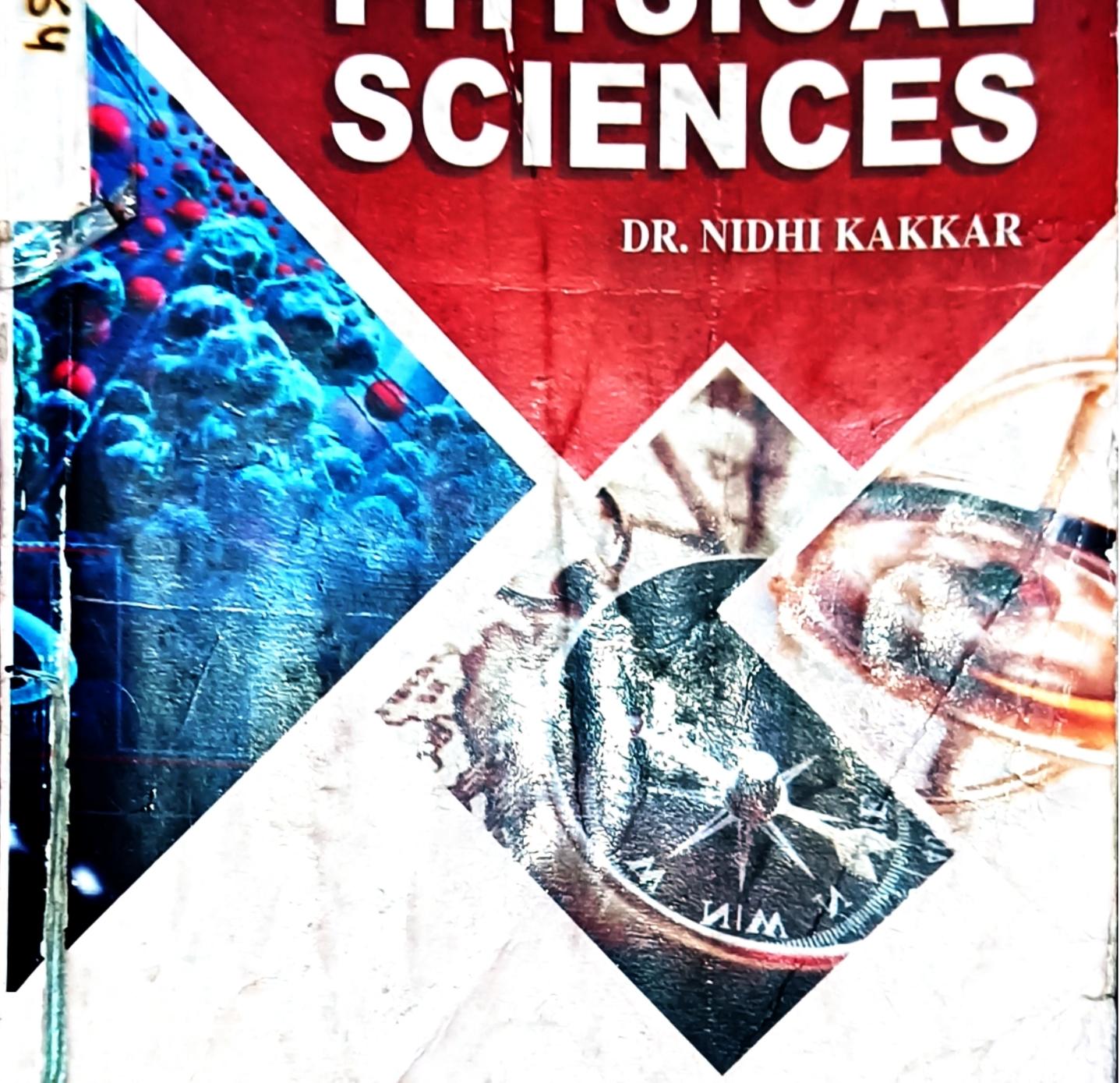


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PEDAGOGY OF PHYSICAL SCIENCES

DR. NIDHI KAKKAR



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CHAPTER 1

Nature, Concept & Scope of Physical Sciences and its Place in the School Curriculum

"The progress, welfare and security of the nation depend critically on a rapid, planned and sustained growth in the quality and extent of education and research in science and technology. Science is universal and so can be its benefits. Science represents a cumulative and cooperative activity of mankind and its rate of growth is externally rapid.

– Indian Education Commission (1964-1966)

"Science have become essential component in any educational enterprises, they must be incorporated into all educational activity intended for children, young people and adults, in order to help the individual to control social energies as well as natural and productive ones thereby achieving mastery over himself, his choices and actions, and finally, we must help a man to acquire a scientific turn of mind so that he becomes able to promote science without being enslaved by it".

– UNESCO'S International Education commission (1972)

CONCEPT OF SCIENCE

Science has been derived from the Latin word "Scientia" which means knowledge.

According to B.F Skinner

Science is first of all a set of attitudes.

It is disposition to deal with facts rather than with what someone has said about them.

According to Albert Einstein

Science searches for relations which are thought to exist independently of the searching individual.

According to Griggs

In the literal sense, science means the pursuit of knowledge, but it has wider connotation for our purpose, and can be said to mean knowledge of nature in the widest possible form. This includes nature study, physics, astronomy, meteorology and much more. It is equally important to look beyond more precise definition and see what science includes and the following are of fundamental importance to the approach to this subject:

1. Direct and indirect observations.
2. Scientific inquiry – asking questions
3. The drawing of inference from evidences.
4. Recording observations.
5. Developing ways and means to find answers.
6. Classification and checking evidences.

Few points about the meaning of science

- ☐ Science is process as well as the product of that process. in its process form it suggests the ways and means of exploring the truth and in its product form it presents a systematic and organized body of useful knowledge.
- ☐ The process form of the science is more important than its products form as the way of exploring the truth and acquiring knowledge is always given more preference in science than the more memorization or gaining knowledge of the accumulated facts.
- ☐ The science constantly remains in the search for truth and what it gets on account of this search can never be taken as absolutely and permanently true. These results can be challenged and modified or altered in view of the further explanation and findings. Therefore science by its nature is always dynamic and not static.
- ☐ The method or process adopted by science in the explanation of truth is quite unique and distinct from the methods, adopted in such study by other subjects. It is known as scientific method

NATURE, CONCEPT & SCOPE OF PHYSICAL SCIENCES.....

and is characterized by the qualities like logically sound, highly valid as well as sufficiently reliable, impartial and objective in its procedure and approach.

- ☐ Science through its study helps in bringing a typical change in the attitude of its readers and followers. The development of such attitude is known as scientific attitude. The person having such attitude is found to have love for the explanation of truth by adopting true for such explanation and believing in the result of such true findings.

Thus, in view of its true nature and temperament, science may be seen to discharge two types of responsibilities, namely :

1. Investigation and exploration of the facts and.
2. Building of a systematic and organized body of facts as a result of such explanation

In reaching its second stage, science attempts to provide us such systematic and organized information comprising scientific facts, concepts, generalizations, laws and theories which may prove helpful to all of us not only in enhancing the Span of our knowledge but also in finding the solution of our problems and making our life happier as much as possible.

Characteristics of science

1. **It deals with Logical Reasoning** : It deals with what and why of the happenings in the present. It usually focuses its attention over the problem like what exists, why is it happening, what would happen. If it continues in the same way etc.
2. **It uses the Scientific Method** : A special method called scientific method is used for carrying out the study. This method is well known for its superiority in terms of objectivity, reliability and validity over all the other methods used in the study of other subjects.
3. **A self-Generating Process** : Science is a self renewing, self-correcting and self – generating process.
4. **Science concepts are Developed Systematically** : Scientific concept are generated by the workers going through the process of science. Scientific concepts are developed while conducting laboratory work and field study.
5. **Scientific Instruments and Appliances are used** : The instruments and appliances used for carrying out experiments

in sciences are quite special in nature. The results obtained through these instruments are known for their comprehensive, reliability validity and objectivity beyond a least scope of any doubt.

6. **It develops the Scientific attitude among the Learners :** It brings the desirable modification in the attitude and behavior of the learners. Gradually an attitude known as scientific attitude is developed among them and consequently those who study sciences begin to imbibe the qualities like impartiality, objectivity and truthfulness in their behavior.

7. **Different from the other forms of Knowledge :** It is evident that basic postulates and assumption employed for studying and discovering facts in science is different from other forms of knowledge. These are

- ❖ There is essentially some definite cause linked with the occurrence of an event.
- ❖ The cause of an event is not related with super natural powers but are essentially physical and mechanical in nature.
- ❖ What occurs in this world in the form of events or happenings is governed by definite laws and principles known as scientific laws or principles.

The causes for the happening of events can be studied in a quite scientific way involving objectivity, reliability and validity.

8. **Science is objective in Nature :** Science establishes its objectivity through observation, experimentation, formulation of hypotheses and their testing and then by drawing relevant inferences.

9. **Science has the ability to Predict :** Through the scientific study of variables involved and causes lying behind the happenings of the events it can safely predict the future happenings in their complete shape and styles. Under the given conditions what would happens to a particular object or in what way an event is going to occur can be predicated quite accurately with the help of scientific facts, laws and principles.

PLACE OF PHYSICAL SCIENCE IN SCHOOL CURRICULUM

Science and technology have become essential components in any educational enterprise, they must be incorporated into all educational activity intended for children, young people and adults, in order to help the individual to control social energies as well as natural and productive ones thereby achieving mastery over himself, his choice and actions and finally, we must help a man to acquire a scientific turn of mind so that he becomes able to promote science without being enslaved by it.

– UNESCO'S International Education Commission (1972)

The rapid advancement of science and technology is visible everywhere. Science influenced the every aspect of man's life. So it becomes the dire need to provide science based education in school. Today, an understanding of science is useful to live successfully. But for gainful employment in the field of science and technology. It is essential to acquire specialized knowledge in one of the branches of science. In other words, it can be said that to understand one's environment and to become a partner in the growth of science and technology. It is essential to acquire specialized knowledge of science. It will make a person scientifically literate citizen who can live efficiently and can take proper decisions. The Secondary Education Commission has recommended that every secondary school pupil should study general science as a compulsory subject, so that he gains a basic quantum of scientific knowledge as a part of his general education. In addition, provision should be made for providing elective subjects in science for those students who want to pursue higher study.

Therefore, the youth today need scientific knowledge to understand the nature in which they are living.

Our future is directly linked to scientific advances and the development of productive activity. Therefore, science has a respectable place in the school curriculum.

Keeping all this in mind through the efforts of National Council of Educational Research and Training (NCERT) science has been made a compulsory subject throughout the school stage.

"We lay great emphasis in making science an important element in the school curriculum. We, therefore, recommended that science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling. In addition, there should be provision of special courses in these subjects at the secondary stage, for students of more than average ability".

– Kothari Commission (1964-1966)

APPLICATION/VALUES OF PHYSICAL SCIENCE IN DAY TO DAY LIFE

Inclusion of science in school curriculum is important and essential due to the following values of the subject

1. Intellectual Value

According to American Association for the advancement of science 1958. "We believe that the primary goal of education should be intellectual development of an individual.

Science is organized in common sense. It has introduced us to new ways of thinking and reasoning. It gives us a real insight ourselves and the things around us. It provides a unique training in truth, inculcates a spirit of enquiry, the capacity to know the unknown and the strength to face hardships and failures. The queries like "why" and "how" of all problems and phenomenon can be satisfactorily answered only by wisdom of science. Thus the individual begins to reason things he meets in daily life and discharges his duties in a better manner and leads a happy, successful and satisfying life.

2. Utilitarian Value

According to Herbert Spencer : The knowledge gained through science is much more useful in guiding our lifestyle than gained through other sources.

We are living in the age of science and technology from the time we get up in the morning till we go to bed, all our activities are controlled and fashioned by science. Science has changed the way of life, the society and the tradition of the countrymen. We are becoming more and more dependent on scientific discoveries and their daily applications. The applications of science in various fields like: Communication, transportation, medicinal value, health etc. is marvelous.

Man has controlled almost all diseases. Today we have sulphur drugs, antiseptics, antibiotics, vaccines, blood transfusions, principles of balanced diet etc. it also help us to solve various problems regarding pollution, population growth, ecological imbalances etc.

Knowledge of the facts and principles of science and their application results in better understanding of the world and a more rational mode of life. Such knowledge is useful to the individual and the community as a whole.

3. Vocational Value

Science forms the basis of many of the studies of a purely vocational nature and thus prepares pupils for various professions like medicine,

engineering, agriculture, poultry farming and dairy farming. There is lot of scope in house-building. Road building, Engineering, Medical Science, Radio and Television Broad- casting and research are other modern vocations due to advancement of science.

4. Cultural Value

"If science is to be pursued with full vigor and zest and is to become a mighty force in the Indian renaissance, it must derive its nourishment from our cultural and spiritual heritage and not by-pass it. Science must become integral part of our cultural and spiritual heritage.

Science is progressive science has its own literature which makes an appeal in the way less powerful and elevating than the humanistic studies. The history of scientific discoveries, the adventures of scientists, their style of living, place science in highest rank of humanistic studies. Science produces in us that breath of imagination which is essential for a proper solution of the problems of life. From these things we have evolved this civilization and culture. Incidentally it places on us a great responsibility of saving this culture and civilization. We should use science for the welfare of mankind not for destructive purpose.

5. Moral Value

Science develops three basic facts "Truth" "Goodness" and "Beauty". Science is an activity where truthfulness is necessary for getting success. A person who misrepresents his observation or deliberately makes fictions argument to draw conclusion deceives himself as a scientific man. He only wastes his energy and time for nothing. It is said that science is the search for truth in truthful manner.

Science includes the various traits of morality i.e. Truth, justice, punctuality, determination, patience, self- control, self-confidence and tolerance are automatically developed in man if he follows scientific method in his pursuit of knowledge. The habit of lawfulness, the faculty of distinction between right and wrong and respect for other's point of view are some other desirable traits of character developed through the study of science.

6. Aesthetic value

Faraday once wrote to Tyndall, "I am old and you are young but then our subjects are so glorious that to work on them rejoices and encourages the feeblest, delights and enchants the strongest."

Every scientist relished the aesthetic aspect of his discoveries and inventions. He feels an intrinsic charm in unfolding the pleasures of nature and natural phenomenon. He manifests his aesthetic impulse when he undertakes a probe for universal law and comprehensive theories.

Moreover, science is an art. Every man of science is an artist. Actually there is no fundamental difference between art and science. An artist aims more deliberately at beauty while a scientist ultimately comes to beauty through reasoning and truthfulness. As it is rightly said by a well-known English poet Keats, 'Truth is Beauty'.

7. Psychological Value

The processes of science are based on the principles of psychology. The principles of 'learning by doing', 'activity method', 'learning by observing concrete and living specimens' are primary things in psychology. Science also fulfils the psychological needs of man. The instinct of curiosity is responsible for the urge of investigation, experimentation and research. In this way the study of science develops all the latent faculties of a child.

8. Social value

In the world of science and technology society also stands on the pillars of scientific techniques and knowledge. All our activities depend upon science. It has given us eyes in the form of telescope, communication in the form of mobiles and internet, wings in the form of helicopters, aeroplanes and rockets. So for the development of any society or nation scientific advancement is very necessary. So science also teaches us to become the responsible citizen of not only society or nation but of world.

