Effect of Constructivist - Teaching Strategies on Academic Performance of Students in Science at the Secondary School Level

PAC 16.02

(2017-18)

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PAC REPORT 16.02

(Research Report)

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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Professor Nityanand Pradhan, Principal, Regional Institute of Education, Bhopal for providing necessary support to carry out the project.

I would like to express my sincere thanks to Mr. Harish Prasad, Head Master, Demonstration Multipurpose School, R.I.E., Bhopal.

I am thankful to my colleagues Prof. Praveen Kulshreshtha Prof. Ratnamala Arya, Dr. Kalpana Maski, Dr. Sabiha khan.

My Esteemed colleague Dr. Shivalika Sarkar deserves a special thank for her support and cooperation during the whole program.

I am also grateful to prof. L. K. Tiwari, Head, Department of Extension Education. R.I.E., Bhopal for providing administrative support.

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INTRODUCTION

Constructivism is a theory of how the learner constructs knowledge from experience, which is unique to each individual. Constructivism according to Piaget (1971) is a system of explanations of how learners as individuals adapt and refine knowledge. Constructivism is relatively a new paradigm which is based on the assumption that knowledge is subjective, contextual and inherently partial. It loudly denied the traditional objectivist view of knowledge. The traditional teaching-learning practices which are based on Objectivism, represent knowledge as authoritarian and certain, whereas constructivism focuses on the resilience of learner beliefs and social construction of reality. Constructivism represents a paradigm shift from behaviorism to cognitive theory. Behaviorist's epistemology focuses on intelligence, domains of objectives, levels of knowledge, and reinforcement. While the Constructivist epistemology assumes that learners construct their own knowledge on the basis of interaction with their environment. Four epistemological assumptions are at the heart of what we refer to as "constructivist learning. "The first one is, knowledge is physically constructed by learners who are involved in active learning. Second is knowledge is symbolically constructed by learners who are making their own representations of action; Knowledge is socially constructed by learners who convey their meaning making to others; and last one is, Knowledge is theoretically constructed by learners who try to explain things they don't completely understand.Science is a dynamic, expanding body of knowledge, covering ever new domain of experiences. So the teaching of science should be so planned that it enables students to examine and analyze everyday experiences. More so at secondary stage where students should be learning science as a composite discipline and for doing this, first teachers should be trained. This is also recommended inNCF2005.It is also pointed out in NCF 2005 that teacher education programs today train teacher to adjust to a system in which education is seen as the transmission of information. (p.107) Teacher education must become more sensitive to the emerging demands from the school system, it mentions. More so far the teaching of science. So it recommends the in-service programs like refresher courses, seminars, workshops etc. for the teachers which can play significant role in the professional growth of teachers and function as an agent in school related practices.(p111).But before this some training material should be prepared in advance on which the above program can be organized and the material thus prepared can be distributed to science teachers. This training package should employ a constructivist approach to learning and teaching using five phases, known as the 5Es (Engage, Explore, Explain, Elaborate and Evaluate). The ***Engage*** phase aims at promoting interest and motivation. During this phase the emphasis is on activities to arouse curiosity, puzzle students and raise questions for further investigation. The ***Explore*** phase provides students with practical experiences. During this phase students continue to raise questions, listen to the views of others and begin to investigate different phenomena. Students are encouraged to express and share views while value judgments about views are suspended. In the***Explain*** phase students explain their findings to others and theirideas are subjected to greater scrutiny. During this phase, the teacher introduces relevant scientific explanations. By the end of the explain phase

students should develop greater understanding of phenomena under investigation. The emphasis in ***Elaborate Phase*** is on students applying their new understandings, developed during previous phases, to a range of familiar and unfamiliarsituations. During this phase, students can see how fruitful their new ideas are. This phase is important as it allows students to see how well their ideas work in a range of contexts. The ***Evaluate*** phase is the final phase. Here students' understanding is assessed formally and students are encouraged to reflect on and question the ideas which they have developed. Each lesson taught involves aspects of each phase, and each phase should be evident in the planning and implementation of the unit as a whole.

CONSTRUCTIVISM – A TEACHING APPROACH

Piaget was the first major constructivist. He emphasized on involvement of children through activities to achieve cognitive development. On the basis of extensive researcheshe identified four stages of cognitivedevelopment:

1.	Sensory motor stage	:	0-2 years
2.	Pre –operational stage	:	2-7 years
3.	Concrete operational stage	:	7-11 years
4.	Formal operational stage	:	11 years onwards

Apart from the identification and sequence of the stages of cognitive development, Piaget underlined that activities conducted by children are major means of learning and meaningful learning does not take place through oral communication. Therefore, inclusion of activities that provide opportunity to operate upon concrete objects enhances quality of learning. Secondly, Social interaction among children also helps to understand others' point of views. Though approximate age of attaining different stages of cognitive development have been mentioned earlier. These are tentative and cognitive development could be accelerated by including various cognitive activities.

Vygotsky was another person who contributed to the understanding of cognitive development. He emphasized on socio-cultural perspective in learning. The traditional classroom teaching is based on 'blank-slate' model and positivist view of learning. The blank-slate model assumesthat,

- Students come to the class with blank mind-slate and anything can be inscribed onit.
- The knowledge is with the teacher, propagated by him/her and is received, interpreted and assimilated by the student in the same form without any distortions,and
- A good lecture therefore, coupled with-some demonstrations, etc. is a sure method to improve efficacy ofteaching.

The positivist view of learning assumes that it is possible to study an object or phenomenon objectively and arrive at the 'universal truth' unaffected by previous ideas or beliefs. Through logic, mathematical applications and objective experience one could discover the reality. As a counteract to this, constructivist view of learning assumes that knowledge is constructed through experience, is continually refined in view of new observations and does not exist independently of human experience. The brain is an active agent which continually draws interpretation on the basis of information received by it. The brain is assumed to be selective in receiving information while it ignore so the information's which it considers as useless for its purpose. The mental constructs are mental models which are continually tested against the new experiences and modified, if need be. In this way the prior experiences, beliefs and emotions affect the individual's perception and interpretation of events. The important features of

constructivist model of learning could thus be statedas,

- Knowledge acquisition is a constructive or generative process and each student's knowledge is personal oridiosyncratic.
- Misconceptions may originate as a result of students interaction / experience with the real world and / or because of his/her misinterpretation of ideas presented tohim/her.
- The process of concept formation is a continuous process of successive approximations andrefinement.
- Due to their different conceptual ecologies, different learners can interpret the same new experience / idea differently in their conceptual structures /frameworks.
- Development of alternative frameworks or misconceptions is from the same mechanism that leads to the development of conception. In addition, some modes and sequences of presenting information during teaching may result into development ofmisconception.
- Students hold intuitive ideas that are both stable and identifiable and have enough commonality to make it worth using in planning instructional strategies.

In the context of constructivist approach, student's errors are recognized as a part of developmental phenomenon and not due to misunderstanding of the concept. The constructivist philosophy regards high epistemological status to individual's personal conceptions. It considers 'error' as a natural developmental stage, rather than the cognitive deficiency, inadequate learning, carelessness on the part of student and poor teaching.

Nature of student's ideas

From the large number of studies, some common features of student's ideas have been observed. These are:

- Ideas are stable and do not change easily despite teachers tutoring them to the contrary in the instructions in the school. Sometimes they seem to change, but students retrograde to the earlier ideas when they encounter new / difficultsituation.
- The ideas are context specific and may not be applied in another scientifically similar situation. They lack generality and have limited application.
- Many ideas are developed prior to teaching. When children come to the classroom, and are provided with different scientific ideas, children either (i) modify the previous view-points (ii) possess two ideas, one for the classroom and the other for personal feelings and interpretate in a compartmentalized manner, or (iii) discard the original idea and adopt the scientificexplanation.
- Ideas are personal. Some experience may have different implications for different students due to their varied conceptual ecology. Thus what they internalize and remember is different. This does not mean that many children do not have common

ideas. For example, some commonly held misconceptionsare:

- If a body is not moving, there is no force acting on it.
- Half lens would make halfimage
- Sun inliving.

- Children's ideas do not have precise language. They may have similarity with-scientific theories rejected in thepast.

Teaching in View of Children's Ideas

In view of existing variety of concepts, which may not be in accordance with scientific ideas, it is necessary to adopt special strategies to bring out necessary conceptual change. For conceptual change the necessary conditionsare:

1. Learner must encounter such a situation which he is not able to understand using existing knowledge. Thereby producing dissatisfaction in thelearner.
2. Learner must come across some knowledge which is intelligible to him and seemsplausible.
3. The new knowledge helps learner to understand some new situations which were beyond his reachearlier.

Driver and Oldham has suggested constructivist teaching sequence consisting of five phases: 1. Orientation, 2. Elicitation of children's ideas, 3. restructuring of children's ideas through (i) clarification and exchange, (ii) exposure to conflict situation, (iii) constructions of new ideas and (iv) evaluation of new ideas, 4. Application of new idea and 5. Review of change in ideas and comparison with previously heldideas.

To reconstruct children's ideas various strategies could be used. These include demonstration, discussion, debate and experiment etc. In this context it is important to rememberthat,

- Conduction of activity in itself is not enough. It is the way it is done and meaning is made out of it isimportant.
- Analyzing student's response, it is important to see the reasoning given in aiming at theresponse.
- Scientific theories are not the unique result of scientific observations. Theories are constructs of humanintellect.
- Learner's construct meaning themselves and do not nearly repeat what is told tothem.
- Learners do not learn in unconnected bits but are able to see relationship with otherideas.
- Teacher understands that meaningful learning cannot take place without consideringpreconceptions.

Characteristics of Constructivist Classroom Environment

- Atmosphere is democratic and student's ideas are paid adequate attention.
- Students feel free to ask questions and raisedoubts.
- Students have autonomy and they are encouraged to takeinitiative.
- For learning raw data, primary sources and interactive material are used.
- Cognitive activities such as reflective thinking, prediction, creating hypothesis are extensivelyused.
- Misconceptions are not considered as mistakes but as point of views whichneedtobeexaminedandevaluatedbythelearnerhimself.
- Supports cooperativelearning.
- Activities are learner centered rather than teachercentered.

Science and Constructivism

The great achievement of the sciences, over the past three or four hundred years, has been to tell us important and interesting things about ourselves and the world in which we live. The sciences by no means tell us everything, or even the most important things we want to know about the world. But what science does, uniquely, is to offer a knowledge that can be relied upon for action. This reliable knowledge is much more than a compendium of things that happen to have been observed; it presents the world in novel and surprising guises, saying that things are in reality often not what they seem to be. Science tells us, for example, that diseases are carried by micro-organisms invisible to the naked eye; that heritable traits are carried by a chemical code, that all substances are made of tiny particles held together by forces which are electrical in nature. –

*Acting on the reliable knowledge which science has produced, scientists have developed a staggering variety of artefacts and products, ranging from electric motors to antibiotics, and from artificial satellites to genetically engineered insulin for treating diabetes, which have transformed our lives and lifestyles as compared with those of past generations. "***(Millar & Osborne 2000 S4.1)**

So thinking and working scientifically emphasizes an approach, which seeks to adopt some of the ways in which scientists construct and acquire knowledge.
Harlen (1996 p2) suggests that this narrow view of science is:

- Objective
- Capable of yielding ultimate truths;
- Proving things;
- Having a defined and unique subject matter;
- Having unique methods;
- Being value free.

Scientists need to be able to do certain things such as use equipment, measure effects and create tables and graphs. These are the mechanical skills a scientist needs to master to work scientifically. Popper (1963) classes this as the 'checkwork' side to science, which comes after the 'guesswork' side where ideas are created (Ross et al 2004).

A constructivist model of learning argues that individuals experience a dynamic interaction of sensory perceptions, memory of previous experience and cognitive processes, which shape our understanding. In this model individuals actively construct meaning in order to make sense of theworld around them.

Frequently these pre-scientific views drawn from common sense are old fashioned, naïve and incorrect even though the logic of development makes sense. For example a young child argues that "orange objects float". They relate this assertion to the orange armbands they use in the swimming pool. The class teacher needs to provide activities, which challenge this viewpoint, and enables a more scientific explanation to be constructed. Constructivist learning is based on student's active participation in problem solving and critical thinking. Learning is an active process in which learner's construct new ideas or concepts based upon their current ideas or past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. They are constructing their own knowledge by testing ideas and approaches based on their prior knowledge and experience, applying these to a new situation, and integrating the new knowledge gained with pre-existing intellectual constraints.

In constructivist thinking, the context, the beliefs, and the attitudes of the learner also affect learning. Learners are encouraged to invent their own solutions and to try out ideas and hypotheses. They are given the opportunity to build on prior knowledge.

People learn best when they actively construct their own understanding. Children are aided in constructing meaning in science through involvement with practical activities whether they are four and in a nursery or ten and in a year six class.

Learning by doing and forming ideas from exploration is the underlying theory behind psychological constructivism. The child is viewed like a scientist who possesses insights, questions, problem solving strategies and new ideas that will be used in experimentation. The scientific process of puzzling, probing, testing are incorporated into the approach. The child develops his picture or understanding of the physical world through manipulation and seeing relationships between objects and learning centrally determined names and labels for the ideas, items and activities involved through experience. Key to the theory is fostering independence in the child, not dependence on adults so that activities, curriculum, environment are based on risk-taking, self-direction, guided or totally free discovery type experimentation through social interaction and problem solving. The teacher acts as a facilitator of the educational context. The teacher provides opportunities for observation, interaction of students with each other and with

skills and values.

- Critical, creative and generative thinking has to be developed.

Improvisation should be encouraged but designing would also be provided as a component in exploration.

- Flexibility in experimentation needs to be widely promoted.
- Teachers could help the learners devise appropriate experimentation activities within and outside the school.

Research Questions/Hypotheses

1. Is there any effect of Constructivist Approach (CA) on Learning Achievement in Science of Secondary school children?
2. What are the various ways to examine the different dimension(s) of achievement in Science of Secondary school children?

Objectives of the Study

1. To study the effectiveness of Constructivist Approach (CA) through 5E Modelin Science in terms of achievement of secondary school students.
2. To examine analyse the different dimension(s) of achievement in Science of Secondary school children.

Delimitations

The study will be conducted under following constraints:

1. The 5E Model of Constructivist approach will be used for the teaching strategies.
2. The study will be conducted only at the Class IX level of secondary students.
3. Only NCERT Science textbooks will be considered for conducting the study.
4. The study will be conducted in the Government Schools of Bhopal.

