**
  - 1.1 All substances are made up of molecules.
  - 1.2 Molecules possess kinetic energy (due to motion).
  - 1.3 Molecules possess potential energy (due to force of attraction).
  - 1.4 The sum of kinetic and potential energy is called *internal energy*.
  - 1.5 Heat is the transfer of internal energy from a hotter body to a colder body.
- **Effects of Heat**
  1. **Expansion**
     - When heat is added to a substance, molecules move faster and spread apart.
     - Expansion is least in solids, greater in liquids, maximum in gases.
     - Example: Railway track gaps.
  2. **Change in State**
     - Solid → Liquid → Gas when heated is added.
     - Reverse process takes place on cooling.
  3. **Change in Temperature**
     - Increase in heat increases kinetic energy. Hence, Temperature rises.

4. **Chemical Change**
   - Heat initiates and speeds up chemical reactions.
   - Example: Cooking food.

STEP 1: Analyze Students' Data and Learning Content

The teacher assess the current knowledge of *understanding of heat, its everyday applications, and common misconceptions related to temperature and energy transfer* using the following guiding statement

Guiding Statement:

Describe how heat is experienced in everyday life and explain its observable effects on materials (e.g., melting, cooking, expansion)

Step 2 : Plan logistics

Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem stones	Clever stars

Timing	45 minutes

Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do their activities assigned in the particular station. All group members shall participate in the allotted activities.

<table>
<tr><td colspan="4">STEP 3: Designing the Stations</td></tr>
<tr><td>Stations</td><td>Station 1</td><td>Station 2</td><td>Station 3</td></tr>
<tr><td>Type of Station</td><td>Teacher-Led Station</td><td>Online Station</td><td>Offline Station</td></tr>
<tr><td>Activity</td><td>Think Pair Share on “Exploring the Effects of Heat”</td><td>Interactive Animation and Online Quiz on Effects of Heat</td><td>Effects of Heat Sorting Activity</td></tr>
<tr><td rowspan="3">Learning Resources</td><td>1. Concept Map - Heat</td><td>1. Laptop with internet connection
2. Short animation videos on Molecular motion Change of state
3. Quiz on Heat</td><td>1. Worksheet – “Effects of Heat Sorting Challenge”</td></tr>
<tr><td colspan="2">Whole Group Instruction</td><td>Wrap Up Session</td></tr>
<tr><td colspan="2">Images of Melting ice and Railway track</td><td>Exit Slip</td></tr>
<tr><td colspan="4">STEP 4: Implementation of Station Rotation Activities</td></tr>
<tr><td>Whole Group Instruction</td><td colspan="3">• Procedure:
o The teacher checks the prior knowledge of students by asking,
“Why does an ice cube melt when left outside?”
o The teacher explains about internal energy as the sum of kinetic and potential energy
o Using the images of melting ice and railway track gaps, the teacher explains that heat is the transfer of internal energy from a hotter substance to a colder one.
o The teacher further clarifies that substances with higher temperature contain more internal energy, The concept is extended by stating that heat produces observable changes in matter such as expansion, change in state, temperature variation, and chemical changes.
o The teacher explains the rules, procedures, and time limits of the station rotation model. After giving clear instructions, the teacher directs the students to move to their respective stations.</td></tr>
<tr><td>Transition Time</td><td colspan="3">The teacher rings the alarm and the students move to their assigned station</td></tr>
</table>

<table>
<tr>
<td>Station Rotation Activity

STATION 1</td>
<td>
Teacher-Led Station (8 minutes)
Procedure:

The teacher presents a concept map linking Internal Energy, Heat and Effects of Heat to help students visualize the relationship between the concept when heat is supplied to a substance.
Next, the teacher discusses about change in state and clarifies change in temperature by stating that an increase in heat raises the kinetic energy of particles
The teacher connects heat to chemical changes, by explaining that heat energy by giving example such as cooking food becomes softens and produces new substances.
Teacher checks the learning outcome of the students by asking questions such as

What happens to molecules when heated?
Which expands more: solids or gases?

Students participate in a Think–Pair–Explain activity where they discuss and explain one effect of heat in their own words

</td>
</tr>
<tr>
<td>Transition Time</td>
<td>The teacher rings the alarm and the students move to the next station</td>
</tr>
<tr>
<td>STATION 2</td>
<td>
Online Station (8 minutes)
Procedure:

Students watch a short animation demonstrating that molecules move faster and spread farther apart when heat is added, leading to expansion.
Another animation visually presents the transition from solid → liquid → gas, helping students to understand how heat alters the arrangement and movement of particles.

</td>
</tr>
</table>

	○ After visualizing, students complete an online quiz that reinforces key ideas such as the direction of heat flow, identification of effects responsible for melting ice, and reasons for maximum expansion in gases. ○ An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning
Transition Time	The teacher rings the alarm and the students move to the next station
STATION 3	Offline Station (8 minutes) • ***Procedure:*** ○ Students work collaboratively in groups of 3 to 4 to complete the **Effects of Heat Sorting Challenge**. They analyze everyday situations such as railway track gaps, cooking food, boiling water, and rising thermometer readings, and match them with the appropriate effects—expansion, chemical change, change in state, and temperature change. ○ As a higher-order task, each group generates one original real-life example for any two effects of heat, strengthening application skills and peer learning
Wrap Up Session	The teacher conducts a rapid recap using short questions to reinforce the four effects of heat and addresses misconceptions such as "heat is the same as temperature." Students complete an **Exit Slip** naming the effects of heat, explaining heat transfer, and providing an example of expansion
Extended Activity 1. Observe your home environment and list four examples showing the effects of heat. 2. *Can a substance change state without changing temperature. Justify*	

Step 5: Evaluation

Evaluation of the station rotation model was carried out through online activities, teacher-led discussions, and worksheet-based offline tasks. In the online station, most of the students performed well in the assessment activity, with many scoring between moderate to high level of marks, which showed a satisfactory understanding of the concepts related to expansion and changes in matter. In the teacher-led station, the students actively participated in the Think–Pair–Share discussion, through which the teacher identified misconceptions among the students and clarified their doubts effectively. In the offline station, the students completed the worksheet activities based on their understanding and were able to identify and explain the concepts appropriately. However, a few students required additional support and improvement, which can be addressed in next station rotation class. The exit slips were filled by the students showed the good grasping level of the concepts

Step 6 : Reflection

The overall implementation of the station rotation model was effective and engaging for the students. The students actively participated in all the stations, especially in the online activities, where they showed great interest and enjoyment in learning through digital tasks. The teacher-led station was highly beneficial in identifying misconceptions and providing immediate clarification to strengthen students' conceptual understanding. The activities were aligned with the learning objectives and helped maintain active student engagement throughout the session. Classroom management was carried out effectively, though slight adjustments in time management were required. Since, it was the first session conducted using the station rotation model. Overall, the session created a positive and interactive learning environment.

LESSON TRANSCRIPT 2

<table>
<tr><td>Name of the Teacher</td><td colspan="3">Juhi Jeluna.J</td></tr>
<tr><td>Name of the School</td><td colspan="3">Yettacode Higher Secondary School, Yettacode</td></tr>
<tr><td>Subject</td><td>Science</td><td>Date: 25-02-2026</td><td>Class: IX</td></tr>
<tr><td>Topic</td><td colspan="3">Heat – Conduction</td></tr>
<tr><td>Book Reference</td><td colspan="2">IX Class Science Textbook</td><td>No. of Students: 46</td></tr>
</table>

Learning Outcome

The pupil,

1. Defines conduction as the transfer of heat without the actual movement of molecules.
2. Explains the process of heat transfer in solids through molecular vibration and collision.
3. Identifies good and bad conductors of heat from daily life examples.
4. Lists the characteristics of conduction.
5. Applies the concept of conduction in real-life situations such as cooking utensils and woollen clothes.
6. Analyses why metals conduct heat faster than liquids and gases.
7. Interprets experimental observations related to conduction in different metals.

Content Analysis

- **Conduction**
  - In solids, molecules are closely packed and cannot move freely.
  - When one end of a solid is heated, molecules absorb heat energy and vibrate faster.
  - Vibrating molecules collide with neighbouring molecules and transfer energy.
  - The transfer continues from molecule to molecule throughout the solid.
  - Heat flows from a region of higher temperature to a region of lower temperature.
  - No actual movement of molecules takes place during conduction.
- **Conduction - Definition**

  The process of transfer of heat in solids from a hotter region to a colder region without actual movement of molecules is called conduction.
- **Characteristics of Conduction**
  - Conduction is a slow process.
  - It occurs when there is a temperature difference.
  - Heat conduction increases when the contact area is large.
  - Metals are good conductors of heat.

- Liquids and gases also conduct heat, but very slowly.

- **Conduction in Daily Life**
  - Aluminium is used for cooking utensils because it conducts heat quickly.
  - Mercury is used in thermometers as it is a good conductor of heat.
  - Woolen clothes keep us warm because air trapped in wool is a poor conductor of heat.
- **Activity on Conduction**
  - Matchsticks are fixed with wax on copper, aluminium, brass, and iron rods. When heated, the wax melts and matchsticks fall.
  - Copper conducts heat fastest followed by aluminium, brass, and iron.

STEP 1: Analyze Students' Data and Learning Content

The teacher analyses the data collected from the previous learning station and identifies students' prior understanding about heat transfer and conductors of heat. The teacher assesses the students' knowledge of real-life examples. Misconceptions such as "heat and temperature are the same" and "all materials conduct heat equally" are also identified through questioning and classroom interaction. Based on the learners' readiness levels, suitable station rotation activities are planned to strengthen conceptual understanding, application, and collaborative learning.

Step 2 : Plan logistics

Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem Stones	Clever Stars

Timing	45 minutes

Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do the activities assigned in the respective station. All group members shall participate in the allotted activities.

<table>
<tr><td colspan="4">STEP 3: Designing the Stations</td></tr>
<tr><td>Stations</td><td>Station 1</td><td>Station 2</td><td>Station 3</td></tr>
<tr><td>Type of Station</td><td>Teacher-Led Station</td><td>Online Station</td><td>Offline Station</td></tr>
<tr><td>Activity</td><td>Role Play on “Transfer of Heat - Conduction”</td><td>Interactive Simulation and Online Quiz on Conduction</td><td>Conduction – Image-Based Analysis</td></tr>
<tr><td rowspan="3">Learning Resources</td><td>1. Image of Dog’s Tongue</td><td>1. Laptop with internet connection
2. Simulation on Conduction
3. Short activity video on conduction of metals
4. Conduction Quiz on Wayground</td><td>1. Worksheet – “Conduction”</td></tr>
<tr><td colspan="2">Whole Group Instruction</td><td>Wrap Up Session</td></tr>
<tr><td colspan="2">Images of Conduction</td><td>Exit Slip</td></tr>
<tr><td colspan="4">STEP 4: Implementation of Station Rotation Activities</td></tr>
<tr><td>Whole Group Instruction</td><td colspan="3">• Procedure:
o The teacher initiates the lesson by asking questions such as: “Why does a metal spoon become hot when kept in hot tea?”
o The teacher shows the image of conduction and explains that molecules in solids are closely packed.
o The teacher introduces conduction as the transfer of heat from a hotter region to a colder region without movement of molecules.
o The teacher explains that molecules vibrate faster when heated and transfer energy to neighbouring molecules through collisions.
o The teacher discusses the characteristics of conduction and introduces examples from daily life such as cooking utensils, thermometers, and woollen clothes.
o The rules, procedures, and time limits for station rotation are explained before students move to their assigned stations. After giving clear instructions, the teacher directs the students to move to their respective stations.</td></tr>
<tr><td>Transition Time</td><td colspan="3">The teacher rings the alarm and the students move to their assigned station</td></tr>
</table>

<table>
<tr>
<td>Station Rotation Activity

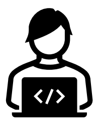
STATION 1</td>
<td>

Teacher-Led Station (8 minutes)

Procedure:

The teacher explains the process of conduction using the dog’s tongue and saliva demonstration, the teacher explains how heat can transfer through direct contact.
The teacher discusses why metals conduct heat better than liquids and gases.
The teacher demonstrates how heat travels through solids without the movement of particles.
Students participate in a Role Play activity by playing the role of molecules and how the heat transfers on heating a solid.
The teacher asks probing questions such as:

What happens to molecules when heat is supplied?
Why is conduction faster in metals?
Which material among copper and iron is a better conductor? Why?

Students explain one daily life example of conduction in their own words.
</td>
</tr>
<tr>
<td>Transition Time</td>
<td>The teacher rings the alarm and the students move to the next station</td>
</tr>
<tr>
<td>STATION 2</td>
<td>

Online Station (8 minutes)

Procedure:

Students interacted with the conduction simulation to observe how heat energy is transferred from one molecule to another in solids.
Another video presents the metal rod activity showing conduction through copper, aluminium, brass, and iron rods.
Students observe the order in which the matchsticks fall and infer the conductivity of metals.

</td>
</tr>
</table>

	○ After visualization, students complete a Wayground quiz assessing About conductionInstruction cards guide students to complete the activities independently.An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning
STATION 2	Online Station (8 minutes) • ***Procedure:*** • Students interacted with the conduction simulation to observe how heat energy is transferred from one molecule to another in solids. • Another video presents the metal rod activity showing conduction through copper, aluminium, brass, and iron rods. • Students observe the order in which the matchsticks fall and infer the conductivity of metals. • After visualization, students complete a Wayground quiz assessing About conduction • Instruction cards guide students to complete the activities independently.An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning
Transition Time	The teacher rings the alarm and the students move to the next station
STATION 3	Offline Station (8 minutes) • ***Procedure:*** ○ Students work collaboratively in groups of 3–4 to complete the worksheet activity. ○ They identify the images and infer about the transfer of heat and how the heat transfers in each of the materials takes place. ○ Students discuss why conduction is slower in liquids and gases compared to solids.

Wrap Up Session	The teacher conducts a rapid recap using short questions to reinforce the concept of conduction and addresses misconceptions such as "molecules move from one place to another during conduction" and the doubts are clarified. Students complete an **Exit Slip** containing a short question and objective type question about conduction
Extended Activity 1. Compare copper, aluminium, brass, and iron and explain which is the best conductor of heat. Give reason	

Step 5: Evaluation

The evaluation of the station rotation model was conducted through online quizzes, teacher-led interaction, worksheet activities, and exit slips. In the online station, most students were able to answer the assessment questions showing a good understanding of the concepts related to expansion and changes in matter. During the teacher-led station, students participated actively in role play. In the offline station, students completed the worksheet activities successfully and demonstrated their understanding through proper identification and explanation of the concepts. A few students needed additional guidance, which can be addressed in future sessions. The exit slips indicated that students had understood the concepts effectively.