9. Value of Scientific Method

The study of science helps the students to attack the problem according to definite procedure. This specific procedure is known as 'scientific method.'

The scientific method involves the following steps:

1. The problem is stated.
2. Collection of observations.
3. Hypothesis consistent with the observations is formulated.
4. Predictions of other observable phenomenon are deduced from the hypothesis.
5. Occurrence or non-occurrence of the predicted phenomenon is observed.
6. The hypothesis is accepted, modified or rejected in accordance with the degree of fulfillment of the predication.

The above method is also needed in solving all the problems of our daily life.

10. Value of scientific attitude

According to Canon Wilson (1867):- "Science is the best teacher of accurate, acute and exhaustive observation of what is, it encourages the habit of mind which will rest in nothing but what is true, truth is the ultimate and only object and there is the ever recurring appeal to facts as the test of truth; "Science teaches us what evidence is what proof is". Every activity or subject has got its own specific disciplines to inculcate among the pupils. The teaching of science has peculiar disciplines, popularly known as scientific attitude, to develop among the learners. These attitudes or discipline include open mindedness, keen observation, critical thinking, suspended judgments and free from bias or superstition.

Such qualities once developed will prove very beneficial in later life of the student.

EVALUATE YOURSELF

1. Explain the meaning of Physical Sciences and give definitions of reputed educationists.
2. Explain the nature and concept of Physical Sciences. What is its scope in the modern world?
3. Define the Concept of Physical Sciences. Also state its nature and its scope.
4. Define the Concept of Physical Sciences. What is its place in the School Curriculum?



CHAPTER 2

History of Physical Sciences with Special Emphasis on Teaching of Physical Science

History of Physical Sciences: Physics is the fundamental branch of science that developed out of the study of nature and philosophy known, until around the end of the 19th century, as “natural philosophy”. Today, physics is ultimately defined as the study of matter, energy and the relationships between them. Physics is, in some senses, the oldest and most basic pure science; its discoveries find applications throughout the natural sciences, since matter and energy are the basic constituents of the natural world. The other sciences are generally more limited in their scope and may be considered branches that have split off from physics to become sciences in their own right. Physics today may be divided loosely into classical physics and modern physics.

As regards the contributions of great Indian Scientists Maharishi Kanada was the first to systematically develop a theory of atomism around 200 BC. It was further elaborated by the Buddhist atomists Dharmakirti and Dignāga during the 1st millennium CE. Pakudha Kaccayana, a 6th-century BCE Indian philosopher and contemporary of Gautama Buddha, had also propounded ideas about the atomic constitution of the material world. These philosophers believed that other elements were physically palpable and hence comprised minuscule particles of matter. The last minuscule particle of matter that could not be subdivided further was termed Parmanu. These philosophers considered the atom to be indestructible and hence eternal. The Buddhists thought atoms to be minute objects unable to be seen to the naked eye that come into being and vanish in an instant. The Vaisheshika School of philosophers believed that an atom

was a mere point in space. Indian theories about the atom are greatly abstract and enmeshed in philosophy as they were based on logic and not on personal experience or experimentation. In Indian astronomy, Aryabhata's *Aryabhataiya* (499 AD) proposed the Earth's rotation, while Nilakantha Somayaji (1444–1544) of the Kerala School of astronomy and mathematics proposed a semi-heliocentric model resembling the Taconic system.

Contribution of Indian Scientists: From C. V. Raman to Salim Ali, the talents of Indian scientists and inventors have been fully established in many different areas, including physics, medicine, mathematics, chemistry and biology. Some of them have also contributed in a substantial way to advanced scientific research in many different regions of the world. Some of the prominent Indian Scientists whose name come into mind including their contributions are narrated hereunder:

Prafulla Chandra Ray: (1861-1944): Famous academician and chemist, known for being the founder of Bengal Chemicals & Pharmaceuticals, **India's first pharmaceutical company.**

Salim Ali: (1896-1987): Naturalist who helped develop Ornithology; also known as the “birdman of India”.

Srinivasa Ramanujan: (1887-1920): Mathematician known for his brilliant contributions to contributions to mathematical analysis, number theory, infinite series and continued fractions.

C. V. Raman: (1888-1970): Sir Chandrasekhara Venkata Raman, General Fellow of Royal Society of London (FRS) was an Indian physicist, born in the former Madras Province, whose ground breaking work in the field of light scattering earned him the 1930 Nobel Prize for Physics.

Homi Jehangir Bhabha: (1909-1966): Theoretical physicist; best known as the chief architect of the Indian atomic energy program.

Jagadish Chandra Bose: (1858-1937): Physicist, biologist and archaeologist who pioneered the investigation of radio and microwave optics.

Satyendra Nath Bose: (1894-1974): Mathematician and physicist; best known for his collaboration with Albert Einstein in formulating a theory related to the gas like qualities of electromagnetic radiation.

A.P.J. Abdul Kalam: (1931-2015): Known for his crucial role in the development of India's missile and nuclear weapons programs.

Har Gobind Khorana: (1922-2011): Biochemist who won the Nobel Prize in 1968 for demonstrating how the nucleotides in nucleic acids control the synthesis of proteins.

S.S. Abhyankar: (1930-2012): Shreeram Shankar Abhyankar is an Indian Mathematician known for his contributions to Algebraic Geometry.

Meghnad Saha: (1893-1956): Astrophysicist who developed the Saha equation, which explains chemical and physical conditions in stars.

Subrahmanyan Chandrasekhar: (1910-1995): Astrophysicist won the Nobel Prize in 1983 for his research on the evolutionary stages of massive stars.

Raj Reddy: (1937-): Dabbala Rajagopal "Raj" Reddy is an Indian-American computer scientist and a winner of the Turing Award, best known for his work related to large scale artificial intelligence systems.

Birbal Sahni: (1891-1949): Pale botanist known for his research on the fossils of the Indian subcontinent.

Prasanta Chandra Mahalanobis: (1893-1972): Statistician and physicist who founded the Indian Statistical Institute.

Conclusion: In the end, it can be said in a nutshell that the depth and breadth of Indian science and technology is staggering, and the above description gives just an ample glimpse into the genius of India's scientists and engineers.

EVALUATE YOURSELF

1. Write a brief note on the History of Physical Science
2. List the contribution of Indian Scientists in the ever-growing field of science with special reference to their contributions in the field of Physics & Chemistry.
3. Describe some of the major life changing Physical Science discoveries with special emphasis on Teaching of Physical Science.



CHAPTER 3

Aims and Objectives of Teaching Physical Sciences

Note: This Chapter has been further sub-divided into following four Chapters:

CHAPTER 3-A

Differentiate Between the Terms 'Aims' and 'Objectives'

"Science Education will be strengthened so as to develop in the child well-defined abilities and values such as the spirit of enquire creativity, objectivity, the courage to question, and an aesthetic sensibility".

—National Policy on Education (1992)

"The objectives of science education are broad. They demand a program rich in experience that leads towards the intellectual, psychological and social growth of young people".

—Thurber and Collette

Science plays a very vital role in our everyday life. It also has an important place in school curriculum as it brings out the desirable modification in the behavior of students i.e. change in their habits, actions, ways of thinking, living and attitudes towards life.

AIMS AND OBJECTIVES

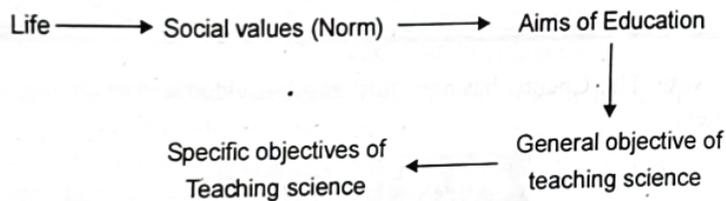
Acc to Redden : Education is the deliberate & systematic influence exerted by the mature person upon the immature through instruction and

harmonious development of physical, intellectual, aesthetic, social & spiritual powers of human being acc. to individual & social need directed towards the union of the educate & his creates as the final end".

This definition explains the aim of education which are to be achieve in the school through the formal teaching of a number of subjects.

Acc. to W. Pauli : "The aim of science teaching Is not the imparting of information & a few skills but to attain the understanding of the relationship which connects the answer to the problem".

There was a time when science was not a compulsory subject in Indian schools even up to matric level. But living in a modern technologically oriented society science has become compulsory subject for all the children in all school as.



AIMS & OBJECTIVES OF EDUCATION

Introduction : All activities have a purpose. A purpose less activity is ineffective. The purpose of the activity is a goal, aim or objective. For achieving a goal effectively. We need to clearly identify the purpose of the activity, plan the experiences & evaluate the success with the help of clear goals. We compare the success of our endeavor in achieving the planned activities. Every science teacher has to know about the aims & objectives of teaching science. It will help the teacher to frame the curriculum, identify the teaching methodology, observe the learning experiences & evaluate learning outputs.

AIMS : Aims are in definite and general in nature. Aims are ideals as long term goals, they are the high expectations that we like to realize as learning outcomes of imparting the knowledge of the science. They also direct the whole teaching programs & are indefinite or also take a long time for achievement. Every science teacher should know about the aims of teaching of science.

OBJECTIVES

The aims of education which can be achieved in a school are called as objective. It is the part of an aim & indicates an end point of possible achievement.

Objectives are immediate attainable goals vary from subject to subject are precise, clearly defined & become meaningful to the students and a teacher in a teaching – leaning situation. They indicate the behavioral changes in the pupil after completion of instructions. It is the expected terminal behavior of the learner.

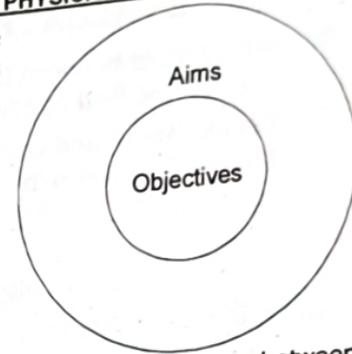


Fig 2.1 Difference between Aims & Objectives

DIFFERENCE BETWEEN AIMS & OBJECTIVES

AIMS	OBJECTIVES
1. Aims are broad & general. They are not of much use to a teacher.	1. Objectives are meaningful & useful to teachers as they are specific, clear & Precisely defined.
2. Aims are directions in education.	2. Objective are the end point of the Possible achievement.
3. Aims are long term goals & are closed to the ideals to be realized.	3. Objective are short term goals and to be achieved through classroom Instructions.
4. A long term planning and some serious Functionable effort on the part of teacher is required.	4. Short term planning within the specified limited resources and time by subject teacher is required.
5. Aims are indefinite in nature.	5. Objectives are definite and specific in nature.
6. The school & society are responsible for their fulfillment as attainment because it involves all round growth.	6. The teacher is responsible for their fulfillment or attainment.
7. They are difficult to evaluate.	7. They can be easily evaluated through the expected behavioral changes or learning outcomes.

EVALUATE YOURSELF

1. Differentiate between the terms 'Aims' and 'Objectives' as regards the field of education.
2. Define 'Aims' and also define 'Objectives'. What are the basic differences between the two terms?

CHAPTER 3-B**Aims of Teaching Physical Sciences at Middle, Secondary and Senior Secondary Stages**

Introduction: Harmonious development of child's personality and social efficiency etc. are the general aims of education. If Physical Science teaching is to be made effective, then its aims should be in accordance with the general aims of education. The following main objectives of Physical Science teaching are:

A. Knowledge: This aim has received the top priority as compared to other aims. Pupils studying Physical Science should acquire the knowledge of:

- (i) Fundamental principles and concepts useful in daily life.
- (ii) Facts for Physical Science study.
- (iii) Inter-dependence and relationship of different branches of science.
- (iv) Knowledge of plants and animals.
- (v) Natural phenomena going on.
- (vi) Knowledge of general rules of health and human body etc.

B. Skills: Physical Science students should acquire skills in experimentation, construction, observation, drawing etc. Experimentation and construction skills include handling, arranging, preserving, and repairing scientific instruments.

C. Abilities: The Physical Science teaching should develop certain abilities such as ability to:

- (i) Sense a problem

- (ii) Organize and interpret
- (iii) Analyse
- (iv) Generalize
- (v) Predict
- (vi) Organize exhibitions, excursions and fairs
- (vii) Discuss, argue and express scientific terminology
- (viii) Improve and manipulate instruments using the acquired knowledge.

D. Attitudes: Physical Science teaching directly inculcates the scientific attitudes among the students. So the students should be taught directly and systematically and every individual should be paid heed to ascertain that he/she develops the desired attitudes and practices them. A student with the scientific attitude is

- (a) Critical in observation and thought
- (b) Open-minded
- (c) Respectful of others' view point and is ready to discuss his problems with others and accepts what appears correct.
- (d) In search of the answers to 'what's' and 'whys' and 'how's' of the things he observes and accepts the natural things as such.
- (e) Objective in his approach to problems.
- (f) Not a believer of superstitions and misbelieves.
- (g) Follower of cause and effect relationship.
- (h) Truthful in his experimentation and conclusions.
- (i) Impartial and unbiased in his judgments.
- (j) Adopts planned procedure in solving a problem.

E. Reflective Thinking: With the above attitudes developed, a Physical Science student will handle a problem scientifically. He will sense a problem, define it, collect evidence, organize and interpret the data, formulate the hypothesis, test its validity and finally draw conclusions impartially. The training in the scientific method should be one of the important aims of teaching Physical Science.

F. Habits: Certain socially desirable habits like honesty, truth, tolerance, self-confidence, self-reliance etc. should be inculcated through the teaching of Physical Science.

G. Interests: The teaching of science should also aim at developing some interests in reading scientific literature, in scientific hobbies, in

activities of clubs, excursions, in natural phenomena; in drawing, in leadership, etc. The motivational techniques like rewards and punishments, praise and blame, rivalry and emulation etc. should be implied by the teacher.

H. Appreciation: The appreciation of natural beauty, scientific inventions, scientists, endeavour must form the outcome of Physical Science teaching. For the purpose the teacher should arrange outings, should relate the life histories of scientists and should keep the students in touch with the new inventions in science.

I. Providing Work for Leisure: As the empty mind is devil's workshop, a Physical Science student should not while away his leisure. He/She can prepare inks, soaps, boot polishes and other daily useful things or he can keep hobbies of stamp collecting, coin collecting, photography, drawing, gardening, study of plants and animals or of minerals etc. He can learn to improvise certain instruments, learn to play for musical instruments along with its construction knowledge.

J. Training for Better Living: A Physical Science student should know the ways and means of prevention and eradication of diseases to maintain good health, and should be able to adjust himself with his own domestic, social environment and economic and cultural conditions.

K. Forming Basis for Career: The attitudes and interests of the students should well be adjudged by the Physical Science teachers and they should impart them the knowledge accordingly. An artist can never be a doctor. So nothing should be forced into the minds of the students. Acceleration should be provided in his own direction to get a suitable vocation and fit himself well in society and prove an asset to it.