Chapter- II

Review of Related Literature

The concept of constructivism has roots in classical antiquity, going back to Socrates's dialogues with his followers, in which he asked directed questions that led his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences but it became an emerging philosophy of 21st century. Jean Piaget, David Ausubel, Bruner and Lev Vygostky had very significant role in foundation of this philosophy. Jean Piaget, who is considered as a founder of individual constructivism, believed that learning is strongly influenced by learner's developmental stages. Later philosopher considered that knowledge is acquired through social interaction. Learner is subsequently move from definite stages of physical, intellectual, emotional and social development and each stage is associated with specific learning experiences which determine what learner can learn with those experiences and up to what extent. Dewey and later, Vygotsky, recognized that the construction of knowledge was rooted in group context (oxford, 1997). Vygotsky believed that learning is social in nature, which employs that learning occur via interaction with other people i.e., interaction among learners or peer group and also with teacher. During this interactive process, meaning is shared and information is exchanged and provides opportunity to learner to compare, examined and redefine his/her knowledge with knowledge and understanding of other group members. All these learning theory drastically change the concept of learner who was considered as "subject" by behaviorist psychologist into "active participant" of learning activity who can controlled their own learning by active meaning making process. Modern educators who have studied, written about, and practiced constructivist approaches to education include John D. Bransford , Ernst von Glasersfeld , Eleanor Duckworth , George Forman , Roger Schank , Jacqueline Grennon Brooks , and Martin G. Brooks.

Constructivist approach in teaching at all levels of school is needed because the conventional pedagogical practices of teaching emphasize learning of answers more than exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understanding the context, reading in lieu of doing i.e, not efficient to achieve the objectives of teaching science as prescribed in NCF-2005. The conventional teaching-learning methods used in schools especially in science classroom encourages the students to memorize knowledge generally in the form of laws, formulae or theories and enforces them to reproduce as such in the examination. Thus, there are very less scope for learner for insightful learning and develop skills like problem solving and reflective thinking. Learning in constructivism framework contributes to intellectual, social and psychological development of learners to transmit it in different context (Kim 2006). A constructivist classroom provides opportunities to observe, work, explore, interact, raise question enquiry and share their expectation to all (Kumar and

Gupta, 2009). Later in 2011, R.K. Nayak & H.K. Senapaty conducted a study to find out the effect of constructivist approach in fostering creativity of primary school children and found that this approach is more effective than traditional instruction in promoting creativity and enhancing interest of students in mathematics. As earlier knowledge is considered as objective and inert facts or information the epistemology of Constructivism is a different. According to this emerging philosophy knowledge is subjective, contextual and pluralistic in nature, which is actively constructed by the learner in meaning making process in their social and cultural context. Therefore, in constructive science classroom provide ample opportunities for the students to learn science as according to nature of science. M.Cakir also suggests that misconception among students can be resolved under constructivist approach. The constructivist approach had positive impact in improving the achievement in science, science process skills, and scientific attitude among VIII standard students (Sridevi, K.V., 2008). In fact traditional classroom also have constructive approach when it provide chance to students/learner to active participation in construction and reconstruction of knowledge. Dogra. B. (2010) discovered the different activities like concept mapping, T-chart etc. that can be used to design constructivist classroom for biology learning. He also emphasized that group discussion and brain storming play a significant role in constructivist classes. From discussion of above mentioned findings of researches (Miha Lee 2006, Dogra. B. 2010, Sridevi, K.V. 2008,R.K. Nayak & H.K. Senapaty2009) it can be infer that constructivism has very significant positive role in pedagogy of science teaching which can develop problem solving abilities, critical and reflective thinking, promoting creativity and scientific attitude among the students.

Studies comparing learner achievement in constructivist classrooms and conventional classrooms have indicated better results in favour of the constructivist learning. In a study conducted by Becker and Maunsaiyat (2004), constructivist-instructed students had higher scores on the post-test and the delayed post-test, compared to those of the traditionally instructed students. This finding showed that the mode of instruction could greatly influence learner achievement. In another study conducted by Akar (2003), there were no statistically significant differences in learner achievement in short structured questions between the constructivist-instructed students and the conventionally instructed students. However, the study found a statistically significant difference in the learner achievements knowledge retention and essay type questions between the constructivist and conventional groups. In the study, the constructivist-instructed students best retained knowledge in achievement test as compared to those instructed through the conventional methods. The constructivist-instructed students equally performed better in essay type questions.

CHAPTER – III

Model Lesson Plan for Tissues based on 5E Model

Chapter III

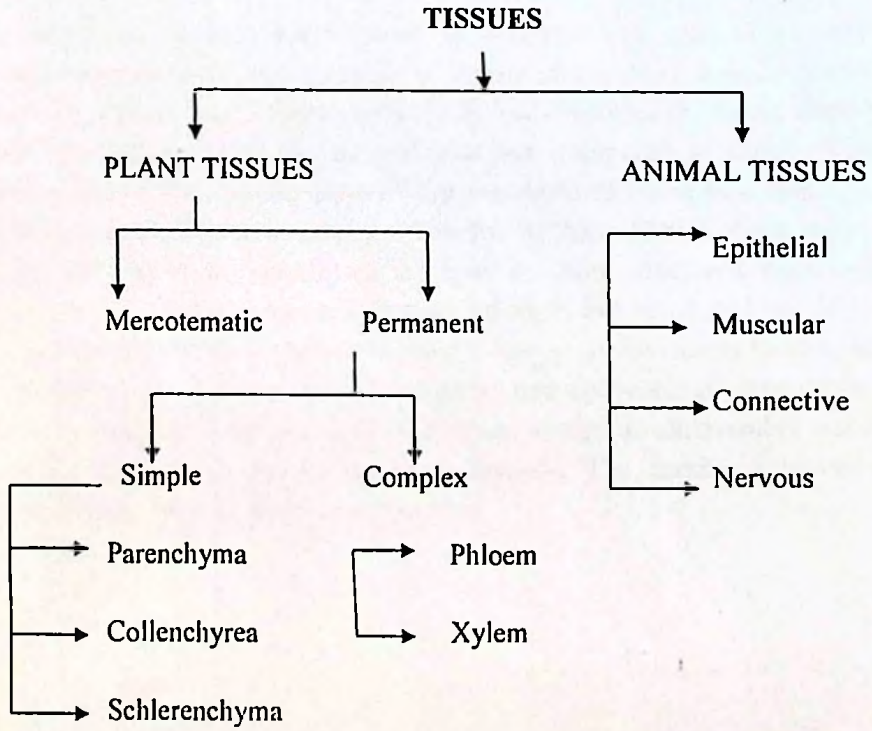
Tissues

Introduction – The chapter will be introduced by taking examples of daily life such as at home or to set up a stall in a school fate. How do the students divide their work and what is the criteria. In the same way each member of a family has a different task so that the family runs as a whole unit. This can be compared with the multicellular organisms where such division of labour is seen. In a multicellular organism cells do not work individually but make a group to perform some specific function. Such a group is known as tissue.

Since plants and animals have different body structures and also perform different functions, therefore the tissues present in there will also be different. For eg animals have muscular tissue as it has to move but plants do not have them. More such examples can be asked from the students.

Key Concepts-plant cell, plant tissues, meristematic and permanent tissues.

Learning Concept-Cell is a structural and functional unit of a plant body. Meristematic tissue is basically responsible for growing a plant in length and girth. Different tissues perform different functions.



PRIOR KNOWLEDGE:- The students already leave the concepts of structure and functions of cells and also of unicelluarity and multicellularity.

TRANSACTIONALL STRATEGIES – The lesson may be started with the help of an activity in which the students will be divided into separate groups and will be given different small herbs (along with roots).

ENGAGE- The teacher will ask them to observe the plant and answer the following questions.

1. In which parts they can see growth in the form of new leaflets and roots?
2. Do they see any change in the girth of the stem in any portion?
3. This observation can be made by using various different herbs of different size)
4. Is the growth restricted to a particular area or is seen every where in the plant.
5. By getting the answers the teacher can explain that the parts of plants where growth take

Place is meristematic tissue and the parts where growth does not take place has permanent tissue.

Based on the observations made the teacher will explain the concept of apical; lateral and intercalary meristem on the basis of their location.

EXPLORE: Activity 6.1 of page 69 of NCERT, will be given to perform by the students in groups. They can also be asked to observe the difference in growth of onion bulbs f different size is taken.

The teacher will explain that the places where growth does not take place the cells have changed to permanent tissue and have lost the ability to divide.

Activity – The students will be given various parts of plants such as tender shoots; thick shoots, nuts, fruits, leaves, woody parts and after observing ans. the following questions –

a. Which parts are flexible?
b. Which parts are green ? and non-green?
c. Which parts are hard or soft to touch?
d. Which parts are easily broken?

On the basis of the answers and discussion the concept of various types of simple permanent tissues and their functions will be given. For eg-

- The soft parts have parendymattions tissue which are green.
- The hard parts such as nuts, woodyparts have Scherenchyura which have mechanical strength and are difficult to break.

Activity – The students are asked to observe a leaf in which the parts such as veins & midribs are to be observed carefully as they have the complex permanent tissues xylem & phloem. This can be explained further by a permanent slide / ICT.

The teacher will give an idea that different issues are organized in different ways to form various tissue systems which the help of the activity (8.2) given on page No. 70

(i) Epidermal Tissue System – makes the outermost protective layer in each part of the plant. Different components of epidermal tissue system can be explained by activity 6.3 of page 72 of the NCERT Text-book.

(ii) Vascular tissue system – consisting of the vascular bundles including xylem, phloem and cambium (lateral meristem).

iii) The teacher should also explain the concept of secondary growth which takes place with the help of cambium and how is bark formed.

ANIMAL TISSUES

The teacher may ask the students to observe their own body parts and see that they are made of various tissues such as epithelial, muscular, connective and nervous. And discusses the following questions-

1. Why layer will make the outermost part?
2. What will happen if your friend pinches you why?
3. What do you observe when you have a cut in any part of your body?
4. Can you move your body parts? Why?

The same tissues help in the formation of internal organ also.

Activity – Permanent slides and ICT may be used to observe the different types of tissue

As we know there are various forms of organisms - some are single celled and others are many celled. The teacher will ask the students to think of multi-cellular organisms, what are different types of cells in the organism, are they all alike? and perform similar or different functions?

EXPLAIN (Group wise presentation):

The students will present their findings group wise and discussion will be carried out on the points presented.

Following points may come out in different groups:

Group-I

(i) Plants are made up of different parts and each part has its specific functions like leaf, stem, root etc.

(ii) Each part a microscope made up of cells examined minutely.

(iii) The cells are of various shapes and sizes.

Group-II

(i) Coloured water roses in the upward direction as seen from the stem.

(ii) If a section of stem is cut with a blade and observed carefully, only some cells are found to be coloured.

Group-III

(i) The cells as shown in the chart in the stem tip and root tip are of different size and shape.

(ii) These cells appear to be of uniform size and with their walls.

Group-IV

(i) The cells re of different sizes, and with varying thickness of cell walls.

(ii) Some cells are with thin cell walls, some with very thick all walls and others with thickenings t the corners.

ELABORATE:

While the presentations are made by the groups, the teacher would elaborate the points introducing the formal terms like-

- What is a tissue?
- What are different types of tissues giving examples of plant tissues and animal tissues?

The teacher can also put questions during the presentations like:

- What are the functions of tuber and the buds present on it?
- How does the growth (increase in length and girth of stem and root) occurs?
- Why the cell walls have different thickenings?
- How structure of group of cells is related to the function performed?

On the basis of the answers given by the students, the teacher introduced the term tissue: A group of cells that are similar in structure and work together to achieve a particular function. Then a comparison can be made between the life of a plant and that of an animal (like pattern of growth, movement etc) and with reference to these differences elaboration can be made on types of plant and animal tissues.

EVALUATION: The evaluation of students is to be conducted in all the above stages. However, at the end some short questions can be asked like;

1. What is a tissue?
2. What are different type's plant and animal tissues?
3. What is the function of meristematic tissues and where are they found?
4. Which tissues are responsible for conduction of water in plants?
   Questions based on diagrams with labeling omitted can be asked?
5. Prepare a cross word puzzle on
   (a) Plant tissue (b) Animal tissue
6. Choice questions can Multiple be made.

CHAPTER – IV

Model Lesson Plan for Diversity in Living Organisms based on 5E Model

Chapter IV

Diversity in Living Organisms

Introduction:

Diversity in Living organisms or biodiversity is often defined as the variety of all forms of life exist on earth. One should know that diversity found on earth today is the result of 3.5 billion years of evolution. There are about 1.75 million species in India and out of these the number of known species is 7.7% (1,34,781). Global species diversity vary from 2 million to 100 million species. It is difficult to study such a huge variety or organisms. So it becomes essential to arrange them in same way under different categories.

- Importance of classification of organisms.
- Basis of classification – Plantea and Animalia.
- Classification and Evolution.
- Fundamental differences between Plant and animal.
- Hierarchy of classification groups (Five kingdom classification).
- Outline classification of Plantae (Plant Kingdom) and Animalia (Animal Kingdom)

Prior Knowledge Required:

1. Basic information of Plants and Animals.
2. Differences between Plant cell and Animals cell.
3. Procaryotic and Eucaryotic cells.
4. Autotrophs and Heterotrophs.

Transaction/Instructional Strategies

ENGAGE:

Activity I: Arrange field trip to nearby field/Park/garden200 etc. Ask the students to note down the local names of various plants and animals found in these locations.

After the visit –

- Plants may be grouped as herbs, shrubs, trees, Creepers, climbers etc.
- Animals may be groups as aquatic, terrestrial and aerial.

ICT. Show the photographs of other plants and animals of the same category find in peoples locality.

EXPLORE.

Teacher may ask questions to students and discuss classification.

Like – on what basis you have put animals and plants in separate groups?

Discussion lead to the following conclusion –

- Plants and Animals may be classified or grouped on the basis of their habitat/ environment.
- Autotrophs and Heterotrophs

EXPLAIN

Basis of classification –

- Habitat – only is not an appropriate way of making groups of organisms to study and think about.
- Single cell to multicellular – Division of Labour.
- Therefore characteristics (Animals and Plants) to be used as the basis for classification or making sub-groups.
- Similarity and dissimilarities.
- Think about – basic fundamental Character.

Insects	Cow	
Animals		Snake
Fish	Frog	Bird

- Unicellular - Multicellular
- Prokaryotic - Eucaryotic
- Mode of nutrition : Autotrophs (green plants) or Heterotrophs (Animals)

Importance of classification:

1. Characteristics help us in developing the hierarchy.
2. Facilitates us to study a wide variety of organisms.
3. Projects a picture of all life forms at a glance.
4. Evolutionary relationship between different groups of organisms.

Evolution (Descent with modification)

↓

Changes in body characters to survive better

in different environment

(New species – speciation)

Hot Spots,

(Rich biodiversity of peculiar species)

Megadiversity

The Hierarchy of classification

- Broad category - Kingdom
- Whittaker (1959) proposed five kingdoms.
- Momera, Protista, Fungi, Plantae, and Animalia.

(Important characters should be described)

- Levels of classification.
- Kingdom
- Phylum (animals)/Division (Plants)

Class

Order

Family

Henus

Species.

- Thus, we arrive at the basic unit of classification i.e. species.

EXPLORE-

Teacher will explain –

- Species includes all organisms that are similar and breed together.

Five Kingdom (Whittaker 1959)

Monera

Photo

Protista	Fungi	Plantae	Animalia
(Ph)	(Ph)	(Ph)	(Ph)

Animalia

Invertebrate or Non chordates (Absence) column

Chordates Presence of vertebral

Lower Invertebrate Phylum

Higher Invertebrate Phylum

1. Protozoa
   e.g. Amoeba
2. Porifera
   eg. Sycon
3. Coelenterata
   eg. Obelia
5. Platyhelminthes
   Eg. Taenia
6. Annelida
   eg. Earthworm
7. Arthropods
   eg. Coakroach
8. Mollusca
   eg. Octopus
9. Echinodermata
   eg. Star fish

Protochordata
eg. balanoglossus

Vertebrata

Fish Amphibia Reptilis birds

Photographs of all examples

- Teacher will explain all phylum and their evolutionary relationship.