Step 6: Reflection

The implementation of the station rotation model was effective and engaging. Students showed active participation in all the stations, especially in the online activities, where they learned with interest and enthusiasm. The teacher-led station helped in providing immediate feedback and clarification of doubts, which strengthened students' conceptual understanding. The activities were well aligned with the learning objectives and supported active learning throughout the session.

LESSON TRANSCRIPT 3

Name of the Teacher	Juhi Jeluna.J			
Name of the School	Yettacode Higher Secondary School, Yettacode			
Subject	Science	**Date:** 26-02-2026		**Class:** IX
Topic	Heat – Convection			
Book Reference	IX Class Science Textbook		**No. of Students:** 46	

Learning Outcome

The pupil,

1. Defines convection as the transfer of heat through fluids by the movement of molecules.
2. Explains the process of convection in liquids and gases.
3. Describes the movement of warm and cold air during convection.
4. Lists daily life applications of convection.
5. Differentiates conduction and convection based on the movement of particles.
6. Applies the concept of convection to explain hot air balloons, breezes, winds, and chimneys.
7. Analyses the formation of sea breeze and land breeze.

Content Analysis

- **Convection**
  - Convection occurs in liquids and gases.
  - When a fluid is heated, molecules gain heat energy and move farther apart.
  - Warm fluid becomes less dense and rises upward.
  - Cooler and denser fluid moves downward to replace it.
  - This creates a continuous circular motion called convection current.

- **Definition of Convection**

  Convection is the transfer of heat through fluids from regions of higher temperature to regions of lower temperature by the actual movement of the fluid itself.

- **Convection in Water**
  - Water molecules at the bottom receive heat energy.
  - Heated water rises upward.
  - Cooler water from the top moves downward.
  - Circular movement transfers heat throughout the liquid.

- **Convection in Daily Life**

  1. Hot Air Balloons
    - Heated air inside the balloon becomes lighter and rises.
    - The balloon moves upward due to convection.

  2. Sea Breeze
    - During daytime, land heats faster than sea water.
    - Warm air above land rises.
    - Cool air from the sea moves toward land.

  3. Land Breeze
    - During nighttime, sea remains warmer than land.
    - Warm air above the sea rises.
    - Cooler air from land moves toward the sea.

  4. Winds
    - Air flows from high-pressure areas to low-pressure areas due to uneven heating.

  5. Chimneys
    - Hot gases and smoke rise upward through chimneys because they are lighter than cool air.

STEP 1: Analyze Students' Data and Learning Content

The teacher analyses the data collected from the previous learning station and identifies students' understanding regarding modes of heat transfer and molecular movement in fluids. The teacher assesses students' prior knowledge through classroom interaction and identifies the misconceptions such as "heat rises" and "air has no weight" were identified through questioning and discussion. Based on students' readiness levels and learning needs, suitable station rotation activities are planned to promote conceptual clarity, collaboration, and application of convection in daily life situations.

Step 2 : Plan logistics

Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem Stones	Clever Stars

Timing	45 minutes				
Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do the activities assigned in the respective station. All group members shall participate in the allotted activities.

STEP 3: Designing the Stations			
Stations	Station 1	Station 2	Station 3
Type of Station	Teacher-Led Station	Online Station	Offline Station
Activity	Role Play on "Transfer of Heat - Convection"	Interactive Simulation and Gameified assessment on Convection	Convection – Image-based Word Tagging
Learning Resources	1. Concept map - Convection	1. Laptop with internet connection 2. Simulation on Convection 3. Short animation video on land breeze and sea breeze 4. Match the word on Wordwall	1. Worksheet – "Convection"

	Whole Group Instruction	**Wrap Up Session**
Learning Resources (continued)	Image of Air balloon	Exit Slip

STEP 4: Implementation of Station Rotation Activities	
Whole Group Instruction	• ***Procedure:*** o The teacher begins the lesson by displaying the image of a hot air balloon and asking: "Why does a hot air balloon rise upward?" o Students share their responses based on prior knowledge. o The teacher explains that when air is heated, it becomes lighter and rises upward.

	o Using the image, the teacher introduces convection as the transfer of heat through fluids by movement of molecules. o The teacher explains convection currents in liquids and gases using examples such as boiling water and movement of air. o Daily life applications such as sea breeze, land breeze, winds, and chimneys are discussed. o The teacher explains the procedures, station rules, and time limits before students move to their assigned stations. After giving clear instructions, the teacher directs the students to move to their respective stations.
Transition Time	The teacher rings the alarm and the students move to their assigned station
Station Rotation Activity **STATION 1**	 Teacher-Led Station (8 minutes) • ***Procedure:*** o The teacher presents a concept map connecting heat, density, movement of fluids, and convection currents. o Students participate in a role play activity demonstrating the movement of warm and cool air molecules. o One student acts as warm air rising upward while another student acts as cool air descending downward. o The teacher explains how convection currents are formed through continuous circulation. o The teacher discusses daily life applications such as sea breeze and chimneys. o The teacher asks probing questions such as: ▪ Why does warm air rise upward? ▪ How does sea breeze occur? ▪ Why are chimneys made tall? o Students explain one real-life application of convection in their own words.
Transition Time	The teacher rings the alarm and the students move to the next station

<table>
<tr>
<td>STATION 2</td>
<td>Online Station (8 minutes)

Procedure:

Students observe an interactive simulation showing convection currents in water and air.
Students identify the direction of movement of warm and cool air during the simulation.
A short animation video demonstrates the formation of land breeze and sea breeze.
After visualization, students complete a gamified assessment using the Wordwall matching activity.
The activity reinforces concepts such as convection currents, density differences, sea breeze, land breeze, and chimneys
An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning.

</td>
</tr>
<tr>
<td>Transition Time</td>
<td>The teacher rings the alarm and the students move to the next station</td>
</tr>
<tr>
<td>STATION 3</td>
<td>Offline Station (8 minutes)

Procedure:

Students work collaboratively in groups of 3–4 to complete the Convection worksheet activity.
Students observe the image related to Convection
They identify and tag appropriate convection-related terms to the images.
Students explain the process occurring in each image using scientific reasoning.

</td>
</tr>
</table>

Wrap Up Session	The teacher conducts a rapid recap session using short oral questions to reinforce the concept of convection and addresses misconceptions such as "heat always rises" are clarified by explaining that heated fluids rise because they become less dense. Students complete an **Exit Slip** containing a short question and objective-type question about convection
Extended Activity 1. Observe your surroundings and identify any five examples where convection takes place in daily life and explain.	

Step 5: Evaluation

Evaluation of learning was conducted through role play, online gamification activities, worksheets, and exit slips. Students' understanding of convection was assessed through their participation in the role play activity, performance in the online "match the word" activity, and completion of the worksheet and exit slip. Most students scored high score in the online assessment, which indicated their clear understanding of the concept of convection.

Step 6: Reflection

The station rotation model created an active and engaging learning environment for the students. Students participated enthusiastically in all the stations, especially in the gamification activities and role play, which helped in better understanding of convection. Proper time management need to be ensured in the future class. Overall, the session was interactive and effective.

LESSON TRANSCRIPT 4

Name of the Teacher	Juhi Jeluna.J		
Name of the School	Yettacode Higher Secondary School, Yettacode		
Subject	Science	**Date:** 03-04-2026	**Class:** IX
Topic	Carbon and its compound		
Book Reference	IX Class Science Textbook	**No. of Students:** 46	

Learning Outcome

The pupil,

1. Defines carbon and identifies its importance in living organisms and daily life.
2. Explains the discovery and historical milestones of carbon.
3. Classifies carbon compounds into organic and inorganic compounds.
4. Identifies examples of organic and inorganic carbon compounds.
5. Describes the importance of carbon compounds in everyday life.
6. Analyses the different forms of carbon such as diamond, graphite, and graphene.

Content Analysis

➢ **Carbon**

- Carbon is an important non-metallic element.
- The word Carbon is derived from the Latin word "Carbo" meaning coal.
- Carbon is present in all living organisms.
- Carbon compounds are essential for life processes and daily life materials.
- Carbon chemistry is also called Living Chemistry.

➢ **Discovery of Carbon – Milestones**

- Antoine Lavoisier proved diamond and charcoal are forms of carbon.
- Carl Scheele showed graphite burns to form carbon dioxide.
- Smithson Tennant proved diamond is pure carbon.
- Benjamin Brodie produced pure graphite from carbon.
- Francis Bundy converted graphite into diamond under high temperature and pressure.
- Robert Curl, Harry Kroto, and Richard Smalley discovered fullerenes.
- Andre Geim and Kostya Novoselov discovered graphene.

➢ **Classification of Carbon Compounds**

- **Organic Carbon Compounds**
  - Obtained from living organisms.
  - Examples: Ethanol, Cellulose, Starch.
- **Inorganic Carbon Compounds**
  - Obtained from non-living matter.
  - Examples: Carbon dioxide, Carbon monoxide, Calcium carbonate.

STEP 1: Analyze Students' Data and Learning Content

The teacher assess the current knowledge of *understanding of carbon and its compound, and identifies the common misconceptions related to carbon* using the following guiding statement

Guiding Statement:

How does carbon become the basis of life and so many materials used in our daily life?

Step 2 : Plan logistics

Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem Stones	Clever Stars

Timing	45 minutes

Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do the activities assigned in the respective station. All group members shall participate in the allotted activities.

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<tr><td>Type of Station</td><td>Teacher-Led Station</td><td>Online Station</td><td>Offline Station</td></tr>
<tr><td>Activity</td><td>Group discussion on “Compounds of Carbon”</td><td>Video and Online Quiz on Conduction</td><td>Analysis of Carbon Mapping</td></tr>
<tr><td rowspan="3">Learning Resources</td><td>1. Image of Diamond and Graphite</td><td>1. Laptop with internet connection
2. Video on Compounds of Carbon
3. Kahoot! – Quiz on Carbon and its compound</td><td>1. Worksheet – “Discovery of Carbon-Milestones”</td></tr>
<tr><td colspan="2">Whole Group Instruction</td><td>Wrap Up Session</td></tr>
<tr><td colspan="2">Presentation on the Discovery of Carbon</td><td>Exit Slip</td></tr>
<tr><td colspan="4">STEP 4: Implementation of Station Rotation Activities</td></tr>
<tr><td>Whole Group Instruction</td><td colspan="3">• Procedure:
o The teacher displays the presentation on the Discovery of Carbon and explains about the discovery of carbons.
o The teacher asks student by showing the images in presentation and asks
▪ “Is diamond made of a different substance than charcoal?”
o The teacher introduces carbon as an important non-metallic element present in all living organisms.
o The teacher explains the importance of carbon compounds in daily life.
o A short presentation on the carbon and its milestones is shown.
o The teacher explains organic and inorganic carbon compounds with examples.
o The rules, procedures, and time limits for station rotation are explained before students move to their assigned stations. After giving clear instructions, the teacher directs the students to move to their respective stations.</td></tr>
<tr><td>Transition Time</td><td colspan="3">The teacher rings the alarm and the students move to their assigned station</td></tr>
</table>

Station Rotation Activity **STATION 1**	Teacher-Led Station (8 minutes) • ***Procedure:*** o The teacher displays the image of diamond and graphite and explains about the experiment conducted by Antoine Lavoisier. o Students discuss the importance of carbon in living organisms and daily life, and share their ideas. o The teacher explains the various forms of carbon and their uses. o The teacher asks probing questions such as: ▪ Why is carbon called Living Chemistry? ▪ How are diamond and graphite related?
Transition Time	The teacher rings the alarm and the students move to the next station
STATION 2	Online Station (8 minutes) • ***Procedure:*** o Students observe a video explaining carbon, its compounds, and their classification. o Students identify important discoveries related to carbon. o Students participate in a Kahoot quiz based on carbon compounds o The quiz reinforces concepts such as allotropes of carbon, organic compounds, and inorganic compounds. o An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning.

<table>
<tr><td>Transition Time</td><td>The teacher rings the alarm and the students move to the next station</td></tr>
<tr><td>STATION 3</td><td>Offline Station (8 minutes)

• Procedure:
○ Students work collaboratively in groups of 3–4 to complete the worksheet activity.
○ Students complete the Analysis mapping on “Discovery of Carbon – Milestones.”
○ Students analyse the timeline and match scientists with their discoveries related to carbon.
○ Students prepare a simple map showing different forms and compounds of carbon and its discovery milestones in it.
○ Students explain their mapping using scientific reasoning.</td></tr>
<tr><td>Wrap Up Session</td><td>The teacher conducts a rapid recap using short questions to reinforce the concept on Carbon and its compounds and addresses misconceptions regarding the forms of carbon and the doubts are clarified. Students complete an Exit Slip containing a short question and objective-type questions about conduction</td></tr>
<tr><td colspan="2">Extended Activity
1.6 Identify any six materials or substances that contain carbon compounds. Classify them as organic or inorganic compounds and explain their uses in daily life</td></tr>
</table>

Step 5: Evaluation

Evaluation of students’ learning was carried out through group discussion, online activities, concept map preparation, and milestone analysis related to Carbon and its Compounds. Students’ understanding of the concepts was assessed based on their participation in the discussion and their ability to prepare and analyze the concept map.

Some students experienced difficulty in organizing and linking the concepts in the map, and these misconceptions were identified and clarified through teacher guidance. Students performed effectively in the online activities and responded accurately to the online assessment, indicating their high level of performance.

Step 6: Reflection

The implementation of the station rotation model was effective and engaging for the students. The activities helped students to understand the concepts of Carbon and its discovery milestones interactively through online station and encouraged active participation throughout the session. Overall, the session was effective to learn through different modes of station.

LESSON TRANSCRIPT 5

Name of the Teacher	Juhi Jeluna.J			
Name of the School	Yettacode Higher Secondary School, Yettacode			
Subject	Science	**Date:** 04-03-2026		**Class:** IX
Topic	Carbon and its Compound – Special features of Carbon			
Book Reference	IX Class Science Textbook		**No. of Students:** 46	

Learning Outcome

The pupil,

1. Defines catenation and tetravalency of carbon.
2. Explains the unique properties of carbon that lead to the formation of numerous compounds.
3. Identifies the different types of carbon chains such as linear, branched, and cyclic chains.
4. Classifies carbon compounds into organic and inorganic compounds.
5. Describes the tetravalent nature of carbon using methane as an example.
6. Analyses the importance of catenation in daily life substances such as plastics, fuels, and natural compounds.