Aims at Different Stages: The aims differ a bit at different stages. Preliminary knowledge of objectives is required at early stages while complete and complex objectives are needed at higher stages. So capabilities of pupils should be kept in mind. The aims and objectives of Teaching Physical Science at different stages have been summarized in the proceedings of the All India Seminar on the Teaching of Science in Secondary Schools, published by Ministry of Education in 1956. They are as follows:

Teaching Physical Science at Primary Stage: The aims and objectives of teaching Physical Science at Primary School level should be:

1. Arousing and maintaining interest in nature and in the physical and social environment, arousing love for nature and its sources.

2. Developing the habit of observation, exploration, classification and systematic way of thinking.
3. Developing the child's powers of manipulative, creative and inventive faculties.
4. Developing neat and orderly habits.
5. Inculcation of habits of healthful living.

Teaching Physical Science at Middle Stage: In addition to the above, the following aims and objectives are suitable for inculcation at the Middle School level:

1. Acquisition of a kind of information concerning nature and science which may also serve as the basis for a late Physical Science Course.
2. Developing the ability to reach generalization and to apply them for solving every problem.
3. Understanding the impact of Physical Science on ways of life.
4. Developing interest in scientific hobbies.
5. Inspiring children by stories about scientists and their discoveries.

Teaching Physical Science at Secondary and Senior Secondary Stages: At the Secondary and Senior Secondary stages, the aims of Physical Science teaching should be:

1. To familiarize the pupil with the world in which he lives and to make him understand the impact of science on society so as to enable him adjust himself to his environment.
2. To acquaint him with the 'scientific method' and to enable him to develop the scientific attitude.
3. To give the pupil a historical perspective, so that he may understand the evolution of the scientific development.

M. Kothari Commission (1964-66)-10+2 Pattern/The Indian Education Commission (1964-66) has suggested the aims and objectives of teaching Physical Science at various levels:

1. Lower Primary Stage:

- (i) At the lower primary stage the accent should be on the child's environment-social, physical and biological.
- (ii) In classes I and II, the accent should be on cleanliness and formation of healthy habits.
- (iii) Development of power of observation.

- (iv) In classes III and IV the study should also include personal hygiene and sanitation.
- (v) In classes IV and V children should be taught the Roman alphabets. This is essential as the internationally accepted symbols for the units of the scientific measurement and the symbols for chemical elements and compounds are written in the Roman alphabet.
- (vi) Developing proper understanding of the main facts, concepts, principles and processes in the physical and biological environment.

2. Middle Stage:

- (i) At this stage emphasis may shift to the acquisition of knowledge together with the ability to think logically, to draw conclusions and to make decisions at a higher level.
- ii) Science should be taught as Physics, Chemistry, Biology, and Astronomy. A disciplinary approach to science learning instead of general science would be more effective in providing the necessary scientific base to young people.

3. Secondary Stage:

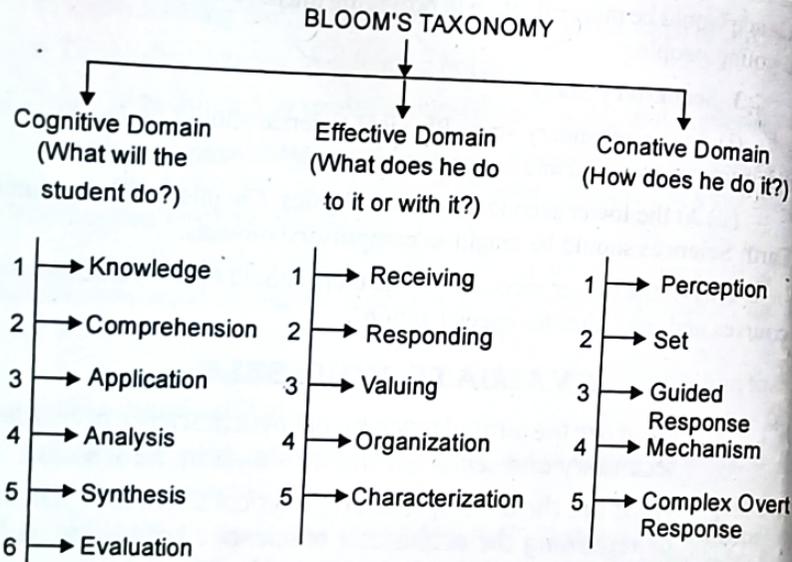
- (i) At the secondary stage Physical Science should be taught as a discipline of the mind and a preparation for higher education.
- (ii) At the lower secondary class's Physics, Chemistry, Biology and Earth Sciences should be taught as compulsory subjects.
- (iii) At the higher secondary stage there should be diversification of courses and provision for specialization.

EVALUATE YOURSELF

1. What are the aims of teaching of Physical Science at middle, secondary and senior secondary stages in the schools?
2. What are the aims of teaching Physical Sciences in schools as regarding the acquisition of scientific knowledge, skills and abilities, etc. by the pupils in the schools?
3. What are the different stages of gaining scientific knowledge in the schools and what are the various aims at those respective stages? Explain in detail.
4. What are the various aims and objectives of teaching Physical Science at various levels in the light of the recommendations made by M. Kothari Commission and the Indian Education Commission?

CHAPTER 3-C

Bloom's Taxonomy of Educational Objectives

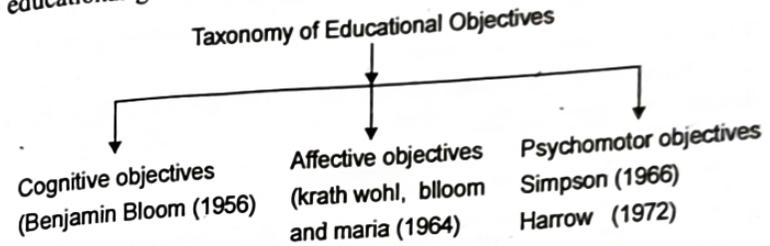


BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES

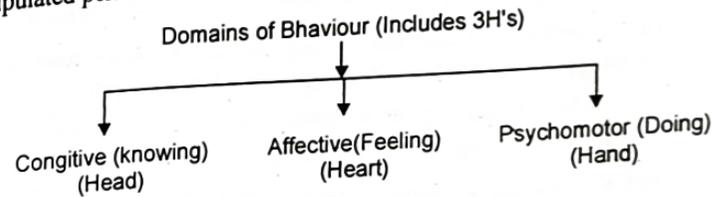
"Taxonomy" means a system of classification and in this sense a taxonomy like bloom's taxonomy presents a system of classification of the objectives. Dr. Benjamin S. Bloom of university of Chicago was the editor of the book 'Taxonomy of Educational objectives' - the classification of Educational goals' produced by a committee of college and university examiners. Taxonomy means a system of classification

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BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES
and Bloom's Taxonomy of Educational objectives has classified the educational goals into three domains.

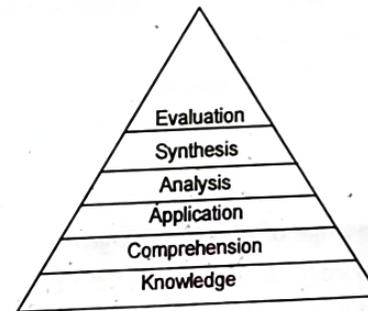


Bloom's instructional objectives are related to learning outcomes which are achieved in terms of change of behavior of learner within stipulated period of fixed duration. Behavior is divided into three domains:



Cognitive Domain

According to Bloom's cognitive domain of the taxonomy consist of six broad categories.

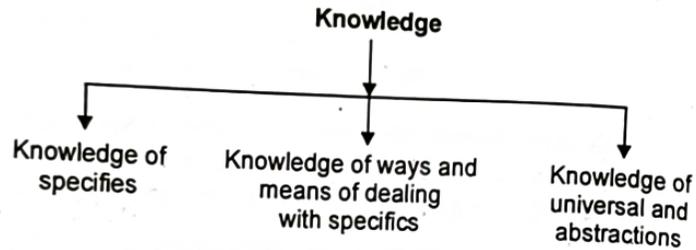


This domain includes those educational objectives which are concerned with the recalling & recognition of the knowledge & development of intellectual skills & abilities. It deals with activities related to head (mind). It comprised of acquisition & manipulation of factual information.

Bloom & his associates have classified the objectives related to cognitive domain into 6 categories arranged from the lowest to highest level of functioning as

1. Knowledge : It is the lowest level of objectives belong to the cognitive domain & primarily aims for the acquisition of knowledge concerning specific facts, terminology, methods & processes; generalized principles, theories & structures.

From the content point of view the knowledge category is further divided into three levels.



(a) Knowledge of specifics : It means recall of specific terminology, facts & information. It is again divided into two.

1. Knowledge of terminology.
2. Knowledge of specific facts.

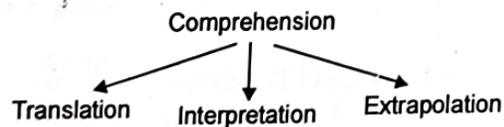
(b) Knowledge of ways & means of dealing with specific : it includes the ways & means of organizing, judging & criticizing. It is further divided into -

- ❖ knowledge of convention.
- ❖ knowledge of trends & sequences
- ❖ knowledge of criteria
- ❖ knowledge of methodology
- ❖ knowledge of classification & categories.

(c) Knowledge of universal & abstractions : It is related with laws, principles, generalization & theories. It classify as

- ❖ Knowledge of principles & generalization
- ❖ Knowledge of stories & structures

2. Comprehension (Understanding) : It is based upon the knowledge. If there is no knowledge, there will be no comprehension. It means basic understanding of the facts, ideas, methods, process, principles, or theories etc.



(a) Translation : The student is expected to translate the communicated knowledge in his own words. It includes

- ❖ Translation of one level of abstraction to other level
- ❖ Translation from one symbolic form to another
- ❖ Translate from one verbal form to another

(b) Interpretation : It means to explain, discriminate, classify, verify, cite examples, to generalize.

(c) Extrapolation : It means to estimate the use of knowledge & extend it to other fields. It includes the process of explaining, differentiation in facts & arrives at conclusions.

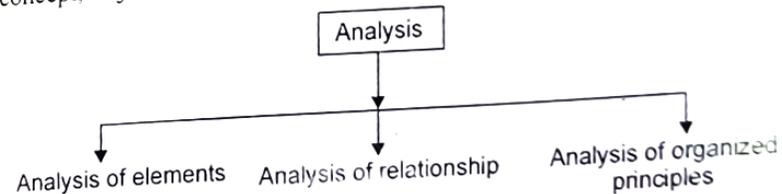
3. Application

For this category, knowledge & understanding are requirements. Application includes the use of abstraction in particular & concrete situations. The facts, principles ideas, rules & theories must be applied. Thus application objective has three levels -

- (a) Generalization of facts, laws, principles & theories
- (b) Diagnosis of pupil's weaknesses.
- (c) Application of contents, terms & laws by the pupils.

4. Analysis

Analysis refers to an understanding at higher level. It is a complex cognitive process that involves knowledge, comprehension as well as application of an idea, fact, principles or theory. It includes the division of matter into its elements & exploring the mutual relationship between these elements & those methods by which they are organized. Through the realization of these objectives the student are expected to acquire the necessary skill in drawing inferences, discriminating, making choices, selection & separating apart the different components or elements of a concept, object or principle.



Analysis of elements : It includes the identification of critical elements included in a communication.

Analysis of relationship : It includes the connections & interactions between both elements & parts of communication.

Analysis of organized principle : It includes the organized and systematic arrangement structure which holds the communication together

5. Synthesis

The objectives belonging to this category aim to help the student to acquire necessary ability to combine the different elements or components of an idea, object, concept or principle so as to produce integrated picture i.e. a figure of wholeness. He may altogether be expected to propagate or present a theory or principle by combining different approaches, idea or view points. He may arrive at something new or originate some novel things or ideas after synthesizing all what is known to him earlier. In this way maximum stress is given on the creative behavior. It includes the activities at three levels.

- Unique combination by arranging different elements :** It involves the development of a communication in which the writer or speaker attempts to convey ideas, feelings, & experiences to other. For example skill of writing the ideas after properly organizing them.
- Suggests new plans by combining all elements :** The plan should satisfy the requirements of a task which may be given to the students. For example ability to plan a unit of instruction for a particular teaching situation, an ability to tell the method of testing hypothesis etc.
- Establish an abstract relationship among different elements:** It includes the development of abstract relations either to classify or to explain particular data or phenomena or the deduction of proposition & relation from a set of basic proposition or symbolic representation.

6. Evaluation

It represents the highest level of the his belonging to the cognitive domain. This category objectives aims to develop in the learner the ability to make proper value adjustment about what has been required by him in the form of knowledge, understanding application, analysis and synthesis. As a result the learner is expected to take proper decision about the value of a particular idea, object, principle or theory. So he may arrive at an appropriate decision about the matter & methods. Evaluation has two levels.

- Judgment in terms of internal evidences :** It includes those evidences for the evaluation of the communication which are internal such as logical, accuracy, consistency etc.
- Judgment in terms of external evidences :** In this the material is evaluated on the basis of selected criteria. These criteria include the methods, rules or norms, with the help of which such decisions are taken.

Summary of cognitive Domain Of Bloom's Taxonomy

Level	Category
Low Level	1. Knowledge
	<ol style="list-style-type: none"> Knowledge of specifics <ol style="list-style-type: none"> Knowledge of terminology Knowledge of specific facts Knowledge of ways and means of dealing with specific <ol style="list-style-type: none"> Knowledge of conventions Knowledge of trends and sequences Knowledge of classifications and categories Knowledge of criteria Knowledge of methodology Knowledge of universal and abstractions in a field <ol style="list-style-type: none"> Knowledge of principles and generalizations Knowledge of Theories and structures
	2. Comprehension
	<ol style="list-style-type: none"> Translation Interpretation Exploration
	3. Application
	<ol style="list-style-type: none"> Application of Abstractions Application of phenomenon of concept Prediction of proper effects
	4. Analysis
Medium Level	<ol style="list-style-type: none"> Analysis of Elements Analysis of Relationship Analysis of Organizational Principles
	5. Synthesis
	<ol style="list-style-type: none"> Production of a unique communication Production of a plan or proposed set of operations. Derivation of a set of abstract relations.
	6. Evaluation
High Level	<ol style="list-style-type: none"> Judgment in terms of Interval evidence. Judgment in terms of External criteria

AFFECTIVE DOMAIN

It deals with feeling i.e related with heart. Bloom, Krathwohl & Maria (1964) have divided the affective domain into following five parts.



(a) **Receiving or attending** : It represents the initial category for the objectives belonging to affective domain. It is directly concerned with the sensitivity of students. Which occurs in the presence of some activity or stimuli. It includes inculcation of certain interests, attitudes, values or ideas. This objective has following three levels.

- (a) Awareness of stimuli or situation or phenomena.
- (b) Willingness to receive these stimuli as to attend situation or phenomenon.
- (c) To control the attention of the learner.

(b) **Responding** : It represents the second level of the objectives for the categories belonging to affective domain. once a learner receive or attends to a particular idea event or thing he must be made to respond to it as actively as possible which is manifested in the active behavior like obeying, answering, reading, discussing recording, writing, & reacting to a stimulus.

Responding has following three levels.

- (1) Learner's obedience for responding.
- (2) Learner's willingness to responding.
- (3) Learner's satisfaction in responding.

(c) **Valuing** : Valuing depends upon both the former categories i.e. receiving and responding. It includes the worth of a thing, phenomenon or behavior. Here the learner is expected to imbibe a definite value pattern towards different ideas, events & objects.