Other information's:

1. Three layer concept (Embryonic layers)  Ecto, Micro, Endodern
2. Organization
3. Symmetry
4. Notochord vs vertebral column

- Binomial Nomenclature with certain examples of domestic animals.
  Eg. Dog, Cat (Fetis domuticus) cow etc.

- Translocation, Fruit, flower & Seeds.

1. Thallophyta 2. Gymnosperm 3. Bryophytes 4. Pteridophytes

Photographs of all form
6.Angiosperm belong to different categories

EVALUATION

1. What do you understand by diversity of life?
2. What is the objectives lof classification?
3. How plants differs from animals?
4. Give the examples of protozoa.
5. Which protogoan causes malaria?
6. Why earthworms lare regarded as plant farmer's friends
7. Name one oviparous mammal
8. Name one group of reptiles in which females give birth to the young ones
9. What is bionomial nomenclature?
10. Give, three major differences between Non chordate and chordate.

Chapter V

Model Lesson Plan for Structure of atom based on 5E Model

(ii) An atom is the smallest particle of the element that can exist independently and retain all its chemical properties.

(iii) A chemical formula of a compound shows its constituent and the number of atoms of each combining element.

(iv) Valency of each element determines the formula of a compound.

Instructional Strategy:-

Development of Concepts through Activities:-

Concept: Matter is electrical in nature:-

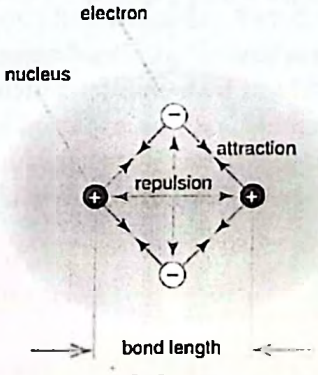
ENGAGE

Activity 1:-

Take a balloon and fill it with air blown through your mouth. Now rub the ballon with your coat, silken or terylene shirt. Bring it near the wall. It is attracted by the wall. Now let us extend this activity further. Take two balloons and fill air in both. Suspend these with the help of thread. Bring the two balloons nearer to each other. You will notice that the balloons can get close to each other (why?). Rub the two balloons with your coast, silken or terylene shirt. Suspend them and again bring them nearer to each other. The balloons move apart. Why do they repel each other? Have you every noticed this phenomenon in your daily life? A few such examples are given below:

1. As you take out your silken or terylene shirt from your body the hair of your arm get erected because of repulsion.
2. When you comb your hair while they are dry, they also get erected because of repulsion.

This property of attraction and repulsion results on account of electrical charge present in matter. Since coat, silken shirt, terylene shirt, wall, balloons, comb and hair are different varieties of matter, you have reason to believe that matter is electrical in nature.



Could you guess what different types of charges are associated with matter?

Concept 2: Atom is composed of electrons, protons and neutrons.

In the activity discussed above you have experienced that matter is electrical in nature. You have studies electrical discharge through gases. Before proceeding further you must answer the

following queries which will help you in generalizing the fact that atoms are composed of electrons, protons and neutrons.

What type of charges is associated with matter?
How are the electrons emitted in radio valve?
Why do only certain radiations when interact with the metal surface, produce electrons and not all?
Way the e/m ratio for the positive particle in the case of hydrogen is found to be the highest?
What relationship does exist between the number of negative and positive particles in an atom?

Concept 3- Model for an atom – arrangement of electrons, protons and neutrons in an atom.

This concept is being taken as an illustration as to how you will teach this concept in the class. On the basis of our knowledge that atom is electrically neutral following models may be proposed, to account for the arrangement of electrons and protons in an atom:

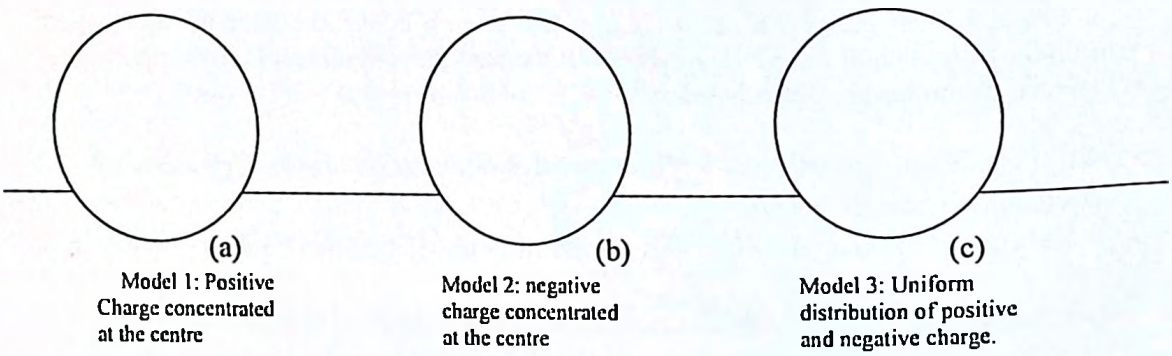
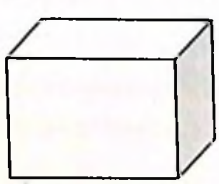


Fig. 18.1. Various models for the atom.

Activity 2:-Matching Experimental Observations with proposed Models

At this stage you will inform pupils about the Rutherford experiment. The Rutherford experiment involved bombardment of thin gold foil by α- particles. The- particles needed for the purpose was obtained from the radioactive element, radium enclosed in a cavity made on a lead block. To detect the- particles coming out the gold foil. Rutherford made use of zinc sulphide screen. With the help of a chart showing Rutherford *experiment explain scattering of α particle to the pupils.*



Now list out the Rutherford's observations as follows:

(i) Most of the alpha particles pass through the thin gold foil undeflected.
(ii) Some alpha particles are deflected at fairly large angles.
(iii) Very few alpha particles are rebounded back along their path at 180°.

In view of the Rutherford observations you many now discuss that if model 3 which in fact is Thomson model) which may be given the analogy of a 'watermelon' where seeds may be regarded as the negative charge uniformly distributed in the reddish material regarded as positive charge) were true then what do you think should be our observations when α – particles bombard the metal foil? The answer perhaps may be that most of the – particles will suffer uniform deflection and this deflection will be very small. Now the question arises: Is this model acceptable to us? Pupils will decline to accept it because it is not in agreement with the experimental observations. Next ask your pupils: Can model 2 answer the observations recorded by Rutherford? Students might tell that if it were the model of the atom then no α- particles would have been deflected back along their path at 180° and therefore this model also cannot be acceptable. On the basis of logical arguments pupils will accept that model 1 only matches the Rutherford observations and so the gold foil atom structure used by Rutherford must resemble model 3.

EXPLORE

Now with the help of observations recorded by Rutherford and through discussion impress upon the pupils that each observation leads to an independent conclusion, as given below:

1. Since most of the- particles pass through the foil unaffected, it looks as if the atom were mostly empty space.
2. Since only a few α – particles are scattered through very large angles the positive fragment of the atom occupies a very small volume of the entire atom.
3. A deflection of 180° indicates that there is an intense electric field inside the atoms since a positive charge spread over total volume of atom will be incapable of producing such a field.

Therefore, it is concluded that total positive charge is in the centre of the atom.

This central positively charged massive body of the atom is called nucleus and electrons revolve around the nucleus in the empty space.

Can you draw a picture of the structure of helium atom?

EXPLAIN.

Based on experimental observations, Rutherford postulated that the atom consists of positively charged nucleus, containing practically all the mass surrounded by electrons whose number is equal to positive charge present in nucleus. In revolving around the nucleus, such a model bears

an analogy to our solar system where the earth is revolving around the nucleus. Can you imagine what would have happened if electrons were stationary? In comparing the Rutherford model with solar system there is one difficulty. An electron is a charged particle and any charged particle following circular trajectory must emit radiations. Now, if the electron following the circular trajectory continuously emits radiations them it must fall into the nucleus. Such a situation renders an atom as unstable whereas our experience is that atoms are stable. The second important experimental finding was that of 'line spectrum' of the elements which in fact could not be explained by Rutherford model.

To overcome the objections to the Rutherford model and also to explain the *spectrum of atomic hydrogen*, Bohr made a revolutionary suggestion that an electron could revolve around the nucleus only in certain specified circular pattern called 'orbit' without emitting or absorbing any energy. This suggestion along with other assumptions are given in the form of following postulates:

1. An atom has a number of stable circular orbits of a definite energy, or 'stationery energy states" in which an electron moves about the central nucleus (proton) without the emission of radiant energy.
2. When an electron makes a jump from one of its non-radiating orbits to another of lower energy, radiations are emitted whose energy equals the energy difference between the initial and final states and whose frequency is given by the relation

$\Delta E = h\upsilon = E_2 - E_1$ or $\upsilon = \frac{E_2 - E_1}{h?}$ where 'h' is Planck's constant and E_2 and E_1 are the Higher and lower non-radiating energy states. This second postulate makes use of the fact that radiant energy is emitted or absorbed in terms of discrete units called quantum (Planck's quantum theory).

3. The angular momentum of an electron following a circular path must be an integral multiple of $h/2\pi$

At this stage before proceeding ahead, answer the following questions.

(a) Can you explain the presence of so many lines in the hydrogen spectrum, even though hydrogen contains only one electron?
(b) Are you now in a stage when you can explain the colour imparted to the flame by various elements as their chlorides when they are heated in Bunsen flame?

Subsequent investigations on the Bohr model led to the following shortcomings:

1. The model does not account for the sharp spectral lines obtained in the case of hydrogen.
2. It is inadequate for multi-electron atoms. (Bohr Theory does not take adequate account of the repulsion between electrons).

3. There is no satisfactory solution to the problem as to why only such orbits are permitted as the on-radiating ones for which the angular momentum is an integral multiple of $h/2\pi$
4. The model fails to answer the question: why do atoms combine to form molecules?

Wave nature of matter:-

Bohr's theory was eventually replaced by a new way of viewing the atoms, called quantum mechanics or wave mechanics. As you still see, the concept of quantized energy states introduced by Bohr remains, but in addition application of Planck's quantum theory enters the picture.

The central idea in the modern theory of atomic structure is that any moving particle and for that reason electron also is associated with wave properties. The solution to the problem of model for an atom is highly mathematical and therefore you would study some of the qualitative ideas only, de-Broglie suggested that particles which come under microscopic category should behave somewhat similar to photons. Therefore he assumed that electron following a circular trajectory carried by means of waves that are propagated in space according to the laws similar to those obeyed by light waves. The wavelength associated with the electron of mass on moving with velocity v, following a circular path is given by the expression:

$$\lambda = \frac{h}{mv} \qquad \text{.....(1)}$$

Where λ is the wavelength and is Plank's constant. Now if the electron is associated with a wave and follows a circular path then the circumference of the circle must be an integral multiple of the wavelength. If r is the radius of the circle, the expression will be

$$n\lambda = 2\pi r \qquad \text{.....(2)}$$

Where, n – 1, 2, 3 .....

Expressions (1) and (2) clubbed together lead us to

$$Mvr = n\ \frac{h}{2\pi}$$

D-Broglie's idea of matter waves has been verified by Davisson and Germer who discovered that a beam of electrons is diffracted from a crystal lattice in the same manner as a beam of X-rays.

What additional evidence therefore we get regarding the nature of electrons from the Davison and Germer experiment?

The idea of matter waves put forth by de-Broglie gave birth to another fundamental principle known as Heisenberg's uncertainly principle which is very much evident in the case of microscopic particle. According to this principle, the position as well as momentum of an electron cannot be determined simultaneously. If the probability for the determination of momentum is high then the probability for the determination of position is small. Following these two ideas, E. Schrodinger developed an equation for the propagation of electron waves. The physical significance of this equation is that that it counts for electron distribution in space as well as the allowed energy levels for its moving in an atom. In terms of this equation the electron is considered to be disposed around the nucleus in the form of cloud and we only talk of the probability of an electron being found at a particular instant as it moves around the nucleus.

Now if we talk of the probability picture then probability at a certain distance from the nucleus may be high and that for others it may be low. The region around the *nucleus where the probability of locating an electron is maximum is called orbital.*

A large number of electron orbital's are possible in an atom. Orbital's can be distinguished in a qualitative manner by their size, shape and orientation. An orbital of small size means there is more chance of finding the electrons near the nucleus. Similarly, shape and orientation mean that electron distribution has more probability along certain directions and less along certain others.

ELABORATE

Methodology related to development of concepts:-

The development of the concept I mentioned earlier is taken as an example for you to teach in the class. This can be regarded as the activity that each student can perform in the class. You may get the instructions given here cyclostyled and distribute them to each student along with the requisite material. Divide the pupils into groups if you feel it necessary. The pupils may be asked to record their observations for each part of the activity in their notebook. The following questions based on the student's observation may emerge for discussion:

(i) Why the balloon gets stuck up to the wall when it is rubbed with silken r or terylene cloth?

(ii) When the experimentation is tried with two balloons, why do they repel each other?

Thereafter you should recall the Coulomb's law and induction phenomenon and bring them home through generalization that matter is electrical in nature. Also try to correlate the activity performed with the everyday experiences.

The method suggested here is known as ***activity method.*** The method used for teaching concept 3 is the lecture method. While adopting the lecture method you must make use of teaching aids, model, chart etc. at the appropriate places of your instruction as suggested in the development of this concept. You should follow a suitable sequencing of content which provides an inherent methodology and involve the pupils by frequently asking them questions. All important

conclusions should emerge out of discussion only. Although it was not a practical approach yet the sequencing of the content highlights two important steps of scientific method, which are:

1. Making hypothesis regarding the models for an atom.
2. Testing hypothesis, which of course has been done here on the basis of logical arguments?

Misconceptions to be Handled by the Teacher:-

1. The electrons revolve around the nucleus in well defined orbits.
2. An atom of the element always shows fixed valency.

EVALUATION:-

1. The number of positive charges in an atom is equal to:

(a) the atomic mass of the atom;
(b) the valence of the atom:
(c) the number of neutrons in the atom;
(d) The atomic number of the atom.

2. The atomic mass of an element is 37 and the atomic number is 17, the number of electrons evolving around the nucleus would be:
   (a) 20 (b) 37 (c) 17 (d) 54
3. On directing a stream of energetic α – particle at an extremely thin piece of gold foil, what would you expect to find?

   (a) All the α – particles absorbed
   (b) All the – particles transmitted with only small deflection.
   (c) Few α – particles transmitted with only small deflection and some of them scattered through large angles.
   (d) All α – particles scattered through large angles.

4. List out all species that are iso electronic with Na^+ ion.
5. Identify that salt amongst the following in which cation and anion both are isoelectronic to each other.

   (a) KF (b) KCl (c) NaCl (d) LiF

6. Take 20 mL of water in a test tube and add to it a piece of sodium approximately 0.5g in mass and record your observations. Now answer the following questions.