Content Analysis

- **Special Features of Carbon**
  - Carbon forms a very large number of compounds.
  - Carbon compounds are more in number than compounds of all other elements together.
  - This is due to the unique properties of carbon.
- **Catenation**
  - Catenation is the ability of an element to bond with itself through covalent bonds.
  - Carbon undergoes catenation to form long chains and rings.
  - Carbon forms linear chains, branched chains, and cyclic structures.
  - Organic chemistry mainly deals with catenated carbon compounds.
  - Plastics, starch, cellulose, and fuels contain long carbon chains.
- **Tetravalency**
  - Carbon has four electrons in its outermost shell.
  - Carbon shares four electrons to complete its octet.
  - Carbon forms four covalent bonds with other atoms.
  - This property is called tetravalency.
  - Methane is an example showing tetravalency of carbon.

STEP 1: Analyze Students' Data and Learning Content
The teacher analyses students' understanding regarding covalent bonding, compounds, and daily life substances containing carbon through classroom interaction. Students' prior knowledge is assessed. Misconceptions such as "carbon forms only simple compounds" and "all carbon compounds are organic" are identified and clarified.

Step 2 : Plan logistics	
Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem Stones	Clever Stars

Timing	45 minutes

Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do the activities assigned in the respective station. All group members shall participate in the allotted activities.

STEP 3: Designing the Stations			
Stations	Station 1	Station 2	Station 3
Type of Station	Teacher-Led Station	Online Station	Offline Station
Activity	Group discussion on "Catenation"	Video and Online Quiz on Conduction	Where do I Belong?

<table>
<tr><td rowspan="3">Learning Resources</td><td>1. Concept Map – Catenation and Tetravalency</td><td colspan="2">1. Laptop with internet connection
2. Animation video on Catenation
3. Kahoot! – Quiz on Features of Carbon</td><td>1. Worksheet – “Classification of Carbon and its Compounds”</td></tr>
<tr><td colspan="2">Whole Group Instruction</td><td colspan="2">Wrap Up Session</td></tr>
<tr><td colspan="2">Images of different chains of compounds</td><td colspan="2">Exit Slip</td></tr>
<tr><td colspan="5">STEP 4: Implementation of Station Rotation Activities</td></tr>
<tr><td>Whole Group Instruction</td><td colspan="4">
• Procedure:
o The teacher displays images of linear chains, branched chains, and cyclic carbon compounds.
o Students carefully observe the structures and identify differences among them.
o The teacher asks:
▪ “Why is carbon able to form so many different chain structures?”
o Students share their responses based on observation and prior knowledge.
o The teacher introduces the concept of catenation as the self-linking property of carbon.
o The teacher explains how carbon atoms form long chains through covalent bonding.
o The teacher further explains tetravalency using the electronic configuration of carbon and about methane structure to show the formation of four covalent bonds by carbon.
o The rules, procedures, and time limits for station rotation are explained before students move to their assigned stations. After giving clear instructions, the teacher directs the students to move to their respective stations.
</td></tr>
<tr><td>Transition Time</td><td colspan="4">The teacher rings the alarm and the students move to their assigned station</td></tr>
</table>

Station Rotation Activity **STATION 1**	Teacher-Led Station (8 minutes) • ***Procedure:*** o The teacher presents the concept map on catenation and tetravalency. o Students discuss how carbon forms long chains and ring structures. o The teacher explains linear, branched, and cyclic chains with examples. o Students identify products in daily life that contain catenated carbon compounds. o The teacher asks probing questions such as: ▪ Why does carbon form more compounds than other elements? ▪ What is the importance of catenation? ▪ How does tetravalency help carbon form stable compounds? o Students present their group ideas and explanations.
Transition Time	The teacher rings the alarm and the students move to the next station
STATION 2	Online Station (8 minutes) • ***Procedure:*** o Students observe an animation video explaining catenation of carbon. o Students identify how carbon atoms combine to form long chains and compounds. o Students participate in a Kahoot quiz on features of carbon. o The quiz reinforces concepts such as catenation, tetravalency, covalent bonding, and classification of compounds. o An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning.

Transition Time	The teacher rings the alarm and the students move to the next station
STATION 3	Offline Station (8 minutes) • ***Procedure:*** ○ Students work collaboratively in groups of 3–4 to complete the worksheet activity. ○ Students receive the worksheet containing different carbon compounds. ○ Students classify the compounds into organic and inorganic categories. ○ Students explain the reason for placing each compound in a particular category. ○ Students discuss their answers and present their classifications.
Wrap Up Session	The teacher conducts a rapid recap using short questions to reinforce the concept on Special features of carbon and addresses misconceptions and clarified. Students complete an **Exit Slip** containing a short question and objective type question about Catenation and tetravalency.
Extended Activity 1. Draw the structure of tetravalency of carbon atom with an example	

Step 5: Evaluation

The evaluation was carried out through various activities such as group discussion, online gamification activities, worksheets, and exit slips. Most students were able to classify the compounds correctly and answer the questions appropriately. The exit slip responses indicated the improvement in students' performance in Station activities.

Step 6: Reflection

The station rotation model created an active and engaging learning environment for the students. Students participated enthusiastically in all the stations, especially in the gamification activities and group activity, which helped in better understanding the concept of Catenation and tetravalency. Overall, the session on Station Rotation Model of teaching was effective.

LESSON TRANSCRIPT 6

Name of the Teacher	Juhi Jeluna.J		
Name of the School	Yettacode Higher Secondary School, Yettacode		
Subject	Science	**Date:** 06-03-2026	**Class:** IX
Topic	Carbon and its compounds – Multiple Bonds and Isomerism		
Book Reference	IX Class Science Textbook	**No. of Students:** 46	

Learning Outcome

The pupil,

1. Explains the ability of carbon to form single, double, and triple covalent bonds.
2. Identifies hydrocarbons based on the type of bonding present in them.
3. Differentiates alkanes, alkenes, and alkynes with suitable examples.
4. Defines isomerism and identifies simple isomers of carbon compounds.
5. Analyses how the arrangement of atoms changes the properties of compounds.
6. Interprets image-based representations of hydrocarbons and multiple bonds.

Content Analysis

- **Multiple Bonds of Carbon**
  - Carbon is tetravalent and forms covalent bonds.
  - Carbon can form single, double, and triple bonds.
  - Multiple bonding leads to the formation of various carbon compounds.
- **Hydrocarbons**

  Hydrocarbons are compounds containing carbon and hydrogen.
  - **Alkane** contains **single bonds.**

    Example: Methane.
  - **Alkene** contains **double bonds.**

    Example: Ethene.
  - **Alkyne** contains **triple bonds.**

    Example: Ethyne.
- **Isomerism**
  - Compounds having the same molecular formula but different structural arrangements are called isomers. This phenomenon is called isomerism.
  - Example: C_2H_6O exists as alcohol and ether with different structures and properties.

STEP 1: Analyze Students' Data and Learning Content
The teacher analyses students' understanding regarding covalent bonding, hydrocarbons, and molecular structures through questioning and classroom interaction. Students' familiarity with single and multiple bonds is assessed using simple molecular examples. Misconceptions such as "all carbon compounds with the same formula are identical" and "carbon forms only single bonds" are identified and clarified. Based on students' readiness levels and learning needs, suitable station rotation activities are planned to strengthen conceptual understanding and collaboration
Step 2 : Plan logistics

Grouping	The class is divided into six groups, with seven to eight students in each group. Each group follows a mixed-ability format, combining students of high, moderate, and emerging readiness levels to promote peer learning and cooperation.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
Blue Diamonds	Galaxy	Glassy Roses	Smart Girls	Gem Stones	Clever Stars

Timing	45 minutes

Whole group Instruction	**Station 1**	**Station 2**	**Station 3**	**Transition Period**	**Wrap up Session**
10 minutes	8 minutes	8 minutes	8 minutes	3 minutes	8 minutes

Directions	The instructions will be provided in each of the stations. The students read and do the activities assigned in the respective station. All group members shall participate in the allotted activities.

<table>
<tr><td colspan="4">STEP 3: Designing the Stations</td></tr>
<tr><td>Stations</td><td>Station 1</td><td>Station 2</td><td>Station 3</td></tr>
<tr><td>Type of Station</td><td>Teacher-Led Station</td><td>Online Station</td><td>Offline Station</td></tr>
<tr><td>Activity</td><td>Group discussion on “Features of Carbon”</td><td>Interactive Simulation and Lineup gamification on Features of Carbon</td><td>Hydrocarbons – Image-Based Analysis</td></tr>
<tr><td rowspan="3">Learning Resources</td><td>1. Concept map on Features of Carbon</td><td>1. Laptop with internet connection
2. Video on Hydrocarbons
3. Features of Carbon - Lineup (Card sort)</td><td>1. Worksheet – “Multiple Bonds”</td></tr>
<tr><td colspan="2">Whole Group Instruction</td><td>Wrap Up Session</td></tr>
<tr><td colspan="2">Image of Carbon And Hydrogen atoms</td><td>Exit Slip</td></tr>
<tr><td colspan="4">STEP 4: Implementation of Station Rotation Activities</td></tr>
<tr><td>Whole Group Instruction</td><td colspan="3">• Procedure:
o The teacher displays images showing carbon and hydrogen atoms forming different bonds.
o Students observe the structures carefully.
o The teacher asks:
▪ “How can carbon form different kinds of compounds using the same atoms?”
o Students share their responses based on prior knowledge.
o The teacher introduces the concept of single, double, and triple covalent bonds.
o The teacher explains hydrocarbons and their classification into alkanes, alkenes, and alkynes.
o Examples such as methane, ethene, and ethyne are discussed.
o The teacher further introduces isomerism using simple structural examples of C_2H_6O.</td></tr>
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Students compare the arrangements of atoms in alcohol and ether.
The rules, procedures, and time limits for station rotation are explained before students move to their assigned stations. After giving clear instructions, the teacher directs the students to move to their respective stations.

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<tr>
<td>Transition Time</td>
<td>The teacher rings the alarm and the students move to their assigned station</td>
</tr>
<tr>
<td>Station Rotation Activity

STATION 1</td>
<td>


Teacher-Led Station (8 minutes)

Procedure:

The teacher presents the concept map on features of carbon.
Students discuss the importance of multiple bonding in carbon compounds.
The teacher explains the formation of single, double, and triple bonds with suitable examples.
Students identify the class of hydrocarbons based on bonding.
The teacher introduces isomerism using simple molecular structures.
Probing questions are asked such as:

Why does carbon form different types of bonds?
How do multiple bonds affect the properties of compounds?
Why can the same molecular formula have different structures?

Students explain one example of hydrocarbon or isomer in their own words.

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<tr>
<td>Transition Time</td>
<td>The teacher rings the alarm and the students move to the next station</td>
</tr>
</table>

STATION 2	Online Station (8 minutes) • ***Procedure:*** ○ Students classifies the features of carbon and participate in the “Lineup” card sort activity by arranging carbon and according to their characteristics ○ Students discuss their answers within the group before final submission. ○ An instruction card placed at the station will provide step-by-step guidance to facilitate independent learning.
Transition Time	The teacher rings the alarm and the students move to the next station
STATION 3	Offline Station (8 minutes) • ***Procedure:*** ○ Students work collaboratively in groups of 3–4 to complete the worksheet activity. ○ Students observe images of hydrocarbon structures provided in the worksheet. ○ Students identify whether the compounds belong to alkane, alkene, or alkyne groups. ○ Students analyse the type of bonds present in each structure and draw the structures of hydrocarbon provided in the worksheet.
Wrap Up Session	The teacher conducts a rapid recap using short questions to reinforce the concept on features of carbon and are clarified. Students complete an **Exit Slip** containing a short question and an objective-type question about carbon.
Extended Activity 1. Draw the basic structures showing single, double, or triple bonds of any two hydrocarbons and explain the type of bonding present in each compound.	

Step 5: Evaluation

The evaluation was carried out through various activities such as group discussion, online gamification activities, worksheets, and exit slip. Most students were able to identify the hydrocarbons correctly and answer the questions appropriately. Some students experienced difficulty in drawing the structures of Alkyne, but these difficulties were identified during the evaluation process and clarified. The exit slip responses and worksheet performance indicated an improvement in students' performance in Station activities.

Step 6: Reflection

The station rotation model created an active and engaging learning environment for the students. Students participated enthusiastically in all the stations, especially in the gamification activities and group activity, which helped in better understanding of the concept of the features of Carbon. Overall, the session was interactive and effective.

Appendix -B

N.V.K.S.D. COLLEGE OF EDUCATION (AUTONOMOUS) ATTOOR

GENERAL DATA SHEET

(2024 – 26)

INSTRUCTIONS

Certain Personal details regarding you are required for my research purpose. The information given by you will be kept confidential and will be used for the research purpose only.