This category has three levels.

- (1) Acceptance of value.
- (2) Preference of value.
- (3) Commitment of value.

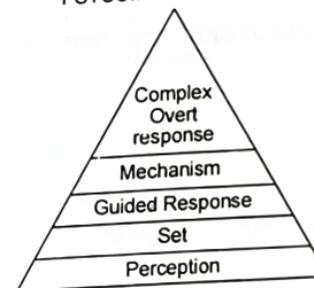
(d) **Organizing** : This category of objectives concerns with the construction of relatively enduring /value structure in the learner by organizing & synthesizing the different value pattern which are imbibed by him from time to time. Ultimately this category of objective leads the learner to form a set valued structure or philosophy of life. It has three types of activities -

- (1) The organization of the values in a system.
- (2) The interrelationship among the values & the determination.
- (3) The establishment of the dominant values.

(e) **Characterization** : It is the highest level category of the objectives belonging to the affective domain. Teacher can characterize the knowledge of system of the pupils very easily. At this stage it is destined to imbibe its own life style two levels.

1. Generalised set
2. Characterization

In fact it is the end point or ultimate goal of the process of education.

PSYCOMOTOR DOMAIN

Psychomotor objectives are concerned with the training of student's physical activities & the development of the skills. This domain include all activities related with hand.

Acc. to E.G Simpson's (1966), the objectives of psychomotor domain are divided in the following five levels.

1. **Perception** : It is lowest level in the psychomotor domain. It is primarily determined with the activities relating to senses. It is always acquired through experience & systematic training.
2. **Set** : It means the initial adjustment which occurs for specific activities & experiences related with mental, physical & emotional levels.
3. **Guided response** : It is the initial stage of developing a practical skill & external behavior of a learner under guidance of another person.

4. **Mechanism** : At this level self confidence & skill for doing some task gets developed in the students.
5. **Complex overt response** : It is said to be the highest level of this domain & learner acquires so much efficiency & skill that can accomplish the most complex task with minimum energy and time.

Thus we conclude that bloom has categorized all the 3 domain of the human behavior into various objectives which are very useful for a teacher in making his teaching learning process effective.

EVALUATE YOURSELF

1. Discuss the cognitive and Affective Domains of Bloom's Taxonomy.
2. Discuss in detail Bloom's Taxonomy of objectives with examples.
3. Explain the six educational objectives as narrated in the Bloom's Taxonomy.
4. Explain the educational objectives determined by Bloom.



CHAPTER 3-D

Instructional Objectives of Teaching Physical Sciences at the School Stage and their Formulation

Characteristics of a good objective

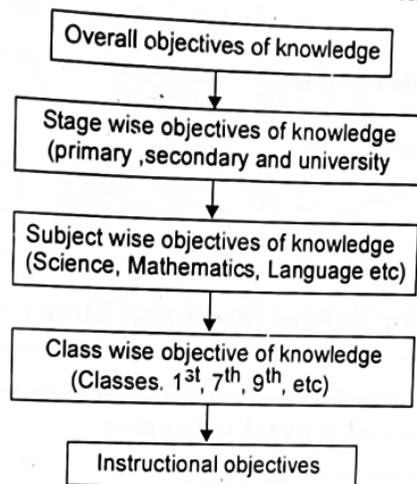
The characteristics are as follows.

1. Clear precise & specific.
2. Describe behavioral outcomes.
3. Attainable.
4. Useful for the students.
5. According to general aims.
6. Appropriateness according to maturity as well as background of the students.
7. Practicability.

The objectives will be considered to be realized if the pupils can

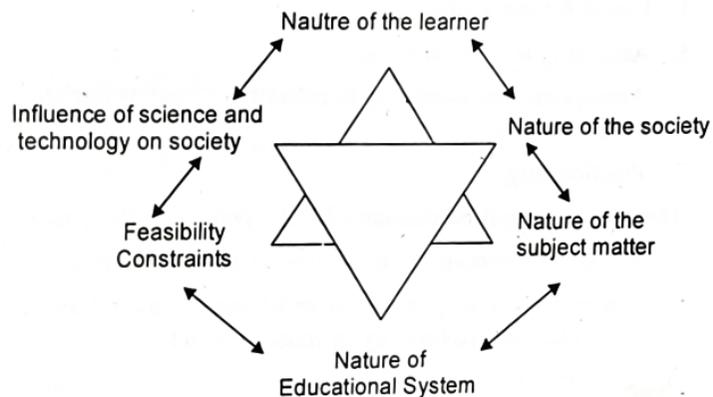
1. Realize the importance of science in human progress.
2. Derive a sense of pleasure in understanding the advancement of science and technology in modern world.
3. Observe the world of things around them and take a delight at the underlying scientific principles, processes etc.
4. Appreciate the contribution made by scientists to human progress.
5. Appreciate the history of scientific developments through the ages.

The main objective of education is the change in the behavior of the learner. So a teacher formulate certain objectives so that desired outcome should be achieved. There are different levels of objectives as:-



BASIS FOR THE FORMULATION OF OBJECTIVES

The main sources for the formulation of objectives are:-



General Objectives of Teaching physical Science at School Stage

Science is taught or learning experiences in the subject of science are given to children for bringing desirable changes. These changes are expected from all the three behavioral domains, namely, cognitive (knowing), conative (doing) and affective (feeling). Therefore when we

INSTRUCTIONAL OBJECTIVES OF TEACHING PHYSICAL SCIENCE

We have to try to mention the objectives of teaching physical science, We have to take care of these three domains in which behavioral changes are expected as an outcome of the teaching and learning of these subjects. Moreover, the different instructional objectives set for this purpose must also be stated in behavioral terms i.e the expected changes in the behavior of the pupil. Let us mention the major objectives of teaching physical science in behavioral terms :-

1. **Knowledge Objective** : The pupil acquires knowledge of the terms, facts, concepts, definitions and processes related with physical science.
2. **Understanding Objective** : The pupil develops understanding of terms, facts, concepts, definitions, principles and process related with physical science.
3. **Application Objective** : The pupil applies his knowledge and understanding of the subject to the day to day activities and the new or unfamiliar situations.
4. **Skill Objective** : The pupil develops various skills like drawing skill, manipulative skills, dissecting spills, collecting, mounting and preserving skills etc.
5. **Interest Skill** : The pupil develops interest in world of science.
6. **Attitude objective** : The pupil develops scientific attitude through the teaching of physical science.
7. **Appreciation objective** : The pupil appreciates the contribution of science to human welfare.

Specification for the Objectives of Teaching physical Science

1. **Knowledge** : It specifies that the pupil should acquire the knowledge of :
 1. Scientific terms, concepts, formulae and processes.
 2. Basic facts to read and understand scientific literature.
 3. Natural phenomenon.
 4. Man's use and manipulation of nature.
 5. Correlation and inter-dependence of various branches of science.
 6. Modern inventions of science.
 7. Human machine and its functioning.

The knowledge aim can be considered to be realized if the pupils recall and recognize scientific terms, facts, concepts, symbols, principles and processes.

2. **Understanding** : When a subject is taught properly, knowledge is transformed into understanding. This objective can be considered to be realized if the pupils can:
1. Explain facts, concepts principles processes and phenomenon.
 2. Discriminate between closely related concepts, facts, principles, processes and phenomenon.
 3. Translate tables, symbols, formulas, terms, and concepts from one form to another.
 4. Interpret charts, graph, data, concepts etc.
 5. Illustrate scientific terms, facts, concepts, phenomenon etc.
 6. Locate errors in faulty statements, concepts, processes, diagrams and experiments.
 7. Identify relationships between various facts, concepts, process and phenomenon.
3. **Applications** : Science teaching in schools must be geared for developing the capacities of application. A pupil, who has realized this objective, will be in a position to:
1. Give reasons for scientific phenomenon.
 2. Draw interences and conclusions from observed facts.
 3. Analyze the given data.
 4. Formulate hypothesis based on observations.
 5. Verify or reject hypothesis.
 6. Give new illustrations.
 7. find cause and effect relationship.
 8. suggest appropriate procedures.
 9. predict new happenings.
 10. Establish relationship between various facts, concepts, process and phenomenon.
4. **Skills** : The pupils through the study of science, are expected to develop these types of skills.
- (A) Drawing skill.
- (B) Manipulative and Experimental skills.
- (C) Dissecting skills.
- (A) **Drawing skill** : The pupils can
1. Draw sketches and diagrams at reasonable speed.
 2. Label diagrams neatly, correctly and methodically.
 3. Draw proportionate diagrams of specimens, apparatus etc.

4. Represent faithfully the various parts of specimen, apparatus etc.
- (B) **Manipulative skill** : The pupils can
1. Keep the apparatus and specimen in order.
 2. Handle apparatus properly.
 3. Improvise apparatus, models and experiments.
 4. Take necessary precautions in handling apparatus and performing experiments.
 5. Perform experiments at a reasonable speed.
- (C) **Dissecting skills** : The pupils can
1. Selects appropriate specimen for the given purposes.
 2. Locates and removes the desired parts of the specimen without any damage.
 3. Displays the req iired parts of the specimen neatly and accurately.
5. **Interest** : it is the function of science to inculcate among the pupils, a living and sustaining interest in the environment in which they live and explore opportunities to satisfy their inner urge of curiosity and creativity. The children who have developed such on interest, will always be on the look out to :
1. Read scientific literature.
 2. Collect specimens, pictures of scientists, scientific information etc.
 3. Take to scientific hobbies.
 4. Participate in debates and declamations on science.
 5. Meet reputed men of science whenever there is an occasion.
 6. Visit places of scientific interest.
 7. Actively participate in science clubs and science fairs.
 8. Undertake some science projects.
6. **Attitudes** : It is one of the most important functions of science teaching to develop and train the pupils for scientific attitude toward life, this quality help the pupils to behave in the following manner. They will
1. Base their judgment on verified facts (not on opinion)
 2. Be free from prejudice and always welcome new ideas and discoveries.
 3. React favorably to efforts made to use science towards human welfare.

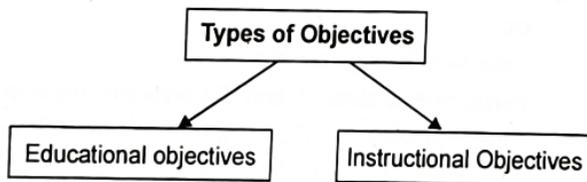
4. Be ready to reconsider their own judgment.
 5. Be free from superstitions.
 6. Be objective in their approach.
 7. Be honest and truthful in recording and collecting scientific data.
7. **Appreciation** : Appreciation can be taught through history of science, modern inventions, life stories of the scientist, impact of modern science on life etc.

The objective will be considered to be realised if the pupils can

- (i) realise the importance of science in human progress.
- (ii) derive a sense of pleasure in understanding the advancement of science and technology in modern world.
- (iii) observe the world of things around them and take a delight at the underlying scientific principles, processes etc.
- (iv) appreciate the contribution made by scientists to human progress.
- (v) appreciate the history of scientific developments through the ages.

Instructional Objectives

Educational Aims : Educational aims are the broad goals, purposes or targets planned to be achieved through education. It is just a simple idea or philosophy but it lacks specificity. These are very difficult and comprehensive to achieve.



Educational Objective : Educational objectives imply the changes that we try to produce in a child by educational activities. These are broad and general, theoretical, indirect and formal, concerned with the entire education. Main source is social philosophy which can be achieved within a long period of duration (from primary to university level).

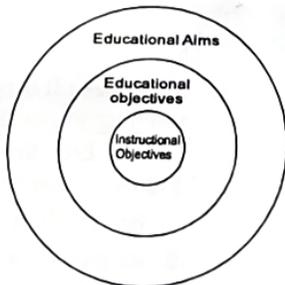
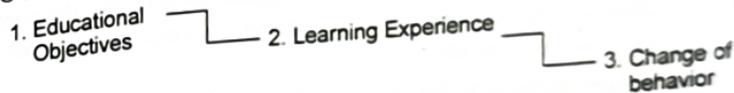


Fig. 2.2 A diagrammatic view of aims and objectives.

Instructional Objectives: Instructional objectives are related to learning outcomes which are achieved in terms of change of behavior of learner within the limited period and means (30 to 40 minutes). They are narrow specific, definite, tangible, precise, clear and functional.

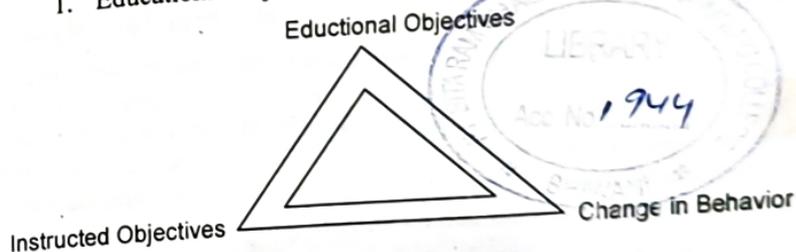
The above figure may well illustrate that instructional objectives are fundamental and basic targets that could be easily achieved with in the limited period and means while Educational aims or educational objectives are quite broad.

Introduction : The objective of educating the children is to improve their understanding, quality of knowledge which leads to modification of the behavior for better living. instructional objectives are identified after analyzing the content to be taught because teaching is a meaningful & purposeful activity. He believes that - EDUCATION IS A TRIPOLAR PROCESS



Objective : It is a statement or a form of category which suggests any kind of change. it provides direction to organized activities which is designed for achieving ultimate goal. Objectives are classified into two categories.

1. Educational objectives
2. Instructional objectives



RCEM APPROACH

Writing objectives in behavioral terms

The learning objectives occupy the central place in teaching because the teacher has to make use of these in his teaching. With the help of these objectives the teacher can present the lesson plan in a well balanced & well planned way.

Specifications of objectives in a task of teaching & learning may prove more affective & purposeful if they are translated into behavioral languages.

The structure of the educational or instructional objectives consist of two parts.

1. Modification part

2. Content part

Modification part : This part represents the behavioral changes that are designed to occur in the behavior of the learner through the related instruction as learning experiences.

Content part : This part refers to the syllabus in particular and to the curriculum in general to be covered by the related instruction.

Therefore, the writing of an objective in behavioral terms is always done in relation to the following three things.

1. The nature of the objective i.e knowledge, application etc.
2. The area or domain of the behavior i.e cognitive, affective.
3. The specific content areas in which behavioral changes are planned to be brought about i.e measurement of temperature, sources of heat etc.

There are several methods of writing objectives in behavioural terms. The three main approaches are as follows :

1. Robert Mager's approach
2. Robert Miller's approach
3. RCEM approach (Regional college of Education, Mysore)

RCEM Approach - (Regional College of education, Mysore)

Both Mager's & Miller's approach have remained unsuccessful in the task of writing all instructional objectives belonging to all the three domains of the behavior where Mager's approach serves the purpose of cognitive & affective objective. Miller's scheme is meant for psychomotor objectives. Both of these approaches lay emphasis on associated action verbs.

On account of these limitations both these approaches have come into severe attack in our country & now being replaced by a more reasonable approach known as RCEM approach developed by regional college of education, mysore.