   (i) In what different ways, you can establish that a chemical reaction has occurred here?
   (ii) Can a solvent other than water be used to carryout this reaction?
   (iii) Would potassium react with a more or less vigour and why?
   (iv) How is the change taking place related to structure of sodium and potassium?

7. Prepare a chart/poster to show the utility of following isotopes:-

^{235}U ^{238}U ^{14}C, ^{18}O and ^{128}I

The teacher may design suitable strategy to evaluate the chart/poster.

8. Which of the following is NOT one electron system?

(a) He^{+} (b) Le^{2+} (c) H^{-} (d) H

9. Consider the element oxygen. Suggest a list of binary compounds (compounds of two elements only) that oxygen forms with the following elements:-

N, P, S

If valency of oxygen is taken 2, then spell out the valency of nitrogen, phosphorus and sulphur in the compounds suggested by you. Do elements always show fixed covalency?

Justify the formation of Cl_2O_7 linked to the electronic configuration of chlorine.

10. Nucleons are present in the nucleus. How is the concept of nucleolus related to:-

(a) Isotopes (b) Isobars (c) Isotones?

Chapter VI

Model Lesson Plan for Natural Resources based on 5E Model

Chapter – VI

Natural Resources

Subject-Science

Topic- natural resources

Learning aspects:

- Plants resources
- Soil resources
- Water resources
- Renewable resources
- Non renewable resources

Learning objectives:

1. To make students understand natural recourses.
2. What are the types of natural recourses?

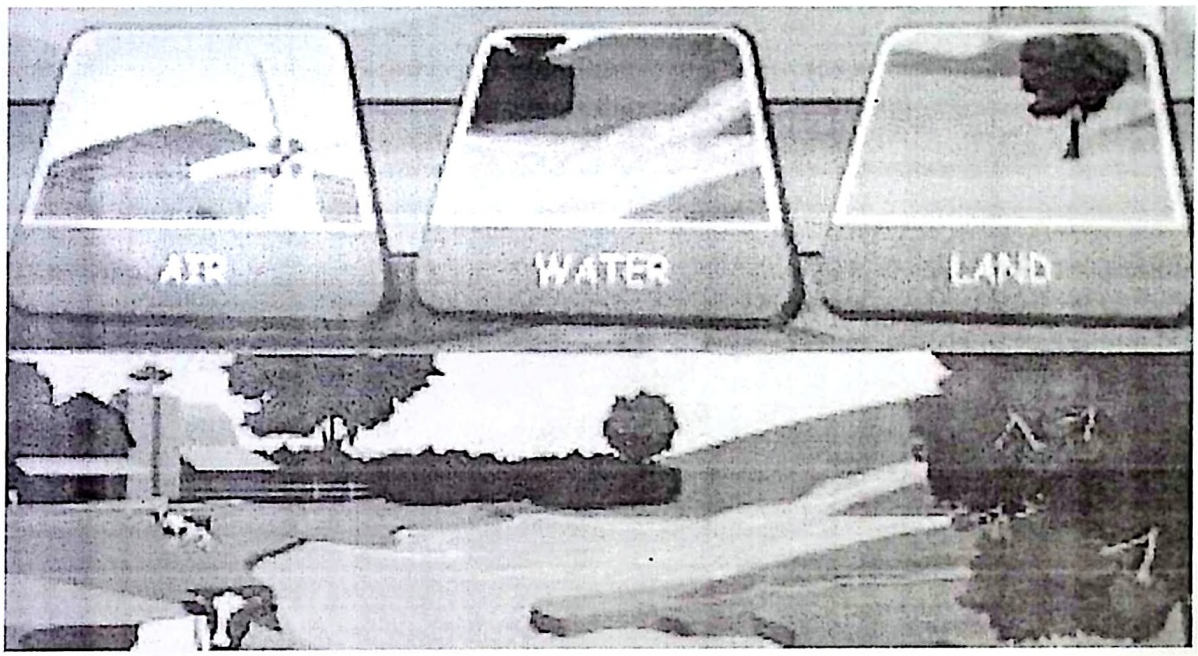
Process skills:

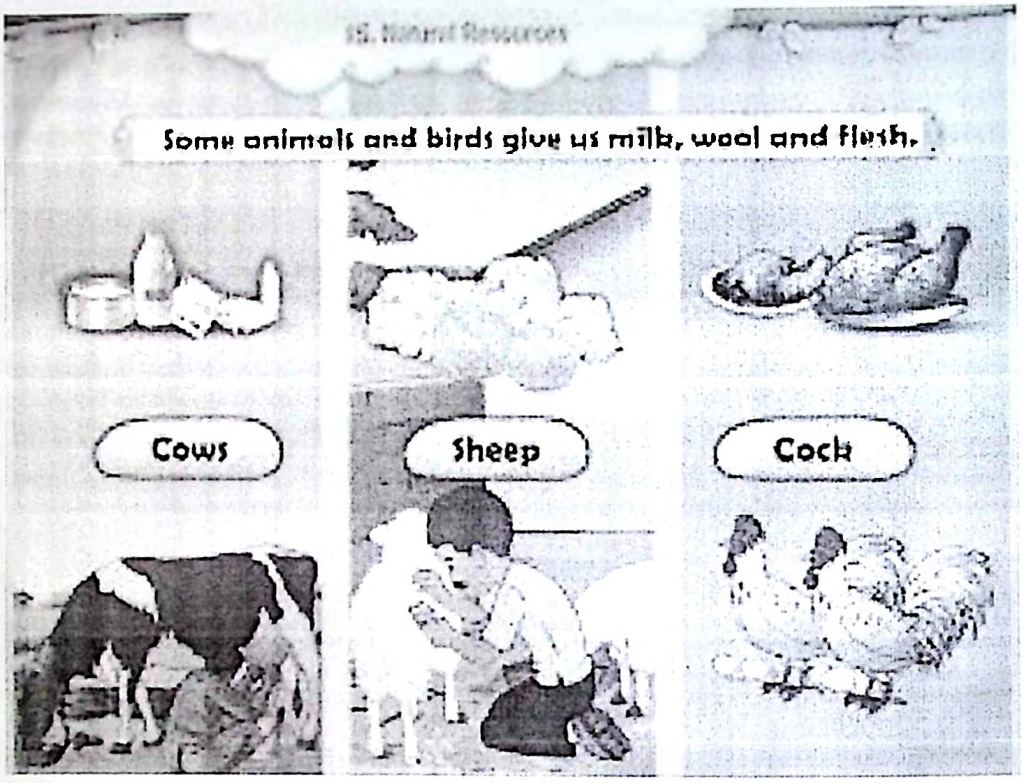
- Observation
- Practically doing
- Demonstration
- Reasoning
- Argumentation
- Problem solving
- Logical thinking
- Reflecting

Learning recourses

- Chart
- Animation
- Power point
- Play way
- Song
- **ENGAGE**

Photographs and video clips of natural resources should be shown to the students in group of 05.give them 05 minute to discuss the topic among them.





EXPLORE

Facilitator will start *(15 minutes)*

- To begin the lesson, ask your students to tell you the first thing they think of when they hear each of these words: plant, water, soil.
- Ask your class is anyone knows what a natural resource is. Encourage your students to make educated guesses.
- Ask the students to write down what they observed from the photos and video clips

- Write the words plants, soil, and water on the board. Explain that these are the three main types of natural resources.
- Start a class discussion about the importance of plants. Great questions include: *Why are plants important? Could we live without plants? How do plants help us stay alive? How do plants help animals?*
- Explain that plants provide us with food, oxygen to help us breathe, and protection through homes and fire. Plants make and protect soil, feed animals, shelter animals, and are used to make clothes and many medicines.

EXPLAIN

- Ask your students about the importance of soil. Great discussion questions include: *What is soil? Why is it important? What would our lives be like without soil? Could we live without it? Why or why not?*
- Share that soil contains important nutrients that plants and humans need to stay alive. Soil also helps plants retain the moisture they need to grow and thrive.
- Finally, ask your students about the importance of water. Suggested questions include: *Could we live without water? What about plants and animals? How long could someone survive without water?*
- Explain that water is the most essential natural resource that the Earth gives us, and those plants, animals, and people would die without it.:

ELABORATE

Facilitator –groups of students are provided with materials consists of many things like plants, minerals, soils, image of animals, water, artificial things like plastic etc.

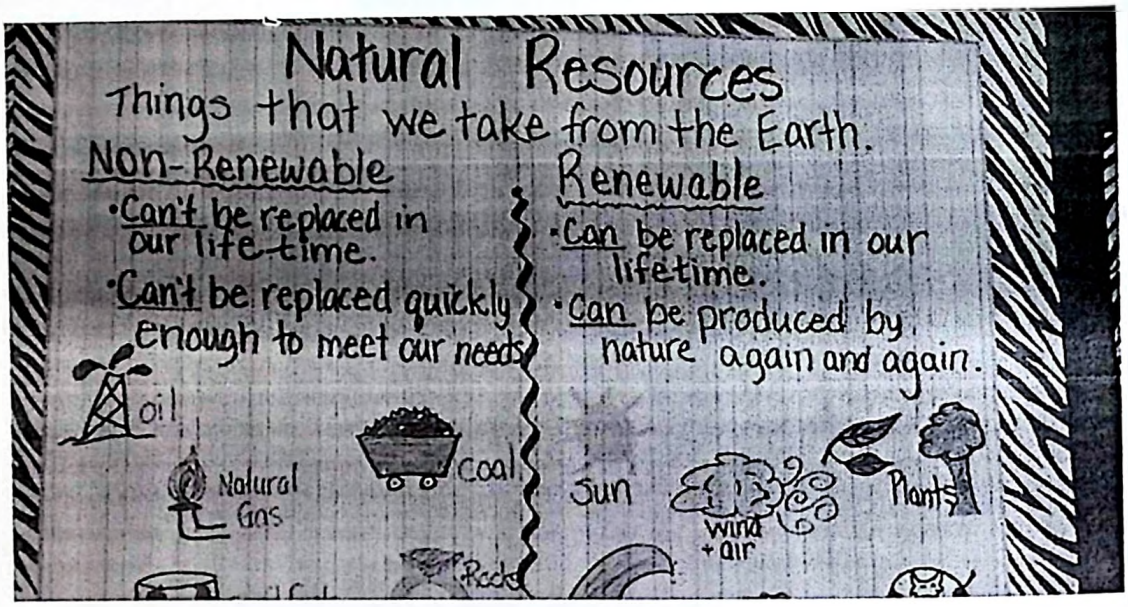
Evaluation -

1. They are asked to pick natural resources from the given things and separate non-natural resources.

2. Separate renewable and non-renewable resources

3. Define

    - Natural resources
    - Renewable resources
    - Non- renewable resources



Facilitator-will inspect the work done by the student group.Then he explains renewable and non renewable resources with example. He also specifies the work done by the group and asks them to come to the dais to explain their findings. Meanwhile other group members are allowed to put questions after the topic

Second period—after understanding natural resources they are asked to identify the way they could manage and conserve natural resources with examples

1. Water
2. Animals
3. Plants
4. Minerals
5. Soil

Chapter VII

Model Lesson Plan for Force and Newtons Laws of motion based on 5E Model

Chapter VII

Force and Newton's Laws of Motion

Subject: Science

Key Concepts of force and Newton's three laws of motion

Learning concepts:

To understand the concept of force, interaction between two objects, explain the motion of an object as resulting from the forces acting on the object and hence the Newton's three laws of motion.

Learning objectives:

1. To understand that force is not only associated with a body in motion
2. To understand that objects at rest are subjected to balanced forces
3. To understand that unbalanced forces will lead to objects slowing down, speeding up or changing direction
4. To understand the concept of NET force, sum of all forces acting on an object and its connection with Newton's first and second laws of motion
5. To find out the direction of force acting on an object
6. To understand that Force acting on any object in any situation is always the result of its interaction with another object force as acting on one object from (or due to) another object. That is concept of pair forces and their connection with Newton's third law of motion.
7. To understand that there does not exist any definition of force independent of Newton's laws of motion
8. To draw free body diagram and calculate the forces associated with it.

Engage: Teacher will ask students to give examples of some situations/statements were the term force is used.

For example:

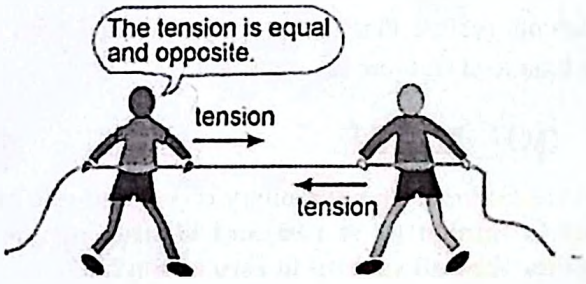
- Police force,
- 'Dad forced me to do it',
- 'May the force be with you',
- 'Don't force it — it might break',

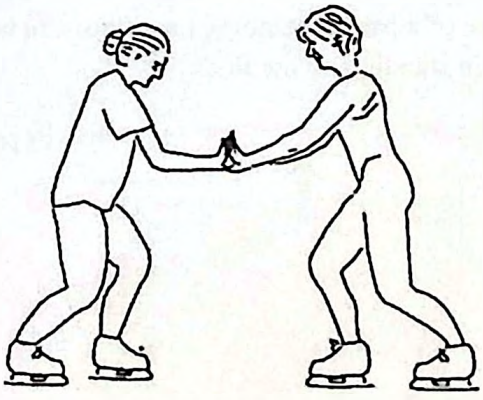
Ask student which of these uses matched most closely to the scientific meaning. The answer will be of course the last point

Exploring questions:

1. **What does the word Force makes you think about?"** Students will share within the group and then choose a few to share with the class.

- Having students arm wrestle to show balanced forces (when the same amount of force is applied by each person) and unbalanced forces (when one person wins). The students will learn the effects of unbalanced forces by sharing what they felt as they were winning or losing. Give a rope and ask two students to hold the opposite ends and start pulling in the opposite directions? Ask the students what will happen? Summarize when we have pulls in opposite direction there is no movement. Ask students what happens pulls are not equal? In which direction will the rope move? This will also be a good example to demonstrate the effect of balanced and unbalanced forces. unequal forces acting in opposite directions that results in movement in the direction of the larger force.

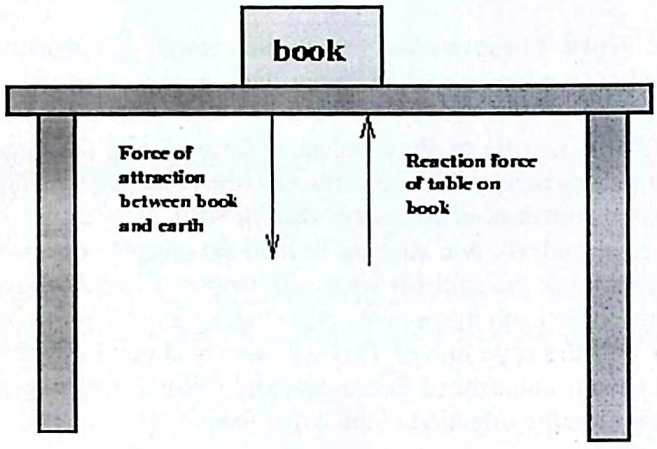




Ask students if they can think of other examples to demonstrate the effect of balanced and unbalanced forces.