Juhi Jeluna. J

PERSONAL INFORMATION

Name of the Student :

Name of the School :

Class :

Section :

Age :

Gender : Male/ Female

Medium of instruction : English/ Tamil

RESPONSE SHEET

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Name: **Signature:**

Appendix - C

N.V.K.S.D. College of Education (Autonomous)

Re-accredited by NAAC with 'A++' grade

(Affiliated to Tamilnadu Teacher Education University)

ATTOOR, KANYAKUMARI DISTRICT

Achievement Test in Science (Draft Form)

Prepared by Juhi Jeluna. J & Dr. K. Gireesh Kumar

(2024-2026)

Standard: IX — Time: 1 hour 30 min

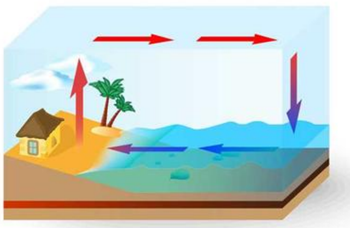
Subject: Science — Total Marks: 80

INSTRUCTION

Read the instruction for every item and write the appropriate answer in the response sheet. Answer all the questions

I. Choose the correct answer:

1) The base of cooking utensils is blackened because black surface
   a) absorbs more heat
   b) reflects more heat
   c) cools faster
   d) prevents conduction
2) A factor that does not determines the amount of heat energy absorbed or lost by a body
   a) Mass of the body
   b) Shape of the body
   c) Change in temperature of the body
   d) Nature of the material of the body
3) A student observes a image and wants to identify the reason for air moving from the sea toward the land. The movement occurs due to
   a) Radiation
   b) Conduction
   c) Convection
   d) Reflection of heat



4) Identify the statement that correctly explains the tetravalency of carbon
   a) It gains electrons
   b) It loses electrons
   c) It shares 4 electrons
   d) It breaks easily

5) A company assigns you the task of designing a water bottle that can keep liquids cold for many hours. While preparing your prototype, which inner design would you propose to achieve maximum temperature retention?
   a) Vacuum-insulated double wall
   b) Single-layer metal
   c) Black plastic lining
   d) Thin aluminium sheet
6) Ramesh wants to make a pencil that can write smoothly. To achieve this, he must select the appropriate form of carbon for the pencil core. The suitable form is
   a) Diamond
   b) Graphite
   c) Charcoal
   d) Fullerene
7) A household aims to reduce environmental pollution from single-use items. The items to avoid using frequently are
   a) Reusable Plastic water bottles
   b) Plastic straws and cups
   c) Cloth bags
   d) Glass containers
8) Identify the carbon forms that does not represent the crystalline form of carbon
   a) Graphite
   b) Diamond
   c) Charcoal
   d) Fullerene
9) The molecular formula C_2H_6O cannot directly tell us the name of the compound because
   a) It has too many carbon atoms
   b) Its atoms are unstable
   c) It represents only inorganic compounds
   d) It does not show how atoms are arranged
10) The weather forecast shows that the temperature in Chennai is 35°C. Riya wants to set her Fahrenheit-based thermostat at home. The temperature in Fahrenheit should be
   a) 95°F
   b) 78°F
   c) 95.5°F
   d) 77°F
11) The following clothes that does not act as a good reflector of heat is
   a) White clothes
   b) Light colored clothes
   c) Black clothes
   d) Silver colored clothes

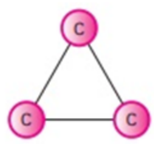
12) A cow ingesting plastic bags is mainly due to
   a) Plastics smell
   b) Shape of plastic
   c) Food traces sticking to plastic
   d) Plastic dissolving in water

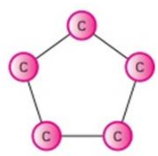
13) A lake and a patch of land receive the same amount of heat from the Sun, but the lake's temperature rises much less. The following explanation that evaluates the reason for this difference
   a) Water is darker than land and absorbs less heat
   b) Land reflects more sunlight than water
   c) Water has a higher specific heat than land
   d) Water is denser than land

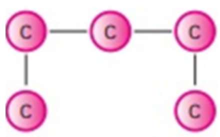
14) You are designing a water purification system using carbon nanomaterials. The system must remove contaminants efficiently without chemically reacting with the water. Which carbon allotrope would you choose for the purification process?
   a) Fullerene
   b) Diamond
   c) Graphite
   d) Charcoal

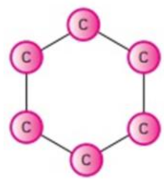
15) A construction company wants a material for cutting and polishing gemstones. The suitable form of carbon is
   a) Graphite   b) Fullerene
   c) Charcoal   d) Diamond

16) Identify the compound that is not a ring-chain compound

a) 

b) 

c) 

d) 

17) The difference in properties of diamond and graphite is due to
   a) arrangement of carbon atoms
   b) number of electrons
   c) impurities present
   d) colour difference

18) Based on scientific evidence about environmental and health risks, The banned item that provides the strongest justification for the government's restriction?

a) Clay toys
b) Cloth bags
c) Reusable PET bottles
d) Thermocol plates

19) A chemist burns equal weights of diamond and charcoal and measures the amount of CO_2 produced. Both produce the same amount of CO_2. Based on this observation, the conclusion is that

a) Diamond and charcoal contain different elements.
b) Diamond contains oxygen atoms in its structure.
c) Both diamond and charcoal are allotropes of the same element.
d) Charcoal is an impure form of carbon.

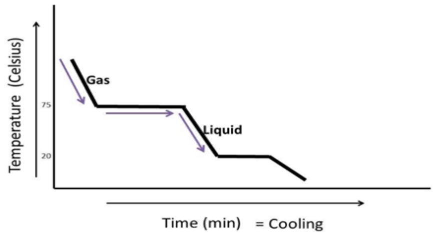
20) A company aims to produce a lightweight and extremely strong material for aerospace applications. The most suitable carbon-based material is

a) Graphene
b) Charcoal
c) Diamond
d) Fullerene

21) A laboratory freezer keeps samples at 200 K. The equivalent temperature in °C is

a) - 73 °C
b) - 63 °C
c) - 83 °C
d) - 93 °C

22) A student cools a hot liquid and records the temperature over time. A flat portion in the cooling curve of a hot liquid indicates



a) The substance is losing mass while cooling
b) The liquid is changing into a solid at constant temperature
c) The temperature is increasing due to heat gain
d) Heat is being transferred only by conduction

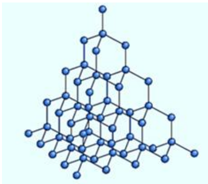
23) Arjun wants an iron that heats clothes quickly. He notices that heat spreads across the metal base plate. To make the iron more efficient, the base plate should be made of

a) Plastic
b) Wood
c) Aluminium
d) Glass

24) Calculate heat needed to melt 1 kg ice. (L = 336 J/g)
   a) 33,600 J
   b) 336,000 J
   c) 3,360,000 J
   d) 3,36,00,000 J
25) Ice cubes melt when placed in a glass of water because
   a) Ice transfers heat to the water
   b) The ice cubes produce heat while melting
   c) Heat moves from the warmer water to the colder ice
   d) The temperatures of ice and water remain the same
26) Harini keeps mothballs in her cupboard to protect her woolen clothes during summer. After some weeks, the mothballs vanish without forming any liquid. This happens because mothballs
   a) Melt first and then evaporate
   b) Condense due to low temperature
   c) Freeze into a solid
   d) Absorb heat and sublimate directly into gas
27) Water is used as coolant because it has
   a) High specific capacity
   b) Low specific capacity
   c) High conductivity
   d) High density
28) A chef stirs hot soup with a spoon, but the handle of a metal spoon gets hot after a few minutes. To avoid burning his hand, the following material chef should choose for the spoon's handle
   a) Metal
   b) Wood
   c) Aluminium
   d) Steel
29) A liquid has a temperature of 50°C. The corresponding Kelvin temperature is
   a) 223.15 K
   b) 373.15 K
   c) 323.15 K
   d) 273.15 K
30) A chemist plans to produce acetylene gas for welding. To generate the gas efficiently, the chemist selects a suitable inorganic carbon compound to react with water. The best choice is
   a) Calcium carbide (CaC_2)
   b) Calcium carbonate ($CaCO_3$)
   c) Carbon dioxide (CO_2)
   d) Carbon disulphide (CS_2)
31) Warm air molecules rise when heated near the ground due to
   a) They become heavier than cold air
   b) They gain heat energy and become less dense
   c) They lose energy and move faster
   d) They turn into liquid

32) Akash is designing a winter jacket to keep people warm. He decides to use wool because the jacket will help retain body heat. This is due to
    a) Wool is a good conductor of heat
    b) Wool absorbs body heat and releases it outside
    c) Air trapped in wool is a poor conductor and reduces heat loss
    d) Wool generates heat chemically

33) The picture shows carbon atoms arranged in a tetrahedral structure. This arrangement represents the allotropic form of
    a) Diamond
    b) Graphite
    c) Fullerene
    d) Charcoal



34) Design a scenario where carbon dioxide suddenly turns solid at room temperature. Predict the immediate observable effect in the environment
    a) Trees grow faster
    b) Fire extinguishers stop working
    c) Atmosphere becomes foggy with solid particles
    d) Water boils at a lower temperature

35) A student is designing an eco-friendly deodorizer. The most suitable carbon compound to use is
    a) Coal tar
    b) Charcoal
    c) Diesel
    d) Graphite

36) Identify the incorrect statement about sea breeze
    a) The warm air over the land raises
    b) The cool air from the sea moves towards the land
    c) The land heats up faster than the sea
    d) During night time, the sea becomes warmer than the land

37) Riya is developing a cooling system for a factory machine that releases a large amount of heat during operation. The most suitable liquid for removing heat is
    a) Oil
    b) Alcohol
    c) Petrol
    d) Water

38) A scientist measures the heat absorbed by 2 kg of a substance during melting and calculates L = Q/m. She observes that L is the same regardless of the mass used. This shows that
    a) Specific latent heat is independent of mass
    b) Heat absorbed depends only on mass
    c) Temperature always increases during phase change
    d) Latent heat varies with the size of the substance

39) A substance heats from 25°C to 75°C absorbing 5000 J of heat. By analysing this information, they are able to determine that

a) Its mass is high
b) It is undergoing change of state
c) Its specific heat can be calculated
d) It lost heat

40) Graphene differs from graphite because it

a) has a single layer of carbon atoms
b) is metallic
c) cannot conduct heat
d) is heavier

41) A beverage company aims to produce disposable cups for cold drinks that will not release toxic chemicals. The safest resin code is

a) PS (Resin code #6)
b) PC/ABS (Resin code #7)
c) PET (Resin code #1)
d) PVC (Resin code #3)

42) You are tasked with designing a school project to reduce one-time use plastic pollution. The strategy that you would implement to make your project effective and safe?

a) Identify plastic items by resin codes and educate peers on harmful types
b) Use Thermocol (#6) for all projects
c) Burn discarded plastics for quick disposal
d) Ignore resin codes and use any available plastic

43) An aircraft designer wants to prevent the airplane from heating up too much under sunlight. He decides to polish the airplane's surface. This helps because Polished surface

a) reflects most of the sun's heat radiation
b) absorbs maximum heat
c) increases convection
d) reduces conduction

44) A student is performing an experiment to measure the heat of a substance and wants to reduce heat loss from the container. The type of wall that the students calorimeter should have

a) Thin metal walls
b) A wide and uncovered top
c) Thick insulating walls
d) Dark-colored inner walls

45) Some Space being left between railway tracks during construction to

a) Allow space for train wheels
b) Prevent corrosion
c) Allow the tracks to expand during summer
d) Let rainwater pass through easily

46) A chef needs to store 5 liters of freshly cooked hot soup in a container for transport. Considering the container must withstand high temperature and be safe for food, The best material to use is
   a) Glass
   b) Aluminum foil
   c) Stainless steel
   d) Plastic

47) A metal worker plans to harden steel used in tools. The carbon reaction that strengthen the metals to apply is reaction with
   a) Sulphur to form CS_2
   b) Oxygen to form CO_2
   c) Metals at high temperature to form carbides
   d) Steam to form CO and H_2

48) A recycler finds different types of plastics in a waste bin , each marked with a resin code. Identify the importance of each plastic item that has a resin code
   a) It helps classify plastics for safe recycling and to identify potentially harmful types
   b) It is used to make plastics colorful
   c) It increases the weight of plastics
   d) It reduces the cost of production

49) Rahul is packing a lunch box for school on a cold day. He wants to keep his food warm. He notices that the air trapped inside the container helps reduce heat loss. This indicates that
   a) Air is a good conductor of heat
   b) Air is a poor conductor and acts as an insulator
   c) Air increases latent heat
   d) Air transfers heat quickly by conduction

50) Diamond is hard because
   a) its carbon atoms are arranged in layers
   b) each carbon forms four strong covalent bonds
   c) it contains impurities
   d) it has free electrons

51) A company is designing strong and heat-resistant kitchenware. While selecting a carbon-based material, they focus on the property that ensures high strength and thermal stability. The most important property of carbon to consider is
   a) Ability to form multiple bonds
   b) Ability to conduct electricity
   c) Poor thermal stability
   d) Low melting point

52) A chemist studies certain carbon molecules that form stable, soccer-ball-like structures. To explain this shape, the chemist must analyze how carbon atoms bond and arrange themselves. The correct explanation is
   a) Carbon forms tetrahedral bonds
   b) Carbon forms planar hexagonal layers
   c) Carbon atoms join in 5- and 6-membered rings
   d) Carbon is amorphous

53) A milk company chooses containers marked with resin code 2 because they are strong and do not react with liquids. The plastic represented by this code is
   a) HDPE
   b) LDPE
   c) PET
   d) PP

54) A factory is designing biodegradable plastics that are safe for human use. The design relies on which feature of carbon
   a) Catenation to form long-chain compounds
   b) High density of carbon
   c) Electrical conductivity
   d) Crystalline hardness

55) A company wants to use polypropylene (resin code #5) for microwavable food containers. Evaluate its suitability based on its properties
   a) It has a high melting point and resists deformation
   b) It has a low melting point
   c) It reacts with water
   d) It releases toxins upon heating

56) Two rods, one made of copper and one of glass, have the same length and thickness. When both rods are heated at one end for some time, a clear difference is observed in how heat reaches the other end. The correct conclusion from this observation is
   a) Copper is lighter than glass
   b) Heat travels the same in all solids
   c) Copper conducts heat better than glass
   d) Glass absorbs more heat than copper

57) A manufacturing company assigns you the task of designing an energy-efficient cooking pot that reduces cooking time. Based on principles of heat absorption and thermal conductivity, which design feature would you include in your prototype?
   a) White exterior surface
   b) Rough aluminium base
   c) Thick ceramic wall
   d) Black base with a copper bottom layer

58) A factory is evaluating two types of plastics, PVC (resin code 3) and PET (resin code 1), for packaging food products. They compare factors such as safety, recyclability, and chemical stability. Based on this analysis, which plastic is the better choice for sustainable and safe packaging?
   a) PVC
   b) PET
   c) Both are equally suitable
   d) Neither is suitable

59) Graphite conducts electricity because
   a) its atoms are loosely packed
   b) it reacts with oxygen
   c) it contains water molecules
   d) it has mobile electrons between layers

60) Two liquids, A and B, are heated with equal amounts of heat. Liquid A shows a greater rise in temperature than liquid B. From this observation, it can be concluded that
   a) Liquid A has a higher specific heat than B
   b) Liquid B has a higher specific heat than A
   c) Both liquids have the same specific heat
   d) Liquid A melts faster than B

61) Why A dog cools its body by letting its tongue hang out and panting because
   a) It absorbs the heat and evaporates the saliva from the tongue
   b) Condensation on the tongue releases heat
   c) The tongue produces cold air
   d) Panting increases body temperature

62) A pet shop assigns you the task of designing an aquarium that keeps the water temperature stable throughout the day. While planning your design, which material would you select for the tank to ensure minimal temperature fluctuations?
   a) Thin metal tank
   b) Glass tank with insulation
   c) Concrete tank
   d) Black steel tank

63) A student wraps ice cubes in a woollen cloth. The effect on the ice will be
   a) Ice melts faster
   b) Heat escapes quickly
   c) Melting slows due to insulation
   d) Cloth conducts heat to ice

64) A student is creating a model chart of carbon allotropes for a science project. To represent fullerene, the student chooses an everyday object that resembles its structure. The most suitable item is
   a) Diamond ring
   b) Graphite pencil
   c) Soccer ball
   d) Charcoal stick

ASSERTION – REASON QUESTIONS

Assertion and Reason Questions are given below. Two statements are given. One statement is represented as Assertion (A) and Other Statement is represented as (R). Select the correct answer to these questions from the following options as given below

a) (A) and (R) are true, (R) is the correct explanation of (A)
b) (A) and (R) are true, (R) is not the correct explanation of (A)
c) (A) is true but (R) is false
d) (A) is false but (R) is true

65) **Assertion (A):** Conduction occurs at different rates in solids, liquids, and gases.
Reason (R): The arrangement affect the transfer of heat energy

66) **Assertion(A):** Food containers made with resin code 5 are suitable for microwaving
Reason(R): Polypropylene (PP), represented by resin code 5, has a high melting point and does not deform easily when heated.