The basic principle of RCEM approach is that a person can learn to the maximum through his own mental process & abilities. In this scheme lengthy list of action verbs like Mager's & Miller's have not been used. RCEM also adopted Bloom's taxonomy of educational objectives with slight modification in it.

Bloom taxonomy divided cognitive domain into six categories.

1. Robert Mager's Approach : According to Robert Mager (1962) objectives are described in terms of the terminal behavior expected from the learners. Mager's approach has adopted Bloom's taxonomy as a starting base for the writing of objectives. He explains the objectives of cognitive and affective domain. A list of associated action verbs for cognitive and affective domain is shown below.

List of Associated action verbs for cognitive domain

Cognitive Objectives	Associated Action Verbs
1. Knowledge	Define, list, Label, measure, name, recall, recognize, select, Reproduce, state, write, underline.
2. Comprehension	Change, classify, distinguish, explain, formulate, identify, justify, name, illustrate, summarize, translate.
3. Application	Change, Choose, Construct, Compute, Discover, Demonstrate etc.
4. Analysis	Analyse, Associate, compare etc.
5. Synthesis	Argue, Conclude, Derive, Discuss etc.
6. Evaluation	Choose, Criticize, Determine, judge etc.

List of Action verbs for Affective Domain

Affective Domain	Associated Action Verbs
1. Receiving	Ask, Accept, Discover, Identify, Observe, Prefer, Receive, Select etc.
2. Responding	Answer, Complete, Derive, Discuss, List, Write, Assist, Record.
3. Valuing	Accept, choose, demonstrate, Discriminate, Prefer, recognize Indicate, Attain.
4. Organizing	Associate, Compare, Correlate, Judge, Find, Determine, Relate, Select, synthesis.
5. Characterization	Accept, Decide, Change, Identify, Develop, Prove, Verify, Discriminate.

2. Robert's Miller's Approach : Robert's Miller's Approach is used for writing psychomotor objectives in behavioral terms. Miller put forward his scheme based on skill analysis. He also gave a list of associated action verbs for the psychomotor domain.

List of Action Verbs for Psychomotor Domain

Psychomotor Domain	Associated Action Verbs
1. Reflex movements	Relax, Stretch, jerk, Lengthen, Straighten etc.
2. Basic fundamental Movements	Jump, Catch, Drink, Walk, Run, Begin etc.
3. Physical abilities	Increase, Start, Stop, Begin, Bend, Conduct, etc
4. Perceptual abilities	Smelling, Hearing, Throw, Write, Catch, Balance etc.
5. Skilled Movements	Dance, Drive, Play, Swim, Speak, Type etc.
6. Non-Discursive communication	Sit, Smile, Stand, Mimic, Pose, Sketch etc.

RCEM scheme have only four categories. The three (analysis, synthesis & evaluation) categories of bloom's taxonomy have been merged & made only one category termed as creativity in RCEM & all the these four categories are divided into 17 mental processes or abilities. These are given as follows.

Bloom's Taxonomy of objectives	RCEM system of Objectives	Mental Processes/Abilities
Knowledge	Knowledge	1. Recall 2. Recognize
Comprehension (Understanding)	Understanding	1. Seeing relationship 2. Cite example 3. Discriminate 4. Classify 5. Interpret 6. Verify 7. Generalize
Application	Application	1. Reason out 2. Formulate hypothesis 3. Establish Hypothesis 4. Infers 5. Predict
Analysis Synthesis Evaluation	Creativity (skill)	1. Analysis 2. Synthesis 3. Evaluate

Writing objectives in behavioral terms according to RCEM approach : In order to write the objective, according to subject matter & selection of appropriate mental processes are necessary. The objective is written in behavioral terms by combining the elements of the subject matter & mental activity.

The following types of instructional objectives should be considered for the planning lesson in the subject life science.

1. Knowledge objectives
2. Understanding objectives
3. Application objectives
4. Skill objectives

Following instructional objectives should be written by the teacher before planning the lesson. How a teacher should write instructional objectives are made clear through the following example shown below.

Example No. 1 showing instructional objectives

Subject :- Physical science

Topic : Light and shadow

Instructional objectives : After studying the lesson, students will be able to

Knowledge :

1. Define light.
2. Recall shadow.
3. List various luminous objects.
4. List various non- luminous objects.
5. Name the things essential for shadow formation.

Understanding :

1. Distinguish between luminous and non- luminous objects.
2. Classify objects according to transparent, translucent and opaque objects.
3. Explain the formation of shadow.

Application :

1. Discover the reason for the formation of shadow.
2. Reason out why we cannot see in a dark room.

Skill :

1. Identify the transparent, translucent and opaque objects.

Example No. 2 showing instructional objectives

Subject :- Physical science

Topic : Air Pollution

After studying the lesson, students will be able to

Knowledge :

1. Define air pollution
2. Recognize the pollutants responsible for air pollution.

Understanding :

1. Discriminate air pollutants on the basis of their origin
2. Distinguish the different sources of air pollutants

3. Explain the harmful effects of air pollution.

Application :

1. Suggest some preventive measures to control air pollution.
2. Reason out why smoking is injurious to health

Skill :

1. Estimate the annual air pollution
2. Necessary precautions to avoid air pollution

Advantages of RCEM Approach

1. Development of this scheme in Indian context is its characteristic in itself & is very useful in writing objectives in behavioral terms.
2. In it mental process are emphasized.
3. Objectives of three domains can be written in behavioral term & applicable in teaching & training.
4. More specific than the Mager's & Miller's approach
5. It is useful in writing text- items with much clarity.
6. This scheme has saved the teachers from lengthy list of action verbs.
7. It help in describing objectives in behavioral terms & thus in preparing lesson plan.
8. The objectives of all school teaching subjects can be conveniently written with the help of 17 frames / statements proposed in it. By placing the elements of content in blank spaces.
9. It makes the task of evaluation & test construction quite simpler & objective.
10. The writing of objectives by this method helps the teacher as well as learners to seek their goals more easily & satisfactorily than in case of Mager's & Miller's.

Limitations & Disadvantages

1. In RCEM approach, there is imbalance in the distribution of mental abilities among different objectives of cognitive, affective & psychomotor domain.
2. Selection of a mental process creates difficulty.
3. The distribution of mental processes among the objectives of all the three domains are not equal.
4. In this scheme only 17 mental processes or abilities are included while scientists have mentioned 120 mental processes. Hence 17 mental processes/abilities look too small & incomplete.

5. Under the creativity (skill) objectives only three mental process are mentioned whereas Torrance has suggested five mental processes.
 6. The compiling of abilities within the categories seems to be quite subjective & arbitrary.
- So, it can be concluded that. It is very useful for the teacher to write objectives in behavioral terms which helps in making teaching-learning process effective.

EVALUATE YOURSELF

1. What do you mean by Instructional Objectives? How it is important for teachers to formulate instructional objectives?
2. What are the three domains of educational objectives? Give examples of each of them.
3. Write a brief note on instructional objectives of teaching Physical Sciences at the school stage and the formation of these instructional objectives.
4. What are the characteristics of a good objective especially as regards the field of education?
5. What is the basis for the formulation of objectives? What is the basic difference between educational objectives and instructional objectives?
6. What is Robert Mager's approach of writing objectives? Explain with the help of examples.
7. What is Robert Miller's approach of writing objectives? Discuss this approach with the help of suitable examples.
8. What do you know about the approach given by Regional College of Education, Mysore (popularly known as RCEM approach) of writing objectives in behavioural terms with the help of suitable examples in the light of teaching of Physical Science to the school students?
9. How will you formulate specific objectives in behavioural terms in teaching of Physical Sciences?
10. How did RCEM approach overcome the drawbacks of Mager's and Miller's approach? Discuss.

CHAPTER 4

Physical Science Teacher: Qualities and Responsibilities

Introduction: Physical science encompasses a broad range of scientific subjects. At Middle, Secondary and Senior Secondary stages in the school; the subject of "Physical Science," includes an introduction to a broad range of scientific principles. Topics include physics, chemistry, astronomy, geology, environmental science, biological science, atmospheric science, and earth science. Physical science teachers introduce these to the students to prepare them for more in-depth study later after their schooling is over.

In addition to their regular teaching duties, physical science teachers may also be expected to serve as mentor teachers, study hall supervisors, or sponsors for student clubs and organizations. Physical science teachers should also be available to talk with parents who may have questions or concerns about their students' progress. Those teaching an integrated Physical Science course to younger students have the opportunity to expose their classes to interesting information about a wide range of scientific fields.

For all levels, engaging the students in lab activities, building models, and other hands-on activities helps them understand the concepts taught in lecture in a way that seems relevant to day-to-day life. Field trips to science centers or other nearby places that have programs established for teaching science to school groups are also valuable experiences for the students to understand and enjoy the material.

Qualities and Responsibilities of Physical Science Teacher: The qualities and responsibilities of the Physical Science teachers determine

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to a great extent their effectiveness in the classroom and, ultimately, the impact they have on student achievement. Several specific characteristics of Physical Science teachers' and their responsibilities as well as their behaviors that contribute directly to effective teaching are listed under the following categories:

- The teacher as a person
- Classroom management and organization
- Planning and organizing for instruction
- Implementing instruction
- Monitoring student progress and potential
- Professionalism

1. The Teacher as a Person: Teachers are the representatives of both their content areas and their schools. How teachers present themselves makes an impression on administrators, colleagues, parents, and students. Often a student links the preference for a particular subject to a teacher and the way the subject was taught. In addition, how the teacher interacts with the pupils has an impact on the students' experience in the class. The teacher's personality is one of the first sets of characteristics to look for in an effective teacher. Many aspects of effective teaching can be cultivated, but it is difficult to effect change in an individual's personality. **A teacher as a person and more particularly a Physical Science teacher must have the following qualities and traits of responsibility:**

- Assumes ownership for the classroom and students' success.
- Uses personal experiences to provide real-world examples in teaching.
- Understands students' feelings.
- Admits mistakes and corrects them immediately.
- Thinks about and reflects on practice.
- Displays a sense of humor.
- Dresses appropriately for the position.
- Is responsive to situations and students' needs.
- Enjoys teaching and expects students to enjoy learning.
- Listens attentively to student questions, comments, and concerns.
- Responds to students with respect, even in difficult situations.
- Conducts one-on-one conversations with students.

- Treats students equally and fairly.
- Engages in positive dialogue and interaction with students outside the classroom.
- Invests time with single students or small groups of students outside the classroom.
- Maintains a professional manner at all times.
- Addresses students by name.
- Speaks in an appropriate tone and volume.
- Works actively with students.

2. Classroom Management and Organization: A classroom reveals tell-tale signs of its user's style. Books and other required teaching aids are arranged so that frequently needed ones are easily accessible. The furniture arrangement and classroom displays often reveal how the teacher uses the space. **A Physical Science teacher possesses the following qualities and owns the responsibilities:**

- Manages student behavior through clear expectations and firm and consistent responses to student actions.
- Covers walls with student work, student-made signs, memos, and calendars of student events.
- Emphasizes students addressing one another in a positive and respectful manner.
- Maximizes the physical aspect of the environment.
- Arranges classroom so that all students can see and hear instruction.
- Provides easy access to instructional materials.
- Establishes procedures for running the classroom and handling routine student needs.
- Provides positive reinforcement and specific, timely feedback.
- Notes positive interactions among students.
- Disciplines students with dignity and respect.
- Shows evidence of established student routines for responsibilities and student leadership.
- Exhibits consistency and fairness in management style.
- Involves students in formulating classroom rules.

3. Planning and Organizing for Instruction: An observer in the classroom of an effective Physical Science teacher can quickly comprehend the teacher's work by viewing the daily lesson objectives and activities posted. Further, the teacher is able to share what the class will be doing to follow-up on the lesson of the day. It is important to note, however, that a lesson plan is not a final product; it is merely a description of what should be occurring in the classroom. Thus, a good plan doesn't guarantee high-quality instruction, but a poor plan most certainly contributes to ineffective instruction. **Here, a Physical Science teacher has the following qualities and responsibilities:**

- Writes lesson plans for every school day.
- Develops a syllabus to serve as a blueprint for the school year.
- Gives students an agenda of objectives and activities so that they know the daily plan.
- Uses student assessment and diagnostic data in instructional planning.
- Considers student work samples when writing lesson plans.
- Creates teacher-developed assessments that promote higher-order thinking skills and are aligned with curriculum guides.
- Incorporates state learning objectives into the lesson plans.
- Writes lesson plans with clearly stated objectives that have measurable outcomes.
- Includes use of available materials in lesson plans.
- Incorporates technology in lesson plans.
- Integrates other content areas when appropriate.
- Indicates start and ending times for activities in lesson plans.
- Includes activities and strategies to engage students of various ability levels in lesson plans.
- Writes lesson plans that address review of materials or remediation and enrichment.
- Incorporates effective questioning into lesson plans.
- Addresses different learning modalities and styles in lesson plans.

4. Implementing Instruction: Effective teaching combines the essence of good classroom management, organization, effective planning, and the teacher's personal characteristics. The classroom presentation of the material to the students and the provision of experiences for the students

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to make authentic connections to the material are vital. A Physical Science teacher must ensure that each student in the classroom is achieving instructional goals in a positive classroom environment that is supportive, challenging, and nurturing of those goals. Effective teachers seem to achieve classroom magic effortlessly. **Here, a Physical Science teacher has the qualities and is responsible on the following counts:**

- Uses students' questions and prior knowledge to guide the lesson.
- Responds spontaneously to student questions.
- Helps students to make real-world connections to the content.
- Delivers instruction in a logical, sequential manner.
- Uses pre-assessments to guide instruction.
- Makes subject matter relevant to students.
- Develops elements of an effective lesson.
- Incorporates higher-order thinking strategies.
- Uses a variety of activities and methods to actively engage students.
- Monitors student engagement in all activities and strategies.
- Plans for student-centered classroom rather than teacher-centered classroom.
- Provides specific feedback (verbal, nonverbal, written).
- Designs and bases assignments on measurable objectives.
- Assists students in planning for homework assignments.
- Makes changes to instruction throughout the lesson based on student feedback.
- Encourages student-to-student and student-to-teacher interaction throughout the lesson.
- Provides opportunities for review and practice.
- Focuses learning at the beginning of the class time.

5. Monitoring Student Progress and Potential: Effective teachers and more particularly Physical Science teachers must have a sense of how each student is doing in the classes that they teach. They use a variety of formal and informal measures to monitor and assess their pupils' mastery of a concept or skill. When a student is having difficulty, the teacher targets the knowledge or skill that is troubling the student and provides remediation as necessary to fill in that gap. Monitoring student progress and potential need not be solely the responsibility of the teacher; indeed, an effective

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teacher facilitates students' understanding of how to assess their own performance. Ultimate accountability, however, does lie with each teacher, so students' progress and performance needs to be documented. **Here, a Physical Science teacher possesses the following qualities and owns his/her responsibilities:**

- Provides methods for students to track their own performances.
- Grades homework.
- Gives specific oral and written feedback.
- Documents student progress and achievement over time.
- Makes instructional decisions based on student achievement data analysis.
- Gives pre-tests and post-tests and graphs results.
- Considers multiple assessments to determine whether a student has mastered a skill.
- Uses student intervention plans and maintains records of the plans' implementation.
- Gives informal and formal assessments on a regular basis.
- Makes use of a variety of assessments.
- Provides assessment data that are both accurate and current.
- Provides time and ways for students to self-assess.
- Designs assessments to assess both higher- and lower-level content and skills.
- Provides progress reports in a timely manner.
- Practices differentiated instruction based on assessment analysis.
- Produces class newsletters.
- Maintains class Web page featuring student work and homework assignments.
- Communicates using informal progress reports.
- Uses appropriate and clear language in communications.