2. Is force associated with moving objects only or with stationary objects also?

Place a book on the table. Ask the students to make a rough picture of this in their notebooks. Ask them whether any forces are involved or not?

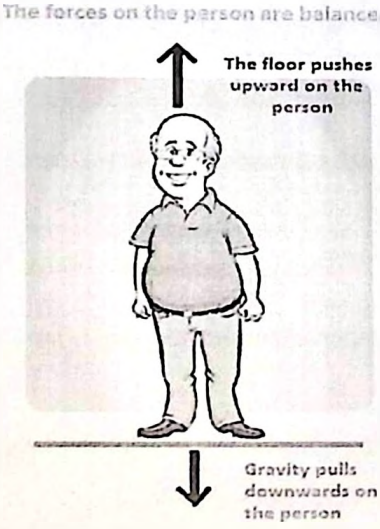


This activity will help students realize that forces are associated with stationary objects also only that the net forces are balanced so there is no motion.

3. What is net force?

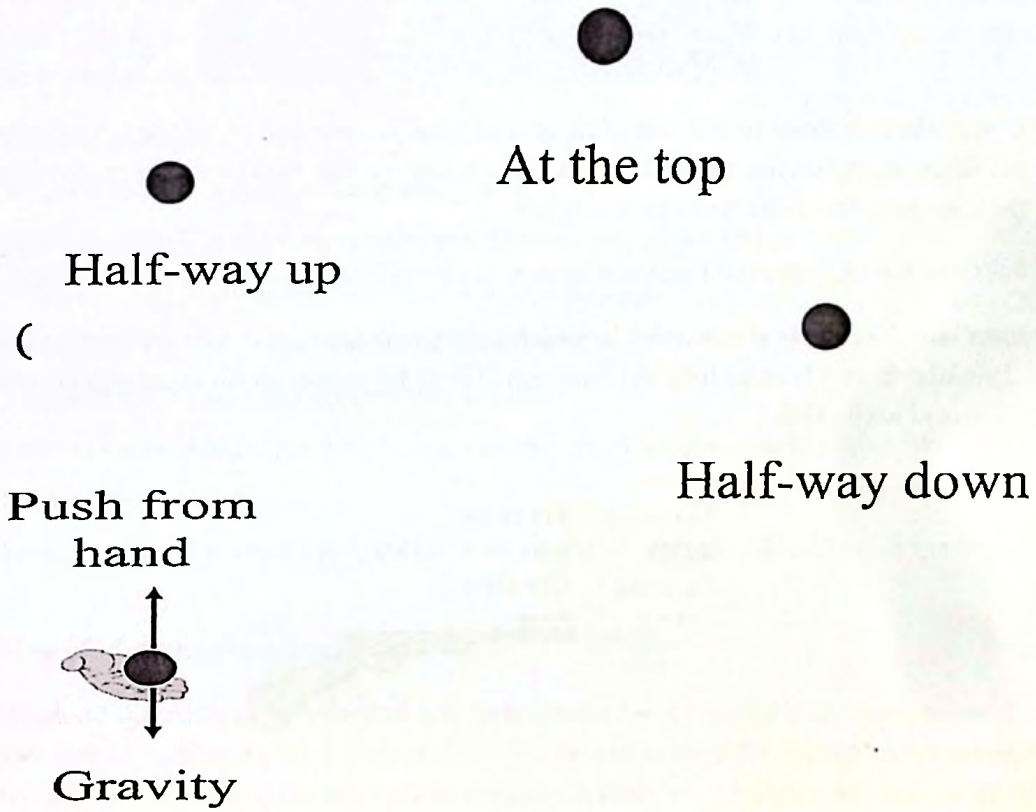
To define net forces give one example of a stationary object and one of moving object. **Take any example of an object in motion or at rest and identify all the forces acting on the object and then state whether they all sum up to zero or not?**
Ask the students to label all the forces involved.

For stationary object the example of a person standing on a floor can be given. Ask the students what forces are acting on a person standing on the floor.



To calculate the net forces on a moving object consider a ball thrown vertically upwards. What kind of motion you expect? You find that the ball loses it speed as it climbs up until it stops climbing up and starts falling down. In this considered example, or you may actually throw a ball upwards in the classroom and ask your students following questions about the upward and downward journey of the ball.

1. Identify the forces acting on the ball also identify by whom each of the force is applied (neglecting air resistance).
2. What is the direction of the net force on the ball as it climbs up and when it comes down?
3. What is the direction of the net force acting on the body as it comes to momentary rest, before its starting of downward journey?
4. What about the magnitude of the force?
5. What is the cause of this force?

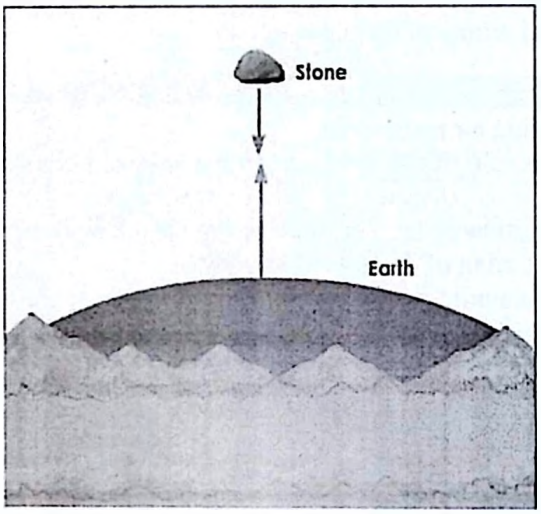


4. How much force is acting on a body moving with constant velocity?

A car travels at a constant 60 mph, along a flat road. What are the forces acting on it?

Is the forward force greater than, equal to or less than the combined backward forces?

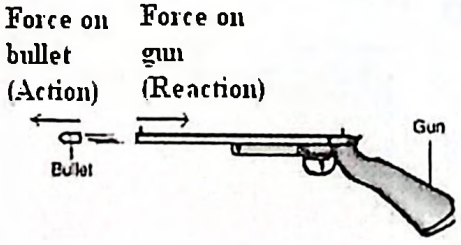
5. Is the wind (blow football, wind on leaves) a force-at-a-distance?
6. If you release a stone from a height what are the forces acting and how you calculate the net force?

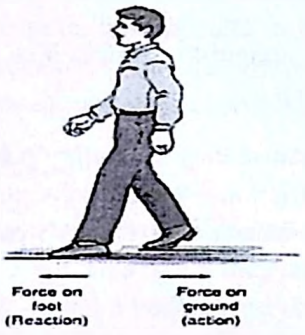


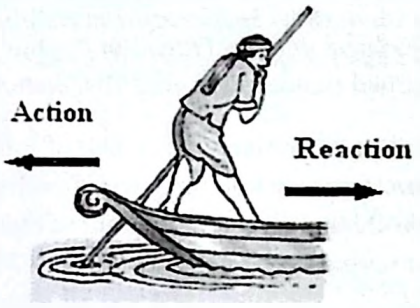
If you allow a stone to fall and if its acceleration is observed as 'a' then 'ma' gives us the net force acting on the stone. This net force is the combination of the force due to earth and the opposing force due to surrounding air.

7. Give ten examples of force acting on one object from (or due to) another object.

Students will give several examples in which action and reaction forces are involved. Recoil of gun, Propulsion of a boat in forward direction. These forces act on different objects and so they do not cancel each other.







Possible misconceptions among students

Students are aware of the fact that force is push (makes something start or stop moving) or pull (makes something that's already moving go faster or slower). Also that force causes change in shape. Some of them might even be aware of the forces at a distance like the gravitational force, magnetic and electric forces. The alternative conceptions that can arise in a student's mind are listed below:

1. Force is associated with the body till it is in motion.
2. When a body is at rest the force acting on it is zero.
3. Force is always in the same direction as the velocity of the body.
4. If the velocity is changing then force is also changing.
5. The action-reaction forces act on the same body.
6. The product of mass and acceleration is force.
7. Only animate things like people and animals exert forces; passive ones like tables, floors do not exert forces.
8. Forces applied by, say a hand, still acts on an object after the object leaves the hand.

Restructuring of ideas/Explanation

Having understood the concept of balanced and unbalanced forces students can now write the newton's first law of motion in their own words. While discussing the examples mentioned above the teacher can explain to the students to consider a body on which no net force acts. If the body is at rest, it will remain at rest. If the body is moving with constant velocity, it will continue to do so. An important word here is NET. It means "total" or "sum of all" (forces). It is not that no force at all can act on the body. It is just that all the forces must add to zero (cancel each other out).

Therefore Newton's First Law of Motion can be written as:

Every object persists (stays) in its state of rest or uniform motion in a straight line unless it is compelled (made) to change that state by forces impressed (acting) on it .

According to Newton's first law of motion things come to rest not because they naturally do but because forces act on them to bring them to rest. A common force is friction – which is the push or pull things give to each other when they rub together. Eliminate friction and things would keep moving in a straight line.

- Compare surfaces with more and less friction

  Ice vs. carpet

- Newton's first law does hold true as long as you account for all the forces.

Discussing the Newton's second law of motion teacher can discuss the example of a stone thrown from a height. If you allow a stone to fall and if its acceleration is observed as 'a' then 'ma' gives us the net force acting on the stone. This net force is the combination of the force due to earth and the opposing force due to surrounding air.

So, newtons second law of motion which is commonly shortened to "F=ma".

Correctly, it is :

$$\sum \vec{F} = m\vec{a}, \qquad \vec{a} = \frac{\sum \vec{F}}{m}$$

This is the reason that the stone and a piece of paper do not fall down with same acceleration. If you attach a small stone to a parachute made out of a polythene bag and allow it to fall, at first, the stone would tend to fall fast enough and increase its speed and we may conclude that there is some net force acting on the stone. But after some time you may notice that the stone is falling down almost with uniform speed with zero acceleration. From this observation you can conclude that net force acting on the stone is zero. The force due to earth remains same but the opposing force due to air because of the parachute increases with increasing speed. When these opposite forces cancel each other the velocity of the stone does not increase.

Discussing the examples mentioned above teacher can explain the Newton's third law of motion. Whenever two bodies interact with each other, the force exerted by the first body on the second is called action. The force exerted by the second body on the first body is called reaction. The action and reaction are equal and opposite.

Newton's Third Law of Motion states: 'To every action there is an equal and opposite reaction'.

It must be remembered that action and reaction always act on different objects. The Third Law of Motion indicates that when one object exerts a force on another object, the second object

instantaneously exerts a force back on the first object. These two forces are always equal in magnitude, but opposite in direction. These forces act on different objects and so they do not cancel each other. Thus, Newton's Third Law of Motion describes the relationship between the forces of interaction between two objects.

Evaluation

1. Assuming air resistance can be ignored, which gets to the ground first, a bowling ball or a tennis ball if they are dropped from the same height at the same time? Explain.
2. Does a book at rest on the table have no forces acting on it? Explain.
3. A car is traveling at a constant 60 mph in a straight line. What is the net force acting on the car?
4. Draw the diagram showing a body of mass m in projectile motion under gravity. Show the magnitude and direction of the force acting on the body when it is a) ascending, b) at the top most position, and c) descending. Give reasons.
5. We take say 5 identical paperweights and put them on a fairly smooth horizontal table so that they touch each other and lie on a straight line. Now if we hit this line of paperweights head on with another identical paperweight moving horizontally in the same line, it is found that one paperweight at the end of the line moves out and the moving paperweight comes to rest. Explain this observation on the basis of the principle of conservation of momentum and in terms of the force acting on each paperweight.

Chapter VIII

Model Lesson Plan for Sound based on 5E Model

Chapter – VIII

Sound

Sounds are all around us—cars honking, phones ringing, friends talking, and dogs barking are all sounds you are probably familiar with. So, what is sound? Sound is a type of energy made by vibrations.

Introduction

Sound is a longitudinal, mechanical wave. Sound can travel through any medium, but it cannot travel through a vacuum. There is no sound in outer space. Sound is a variation in pressure. A region of increased pressure on a sound wave is called a compression (or condensation). A region of decreased pressure on a sound wave is called a rarefaction (or dilation). The speed of sound depends upon the type of medium and its state. It is generally affected by two things: elasticity and inertia.

Key concepts:

1. Form of energy: transfer from one point to another with the help of particles of the medium.
2. Exert pressure on a wave
3. Humans are generally capable of hearing sounds between 20 Hz and 20 kHz
4. Simple harmonic waves
5. Echo and resonance are the examples of forced vibrations.

Prior Knowledge:

The student

1. give the location of a sound
2. describe source of sound as the vibration of matter, including air
3. describe and demonstrate with vibrating objects how sound travels through substances by wave motion
4. had an opportunity to experience or talk about an echo
5. compare and contrast music and noise using concepts of rhythm, pitch and volume related to wave motion
6. worked with forms of matter such as a solids, liquids and gases
7. describe the human voice range as related to frequency
8. worked with examples of at least two forms of energy, such as light and heat

Instructional strategy: The concept of sound will be explained with the help of demonstration of different activities, examples, models, charts, animations, slide-show etc and the previous knowledge of the students.

ENGAGE

Activity: These three activities will help us examine vibrations, how sounds develop and characteristics of sounds.

The students

6. Strike a tuning fork and then put it on their hands to sense the vibrations. The students try to discover how to make the tone louder. Ask students if they think they can change the tone. The students describe the tuning fork as they felt it on their hands.
7. Place a meter stick with one end extending at least 15 cm. over a table and hold it firmly on the table with one hand. Students pluck the protruding end of the meter stick to make a sound. They determine what the meter stick is doing as it makes a sound.
8. Experiment with the meter stick, trying to make high and low and loud and soft sounds. They record their observations for future use.

EXPLORE

Ask students to tell what they think sound is. Sound develops when something is vibrating — when it is moving back and forth. Hold a loose rubber band between your fingers and thumb and pluck it gently. Ask the students: Is it making a sound? Why not? You are right. It has to move back and forth — vibrate very fast — for us to hear the sound.

The vibration of matter causes all sounds. Sound is very important in our lives. Sound can make us happy, as with music, dancing or playing a musical instrument. However, sound can be harmful when it is too loud. Sounds can also warn us of danger, as with a fire siren. Sometimes when we are home alone, the sound of the radio or television can give us comfort.