67) **Assertion(A):** Graphite cannot be used for making jewellery despite being a carbon allotrope.
Reason(R): Graphite has a soft and slippery layered structure.

68) **Assertion(A):** Dry ice changes directly from solid to gas at room temperature without becoming liquid.
Reason(R): Sublimation is the process in which a solid first becomes liquid and then gas.

69) **Assertion(A):** Vacuum flasks prevent heat loss.
Reason(R): They reduce only conduction and convection.

70) **Assertion(A):** Carbon is able to form long chains and ring structures with itself.
Reason(R): Catenation is the ability of an element to form bonds with atoms of the same element.

Appendix -D

Question wise Analysis (Draft)

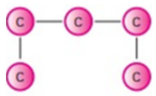
Qs No.	Unit	Objective	Form of question	Difficulty level	Score	Time
1	Heat	Understanding	Objective	Easy	1	50 s
2	Heat	Understanding	Objective	Average	1	60 s
3	Heat	Applying	Objective	Average	1	60 s
4	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
5	Heat	Creating	Objective	Difficult	1	90 s
6	Carbon and its Compounds	Applying	Objective	Average	1	60 s
7	Carbon and its Compounds	Applying	Objective	Average	1	60 s
8	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
9	Carbon and its Compounds	Understanding	Objective	Average	1	60 s
10	Heat	Applying	Objective	Average	1	60 s
11	Heat	Understanding	Objective	Easy	1	50 s
12	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
13	Heat	Evaluating	Objective	Difficult	1	90 s
14	Carbon and its Compounds	Creating	Objective	Difficult	1	90 s
15	Carbon and its Compounds	Applying	Objective	Average	1	60 s
16	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
17	Carbon and its Compounds	Understanding	Objective	Average	1	60 s
18	Carbon and its Compounds	Evaluating	Objective	Difficult	1	90 s
19	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
20	Carbon and its Compounds	Applying	Objective	Average	1	60 s
21	Heat	Applying	Objective	Average	1	60 s
22	Heat	Understanding	Objective	Average	1	60 s

23	Heat	Applying	Objective	Average	1	60 s
24	Heat	Applying	Objective	Average	1	60 s
25	Heat	Understanding	Objective	Average	1	60 s
26	Heat	Applying	Objective	Average	1	60 s
27	Heat	Understanding	Objective	Average	1	60 s
28	Heat	Applying	Objective	Average	1	60 s
29	Heat	Applying	Objective	Average	1	60 s
30	Carbon and its Compounds	Applying	Objective	Average	1	60 s
31	Carbon and its Compounds	Understanding	Objective	Average	1	60 s
32	Heat	Applying	Objective	Average	1	60 s
33	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
34	Carbon and its Compounds	Creating	Objective	Difficult	1	90 s
35	Carbon and its Compounds	Applying	Objective	Average	1	60 s
36	Heat	Understanding	Objective	Easy	1	50 s
37	Heat	Applying	Objective	Average	1	60 s
38	Heat	Analyzing	Objective	Difficult	1	90 s
39	Heat	Analyzing	Objective	Difficult	1	90 s
40	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
41	Carbon and its Compounds	Applying	Objective	Average	1	60 s
42	Carbon and its Compounds	Creating	Objective	Difficult	1	90 s
43	Heat	Applying	Objective	Average	1	60 s
44	Heat	Applying	Objective	Average	1	60 s
45	Heat	Understanding	Objective	Average	1	60 s
46	Heat	Applying	Objective	Average	1	60 s
47	Carbon and its Compounds	Applying	Objective	Average	1	60 s
48	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
49	Heat	Evaluating	Objective	Difficult	1	90 s
50	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s

51	Carbon and its Compounds	Applying	Objective	Average	1	60 s
52	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
53	Carbon and its Compounds	Applying	Objective	Average	1	90 s
54	Carbon and its Compounds	Applying	Objective	Average	1	60 s
55	Carbon and its Compounds	Evaluating	Objective	Difficult	1	90 s
56	Heat	Analyzing	Objective	Difficult	1	90 s
57	Heat	Creating	Objective	Difficult	1	90 s
58	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
59	Carbon and its Compounds	Understanding	Objective	Average	1	60 s
60	Heat	Analyzing	Objective	Difficult	1	90 s
61	Heat	Understanding	Objective	Average	1	60 s
62	Heat	Creating	Objective	Difficult	1	90 s
63	Heat	Applying	Objective	Average	1	60 s
64	Carbon and its Compounds	Applying	Objective	Average	1	60 s
65	Heat	Analyzing	Objective	Difficult	1	90 s
66	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
67	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
68	Heat	Analyzing	Objective	Difficult	1	90 s
69	Heat	Analyzing	Objective	Difficult	1	90 s
70	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
Total					**70**	**80 min**

Appendix -E

Scoring Key (Draft)

Question No.	Answers	Mark
1	Absorbs more heat	1
2	Shape of the body	1
3	Convection	1
4	It shares 4 electrons	1
5	Vacuum-insulated double wall	1
6	Graphite	1
7	Plastic straws and cups	1
8	Charcoal	1
9	It does not show how atoms are arranged	1
10	95.5°F	1
11	Black clothes	1
12	Food traces sticking to plastic	1
13	Water has a higher specific heat than land	1
14	Fullerene	1
15	Diamond	1
16		1
17	Arrangement of carbon atoms	1
18	Thermocol plates	1
19	Both diamond and charcoal are allotropes of the same element.	1
20	Graphene	1
21	- 73 °C	1

22	The liquid is changing into a solid at constant temperature	1
23	Aluminium	1
24	336,000 J	1
25	Heat moves from the warmer water to the colder ice	1
26	Absorb heat and sublimate directly into gas	1
27	High specific capacity	1
28	Wood	1
29	323.15 K	1
30	Calcium carbide (CaC_2)	1
31	They gain heat energy and become less dense	1
32	Air trapped in wool is a poor conductor and reduces heat loss	1
33	Diamond	1
34	Atmosphere becomes foggy with solid particles	1
35	Charcoal	1
36	During night time, the sea becomes warmer than the land	1
37	Water	1
38	Specific latent heat is independent of mass	1
39	Its specific heat can be calculated	1
40	has a single layer of carbon atoms	1
41	PET (Resin code #1)	1
42	Identify plastic items by resin codes and educate peers on harmful types	1
43	Reflects most of the sun's heat radiation	1
44	Thick insulating walls	1
45	Allow the tracks to expand during summer	1
46	Stainless steel	1

47	Metals at high temperature to form carbides	1
48	It helps classify plastics for safe recycling and to identify potentially harmful types	1
49	Air is a poor conductor and acts as an insulator	1
50	Each carbon forms four strong covalent bonds	1
51	Ability to form multiple bonds	1
52	Carbon atoms join in 5- and 6-membered rings	1
53	HDPE	1
54	Catenation to form long-chain compounds	1
55	It has a high melting point and resists deformation	1
56	Copper conducts heat better than glass	1
57	Black base with a copper bottom layer	1
58	PET	1
59	it has mobile electrons between layers	1
60	Liquid B has a higher specific heat than A	1
61	It absorbs the heat and evaporates the saliva from the tongue	1
62	Glass tank with insulation	1
63	Melting slows due to insulation	1
64	Soccer ball	1
65	(A) and (R) are true, (R) is the correct explanation of (A)	1
66	(A) and (R) are true, (R) is the correct explanation of (A)	1
67	(A) and (R) are true, (R) is the correct explanation of (A)	1
68	(A) is true but (R) is false	1
69	(A) is true but (R) is false	1
70	(A) and (R) are true, (R) is the correct explanation of (A)	1

Appendix -F

N.V.K.S.D. College of Education (Autonomous)

Re-accredited by NAAC with 'A++' grade

(Affiliated to Tamilnadu Teacher Education University)

ATTOOR, KANYAKUMARI DISTRICT

Achievement Test in Science (Final)

Prepared by Juhi Jeluna. J & Dr. K. Gireesh Kumar

(2024-2026)

Standard: IX　　　　Time: 40 minutes

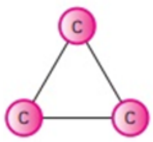
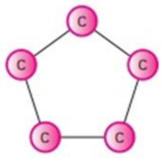
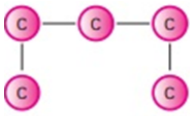
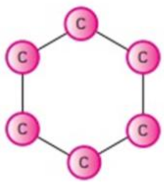
Subject: Science　　　　Total Marks: 36

INSTRUCTION

Read the instruction for every item and write the appropriate answer in the response sheet. Answer all the questions

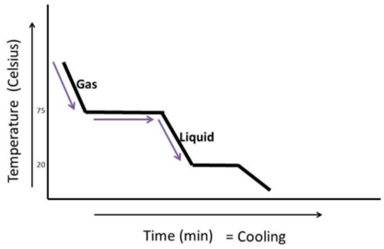
II. Choose the correct answer:

1) A factor that does not determines the amount of heat energy absorbed or lost by a body
   a) Mass of the body
   b) Shape of the body
   c) Change in temperature of the body
   d) Nature of the material of the body
2) Identify the statement that correctly explains the tetravalency of carbon
   a) It gains electrons
   b) It loses electrons
   c) It shares 4 electrons
   d) It breaks easily
3) A company assigns you the task of designing a water bottle that can keep liquids cold for many hours. While preparing your prototype, which inner design would you propose to achieve maximum temperature retention?
   a) Vacuum-insulated double wall
   b) Single-layer metal
   c) Black plastic lining
   d) Thin aluminium sheet
4) Ramesh wants to make a pencil that can write smoothly. To achieve this, he must select the appropriate form of carbon for the pencil core. The suitable form is
   a) Diamond
   b) Graphite
   c) Charcoal
   d) Fullerene

5) A cow ingesting plastic bags is mainly due to
    e) Plastics smell
    f) Shape of plastic
    g) Food traces sticking to plastic
    h) Plastic dissolving in water
6) A construction company wants a material for cutting and polishing gemstones. The suitable form of carbon is
    a) Graphite
    b) Fullerene
    c) Charcoal
    d) Diamond
7) Identify the compound that is not a ring-chain compound
    a) 
    b) 
    c) 
    d) 
8) Based on scientific evidence about environmental and health risks, The banned item that provides the strongest justification for the government's restriction?
    a) Clay toys
    b) Cloth bags
    c) Reusable PET bottles
    d) Thermocol plates
9) A chemist burns equal weights of diamond and charcoal and measures the amount of CO_2 produced. Both produce the same amount of CO_2. Based on this observation, the conclusion is that
    a) Diamond and charcoal contain different elements.
    b) Diamond contains oxygen atoms in its structure.
    c) Both diamond and charcoal are allotropes of the same element.
    d) Charcoal is an impure form of carbon.

10) A laboratory freezer keeps samples at 200 K. The equivalent temperature in °C is
a) - 73 °C b) - 63 °C
c) - 83 °C d) - 93 °C

11) A student cools a hot liquid and records the temperature over time. A flat portion in the cooling curve of a hot liquid indicates



a) The substance is losing mass while cooling
b) The liquid is changing into a solid at constant temperature
c) The temperature is increasing due to heat gain
d) Heat is being transferred only by conduction

12) Arjun wants an iron that heats clothes quickly. He notices that heat spreads across the metal base plate. To make the iron more efficient, the base plate should be made of
a) Plastic b) Wood
c) Aluminium d) Glass

13) Calculate heat needed to melt 1 kg ice. (L = 336 J/g)
a) 33,600 J
b) 336,000 J
c) 3,360,000 J
d) 3,36,00,000 J

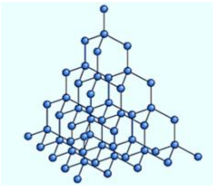
14) Harini keeps mothballs in her cupboard to protect her woolen clothes during summer. After some weeks, the mothballs vanish without forming any liquid. This happens because mothballs
a) Melt first and then evaporate
b) Condense due to low temperature
c) Freeze into a solid
d) Absorb heat and sublimate directly into gas

15) Water is used as coolant because it has
a) High specific capacity
b) Low specific capacity
c) High conductivity
d) High density

16) A chef stirs hot soup with a spoon, but the handle of a metal spoon gets hot after a few minutes. To avoid burning his hand, the following material chef should choose for the spoon's handle
a) Metal
b) Wood
c) Aluminium
d) Steel

17) Akash is designing a winter jacket to keep people warm. He decides to use wool because the jacket will help retain body heat. This is due to
    a) Wool is a good conductor of heat
    b) Wool absorbs body heat and releases it outside
    c) Air trapped in wool is a poor conductor and reduces heat loss
    d) Wool generates heat chemically

18) The picture shows carbon atoms arranged in a tetrahedral structure. This arrangement represents the allotropic form of



    e) Diamond
    f) Graphite
    g) Fullerene
    h) Charcoal

19) Design a scenario where carbon dioxide suddenly turns solid at room temperature. Predict the immediate observable effect in the environment
    a) Trees grow faster
    b) Fire extinguishers stop working
    c) Atmosphere becomes foggy with solid particles
    d) Water boils at a lower temperature

20) Riya is developing a cooling system for a factory machine that releases a large amount of heat during operation. The most suitable liquid for removing heat is
    a) Oil
    b) Alcohol
    c) Petrol
    d) Water

21) A substance heats from 25°C to 75°C absorbing 5000 J of heat. By analysing this information, they are able to determine that
    a) Its mass is high
    b) It is undergoing change of state
    c) Its specific heat can be calculated
    d) It lost heat

22) Graphene differs from graphite because it
    a) has a single layer of carbon atoms
    b) is metallic
    c) cannot conduct heat
    d) is heavier

23) A beverage company aims to produce disposable cups for cold drinks that will not release toxic chemicals. The safest resin code is
    a) PS (Resin code #6)
    b) PC/ABS (Resin code #7)
    c) PET (Resin code #1)
    d) PVC (Resin code #3)

24) You are tasked with designing a school project to reduce one-time use plastic

pollution. The strategy that you would implement to make your project effective and safe?

a) Identify plastic items by resin codes and educate peers on harmful types
b) Use Thermocol (#6) for all projects
c) Burn discarded plastics for quick disposal
d) Ignore resin codes and use any available plastic