6. Professionalism: The effective Physical Science teacher engages in dialogue with students, colleagues, parents, and administrators and consistently demonstrates respect, accessibility, and expertise. Effective teachers are easily identified by their adept use of questioning and by the quality of instruction given in the classroom. The true teacher is a master of teaching. **And for mastering the teaching technique as regards the**

subject of Physical Science; the concerned teacher is expected to have the following qualities and responsibilities:

- Practices honest, two-way communication between teachers and administrators.
- Maintains accurate records.
- Is able to discuss teaching philosophy.
- Attends grade-level meetings and is a true team player.
- Attends and participates in faculty and other school committee meetings.
- Focuses on students.
- Performs assigned duties.
- Volunteers to assist others.
- Seeks community involvement.
- Seeks leadership roles on school committees and teams.
- Works collaboratively with faculty and staff.
- Attends professional development opportunities.
- Provides constructive feedback during meetings.
- Supports school initiatives.
- Submits required reports accurately and on time.
- Writes constructive, grammatically correct communications.

Subject-Specific Qualities of Physical Science Teachers:

Scientific discoveries are constantly adding to and changing the body of science knowledge. Effective teachers engage students in experimentation and discussion of the latest findings and developments taking place in the scientific field.. They are aware of changes and highlight new and older discoveries with students as, together, they investigate and develop an understanding of science.

Role of Physical Sciences Teacher in the Development of Scientific Attitude

Development of scientific attitudes among the students or learners is one of the main objectives of science teaching, because of which various experts have put forwarded their views regarding the methods by which this objective can be fulfilled. Majority of experts consider that this objective can be fulfilled by making use of following things or keeping following points in the mind:

1. Proper Encouragement: During the young age, probability of developing the habit of relying on the superstitions is found to the maximum extent. Such kind of thinking prove to be an important blocker in developing the scientific attitudes among the students, for which teacher should stress on the removal of such impressions of these false beliefs and superstitions through the proper and well-arranged study of science. For this purpose, teacher should provide the task of collecting evidences and beliefs based on their self-observations, experiences and experimentation with the aim to test the validity of such baseless beliefs and superstitions.

2. Organizing Exhibitions: Teacher should encourage the students to find out the evidences on which they base their beliefs. They should be led to the unknown for finding and exploring the further aspects of knowledge. Some opportunities should be provided to the students by which they can experience complete freedom in their thoughts. Teacher should never indulge in such practice by which students can get ready-made responses. All those facilities should be provided in the schools through practices of free thought so that active participation can get developed among the students.

3. Organizing Science Conferences: Experts and teachers from other schools or institutions should be invited and science conferences should be organized in the schools by which scientific attitudes can get developed among them easily and quickly. For developing scientific attitudes among the students, it is necessary that classroom in which science information is imparted, laboratories where various kinds of experiments are being conducted and other places where scientific activities are being conducted be equipped with a sense and spirit of scientific environment.

4. Use of Reference Books: Various reference books are published by prominent authors in addition to the text books. Teachers should make use of such books in the classroom and he should encourage the students to make use of such books to maximum possible extent. In the school libraries, there should be provision of extra science books; as such literature will help in prompting scientific attitude among the students. No science teacher can play effective role in developing scientific attitudes among the students unless and until he does not possess such kind of attitudes.

5. Using Personal Examples: As said that students consider teacher as their role model and try to imitate him in every possible respect. Teacher should make use of scientific methods for imparting information regarding scientific facts and concepts. Not only this, he should make use of his personal experiences during the teaching process. Majority of the experts

are of the view that tendency to copy elders is found among the children because of which teacher will generate his own type of students. A known fact that scientific attitudes can get developed in a person who is free from all kinds of biases and prejudices and who possess the ability to take decisions on the basis of various valid and true proofs.

6. Physical Science Journals: Today, one can find number of journals/magazines which are devoted to science and provide the exercise through which certain kinds of attitudes can be developed among the students. Teacher should have thorough knowledge of such magazines or books and during teaching process, should make use of such sources at frequent intervals. For this purpose, any information provided in any book, journal and even in newspaper can be used. Generally such kinds of information are being provided in the form of pictures in the journals.

7. Co-Curricular Activities in Science Programme: For developing the level of science knowledge among the students and to encourage them to function independently in various functions, it is necessary for the science teacher to organize seminars and discussions in the school from time to time. In such seminars, experts should be called from the other institutions and they should provide information to the students regarding latest developments taking place in the area of science and technology. Not only this, provision of arranging science exhibition should be made by the science teacher and the responsibility to arrange such exhibitions should be laid on the shoulders of students.

8. Effective Use of Laboratory Period: There should be provision of well-equipped laboratory in the schools, where students can get indulged in various kinds of experimentation. As known that in school, students are provided information of various subjects, because of which science teacher gets a specific time period for imparting information to the students. Teacher should make use of obtained time in such a way that students can get opportunities to get involved in various experimentation processes conducted in the laboratory of the school. Science teacher should understand the fact that as science is a practical subject, thus, laboratory period can offer various opportunities for the students to learn certain elements of scientific attitude in them.

9. Use of Scientific Literature: It has been found that students who remain engaged in reading scientific literature and other books get scientific attitudes in themselves developed more easily and quickly in comparison to those who do not engage themselves in such activities. Thus, teacher should encourage the students to read supplementary and reference books written on the science. This can only be done in case there is a separate

Science Library in the school. Science teacher should have love for reading such kinds of books, and then only he can transfer in the students this love for reading and inculcate the ability to use and to understand the information.

10. Developing Appropriate Classroom Atmosphere: The thinking pattern of the students can be diverted towards the inculcation of scientific attitudes if internal setting of the class is properly arranged and the room is decorated in such a manner which helps in contributing to development of proper atmosphere in which information regarding scientific facts and concepts can be imparted. In developing a desirable and appropriate kind of atmosphere in the classroom, science teacher plays a very important and significant role. Teacher should encourage spirit of friendly criticism of procedures, hypotheses and results among the students.

Conclusion: By making use of all the functions discussed above, a science teacher can get scientific attitudes developed among the students. It should be properly understood by the science teacher that his duty does not get finished with imparting information provided in the text books to the students, but he should make all the efforts through which students can get new information. For this purpose, teacher should get himself engaged with the new sources and should try to expand his level of knowledge, as without it, he will not be able to develop level of student's existing knowledge to considerable extent.

EVALUATE YOURSELF

1. What are the qualities and responsibilities of Physical Science Teacher in the school?
2. What qualities a teacher must possess as a person while handing his/her job without comprising on professionalism?
3. How should a Physical Science teacher plan and organize for instruction in the classroom? How he/she should implement the plan and later on how he/she should monitor the progress of the students?
4. What subject-specific qualities Physical Science teacher must possess besides their normal qualities and responsibilities? Explain in detail.
5. Explain the Role of Physical Sciences teacher in the development of Scientific Attitude among the students.



CHAPTER 5

Need for Professional Orientation

Introduction: Teachers vary in terms of how they conceptualize their role, their duties and responsibilities as teachers. Some teachers view their work as taking place solely within their classrooms. They are content to let educational decisions about curriculum, policies made by outside experts and focus their work on implementation issues. Others view their responsibilities as extending beyond classroom teaching to include participation in a larger community of educators and administrators.

Subject-Specific Courses: Traditionally, the job of teaching involved accepting sole responsibility for the education of a small group of students over a period of time. As schools grew in size, the organization shifted to graded classrooms for younger students and subject-specific courses for senior students and having more teachers and students. But the structure of one teacher to each class of 20 to 40 students has remained uniform. Some teachers orient almost to their assigned students using what they have learned in the past to structure their lessons.

The Real Need for Professional Orientation: Teachers with a private orientation have little time for meetings, conferences, or other forms of professional engagement. Novice teachers learn through practice without the benefit of the vast knowledge base of more experienced teachers. Experienced teachers are often seen as resisting change while asserting their right and independence to establish goals, design curriculum and structure their own approach to teaching. More recently, highly interactive technology supported learning materials have been promoted.

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Teachers at the end of the orientation to teaching view their responsibility simultaneously in terms of their relationship to their students and to a larger educational community. What happens in any single classroom is the concern of all teachers as their success is only possible through collective, interdependent effort. Teaching is viewed as a process of continual, reflective inquiry and exchange of ideas with other professionals that lead to the development of a shared technical language and a shared knowledge base.

Teachers today are expected to prepare all students to reach significantly higher academic standards than have ever been attempted. The student community that teachers are asked to work with consists of diverse range of students and has complex learning needs. The theories of teaching and learning besides various methods and approaches urge upon teachers to have extensive intellectual preparation and continual learning. Teaching expertise can grow through reflection, analysis and benefits from an exchange with others engaged in similar processes.

Collaborative practice encourages dialogue over research findings, sharing ideas from conferences and collective work to evolve the most effective strategies for reaching consensus

about good teaching practices. Teachers who adopt a collaborative stance toward teaching are more likely to build a professional identity than those engaged in private practice. This professional identity includes publishing papers, offering workshops and speaking at conferences.

School culture is one of the most powerful variables affecting teaching and learning. Many factors contribute to creating the whole school culture. Schools, like all social organizations for work, have cultures that reward, foster, discourage, or constrain the actions of teachers. Those cultures are partly determined by policies and practices of school leaders, and by a pattern of expectations that emerge from the interactions of participants. Teachers' work orientations contain varying mixtures of attention to their own classroom practice and interest.

The poles of work culture are embodied in contrasting organizational structures that are designed to address fundamental needs of social organization. Hierarchical, bureaucratic structures are characterized by differentiated roles and responsibilities which enable individuals to take clear and authoritative actions based on the expertise that comes from specialization. Such structures produce norms of collaboration, mutual assistance, and collective responsibility and decision-making.

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The expectation that teachers' efforts will be almost entirely directed towards improving student outcomes in their own classroom is consistent with a hierarchical and bureaucratic organizational structure. In this structure, the curriculum— which all students are expected to learn—is defined by education specialists. The teacher's job is to present information and explanations about those topics and skills to their individual classes and to establish a routine of clearly defined activities that efficiently enable students to master the prescribed facts and skills.

Tests are used, not just to judge whether students have mastered what they were taught, but as part of an effort to sort students homogeneously into grade levels, programs, and classrooms. These efforts to specify uniformity in content and tasks across classrooms and to manage diversity by creating homogeneity within classrooms rest on an implicit assumption that effective schooling depends on having the right content transmitted to the most appropriate students at the best time.

The school culture gives each teacher relative autonomy over procedural decisions but at the same time restricts him or her from involvement in fundamental curricular and organizational decisions. School principals, school boards, and state and national policy-makers set the course of action for teachers. They set educational standards, develop frameworks, evaluate materials and mandate the use of specific textbooks. High performance on standardized tests drives the system of education encouraging a focus on content knowledge that is easily tested.

Such a structure is highly functional for certain aspects of the educational enterprise. In particular, it provides a supportive environment that encourages teachers with limited pedagogical preparation or skill to successfully transmit factual knowledge and procedural skills. To be successful, all teachers must be motivated to follow federal, state, district and state mandates and programs and implement them at the classroom level. They need to motivate their students to do the required work.

The most common approaches to reform—admonishing teachers to teach better, raising the stakes for failure, implementing new standards for student achievement and new tests to measure it, and even raising salaries and improving working conditions—do not challenge the bureaucratic school culture. Instead, these reforms are implemented in order to increase efficiency and success. However, others argue that a wholly different school work culture is necessary for the goals of reformers to succeed—a professional culture.

A professional culture type of orientation is a model where individual practitioners give up some degree of procedural autonomy in exchange

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for involvement in negotiating the larger principles and priorities of the educational enterprise sharing beliefs that they, as well as students, are learners, in an evolving structure adapting to individual needs and changing circumstances. Decisions are based on a guiding philosophy about teaching and learning, a deep understanding of current political and social issues, and a thoughtful sensitivity to learning needs of students.

Teaching is a complex integrated whole—one that cannot be decomposed into subsystems mastered one at time in workshops and used as formulas in practice. Instead, teachers need to pool evidence, discuss possibilities, and formulate learning experiences tailored to the changing needs of their specific student population. In doing so, they create a shared knowledge base, common beliefs, and vales about the institution of schooling making it possible for novice teachers to benefit from the experience of the collectivity.

Teachers have limited opportunity to develop broader understandings of the educational enterprise. Powerful norms of privacy, coupled with a practice of having teachers teach all day tend to confine teachers' own intellectual development to procedural and instructional matters. A culture of teacher-professionals drives intellectual engagement with basic issues of curriculum and school organization. Such cultures may be facilitated by a structural reorganization of schools into small units in which teachers take broader responsibility academically and socially.

Teachers engaged in collaborative learning organizations will be able to teach in ways that are compatible with constructivist pedagogy than with traditional knowledge transmission models. Several aspects of school culture seem particularly indicative of the emergence of a professional culture like collaborative work among teachers; the development of common goals and priorities among teachers and between teachers and school site administrators; opportunities for teachers to learn from one another; and collective responsibility for teacher performance in all classrooms.

How teachers organize their classes to a large extent reflects their beliefs about good teaching. Their practices and their philosophies themselves are subject to influence based on their continued experiences in teaching, the values and opinions expressed by their peers around them, and by the expectations of influential others which are transmitted to them through formal rules and procedures and informal norms. It depends upon as to what extent is working in a school culture is professional and collaborative associated with more constructivist teaching practices.

Conclusion: In a nutshell, it can be concluded that the teachers who are actively engaged in a professional community are more likely to employ constructivist-compatible teaching practices than teachers who see their role as primarily one of implementing curriculum in their own classrooms. The teachers who have a professional orientation and who work at a school where a professional culture prevails are more likely to report changes in their pedagogy in a constructivist direction.

EVALUATE YOURSELF

1. What is the need for Professional Orientation of the teachers?
2. What is the real need for Professional Orientation of the teachers in the light of various developments taking place in various subject-specific courses?
3. 'Teachers in the classroom are not just implementers of the given curriculum; they are actively engaged as a professional community.' Discuss.



UNIT - II APPROACHES & METHODS OF TEACHING PHYSICAL SCIENCES

- Development of Teaching Skills through Micro Teaching (Probing Questions, Introducing the Lesson, Explaining, Illustration with Examples, Using Chalkboard and Stimulus Variation).
- Methods of teaching Physical Sciences (Lecture cum Demonstration method, Project method and Problem Solving method).
- Aids, Equipments and Assistance in teaching Physical Sciences:
- Need and utilities of Physic Sciences Laboratory.
- Preparation and use of Teaching Aids.
- Unit and Lesson Planning.
- Popularization and Propagation of Physical Sciences through Science Exhibition, Science Magazine, Science Trip and Science Quiz.
- E-teaching of Physical Sciences using technology for self-learning and collaborative learning of science

CHAPTER 1

Developing of Teaching Skills through Micro Teaching (Skill of Probing Questions, Skill of Introducing the Lesson, Skill of Explaining, Skill of Illustration with Examples, Skill of Using Blackboard/Chalkboard Writing and Skill of Stimulus Variation)

"Microteaching is defined as a system of controlled practice that makes it possible to concentrate on specified teaching behavior and to practice teaching under controlled conditions."