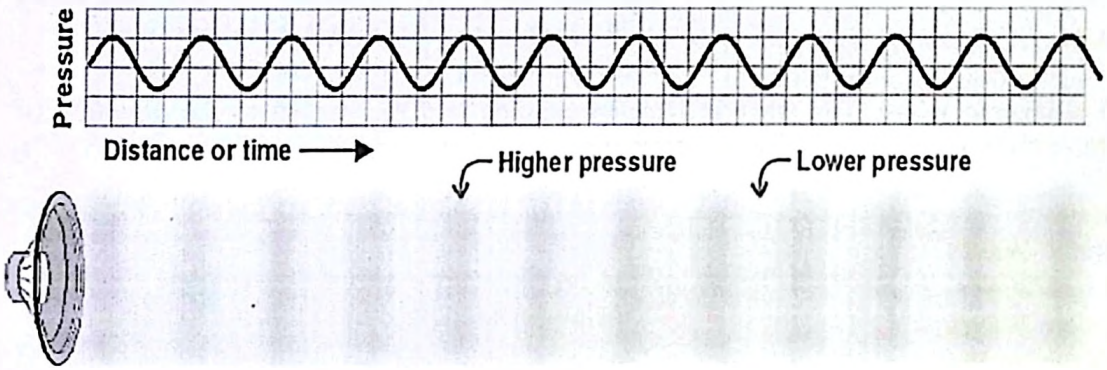
Discuss each activity with the students, stressing that sounds develop in many ways as vibrations in matter.

A wave is a disturbance or oscillation that travels through space and matter, accompanied by a transfer of energy. Wave motion transfers energy from one point to another, often with no permanent displacement of the particles of the medium—that is, with little or no associated mass transport. They consist, instead, of oscillations or vibrations around almost fixed locations.

Sound Waves (~ any longitudinal wave)

A sound wave is similar in nature to a slinky wave for a variety of reasons. First, there is a medium that carries the disturbance from one location to another. Typically, this medium is air; though it could be any material such as water or steel.

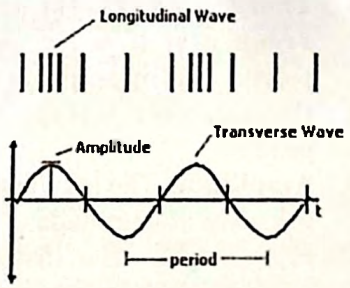
A sound wave is a longitudinal wave in an elastic medium (which could be a gas, liquid or solid). In such a wave the particles of the medium oscillate back and forth along the direction in which the wave travels such that regions of high and low density are created. It is these regions of compression and rarefaction which make up the wave fronts which travel through space and carry energy.



The waves have a speed which comes from the elastic properties of the medium. When a molecule moves, it collides with the next one and makes it move too. The energy of a sound wave travels away from the source trough a series of molecule collisions parallel to the direction of the wave. Sound cannot travel through a vacuum.

Sound waves can also travel through liquids and solids. The velocity of a sound wave depends on the temperature of the medium and its elasticity (more elasticity means that molecules will move easily). **Through air, sound waves travel at 343 m/s.** Actually, sound waves move faster through liquids and solids than through gases.

Some basic definitions



1. **Vibration**
   One complete round trip of a simple harmonic motion is called vibration.
   or
   If a body in periodic motion moves to and fro over the same path, this motion is called Oscillation.

2. **Wave**: A method of energy transfer involving some form of vibration is known as a wave.

3. **Wave Motion**: Wave motion is a form of disturbance, which travels through a medium due to periodic motion of particles of the medium about their mean position.

EXPLAIN

We see that if we dip a pencil into a tap of water and take it out a pronounced circular ripple is set up on the water surface and travels towards the edges of the tub. However if we dip the pencil and take it out many times, a number of ripples will be formed one after the other.

Waves can also be produced on very long ropes. If one end of the rope is fixed and the other end is given sudden up and down jerk, a pulse-shaped wave is formed which travels along the rope.

4. **Transverse Wave**: The wave in which amplitude is perpendicular to the direction of wave motion is known as Transverse Wave.

Examples

- Radio Waves
- Light Waves
- Micro Waves
- Waves in Water
- Waves in String

5. **Longitudinal Wave:** The wave in which amplitude is parallel to wave motion is called longitudinal wave.

Examples

- Sound Waves
- Seismic Waves

6. **Time Period (T)**: The time required to complete vibration is known as time period.
7. **Frequency**: It is the number of vibrations executed by an oscillating body in one second. It is measured in Hertz or cycles per second
8. **Displacement**: It is the distance of a vibrating body at any instant from the equilibrium position.
9. **Amplitude**: The maximum distance of the body on either side of its equilibrium position is known as amplitude.
10. **Wavelength**: The distance between two consecutive crests and troughs is called wavelength. It is measured in meter.
11. **Natural Frequency**: The frequency at which an object will vibrate freely (without any external periodic force or resistance) is known as natural frequency of that object.
12. **Audible Sound**: Our ear can hear only those sounds whose frequency is between 20Hz

and 20000Hz. This range is known as audible sound.

13. **Ultrasonic Sound**: Sound with frequency greater than 20000 Hz is known as ultrasonic sound.
14. **Interference of waves**: When two or more waves with the same frequency reach the ear, the ear interprets these waves as one wave with amplitude as big as the sum or difference of the initial waves.
15. **Octave**: The interval between a waveform and another of twice the frequency is known as Octave.
16. **Simple Harmonic Motion (S.H.M)**: To and fro motion of a body in which acceleration is directly proportional to displacement and always directed towards mean position is known as Simple Harmonic Motion.

Condition for S.H.M: The conditions for simple Harmonic Motion are given below:

- Some resisting force must act upon the body.
- Acceleration must be directly proportional to the displacement.
- Acceleration should be directed towards mean position.
- System should be elastic.

Examples: Following are the examples of S.H.M:

- Body attached to a spring horizontally on an ideal smooth surface.
- Motion of a simple and compound pendulum.
- Motion of a swing.
- Motion of the projection of a body in a circle with uniform circular motion.

ELABORATE

Sound: A vibration transmitted by air or other medium in the form of alternate compressions and rarefactions of the medium is known as Sound.

Production of Sound: Sound is produced by a vibrating body like a drum, bell, etc, when a body vibrates. due to the to and fro motion of the drum, compressions and rarefactions are produced and transmitted or propagated in air.

Propagation of Sound Waves: When a body vibrates in air, it produces longitudinal waves by compressions and rarefactions. These compressions and rarefactions are traveled by the particles of the medium and transferred into the next particles. Due to this transference, sound propagates in a medium.

Experiment: Suspend an electric bell in a jar by its wires through a cork fixed in its mouth. Switch on the bell, we will hear the sound of the bell. Now start removing air from jar with the help of an exhaust (vacuum) pump. The sound will decrease, although the hammer is still seen striking the bell. This experiment shows that air or any other medium is necessary for the propagation of sound.

Velocity of Sound: It is a matter of common experience that the flash of lightning is seen earlier than hearing the thunder of cloud. Similarly when a gun is fired its sound is heard a little after seeing its flash. The reason is that light is faster than sound. Due to its slow velocity sound lags behind.

Experiment: Select two stations at a distance of 8 km (or any more distance) such that there is no obstacle between them. Fire a gun at station A and note the time of sound taken for such distance. Repeat the process and note the time taken by the sound to travel from B to A. If we substitute the mean of the two times recorded and distance S (8km) in the formula $V = S/t$, we will get the velocity of sound.

Factors Effecting Velocity of Sound: The factors are given below:

- Velocity of air or any other medium.
- Density of the medium.
- Temperature of the medium.
- Nature of the medium

Characteristics of Sound: The characteristic properties of sound by which we can distinguish between noise and music, shrill and grave sounds or sound of men and women are known as characteristics of sound. The properties of sound are given below:

A. Loudness: Loudness is the magnitude of auditory sensation produce by sound. Intensity can be defined as the energy carried by the sound waves through a unit area placed perpendicular to the direction of waver per second.

Factors Effecting Loudness of Sound: Loudness depends on following factors:

(i) **Area of Vibration of Body:** Greater will be the surface area more will be the loudness.
(ii) **Amplitude of Motion of Vibrating Object:** Greater will be the amplitude, more will be the loudness.
(iii) **Density of Medium:** Loudness is directly proportional to the density of medium.
(iv) **Motion and Direction:** If source of sound is moving towards the listener loudness will be greater or if wind supports the velocity of sound the loudness will be greater.

B. Pitch: The sensation that a sound produces in a listener as a result of its frequency is known as Pitch. This is the property of sound by virtue of which we can distinguish between a shrill and grave sound.

Factors Effecting Pitch of Sound: Pitch depends on following factors:

(i) **Frequency of Vibrating Body:** The greater the fundamental frequency, more shrill will be the sound.

(ii) **Relative Motion of Sound:** If source and listener both are coming closer pitch will increase.

C. Quality or Timbre or Tone: The characteristic of a musical note that is determined by the frequency present is known as Quality or Timbre or Tone of that sound. This is the property of sound by virtue of which it is possible to identify a sound of the same loudness and pitch but originating from different instrument.

Factors Effecting Quality: Quality depends upon the following factors:

(i) Phase of the Sound Wave.

(ii) Shape of Waves

D. Intensity of Sound: The rate at which a wave's energy flows through an area (I=P/A). It is measured in decibels.

Factors affecting Sound Intensity: Sound intensity depends on

(i) the strength, or amplitude,
(ii) the vibrations producing the sound
(iii) Distance from source

Normal sounds carry small amounts of energy, but our ears are very sensitive. Human can hear sounds with intensities as low as 10^{-12} W / m ^{2}. This is called the threshold intensity, I_0. i.e.

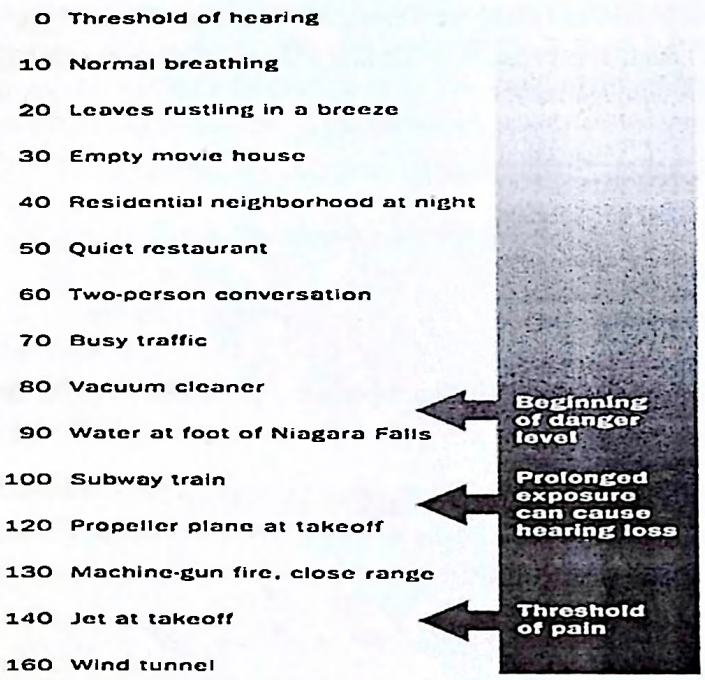
$$I_0 = 10^{-12} \text{ W} / \text{m}^2$$

The Decibel Scale (1/10th of bel): The decibel (abbreviated dB) is the unit used to measure the intensity of a sound. On the decibel scale, the smallest audible sound (the threshold of hearing) is 0 dB. The decibel (dB) is a logarithmic unit used to express the ratio between two values of a physical quantity (usually measured in units of power or intensity). A decibel (dB) is one tenth of a bel (B), i.e., 1B = 10dB.

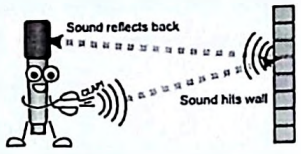
Intensity level = 10 log10 (I_1 /I_0) (dB)

The decibel is also commonly used as a measure of gain or attenuation, the ratio of input and output powers of a system, or of individual factors that contribute to such ratios. The decibel is

used for a wide variety of measurements in science and engineering, most prominently in acoustics, electronics, and control theory.



Reflection of Sound: Sound waves encountering a surface and follows laws of reflection.



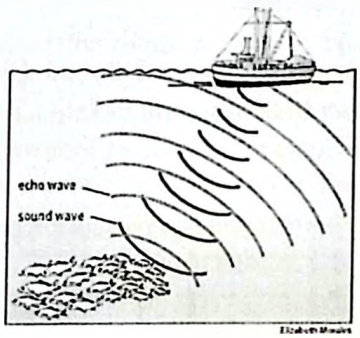
Echo: An echo is simply a reflected sound wave. The word *echo* derives from the Greek ἠχώ (*ēchō*), itself from ἦχος (*ēchos*), "sound".It is the phenomenon of repetition of sound of a source by reflection from an obstacle.It is more commonly used for the special branch of that PHYSICS that deals with the construction of enclosed areas so as to enhance the hearing of speech or music. Reflection of sound off a surface (**Acoustics** (Greek *akouein*,"to hear"). For echo $T = 2d/v$.

Production of echo: Typical examples are the echo produced by the bottom of a well, by a building, bell or by the walls of an enclosed room and an empty room. A true echo is a single reflection of the sound source. An echo is produced when sound waves bounce off of another surface. It is the second sound produced after reflection of sound waves on a rigid object.

Condition for formation of echo:

1. The size of the obstacle/reflector must be large compared to the wavelength of the incident sound (for reflection of sound to take place).
2. The distance between the source of sound and the reflector should be at least 17m (so that the echo is heard distinctly after the original sound is over.)
3. The intensity or loudness of the sound should be sufficient for the reflected sound reaching the ear to be audible. The original sound should be of short duration.

Use of echo: Use of echo by Bats, dolphins, fisherman (SONAR) and in medical field.



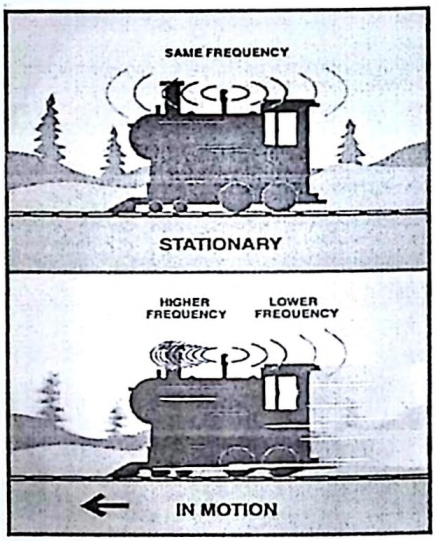
Resonance: The large amplitude vibration of an object when given impulses at its natural frequency is known as Resonance.

Experiment: Consider a long string stretched tightly between two pegs. Four pendulums A, B, C and D of different lengths are fastened to the string. Another pendulum E of same length as A is also fastened. When pendulum E is set to vibrate, it will be observed that all the pendulums start to swing but pendulum A begins to vibrate with larger amplitude, as pendulum E is set into vibration. It imparts its motion to the string. This string in turn imparts the same periodic motion to the pendulums. The natural frequency of all other pendulums except A is different. Due to the same natural frequency only A vibrates as the same vibration of E. This phenomenon under which pendulum A begin to vibrate is called resonance.

Example: March of Soldiers while Crossing the Bridge: Each bridge has its own natural frequency and marching of soldiers is another vibrating system. So there may occur a force on

vibration in bridge. This may damage the bridge. So, for safely precautions, it is written that soldiers must march out of stop while crossing the bridge.

Dopplers Effect: The apparent frequency of a sound changes due to the relative movement of the source and/or observer. The Doppler Effect – the change in pitch due to a moving wave source.



1. Objects moving toward you cause a higher pitched sound.
2. Objects moving away cause sound of lower pitch.
3. Used in radar by police and meteorologists and in astronomy.