25) An aircraft designer wants to prevent the airplane from heating up too much under sunlight. He decides to polish the airplane's surface. This helps because Polished surface
a) reflects most of the sun's heat radiation
b) absorbs maximum heat
c) increases convection
d) reduces conduction

26) A student is performing an experiment to measure the heat of a substance and wants to reduce heat loss from the container. The type of wall that the students calorimeter should have
a) Thin metal walls
b) A wide and uncovered top
c) Thick insulating walls
d) Dark-colored inner walls

27) A chef needs to store 5 liters of freshly cooked hot soup in a container for transport. Considering the container must withstand high temperature and be safe for food, The best material to use is
a) Glass
b) Aluminum foil
c) Stainless steel
d) Plastic

28) A recycler finds different types of plastics in a waste bin , each marked with a resin code. Identify the importance of each plastic item that has a resin code
e) It helps classify plastics for safe recycling and to identify potentially harmful types
b) It is used to make plastics colorful
c) It increases the weight of plastics
d) It reduces the cost of production

29) Diamond is hard because
a) its carbon atoms are arranged in layers
b) each carbon forms four strong covalent bonds
c) it contains impurities
d) it has free electrons

30) A company is designing strong and heat-resistant kitchenware. While selecting a carbon-based material, they focus on the property that ensures high strength and thermal stability. The most important property of carbon to consider is
   a) Ability to form multiple bonds
   b) Ability to conduct electricity
   c) Poor thermal stability
   d) Low melting point

31) A company wants to use polypropylene (resin code #5) for microwavable food containers. Evaluate its suitability based on its properties (E)
   a) It has a high melting point and resists deformation
   b) It has a low melting point
   c) It reacts with water
   d) It releases toxins upon heating

32) A manufacturing company assigns you the task of designing an energy-efficient cooking pot that reduces cooking time. Based on principles of heat absorption and thermal conductivity, which design feature would you include in your prototype?
   a) White exterior surface
   b) Rough aluminium base
   c) Thick ceramic wall
   d) Black base with a copper bottom layer

33) Why A dog cools its body by letting its tongue hang out and panting because
   a) It absorbs the heat and evaporates the saliva from the tongue
   b) Condensation on the tongue releases heat
   c) The tongue produces cold air
   d) Panting increases body temperature

ASSERTION – REASON QUESTIONS

Assertion and Reason Questions are given below. Two statements are given. One statement is represented as Assertion (A) and Other Statement is represented as (R). Select the correct answer to these questions from the following options as given below

   a) (A) and (R) are true, (R) is the correct explanation of (A)
   b) (A) and (R) are true, (R) is not the correct explanation of (A)
   c) (A) is true but (R) is false
   d) (A) is false but (R) is true

34) **Assertion (A):** Conduction occurs at different rates in solids, liquids, and gases.
   Reason (R): The arrangement affect the transfer of heat energy

35) **Assertion(A):** Dry ice changes directly from solid to gas at room temperature without becoming liquid.
   Reason(R): Sublimation is the process in which a solid first becomes liquid and then gas.

36) **Assertion(A):** Carbon is able to form long chains and ring structures with itself.
   Reason(R): Catenation is the ability of an element to form bonds with atoms of the same element.

Appendix -G

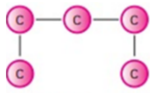
Question wise Analysis (Final)

Qs No.	Unit	Objective	Form of question	Difficulty level	Score	Time
1	Heat	Understanding	Objective	Average	1	60 s
2	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
3	Heat	Creating	Objective	Difficult	1	90 s
4	Carbon and its Compounds	Applying	Objective	Average	1	60 s
5	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
6	Carbon and its Compounds	Applying	Objective	Average	1	60 s
7	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
8	Carbon and its Compounds	Evaluating	Objective	Difficult	1	90 s
9	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
10	Heat	Applying	Objective	Average	1	60 s
11	Heat	Understanding	Objective	Average	1	60 s
12	Heat	Applying	Objective	Average	1	60 s
13	Heat	Applying	Objective	Average	1	60 s
14	Heat	Applying	Objective	Average	1	60 s
15	Heat	Understanding	Objective	Average	1	60 s
16	Heat	Applying	Objective	Average	1	60 s
17	Heat	Applying	Objective	Average	1	60 s
18	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
19	Carbon and its Compounds	Creating	Objective	Difficult	1	90 s
20	Heat	Applying	Objective	Average	1	60 s
21	Heat	Analyzing	Objective	Difficult	1	90 s
22	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s

23	Carbon and its Compounds	Applying	Objective	Average	1	60 s
24	Carbon and its Compounds	Creating	Objective	Difficult	1	90 s
25	Heat	Applying	Objective	Average	1	60 s
26	Heat	Applying	Objective	Average	1	60 s
27	Heat	Applying	Objective	Average	1	60 s
28	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
29	Carbon and its Compounds	Understanding	Objective	Easy	1	50 s
30	Carbon and its Compounds	Applying	Objective	Average	1	60 s
31	Carbon and its Compounds	Evaluating	Objective	Difficult	1	90 s
32	Heat	Creating	Objective	Difficult	1	90 s
33	Heat	Understanding	Objective	Average	1	60 s
34	Heat	Analyzing	Objective	Difficult	1	90 s
35	Heat	Analyzing	Objective	Difficult	1	90 s
36	Carbon and its Compounds	Analyzing	Objective	Difficult	1	90 s
Total					**36**	**40 min**

Appendix - H

Scoring Key (Final)

Question No.	Answer	Mark
1	Shape of the body	1
2	It shares 4 electrons	1
3	Vacuum-insulated double wall	1
4	Graphite	1
5	Food traces sticking to plastic	1
6	Diamond	1
7		1
8	Thermocol plates	1
9	Both diamond and charcoal are allotropes of the same element.	1
10	- 73 °C	1
11	The liquid is changing into a solid at constant temperature	1
12	Aluminium	1
13	336,000 J	1
14	Absorb heat and sublimate directly into gas	1
15	High specific capacity	1
16	Wood	1
17	Air trapped in wool is a poor conductor and reduces heat loss	1
18	Diamond	1
19	Atmosphere becomes foggy with solid particles	1
20	Water	1
21	Its specific heat can be calculated	1
22	has a single layer of carbon atoms	1
23	PET (Resin code #1)	1
24	Identify plastic items by resin codes and educate peers on harmful types	1
25	Reflects most of the sun's heat radiation	1
26	Thick insulating walls	1
27	Stainless steel	1
28	It helps classify plastics for safe recycling and to identify potentially harmful types	1
29	Each carbon forms four strong covalent bonds	1
30	Ability to form multiple bonds	1
31	It has a high melting point and resists deformation	1
32	Black base with a copper bottom layer	1
33	It absorbs the heat and evaporates the saliva from the tongue	1
34	(A) and (R) are true, (R) is the correct explanation of (A)	1
35	(A) is true but (R) is false	1
36	(A) and (R) are true, (R) is the correct explanation of (A)	1

Appendix – I

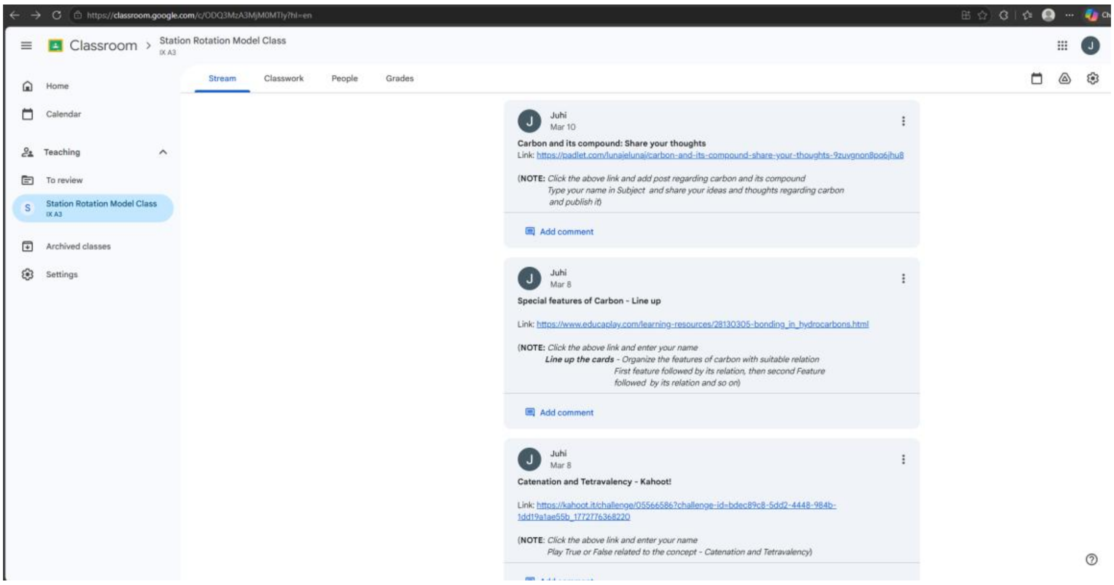
Station Rotation Model: Teaching and learning materials

- Station Rotation Chart
- Screenshot of Google Classroom used for Station Rotation Model
- Screenshot of a Presentation on Carbon and its compounds
- Screenshots of Station Rotation Online Activities
- Activity Sheets
- Exit Slips
- Instruction Card

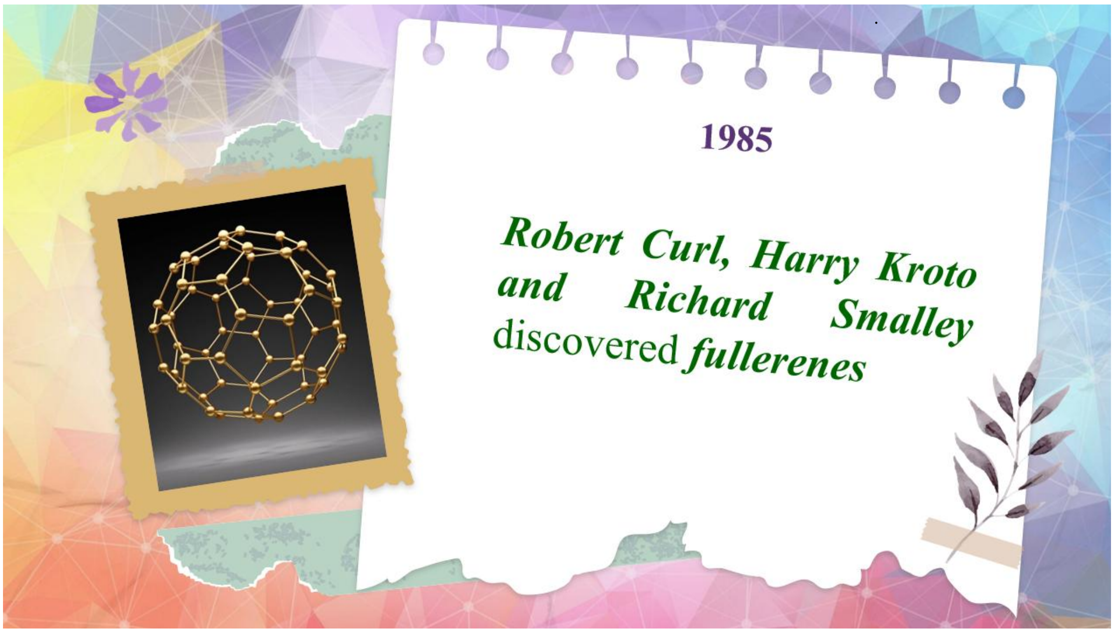
STATION ROTATION CHART

Stations	Rotation 1	Rotation 2	Rotation 3
 **Teacher-Led Station**	Blue Diamonds Galaxy	Glassy Roses Smart Girls	Clever Stars Gem Stones
 **Online Station**	Clever Stars Gem Stones	Blue Diamonds Galaxy	Glassy Roses Smart Girls
 **Collaborative Station**	Glassy Roses Smart Girls	Clever Stars Gem Stones	Blue Diamonds Galaxy

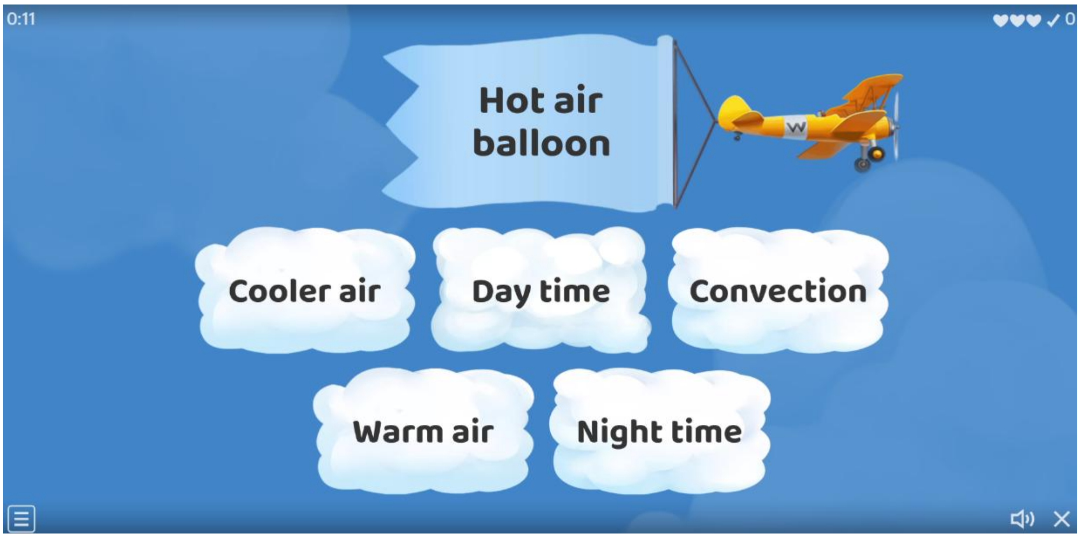
Google Classroom used for Station Rotation Model