- D.W. Allen & A.W. Eve (1968)

The modern age is leading towards the concept that the teachers are not born, but they can be made. The responsibility of producing competent teachers goes to the training institutions. Educational technology has played the key role in this job. Now the teacher's behavior can be modified. In order to modify teacher's behavior the technique can be effectively used.

Getting in front of students is a terrifying experience for a budding teacher. One may earnestly try to prepare him or herself: read books about teaching methods attend lectures and take courses on communication skill. Yet, in theory everything seems much simpler than in practice. The complexity of a teaching situation can be overwhelming. To deal effectively with it, teachers must not only have a good knowledge of the subject in hand, but also some communication skills such as ability to observe, supervise, lead a discussion and pose questions. Furthermore, a teacher should be aware of how students perceive him or her. This perception is sometimes quite different from the teacher's self-image. It is difficult to self assess one's own abilities and we benefit

from colleagues' feed back to recognize our strength and identify areas for possible improvement.

Evaluation of teaching by students is becoming a common practice, and a constructive feedback could be an effective way to improve one's rating as a teacher. Even the experienced educators may sometimes reflect about strengths and weaknesses of their teaching style

What is Micro-Teaching

Microteaching is a scaled-down, simulated teaching encounter designed for the training of both pre-service and in-service teachers. Its purpose is to provide teachers with the opportunity for the safe practice of an enlarged cluster of teaching skills while learning how to develop simple, single-concept lessons in any teaching subject. Microteaching helps teachers improve both content and methods of teaching and develop specific teaching skills such as questioning, effective reinforcement techniques, and introducing and closing lessons effectively. Immediate, focused feedback and encouragement, combined with the opportunity to practice the suggested improvements in the same training session, are the foundations of the microteaching protocol.

The History of Micro Teaching

Goes back to the early and mid 1960's, when Dwight Allen and his colleagues from the Stanford University developed a training program aimed to improve verbal and nonverbal aspects of teacher's speech and general performance. The Stanford model consisted of a three-step (teach, review and reflect, re-teach) approach using actual students as an authentic audience. The model was first applied to teaching science, but later it was introduced to language teaching. A very similar model called Instructional Skills Workshop (ISW) was developed in Canada during the early 1970's as a training support program for college and institute faculty. Both models were designed to enhance teaching and promote open collegial discussion about teaching performance.

In the last few years, microteaching as a professional development tool is increasingly spreading in the field of teacher education.

Micro-Teaching in India

Micro-teaching in India was introduced in 1976, with the humble attempt made by D.D. Tiwari of Government Central Pedagogical Institute, Allahabad. In 1970, G.B. Shaw experimented with micro-teaching at M.S. University Baroda. Then the Technical Teacher Training Institute, Madras introduced Micro-Teaching to train the Technical teachers. Dr. N.L. Dosajh

DEVELOPING OF TEACHING SKILLS THROUGH MICRO...
used Micro-Teaching as a teaching device in Teachers Training Institute, Chandigarh.

A Few Definitions of Micro-Teaching

D.W Allen (1966), "Micro-Teaching is a scaled down teaching encounter in class size and time."

Buch (1968), "Micro -Teaching is a teacher education technique which allows teachers to apply clearly defined teaching skills to carefully prepared lessons in a planned series of five to ten minutes encounters with a small group of real students, often with an opportunity to observe the result on video tape,"

Allen and Eve (1968), "Micro - teaching is defined as a system of controlled practice that makes it possible to concentrate on specific teaching behavior and to practice teaching under controlled conditions."

David B.Young Micro-Teaching as "a device which provides the novice and experienced teacher alike, new opportunities to improve teaching."

Clift and others (1976), "Micro-Teaching is a teacher training procedure which reduce the teaching situation or simpler and more controlled encounter achieved by limiting the practice teaching to a specific skill and reducing time and class size."

M.C Alleese and Unwin (1970), "Micro-Teaching is most often applied to the use of closed circuit television (CCTV) to give immediate feedback of a trainee teacher's performance in a simplified environment."

Passi, B.K (1976) says, "It is a training technique which requires pupil-teacher to teach a single concept using specified teaching skills to a small number of pupils in a short duration of time."

According to the **Encyclopedia of education (Ed.DeigHton)**, "Micro- Teaching is a real, constructed scaled down teaching encounter which is used for teacher training curriculum development and research."

Characteristics of Micro-Teaching

A few characteristics of Micro-Teaching are as under:

1. It is a teacher training technique and not a method of classroom instruction.
2. It is micro in the sense that it scales down the complexities of real teaching
 - (a) Out of contents, a single concept is taken up at a time.
 - (b) Only one skill at a time is practiced.
 - (c) Size of the class is reduced and thus the number of students is just 5 to 7.
 - (d) Duration of each micro lesson is 6 to 8 minutes.

3. Feedback is provided immediately after the completion of the lesson.
4. The use of video tape and closed circuit television makes the observation very objective.
5. It is highly individualized training device.
6. There is high degree of control in practicing a skill when this technique is used.
7. Micro-Teaching is an analytic approach to training.

Micro-teaching involves actually teaching a real lesson to real pupil with none of the role-playing of earlier modeled teaching situations.

Components of Micro-Teaching

The components of Micro-teaching are:

1. A teacher
2. The pupil (usually 4 or 5)
3. A brief lesson
4. The objectives of the specific Micro-Teaching occasion
5. Feedback by the supervisor, or by using audio tape recording, video tape recordings and closed circuit television.

Assumptions of Micro-Teaching

The assumptions on which Micro-Teaching is based areas under:

1. Teaching behavior of a teacher can be observed in classroom situations.
2. Drawbacks in the teaching competency can be traced out and then they can be improved upon.
3. Complexities of normal class-room situation can be reduced. The size of the class, the duration of teaching, teaching contents etc, can be reduced for giving training to the beginner teachers.
4. Training of specific skills can be given very well taking up on skill at a time.
5. Practice of teaching can be controlled by providing regular feedback.
6. In service teachers can also be better trained through Micro-Teaching technique.
7. Teacher training program can be highly individualized.
8. Observation of teaching can be done objectively by using video-tape and closed circuit television.
9. Feedback to the teacher trainee can be possible immediately. The earlier the feedback to the teacher trainee, the better is his learning the different skills of teaching.

Through Micro-Teaching, the pupil teacher is able acquire 5R's. Recording, reviewing, responding, refining and redoing.

Principle Underlying Micro-Teaching

Micro-Teaching is based on a few sound principles which are briefly explained below:

1. **Principle of one skill at a time** : In micro-Teaching training of one skill is given till the person has acquired mastery over it. Then the second skill is taken up and so on. Thus, we find that Micro-Teaching is based on the principle of giving training of one skill at a time.
2. **Principle of limited contents** : In Micro-Teaching, limited contents are taken up and the teacher is required to use those contents only. It helps the beginner teacher teach that limited material easily and confidently.
3. **Principle of Practice** : Micro-Teaching is based on the sound principle of practice. Here lot of practice is given by taking up one skill at a time. Practice makes a man perfect. It helps the pupil teacher in becoming better and better.
4. **Principle of Experimentations** : A lot of experimentation is involved in Micro-Teaching. The experiment consists of objective observation of actions perfermed under controlled conditions.
The pupil-teacher and the supervisor conduct experiment on teaching skills under controlled conditions. Variables like time duration of the lesson, contents of the lesson to be taught, number of students sitting in the class etc, can be easily controlled.
5. **Principle of immediate feedback** : The micro lesson lasts for four or five minutes only. Thereafter, feedback is provided to the pupil teacher. It helps the pupil teacher to know his drawbacks and improve them effectively without any delay.
6. **Principle of Evaluation** : In micro teaching there is continuous assessment of the pupil-Teacher. Evaluation helps the Lerner know his drawback and then he is able to improve it..
In micro-Teaching each micro lesson is supervised by the supervisor or the peers. Drawbacks in teaching are pointed out and suggestion for improvement is given. Self-evaluation is also possible. Thus, evaluation ensures good learning by the pupil-teacher.
7. **Principle of Continuity** : Learning of different skills of teaching is a continuous process in Micro-Teaching programme. The

pupil-teacher is learning one skill at a time and learning continues till he has mastered the skill. For each skill, the principle of continuity is implied. It makes the teacher good and effective.

8. **Principle of Individualized Training :** In Micro-Teaching, each trainee is given training very thoroughly. There is individual attention by the supervisor. The drawback in teaching are pointed out, suggestions given one by one and thus improvement is brought about,

Importance of Micro-teaching Program in teacher education program

Microteaching is an excellent way to build up skills and confidence, to experience a range of lecturing/tutoring styles and to learn and practice giving constructive feedback. Microteaching gives instructors an opportunity to safely put themselves "under the microscope" of a small group audience, but also to observe and comment on other people's performances. As a tool for teacher preparation, microteaching trains teaching behaviors and skills in small group settings aided by video-recordings. In a protected environment of friends and colleagues, teachers can try out a short piece of what they usually do with their students, and receive a well-intended collegial feedback. A microteaching session is a chance to adopt new teaching and learning strategies and, through assuming the student role, to get an insight into students' needs and expectations. It is a good time to learn from others and enrich one's own repertoire of teaching methods.

Microteaching is an organized method of practice teaching which involves a small group of preceptors/instructors who observe each other's teaching, provide feedback and discuss with one another the strengths of their presentations and potential areas for improvement

Microteaching is so called since it is analogous to putting the teacher under a microscope so to say while he is teaching so that all faults in teaching methodology are brought into perspective for the observers to give a constructive feedback. It eliminates some of the complexities of learning to teach in the classroom situation such as the pressure of length of the lecture, the scope and content of the matter to be conveyed, the need to teach for a relatively long duration of time (usually an hour) and the need to face large numbers of students, some of whom are hostile temperamentally.

Microteaching also provides skilled supervision with an opportunity to get a constructive feedback. To go back to the analogy of the swimmer, while classroom teaching is like learning to swim at the deeper end of

DEVELOPING OF TEACHING SKILLS THROUGH MICRO.....
the pool, microteaching is an opportunity to practice at the shallower and less risky side.

Micro teaching makes the teacher education program, more purposeful, goal oriented and helps to decide common objectives for the program. It provides individualized training with more realistic evidence to students. Which enables them to develop competency in using specific teaching skills in view of their unique needs?

It provides a democratic type of behavior among faculty members and student-teachers.

It provides a facility of supervision which is not critical or threatening type, but is of a helpful and suggestive type, which equips them for transition to school teaching. It is a system of controlled practice that makes it possible to concentrate on specific teaching behavior and to practice teaching under controlled conditions.

This way Micro teaching is a teacher education technique which allows teachers to apply clearly defined teaching skills to carefully prepared lessons in planned series to five to ten minutes encounters with a small group of real students, often with an opportunity to observe the result on video-tape.

COMPONENTS OF MICRO TEACHING

The involvement of the following component in micro teaching is necessary. In the absence of any component the success of this technique is doubtful.

1. **Micro-teaching Situations :** It consists of size of the class, length of the content and teaching method etc. There are 5 to 10 students in the class and the teaching period ranges from 5 to 10 minutes. The content is presented in a unit.
2. **Teaching skill :** The development of teaching-skills of the student's teachers is provided in the training programme such as explaining skill, skill of black-board writing, skill of probing questions etc.
3. **Student Teacher :** The student who gets the training of a teacher is called student- teacher. During training his various capacities are developed in him, such as capacity of class management, capability of maintaining discipline and capacity of organizing various program of the school etc
4. **Feed-back Devices :** Providing feedback is essential to bring changes in the behavior of the students. Feedback can be provided through videotape and feed-back questionnaires

PHASES OF MICRO-TEACHING

Generally the micro-teaching is structured in three phases.

Phase one—Knowledge Acquisition Phase : It is also known as modeling phase. Student-teacher is kept in conditions where observes model teacher who presents the teaching behavior to be learned. Inclusion of modeling in micro-teaching before actual practice is a pragmatic approach which foster the skill learning by student-teachers, as learning by observation is said to occur through informative function of modeling.

Phase two-Skill Acquisition Phase : It is also known as practicing phase. Student-teacher are given opportunity in real classroom situations, but scaled down, to practice the same behavior or skill.

Phase three-Transfer Phase : It is also known as feedback phase. Student-teachers are reinforced for those instances of desired behavior they have acquired and have provision for feed-back for developing the desired behavior or skill up to the mark.

PROCEDURE OF MICRO-TEACHING / STEPS OF MICRO-TEACHING

The following steps are recommended for a successful micro-teaching session – Teaching among teacher-educators and student teachers

Step one—Orientation

Theoretical background, merits and demerits of micro-teaching may be arranged.

Step Two-Discussion of Teaching Skills

Concept of teaching skills should be cleared. At least, five teaching skills should be selected and explained at length with the help of handbooks developed by competent authorities. One skill at a time may be discussed before practice.

Step Three-Presentation of Model Lesson

Model lesson of corresponding skills is demonstrated by the trained teacher educator in selected subjects to the student teacher.

Step Four-Presentation of Micro lesson plan

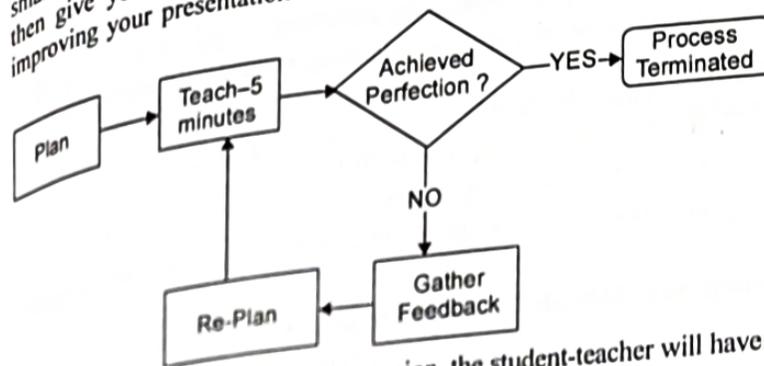
Student-teacher selects one topic or unit for micro-lesson and prepares the lesson plan logically.

The Presentation

Participants of the microteaching session prepare a 'micro lesson' for 5 minutes to be addressed to a 'micro-class' comprising of a small group of peers and a facilitator.

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To plan a 6–8 minutes lesson of your choice, present it before a small group of peers who will role play the students in your class and then give you feedback on your presentation with the intention of improving your presentation and teaching skills.