Harmful Effects of Sound (Noise): Nowadays noise is considered as a great pollution, which is very dangerous for us. Some of them are as follows:

- Continuous noise damages hearing and can result in complete deafness.
- Noise has become a great cause for depression and blood pressure.
- Mental system shows less efficiency due to noise.
- Consequently it is harmful in all respects for living body.

Musical Sound

The sound producing pleasing effect on our ears are called musical sounds.

Sound Activities and Experiments

Understanding sound as vibrations: Put rice on a drum, when you strike the drum the rice will dance because of the vibrations (Title – Have you ever seen rice dance?)

Voice vibrations: Put two fingers on your throat and then talk, you will feel the vibrations from your voice box

Sound travels through solids: Ask the children to come and sit in a circle. Ask the children, how did you hear me? Where did the sound start?

The vibration made by your voice box vibrates tiny invisible particles in the air causing the sound vibration to cross through the air and vibrate their ear drums. Now say that sound doesn't just travel through air, but though other materials too.

Then, decide on a magic word as a class. Next, one pupil goes and stands outside the room, ensuring they cannot see through windows etc. Finally the teacher talks to the class and drops the magic word into conversation- as soon as the pupil outside hears the magic word they return to the class room.

Thought this may be useful to do before the muffling experiment, maybe as a lesson starter.

How good is your hearing? (direction of sound): Thought this activity may be useful to start the topic or maybe as a time filler in our first week.

- Blindfold a volunteer
- Class stand in a ring around the volunteer.
- Children take turns to make gentle noises, such as a clap of the hands, a click of the fingers or a quiet call.
- After each sound, the person with the blindfold should point to where they think the sound is coming from.
- The experiment could be tried with an ear muff on or a cotton wool pad over the person's ear.

This could be referred to during the muffling experiment.

Tick-tock Trick: I thought this experiment could be used to help the children understand how sound travels (spreads out). By doing this experiment the children should understand that sounds can be directed/amplified.

Equipment:

- Two plastic funnels
- 2 metres of plastic tubing
- Watch (analogue)

Push one funnel on either end of the tubing

Place the watch about 2 metres away

Ask a friend to hold the funnel over the watch and put the other funnel to your ear. You should be able to hear the watch ticking quite clearly.

Make a tube telephone: Same equipment and method as the tick-tock trick)

Make a stethoscope: This will help the children understand that we can hear very quiet sounds (If the sound energy is directed along a single narrow pathway, it is possible for us to hear very quiet sounds)

This experiment is similar to those above- one funnel and a piece of rubber pipe.

Make a yoghurt pot telephone: Typical yoghurt pot and string experiment, this could use this to demonstrate the whole vibrations thing

Measuring the speed of sound: Equipment – stopwatch, tape measure (500 metres) and two large stones

One person stands at one end of the 500 metres with a large stone in each hand. The other person stands at the opposite end with a stop watch. On an agreed command, the person with the stones bangs them together as hard as possible. The person with the stop watch starts the timer when the stones are hit together, and stops it when the sound is heard. The time should be recorded to the nearest tenth of a second. This experiment should be repeated to get an average time.

Speed of sound= distance/ time

Underwater recorder (useful to understand the change of pitch)

For this experiment, you will need an old plastic recorder and a tall jug of water.

Cover all the holes on the recorder with your fingers (if this is too difficult, stick some tape over the holes). Blow gently into the recorder and you should heat a single, low pitched note.

Take a deep breath and blow into the recorder while you push it into a jug of water.

(The pitch of the note depends on the length of the column of air inside the recorder)

Make a glass xylophone: Find four glass beakers which are the same size and shape. Fill one beaker with water almost to the top. In the second beaker make the water level about 2 cm from the top of the glass. In the third beaker, make the level 4cm from the top. Don't put any water in the fourth glass.

Tap the side of each glass with a wooden spoon. Each glass will ring with a note of a different pitch (more water the lower the pitch.)

Assessment Activities for students: Students play a variety of classroom musical instruments to determine how the sound is produced, whether it can change pitch or volume, and if so, how pitch and volume are changed.

Suggestion: The teacher can set up instruments in various parts of the room. Allow about 8 minutes for each station. Use these instruments or others that are available: piano, drum, recorder, guitar, claves and autoharp.

Students blow across the tops of bottles of water which have been prepared by the teacher, tuned to the first five notes of the major scale.

Suggestion: Prepare enough bottles so that each pair has a set of five bottles,tuned to the first five steps of the major scale by placing the appropriate amount of water in each one. Use sections of plastic straws to blow across the tops of the bottles to avoid the spread of germs.

Students look at wave patterns as shown on an oscilloscope

Suggestions: Computer programs, such as Sound Effects , a Shareware program, Sound View or Sound Vision , both freeware programs, can be used to view the sound waves produced by various sources.

Use a computer projection system so that all the students may see the patterns. Students are to label each wave pattern/sound by describing the volume (high, medium, or loud) and the pitch (low, medium or high).

EVALUATION:

1. Hypothesize what happens to sound waves when they reach a wall or other solid, flat object.
2. If sound can't travel in space, hypothesize what other modes of communication astronauts can use when they are outside the space shuttle?
3. Explain why, based on the behavior of sound waves, a classroom with a tile floor is louder than a library that is carpeted
4. How does sound travel when you have a conversation with your friends?
5. Think about what it is like to hear things under water. Debate whether sound travels better in liquids (like water), gases (air), or solids (like putting your head down on a desk and having someone slam a book down on the surface)?
6. Discuss why you see lightning before you hear thunder during storms.

CHAPTER – IX

METHODOLOGY

Chapter IX

Methodology

The researcher used a quasi-experiment following a non equivalent control group design to verify the effectiveness of the constructivist approach in learning science at the secondary level. It involved the comparison of concept learning in science between students exposed to constructivist approach-based experiments and those to traditional experiments. The students that were exposed to constructivist approach-based experiments were designated as experimental group and those students that were exposed to traditional experiments were designated as control group. The students' achievement score towards science before and after the experiments were gathered and measures were employed.

Sample for the Study: The research was conducted at Demonstration Multipurpose School (DMS), Bhopal. The respondents of the study were the two sections of the Class 9th students wherein the researcher conducted the constructivistapproach-based sessions. In total of 47 students were selected for the study out of which the control group comprised of 23 students and experimental group comprised of 27 students.

Tools: This research made use of the following data gathering instruments:

a. The Pre and Post Achievement Test

b. The Traditional Approach of learning

c. The Constructivist Approach of learning

Before the experimental study, the pre-achievement test was administered to the two groups of respondents to find out their preconceptions and misconceptions in selected topics of science and likewise to measure their achievement level.

The treatment for the experimental group differs from that of control group in only one aspect. During the period of study, the experimental group was exposed to the constructivist approach of learning based on the 5E model.

At the end of the study, a post achievement test was again administered to measure the achievement level of the students.

The t- test was used to determine if there was difference between the experimental and control groups in their:

a. Pre-achievement scores in science

b. Post-achievement scores in science

Chapter X

Results and Discussion

Chapter X

RESULTS AND DISCUSSION

A. The Difference between the Pre- Achievement Scores of Experimental and Control Groups

The pre-achievement test was conducted to find out if both groups of respondents possess the same cognitive level before the conduct of the study. The null hypothesis states that there is no difference between the pre- achievement scores of Experimental and Control Groups

Group	Mean	SD	df	t	p
Control	26.67	3.284			
45	1.607	.122			
Experimental	24.31	3.987			

TABLE 1: THE DIFFERENCE BETWEEN THE PRE-ACHIEVEMENT SCORES OF EXPERIMENTAL AND CONTROL GROUPS

It can be seen from the table above that control group had a mean score of 26.67 and a standard deviation of 3.28 while that of experimental group had a mean score of 24.31 and a standard deviation of 3.987. The t test was performed to find out whether there is a significant difference between the two means. It has been assumed that distribution of the achievement scores of control and experimental group were sufficiently normal for the purpose of conducting a t test. Assumption of homogeneity of variances was tested and satisfied via Levene's F test, $F(35) = .021$, $p = .885$

The t ratio of 1.607 has an associated probability of .122. The obtained t value is less than table t value at 0.05 level of significance. This means that the null hypothesis is accepted. Hence, there is no significant difference between the pre-test mean scores of the two groups of respondents. This only means that the two groups of respondents have the same cognitive level before the study was conducted.

B. The Difference between the Post-Achievement Scores of Experimental and Control Groups

After the study, the effect of constructivist approach and traditional approach in physics laboratory teaching was determined. The actual scores of the two groups were treated. The null hypothesis states that there is no difference between the post- achievement scores of Experimental and Control Groups

Group	Mean	SD	df	t	p
Control	17.236.070				
45	5.636	.000			
Experimental	25.44	3.787			

TABLE 2. THE DIFFERENCE BETWEEN THE POST-ACHIEVEMENT SCORES OF EXPERIMENTAL AND CONTROL GROUPS

As shown in the table, the students exposed to constructivist approach-based learning had a post-test mean score of 25.44 and a standard deviation of 3.787 while the group exposed to traditional experiments had a mean score of 17.23 and a standard deviation of 6.070. The t ratio of 5.636 has an associated probability of .000. The t value obtained is greater than the table t value at 0.01 level of significance hence the null hypothesis is rejected. Hence, there is a significant difference between achievement scores of the two groups after the study.
After the treatment, the two groups of respondents varied statistically in terms of their learning achievement. It also signifies that constructivist approach-based theory of learning did enhance better achievement of students as compared to traditional teaching.

C. The Difference between the Pre and Post Achievement Scores of the Students Exposed to Constructivist Approach-Based Experiments

The pre and post achievement test were administered in order to determine whether was a significant change on the achievement of the students as a result of using constructivist approach-based experiments as a tool in teaching laboratory physics.

Table 4 shows the difference between the pre and post achievement scores of the experimental group.

Achievement		Mean	SD	df	t	p
PRE		19.955.744	21			
4.134	0.000					
POST		25.503.419				

TABLE 4. THE DIFFERENCE BETWEEN THE PRE AND POST-ACHIEVEMENT SCORES OF THE EXPERIMENTAL GROUP

Before the conduct of the conduct of the study, the mean score of the students was 19.95 with a standard deviation of 5.744 which was increased significantly to 25.50 with a standard deviation of 3.419 after the conduct of the study.

The table also reveals that the t-ratio is 4.134 which has a probability of 0.000. which means that the null hypothesis is rejected. The obtained t value is greater than the table t value at 0.01 level of significance. Hence, there is a significant difference between the pre and post achievement scores of the students exposed to constructivist learning situations and we reject the null hypothesis. It also suggest that constructivist learning situations in different subjects did enhance achievement. The students performed better as a positive effect of the approach that was employed.

Furthermore, it was also observed that during the conduct of the study, students showed willingness to undertake new tasks, initiative new ideas related to classroom activities, project and adapt easily to changes in procedures.

CONCLUSION

The studyused constructivist approach based 5E model wherestudents where in learning is the center where all other learningprocesses revolve around. We have correlated the constructivism learning situation with the traditional learning: the twobeing student-centered paradigm of learning. Themodel was applied to science classroom at the secondary level for effectivelearning of the students. It was highlighted that foreffective science learning: teacher mustalways consider the students' prior knowledge. Thisprior knowledge determines everything the studentslearned and the teacher instruction. The study equallyargues that the teacher should promote studentinteractions and respect student ideas: being thekernel of the constructivist learning.

Chapter XI

Implications of the Study

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Implications of the Study

The most outstanding characteristics of any research is that it must contribute something new to the development of the area concerned. The present study was conducted on Class IXth students to find the effectiveness of 5E model of teaching in science. The result is useful for teachers, curriculum planner, students, teacher educators, text book writers, researchers, corporate and government organization. 5E model can be used by a teacher as effective teaching methodology for difficult and complex concepts; a model of learning that may also help the learners construct their knowledge in a meaningful way as it gives enough scope for active participation and interaction in classroom with peers and teachers. Through 5E interaction, low intelligent students can get better opportunity to acquire knowledge and comprehend what they are learning. In addition, this model will create a joyful learning environment between teacher and students. The implications can also be categorized as follow:

i) For learners: In general constructivist approach and in particular, 5E's model of teaching helps the learners construct their knowledge positively. It gives enough scope for active participation and social interaction inclassroom with peers and teachers. Through interaction, students of all intelligent levels can get better opportunity to acquire new knowledge, especially for low intelligent students. They can develop the ability of analysis, divergent thinking, interpretation, ability, critical thinking and scientific attitude towards science education.

ii) Teachers: Teacher will benefit greatly by understanding the constructivist approach of teaching which the findings of the present study handles. As such, teachers need to encourage peer interaction, group discussion, experimentation, field visiting etc. 5E's model of learning can provide such situation between teacher and student. This model promotes joyful learning among students in classroom situation by facilitating learning process as a two-way mode of learning between learners and teacher. The ideals of teaching learning process of teacher as a facilitator while students develop their potentialities after getting instructions from teacher is what the study indicated.

iii) School administration: School atmosphere plays crucial role in managing the teaching learning process. The administration of school has important role to develop a congenial atmosphere among teachers as well as students. 5E's model may create such situation where a learner can interpret the concepts in many ways and teachers always try to provide them appropriate learning situation. Constructivist approach of learning brings better academic achievement of the students. For successful implementation of this strategy, the school administration should understand how learning need to be supported a ıd provide all required learning resources to the learners.

iv) Policy makers: The present study and its finding has shown how the constructivist approach learning in science at secondary level enhance students' achievement and this need is taken into consideration while framing the policies of school education to bring qualitative change. At the same time, curriculum planner may incorporate this strategy in curriculum planning and development and preparation of framework/guidelines for achievements of intended learning outcomes.

CHAPTER – XII

SUMMARY OF REPORT

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SUMMARY OF REPORT

The study developed constructivist approach experiments to determine its effectiveness in teaching physics concepts. The research was conducted at Demonstration Multipurpose School, Bhopal. The respondents of the study were the two sections of the Class IX th students wherein the researcher conducted the study. We used constructivist pedagogy during the teaching science at secondary level so that concepts become more visible and meaningful to students. The topics that selected were force, sound, natural resources, tissues, structure of atom and diversity in living organisms

The study administered pre-test and post-test. The scores in the achievement test and standardized attitude inventory test were compared and the significance of their difference was determined using the t-test. The control group and the experimental group were equal in terms of cognitive level in science. However, the students exposed to the constructivist pedagogy of teaching had significantly higher posttest scores and higher mean gain scores than the students exposed to the traditional approach after the study was conducted. Moreover, there was a significant difference between the post achievement scores of the students exposed to constructivist pedagogy and traditional pedagogy. The Constructivist Approach pedagogy are effective in enhancing students' achievement.

Research Questions/Hypotheses

1. Is there any effect of Constructivist Approach (CA) on Learning Achievement in Science of Secondary school children?

2. What are the various ways to examine the different dimension(s) of achievement in Science of Secondary school children?