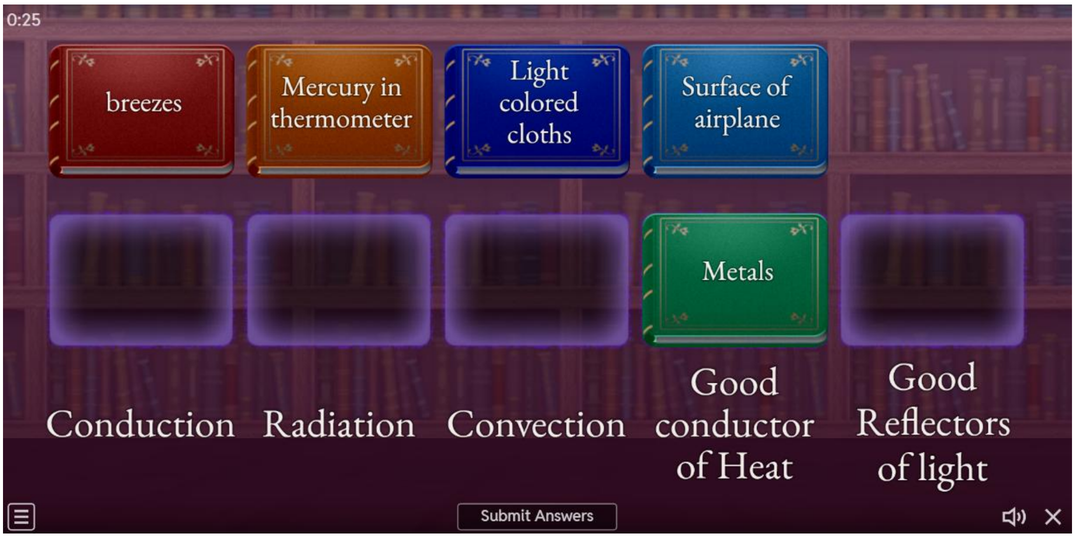


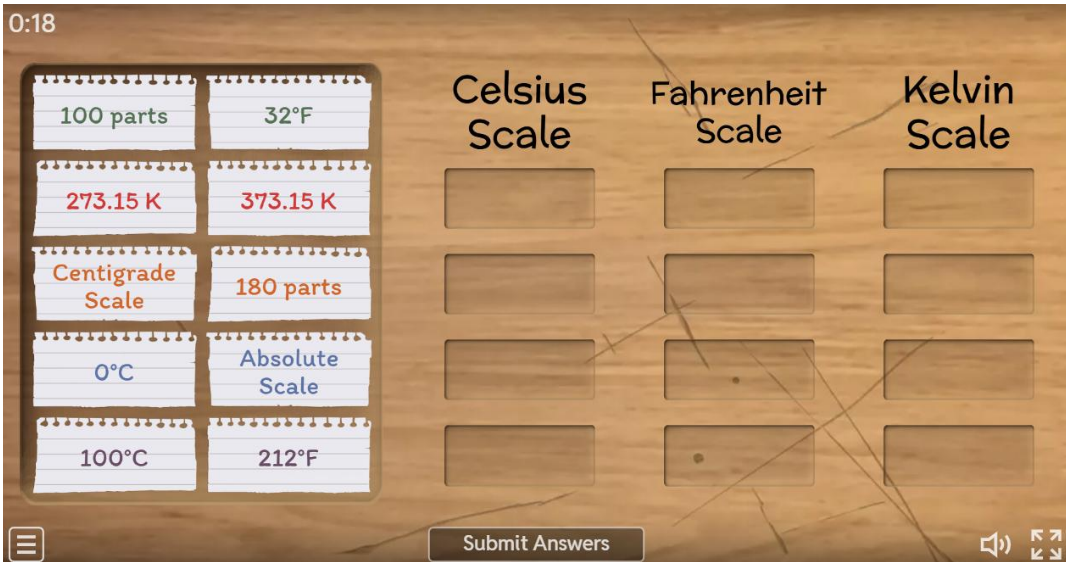
Presentation on Carbon and its compounds

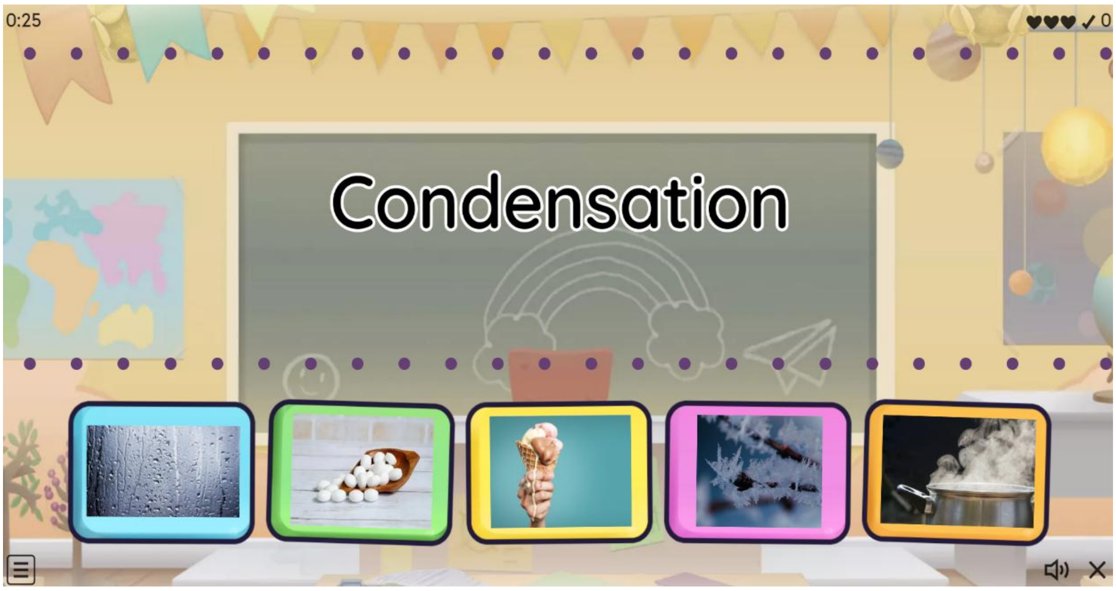


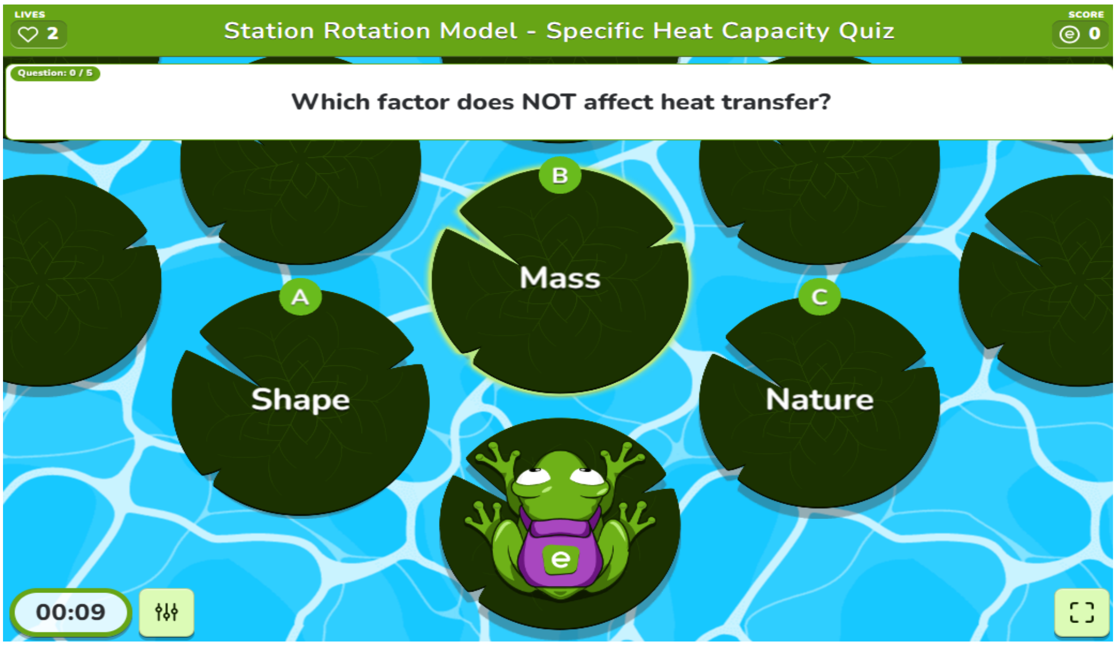
Screenshots of Station Rotation Online Activities

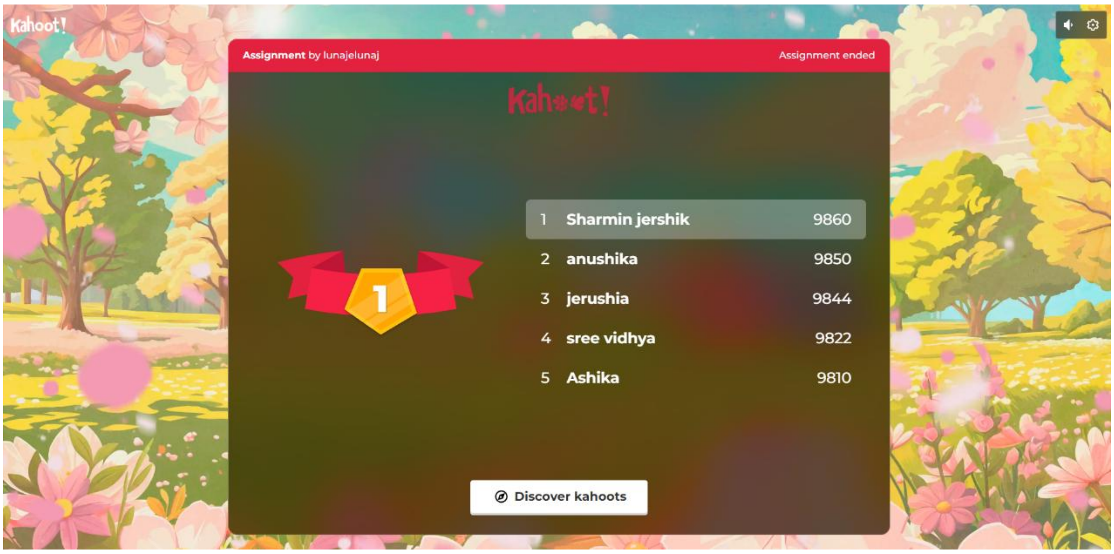


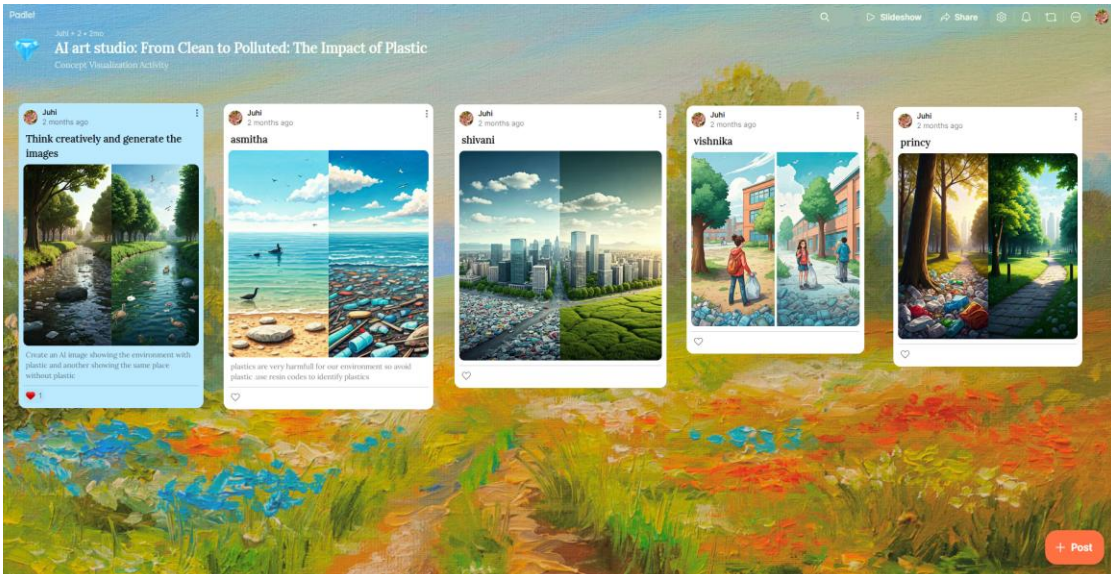


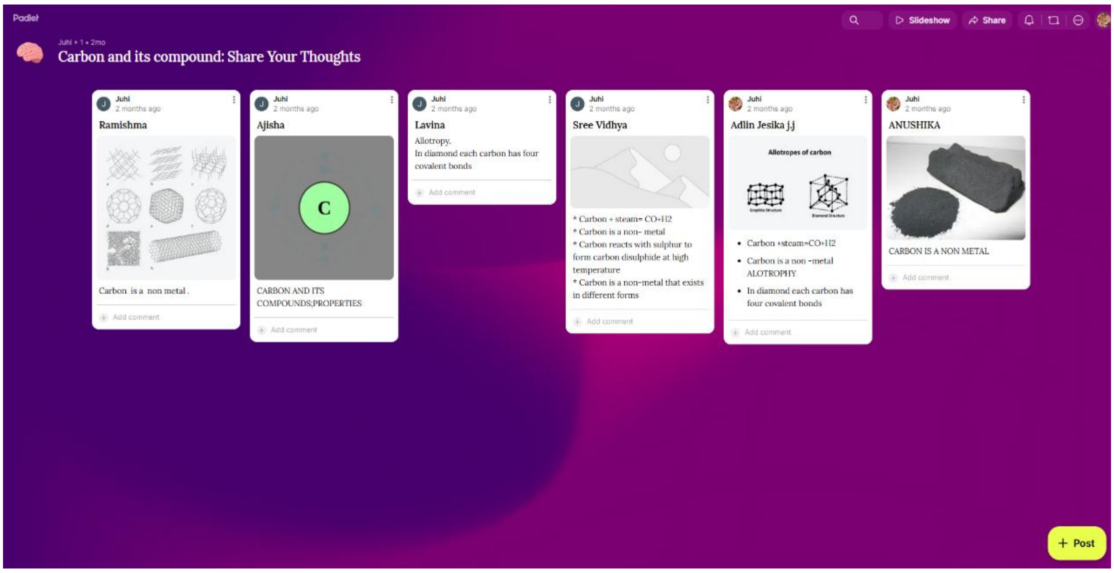


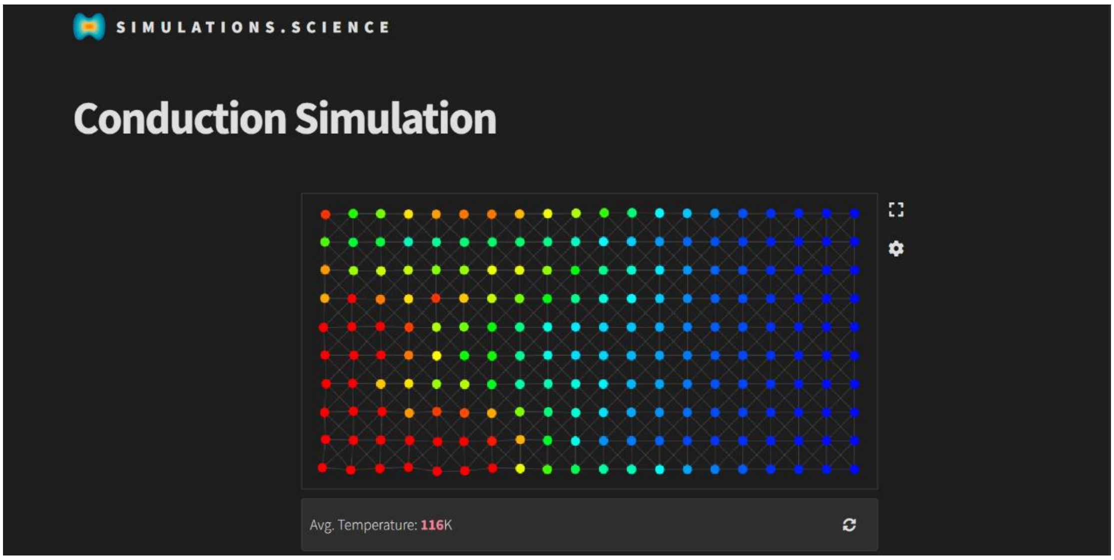

0:25
Condensation


LIVES
2
Station Rotation Model - Specific Heat Capacity Quiz
SCORE
0
Question: 0 / 5
Which factor does NOT affect heat transfer?
B
Mass
A
Shape
C
Nature
00:09