METHODOLOGY: The researcher used a quasi-experiment following a non equivalent control group design to verify the effectiveness of the constructivist approach in learning science at the secondary level. It involved the comparison of concept learning in science between students exposed to constructivist approach-based experiments and those to traditional experiments. The students that were exposed to constructivist approach-based experiments were designated as experimental group and those students that were exposed to traditional experiments were designated as control group. The students' achievement score towards science before and after the experiments were gathered and measures were employed.

Important findings:

- The pretest scores indicated that the two groups of respondents had the same cognitive level before the study was conducted.
- After the treatment, the two groups of respondents varied statistically in terms of their science achievement.
- Constructivist approach (using 5E model) has significantly improved the achievement of students in science at secondary level.
- The higher post-achievement score of the experimental group can be attributed to the fact that the students were highly motivated to play an active part in their acquisition of knowledge giving them an active role in their own learning which made them perform better academically after the study.

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APPENDIX A

ACHIEVEMENT TEST

This activity is not an examination. This test has questions on topics from Class IX grade. This test consists of multiple choice questions. Each question has one correct answer. Attempt all the questions.

1 The structural organization of organs and organ system is far more developed & specialized in -

(a) Complex animals (b) Complex plants

(c) In both (d) None

2 Buoyancy to the aquatic plants is provided by the large air cavities present in -

(a) Aerenchyma (b) Collenchyma

(c) Sclerenchyma (d) None of the above

3 Which type of phloem cells are dead cells -

(a) Seive tuves (b) Companion cells

(c) Phloem parenchyma (d) Phloem fibers

4 A person met with an accident in which two long bones of hand were dislocated what may be the reason -

(a) Tendon break (b) Break of skeletal muscle

(c) Ligament break (d) Areolar tissue break

5 Presence of tissues in a multi cellular organisms ensures -

(a) Faster development (b) Division of labour

(c) Higher reproductive Potential (d) Body strength.

6 In human beings muscle cells -

(a) Conduct food and water (b) Carry messages from brain

(c) Contract and relax to cause movement

(d) Transport oxygen and other gases.

7 Tissue that stores energy, act as insulation and protect some organs is -

(a) Muscle (b) Neurons

(c) Adipose (d) Bone.

8 While studying permanent slide sahil observed -

i) Cells are long and cylindrical

ii) Light and dark bands are present

It could be a slide of

(a) Smooth muscle fiber (b) Striated muscle fiber

(c) Neuron (d) Parenchyma cells

9 The muscular tissue which functions throughout the life continuously without fatigue is -

(a) Skeletal muscle (b) Cardiac muscle

(c) Smooth muscle (d) Voluntary muscle.

10 Which of the following characteristics pertains to meristanatic tissue.

(a) Capacity to do photosynthesis

(b) Capacity to divide

(c) Capacity to locomote

(d) Complexity to transpire

11 Which tissue is responsible for increasing the length of the plant ?

(a) Apical meristem (b) Lateral meristem

(c) Intercalary meristem (d) Epidermis

12 A group of cells alike in form, function and origin is called -

(a) Tissue (b). organ (c) Organelle (d) None of these

13. Which of the following plants is a gymnosperm

a) Deodar b) Coconut c) Marsilea d) Funaria.

14. In which of the following groups of animals the body has bilateral symmetry with jointed appendages

a) Nematoda b) Annelida c) Arthropoda d) Porifera.

15. Plant groups thallophyta, Bryophyta and pteridophyta are collectively called as 'cryptogams' as in these groups.

a) Plant body is not well differentated

b) Reproductive organs are very inconspicuous

c) Plants dwell on land

d) Plants are multicellular

16. If a plant is having vascular system and does not produce seeds, it belong to

a) Gymnosperms b) Bryophytes

c) Thallophytes d) Pteridophytes

17. Which of the following is a common feature of Morera and Protista

a) Prokaryotic cell b) Autotrophic mode of nutrition

c) Unicellular body d) Eukaryotic body.

18. Which among the following have vascular tissue:

1. Thallophyta 2. Bryophyta

3. Pteridophyta 4. Gymnosperms

a) 1 and 2 b) 1 and 4 c) 2 and 3 d) 3 and 4

19. Which of the following is not an aquatic animal.

a) Hydra b) Corals c) Jelly fish d) Silver fish.

20. Which group of animals is most abundantly found in our surroundings.

a) Birds b) Insects c) Fishes d) Mammals

21. Salim and Heera went to a field in the month of July. They observed that the crop plants had broad leaves with reticulate venation. Which of the following crops was growing in the field.

a) Soybean b) Paddy c) Wheat d) Maize.

22. Which of the following characteristics is not shared by birds and mammals.

a) vertebral column

b) Breathing using lungs

c) Vivipary

d) Warm blooded nature

23. A man is standing on the floor. What is the net (resultant) force acting on it?

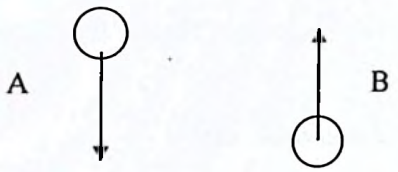
a) Equal to his weight

b) Less than weight, but acting down ward

c) Less than weight, but acting upward

d) Zero

24.



Ball going down Ball going up

Consider two balls A and B. Ball A is going down and ball B is going up. The speed of two balls is equal. The net force acting on two balls is, (ignoring air resistance)

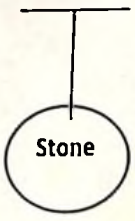
a) equal is magnitude and in some direction

b) more on ball A than on ball B

c) more on ball B than on ball A

25. A stone of mass 1 kg is hanging with the help of a non-flexible (see fig.)

Name of the major forces acting on the stone.



26. A satellite is moving in outer space with constant velocity. In order to reduce its speed.

a) it should throw rockets in the direction of motion.

b) it should throw rockets in the direction opposite to the motion.

c) it should throw rockets in any direction

d) it should put of its engine.

27. What is the net force acting on a body kept on the table ?

a) Zero

b) non-zero, acting downward

c) non-zero, acting onward

d) equal to its weight, acting downward.

28. A ball is thrown up vertically with velocity 10m/s It comes down vertically downward with velocity 10m/s.

a) Their momentum were equal in two conditions

b) Momentum is more while going up

c) Momentum is more while going down.

d) The momentum in two cases cannot be compared.

29. Sound waves in air cannot be polarized because

a) their speed is small

b) they require a medium

c) these are longitudinal

d) their speed is temperature dependent

30. The minimum distance of an obstacle from the source of sound required to hear an echo is

a) 1.7m

b) 17 m

c) 7m

d) 71m

31. SONAR determines the speed of submarines using the principle of

a) Interference

b) Diffraction

c) Doppler effect

d) Formation of beats

32. Bats determines the presence of obstacle or prey using

a) Ultrasonic waves

b) Infrasonic waves

c) Light waves

d) Ultraviolet waves

33. Sound waves of wavelength λ travelling in a medium with a speed of v m/s enter into another medium in which its speed is 2v m/s. wavelength of sound wave in the second medium is

a) $\lambda/2$

b) λ

c) 2λ

d) 4λ

34. Which characteristics of sound waves changes with change in temperature of medium

a) Frequency

b) Amplitude

c) Wavelength

d) Loudness

35. A sound wave travels from east to west, in which direction do the particles of air move

a) East-west

b) North-South

c) Up and down

d) none of these

36. Pitch of high frequency sound is

a) High

b) Low

c) Zero

d) infinite

37. Propagation of wave transfers

a) energy only

b) matter only

c) energy and matter both

d) velocity

38. In which of the following speed of sound is maximum

a) air

b) water

c) steel

d) kerosene

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(b) they require a medium

(c) these are longitudinal

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a) λ/2

b) λ

c) 2 λ

d) 4 λ

44. Which characteristics of sound waves changes with change in temperature of medium

a) Frequency

b) Amplitude

c) Wavelength

d) Loudness

45. A sound wave travels from east to west, in which direction do the particles of air move

a) East-west

b) North-South

c) Up and down

d) none of these

46. Pitch of high frequency sound is

a) High

b) Low

c) Zero

d) infinite

47. Propagation of wave transfers

a) energy only

b) matter only

c) energy and matter both

d) velocity

48. In which of the following speed of sound is maximum

a) air

b) water

c) steel

d) kerosene

49. Identify which of the following are not the part of biotic environment.

a-soil ,b-plant, c-fish, d-animal

50. what are the two major oxides formed by burning fossil fuel responsible for acid rain-

a-NO_2 ,$S0_2$ b- NO,SO_3 , c- N_2O,NO_2 d- CO_2, CO

51. Atmosphere acts as blanket for earth. how

a-filters harmful rays coming from the sun b-stops meteoroids entering earth

c-check ozone layer leaving earth surface d-controls pollution

52. -car with glass closed is parked under sun, temperature inside the car increase very high due to-

a-green house affect as heat get trapped in the car.

b-car is made of metal so heats up

c-sun heats up the car

d-because of climate change

53. -Natural recourse can be

a-replaced in our lifetime

b-can be produced by nature again and again

c-they are non-renewable

d-all the above

54. -"Water need conservation even though maximum of earth is occupied by water". Select correct answer

a-ocean water are not directly usable to human as its saline.

b-percentage of fresh water is limited and is exploited

c-[a,b] are correct

d--[a,b] are not correct

55. Fertile soil has lots of humas.why

a-water get entangled in soil

b-rich in organism that decompose dead matter.

c-fertilizer is added to the soil

d-none of the above

56. -Mortality of fish in a pond is because of-

a- decrease of CO_2 in water.

b-fish are cached by human for money

c- increase of CO_2 in water

d- thermal pollution, chemicals dissolved and blockage of gills.

57. Which of the following atom may not contain any neutron in its nucleus?

a) C b) H c) He d) O

58. For discovery of the nucleus, thin which of the following particles was used by Rutherford?

a) α-particle b) β - particle
b) Deutron particles d) Accelerated proton particles

59. For discovery of the nucleus, thin foil of which of the following metals was used by Rutherford?

a) Pt b) Ag c) Au d) Cu

60. If isotones have the same number of neutrons present in the nuclei then which of the following pair of nuclei is isotonic with each other?

a) $^{12}C_6$ and $^{16}O_8$ b) $^{4}He_2$ and $^{7}Li_3$
c) $^{12}C_6$ and $^{14}C_6$ d) $^{18}O_8$ and $^{20}Ne_{10}$

61. If isoelectronic species have the same number of electrons present around their nuclei then which of the following species are isoelectronic?

a) Na^+ and $Mg2^+$ b) F^- and O^{2-}
c) Al^{3+} and C^{4-} d) All of these

62. The number of valence electrons present in the species O^{2-} is :-

a) 6 b) 8 c) 10 d) 4

63. Arrangement of electrons around the nucleus may decide the chemistry associated with the element. Amongst elements H, Li, Na and K The most active elements among these to form monovalent caution is:-

a) K b) Na c) Li d) H

64. Which of the following is NOT one electron system?

a) He^+ b) $Li2^+$ c) H^- d) H

65. When an object is moving with uniform velocity., what is its acceleration

a. Zero
b. Uniform
c. non- uniform
d. negative

66. For the equations $S = 10$ to $+ P t^2$ What is the acceleration of the body.

a. 8 m/s^2
b. 10 m/s^2
c. 4 m/s^2
d. 8 m/s

67. The instrument used to measure instantaneous speed of a vehicle.

a. Accelerator
b. Speed ammeter
c. Ammeter
d. Multimeter

68. Which type of motion is hands of a clock.

a. circular
b. rectilinear
c. periodic
d. non of above.

69. A body moving unequal displacements in equal interval of time. The velocity is known as

a. Average vel
b. instantaneous vel
c. non uniform vel
d. non of the above.

70. A car moving with constant speed has

a) No force acting on it

b) Constant force is acting on it

c) gravitational force acting on it

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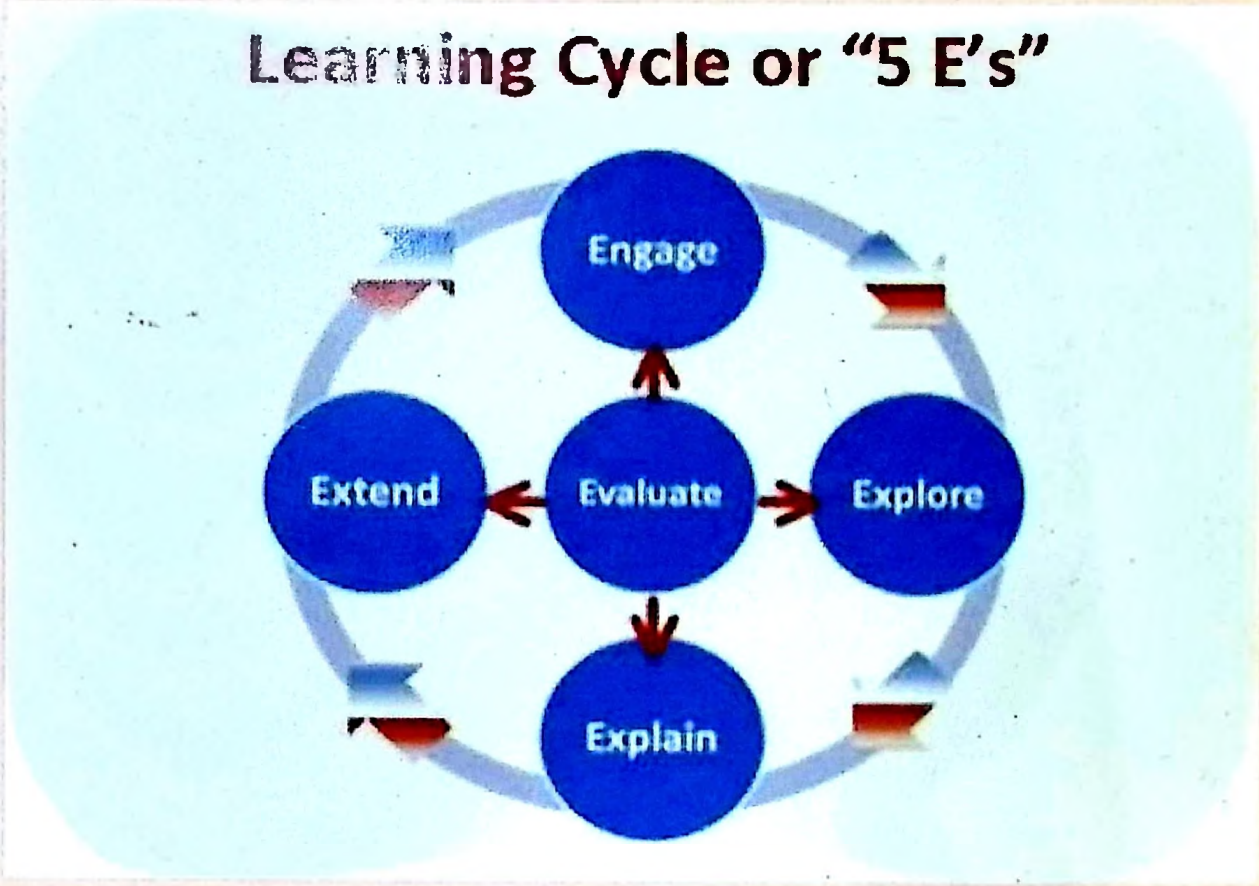

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