Kahoot!
Assignment by lunajelunaj
Assignment ended
Kahoot!
1 Sharmin jershik 9860
2 anushika 9850
3 jerushia 9844
4 sree vidhya 9822
5 Ashika 9810
1
Discover kahoots


Padlet
Slideshow
Share
AI art studio: From Clean to Polluted: The Impact of Plastic
Concept Visualization Activity
Juhi
2 months ago
Think creatively and generate the images
Create an AI image showing the environment with plastic and another showing the same place without plastic
asmitha
plastics are very harmfull for our environment so avoid plastic use resin codes to identify plastics
shivani
vishnika
princy
Post


Padlet
Slideshow
Share
Carbon and its compound: Share Your Thoughts
Juhi
2 months ago
Ramishma
Carbon is a non metal .
Add comment
Ajisha
C
CARBON AND ITS COMPOUNDS,PROPERTIES
Lavina
Allotropy.
In diamond each carbon has four covalent bonds
Sree Vidhya
* Carbon + steam= CO+H2
* Carbon is a non- metal
* Carbon reacts with sulphur to form carbon disulphide at high temperature
* Carbon is a non-metal that exists in different forms
Adlin Jesika j.j
Allotropes of carbon
Carbon +steam=CO+H2
Carbon is a non -metal
ALOTROPHY
In diamond each carbon has four covalent bonds
ANUSHIKA
CARBON IS A NON METAL
Post


SIMULATIONS.SCIENCE
Conduction Simulation
Avg. Temperature: 116K

Activity Sheets

STATION ROTATION MODEL

Transfer of Heat

Group Name: ____________________ **Date:**

Names:____

1. Observe the images carefully and classify the following examples into their respective transfer of Heat

Conduction

Convection

Radiation

2. Analyze and Explain the different modes of heat transfer taking place in the campfire

STATION ROTATION MODEL

Where do I belong ?

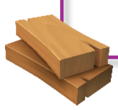
Group Name: ____________________ **Date:** ______________________

Instruction

Work collaboratively with your group (3–4 members) to classify the carbon compounds

HCN	CO_2	Propane	PVC	CO
Kerosene	LPG	Coconut oil	Wood	Perfume
Alcohol	Cotton	Petrol	MgO	$CaCO_3$


Organic carbon compounds	Inorganic carbon compounds



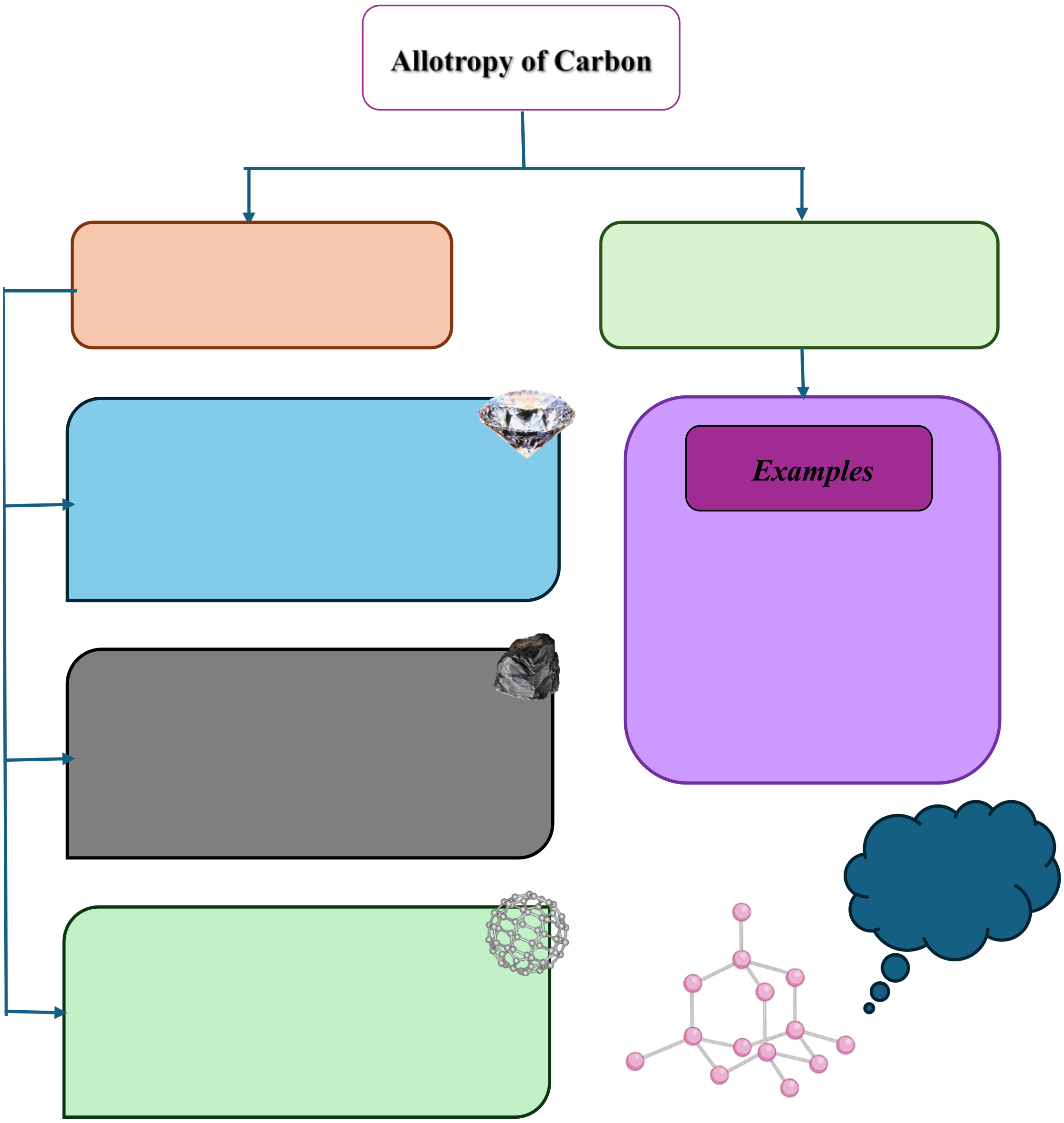

STATION ROTATION MODEL

Allotropy of Carbon

Group Name: ___________________ **Date:** _____________________

Instruction

Work collaboratively with your group (3–4 members) to complete the graphic organizer for allotropy of carbon with examples and write the nam

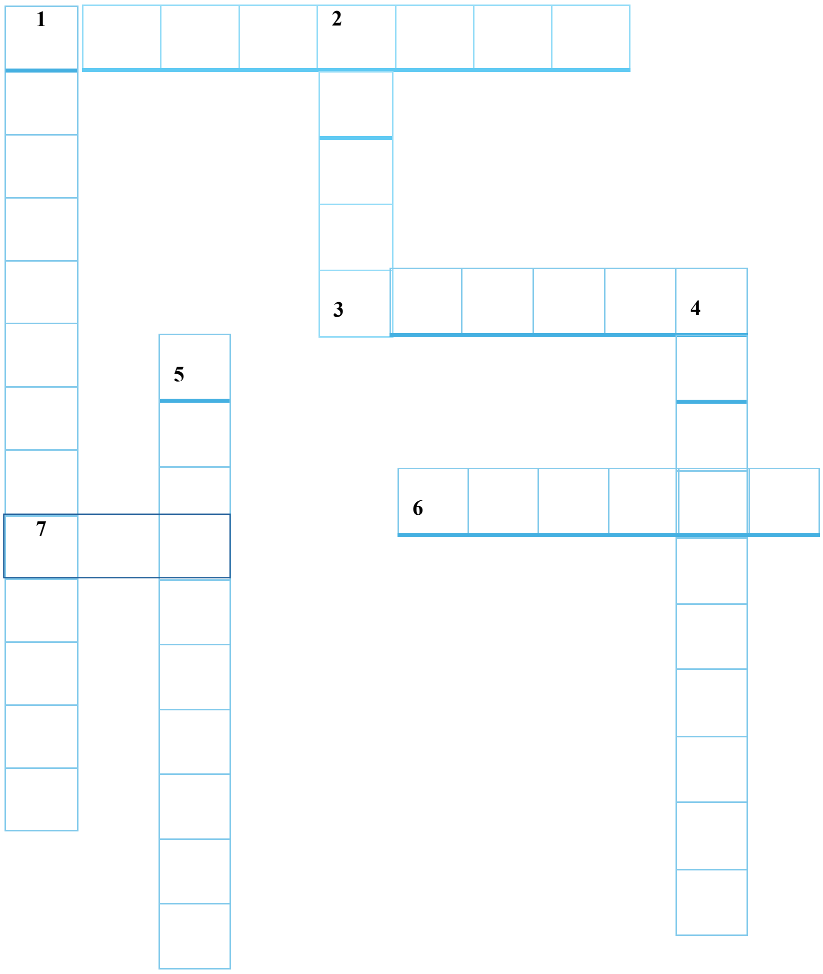


STATION ROTATION MODEL

Crossword Puzzle

Plastics and its Harmful Effects

Group Name : ____________________ **Date:** ____________________



Across →

1. Major class of catenated organic carbon compounds
3. Styrene may cause
6. One of the most toxic chemicals known to humans
7. Resin Code number of PET

Down ↓

1. Resin Code 6 represents
2. Burning plastics releases
4. Secret language of plastics is
5. Polystyrene is also called as

Exit Slips

Conduction

Name: **Date:**

III. **Fill in the blanks**

1. Heat energy flows from __________ temperature to __________ temperature.
2. Conduction is a ___________ process

IV. **Short Answer**

1. Why does a dog keep its tongue out and breathe fast?

____

____

Mention your doubt (if any):

Properties of Carbon

Name: **Date:**

I. **Fill in the blanks**

1. Carbon + Steam = ______________
2. Diamond is __________ and shiny in appearance.

II**. Write True or False**

1. Carbon is a metal that exists in different forms.
2. Carbon reacts with sulphur to form carbon disulphide at high temperature

Mention your doubt (if any):

Latent Heat

Name: **Date:**

I. **Write True or False**

3. The symbol of Specific Latent heat is Q
4. Latent heat means hidden energy

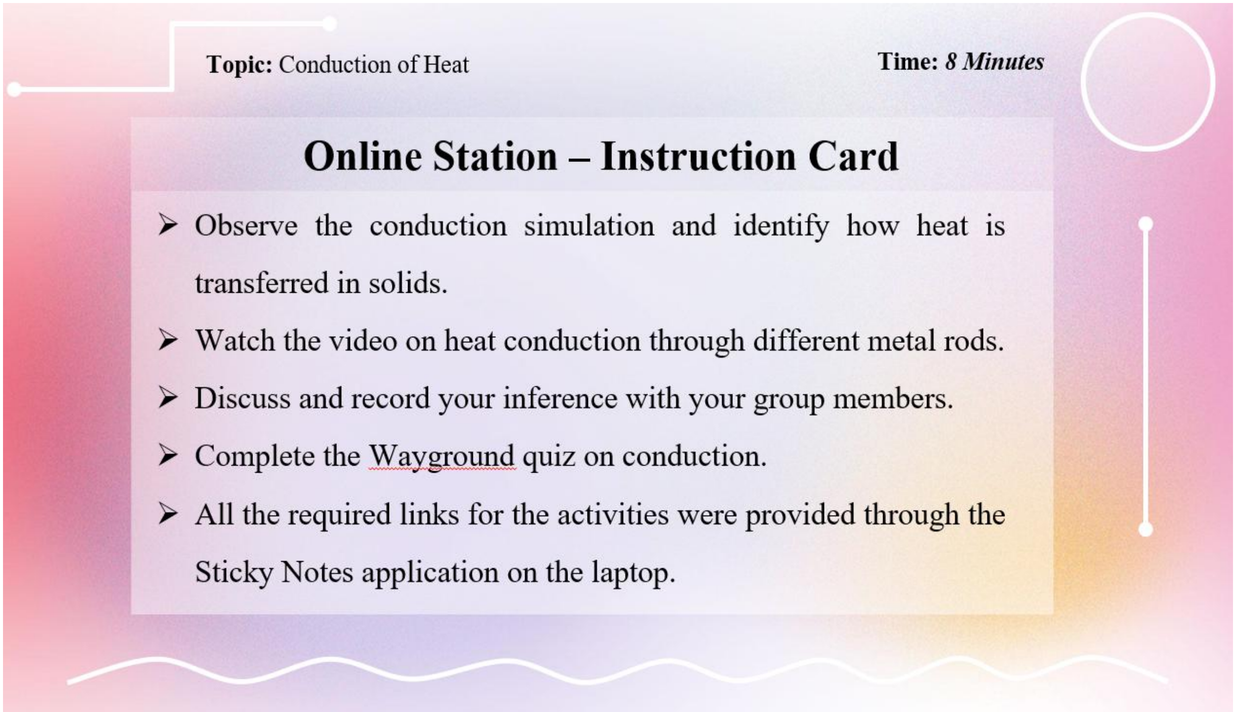
II. **Short Answer**

1. Both boiling water and steam are at 100°C. Which has more heat energy? Justify

   ____
   ____
   ____

Mention your doubt (if any):

Instruction Card



Appendix - J

Pictures of Station Rotation Model of Teaching