And so on... At the end of the session, the student-teacher will have:

- Reflected on how best he/she can teach
- Perceived his/her strengths
- Enhanced his/her understanding of various effective teaching styles
- Identified areas for improvement
- Improved his/her ability to provide and receive effective feedback

Components of the microteaching cycle : The Microteaching cycle starts with planning. In order to reduce the complexities involved in teaching, the student teacher is asked to plan a "micro lesson" i.e. a short lesson for 6–8 minutes which he will teach in front of a "micro-class" i.e. a group consisting 5–10 students, a supervisor and peers if necessary. There is scope for projection of model teaching skills if required to help the teacher prepare for his session. The student teacher is asked to teach concentrating one or few of the teaching skills enumerated earlier. His teaching is evaluated by the students, peers and the supervisor using checklists to help them. Video recording can be done if facilities permit. At the end of the 5 or 10 minutes session as planned, the teacher is given a feedback on the deficiencies noticed in his teaching methodology. Feedback can be aided by playing back the video recording. Using the feedback to help himself, the teacher is asked to re-plan his lesson keeping the comments in view and reteach immediately the same lesson to another group. Such repeated cycles of teaching, feedback and re-teaching help the teacher to improve his teaching skills one at a time. Several such sequences can be planned at the departmental level. Colleagues and postgraduate students can act as peer evaluators for this purpose. It is

important, however, that the cycle is used purely for helping the teaching and not as a tool for making a value judgment of his teaching capacity by his superiors.

Step Five-Micro-teaching setting

To set up micro-teaching following variables should be taken into considerations :

- Time; 36 minutes.
- Number of students; 8-10.
- Supervisors; one or two
- Teaching technique of feedback by superior video or audio or supervisor himself

Step Six-Simulated conditions

Peers should act as pupils. Microteaching is conducted in the training college itself.

Step Seven-Practice of teaching skills

At least five skills may be practiced by a student teacher at one time. Any of the five may be selected from the following list of teaching skills.

- Introducing the lesson.
- Probing questions.
- Stimulus Variation.
- Reinforcement.
- Illustrating with examples.
- Encouraging student's participation.
- Explaining.
- Effective use of black-board.

Step eight-Observation of teaching skill

Observation of teaching skill-is done by peers and supervisors

Characteristics of a good quality presentation

The felicitor should tick Yes or No when assessing) the presentation.

The felicitor should tick Yes or No when assessing) whether is the presentation stimulating-

- visualization is clear and well-structured
- includes graphic elements and optical stimuli-
- easily legible writing
- colors help to focus on the important aspects

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- eye contact-
- speaker varies his position
- participants are encouraged to contribute-
- use of humor to create a relaxed atmosphere
- presented with commitment and confidence
- friendly/respectful behavior

Step nine-Immediate feedback is given to student - teachers

Tallies and ratings by peer groups and supervisors may be used for interpretation and feed-back about the performance of student-teacher.

The feedback

Under the guidance of the professional supervisor, the presenter is first asked to present a self feed back of his mini lesson. With this new information taken into account, the supervisory team member who volunteered to be the speaker summarizes the comments generated during the analysis session. This part of the session is intended to provide positive reinforcement and constructive criticism. The presenter is encouraged to interact freely with the team so that all comments are clarified to his/her satisfaction. The way in which feedback is given and received contributes to the learning process. Feedback should be honest and direct, constructive, focusing on the ways the presenter can improve, and containing personal observations.

The following is a series of suggestions on how to give and receive feedback in a microteaching workshop.

Providing feedback

When you are giving feedback, try to develop the skill to give an effective feedback.

- Be respectful, give a specific but detailed comment, start on a positive note, do not be judgmental, maintain collegiality, listen and speak in turn, so that everyone can hear all the comments, complete the Microteaching Feedback Form.
- Be descriptive and specific, rather than evaluative.
- Begin and end with strengths of the presentation.
- Be specific rather than general.
- Describe something the person can act upon.
- Choose one or two things the person can concentrate on.
- Avoid conclusions about motives or feelings.

Receiving feedback

When receiving feedback, try to listen to feedback given during the session: Listen to and acknowledge the positive feedback that so as to focus on the strengths and work on the weaknesses.

- Be open to what you are hearing.
- Not to respond to each point, rather listen quietly.
- Ask for specific examples if you need to.
- Take notes, if possible.
- Judge the feedback by the person, who is giving it.

Step ten-Discussion and Analysis

While the presenter goes to another room to view the videotape, the supervisory team discusses and analyses the presentation. Patterns of teaching with evidence to support them are presented. The discussion should focus on the identification of recurrent behaviors of the presenter in the act of teaching. A few patterns are chosen for further discussions with the presenter. Only those patterns are selected which seem possible to alter and those which through emphasis or omission would greatly improve the teacher's presentation. Objectives of the lesson plan are also examined to determine if they were met. It is understood that flexible teaching sometimes includes the modification and omission of objectives. Suggestions for improvement and alternative methods for presenting the lesson are formulated. Finally, a member of the supervisory team volunteers to be the speaker in giving the collected group feedback. Complete cycle of a micro-lesson by a trainee will take about 36 minutes to be completed.

Precautions in micro-teaching application

- Clarity of objectives is a must.
- Micro-lesson plan should be prepared for one skill only at a time.
- Delivering model lessons is essential.
- Before teaching the student-teacher must prepare his micro-lesson plan.
- Substantial suggestions should also accompany criticism in order to improve the teaching skill of the student-teachers.

Merits of Micro-Teachin

Micro-Teaching is an innovation which has sound basis of principles of learning and application of technology. The advantages of Micro-Teaching are as follows:-

DEVELOPING OF TEACHING SKILLS THROUGH MICRO...

1. It is an effective feedback device for the modification of teacher's behavior.
2. It is highly individualized type to teacher training.
3. It is useful for developing teaching efficiency in pre-service and in-service teacher training programme.
4. It helps in systematic and objective observation by providing specific observation schedule.
5. It helps in acquiring various types of skills which ultimately form the basis of successful teaching.
6. It reduces the complexities of normal class-room teaching such as size of class, time and problem of discipline.
7. It is a training device for improving teaching practice and to prepare effective teachers.
8. Teaching is a complicated type of activity. Micro-Teaching simplifies it so as to make it suitable for the beginner teachers.
9. It develops the feeling of confidence, among the teachers.
10. It provides economy in mastering the teaching skills. The use of video-tape enables the trainee to analyse his own teaching performance.
11. It can be done either in real class-room conditions or simulated conditions.
12. It focuses on training for the accomplishment of special tasks such as practice of instructional skills, mastery of certain curricular materials and practice of techniques of teaching.
13. It permits increased control and regulates teaching practice.
14. It enables the trainee to make progress in developing teaching skills at his own rating depending upon ability.
15. Trainee gets satisfaction when they hear and see themselves through audio-video-tapes.

Demerits of Micro-Teaching

The drawbacks of Micro-Teaching are as follows:

1. It is more time consuming as a trainee will take 36 minutes to practice one skill only.
2. It presents fragmented view of teaching.
3. It may enable a trainee to seek mastery over the isolated teaching skills but hardly trains him to meet the needs of the real teaching encounter.
4. The immediate feedback which is a must may not be feasible in all conditions.

5. Due to short lesson of 6 minutes, a trainee cannot get training in evaluation, diagnostic and remedial skills.
6. It cannot fit in Indian conditions and situations due to its short practice which may create academic and administrative problems in the schools.
7. It depresses the creativity of teachers. During teaching a teacher evolves something new but he has to stop as the micro lesson flexible.
8. Micro-Teaching can be carried on successfully only in controlled environment but generally it is found classroom situations are flexible.
9. It wastes a lot of time of students. Each micro lesson goes on or 5 to 10 minutes where the main emphasis is on teaching technique, learning by students is almost ignored.
10. Micro-Teaching alone may not be sufficient. There is need of integrating it with other teaching techniques.

Micro Teaching Skills

Teaching is a complex phenomenon that comprises of various specific teaching skills. A skill is defined as any repeated activity which we do in our classroom to make our teaching – learning process effective. These teaching skills can be defined as a set of inter- related components, teaching behavior for the realization of specific instructional objectives.

Acc to Pass : "Teaching skills are a set of related teaching acts or behavior performed with the intention to facilitate pupil's learning".

Acc to N.L Gage (1968) : "Teaching skills are specific instructional activities & procedures that a teacher may use in his class-room. These are related to the various stages of teaching or in the continuous flow of the teacher's behavior". (Performance)

These components in teaching behavior may be modified through the exercise done in micro- teaching & thus a pupil teacher may be able to acquire necessary teaching skills for becoming an effective teacher.

There are various skills which can be developed among pupil-teacher given

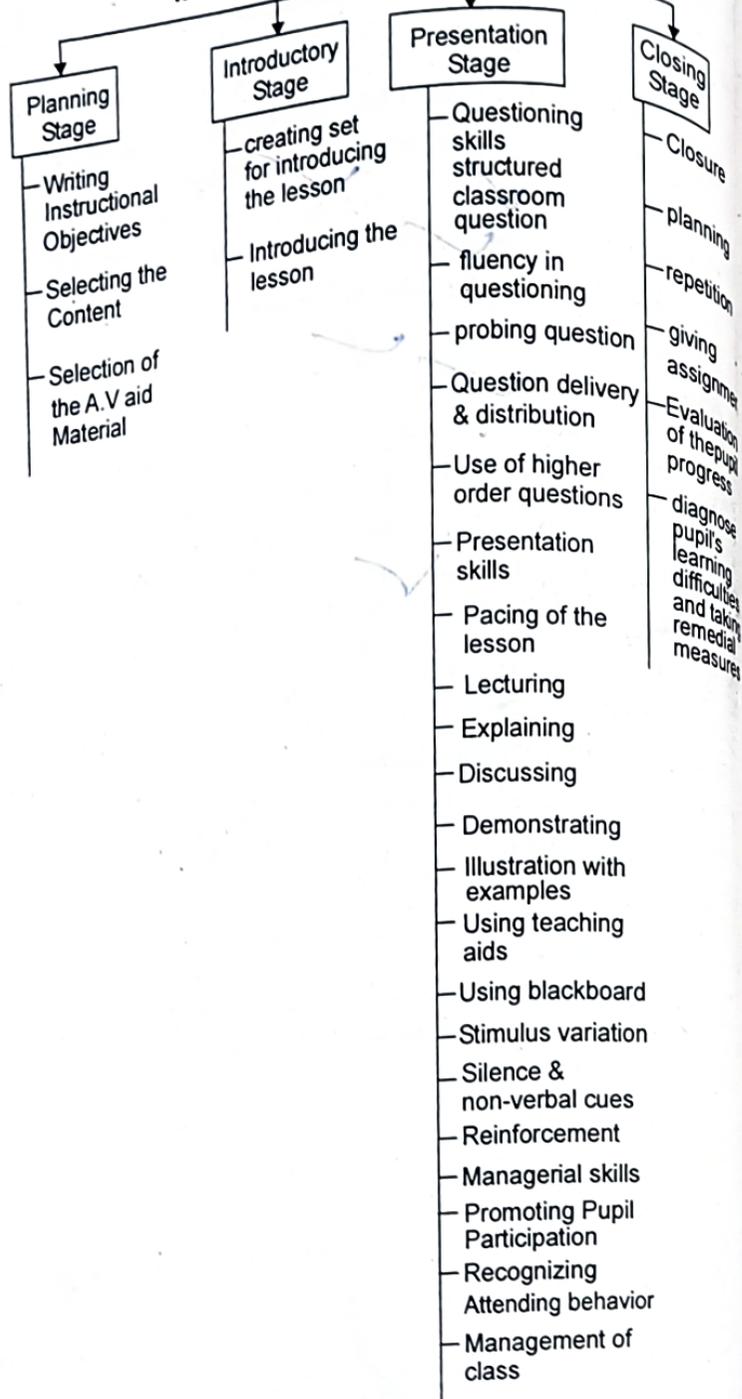
- | | |
|----------------------------|-------------|
| By Allen and Rayans (1969) | - 14 skills |
| By B.K Passi (1976) | - 13 skills |
| By L.C Singh | - 22 skills |

DEVELOPING OF TEACHING SKILLS THROUGH MICRO

Various skills are

1. Skill of stimulus variation.
2. Skill of set induction
3. Skill of closure
4. Skill of teachers silence / non-verbal cues.
5. Skill of reinforcement & pupils participation
6. Skill of questioning
7. Skill of probing question
8. Skill of recognizing attention behavior
9. Skill of illustrating & use of examples
10. Skill of explaining
11. Skill of using black-board
12. Skill of increasing pupil participation
13. Skill of writing instructional objectives.
14. Skill of class management
15. Skill of using A V aids
16. Skill of giving assignment
17. Skill of pacing the lesson
18. Use of higher order questions
19. Skill of divergent questions
20. Skill of lecturing

Components of teaching skills associated with different stages of a lesson



SKILL OF PROBING QUESTIONING

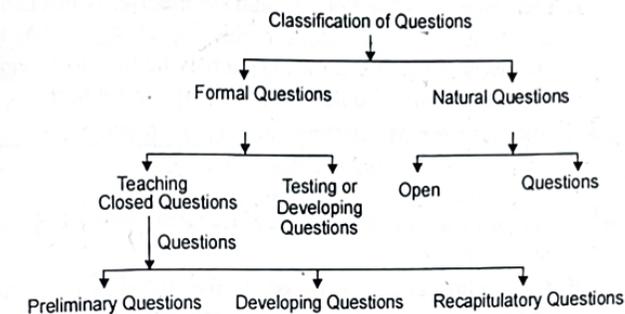
According to Parker: "Questioning is the key to all educative activity".

According to Ryburn: "it is no exaggeration to say that the success of teachers in any particular lesson, and in teaching in general depends up his ability to question well"

Questioning plays an indispensable part in learning, teaching and testing. The success of teaching to a great extent depends upon the skill or art with which we put questions.

Purpose of Questions:

- To test the previous knowledge of students.



- To arouse motivation.
- To find out the weakness of the students.
- To enhance the confidence of the students.
- To recapitulate the lessons.
- To keep the children mentally alert and active.

Components of skill of Probing Questions

Questioning skill is composed of two aspects. The first aspect includes the structuring of the question and the second aspect includes the presentation of the questions in the classroom.

1. Structure of questions
 - I. Relevancy
 - II. Conciseness
 - III. Clarity
 - IV. Specificity
 - V. Grammatically Correctness.
2. Presentation of questions
 - I. Voice
 - II. Speed and pause
 - III. Distribution of Questions
 - (a) Whole class
 - (b) To student volunteers
 - (c) To students non volunteers

IV. Teachers behavior.

1. **Structuring of questions:** It means while constructing the questions we should keep in mind that all the questions should be understandable by all the students of the class, so during framing the questions following things should be kept in mind.

I. **Relevancy:** A relevant question is that which is related to the subject-matter, so that students may answer the question correctly. An irrelevant question distracts the attention of the students and students get confused.

II. **Clarity:** A questions asked to the students should be clear other else students will not be able to understand the questions clearly.

III. **Conciseness:** Questions should be precise. A brief, direct and to the point. A question which is lengthy or has extra words is not good. So a question is neither too long nor too short but it should solve its purpose properly.

IV. **Specification:** A question should not be general. It should be specific. It means we ask such a question which has a single answer. A general question couldn't able to solve, its purpose and produces confusion in the mind of the students.

V. **Grammatical correctness:** While framing question, it should be kept in mind that the question should be grammatically correct. If it is not grammatically correct sometime the meaning of the question is changed.

2. **Presentation of questions:** During the teaching learning process. A teacher asks various questions to his students. If the questions presented before the student is right he will easily understand the question and give its correct response. So the desirable components during the presentation of the lesson are as follows:

I. **Voice of the teacher:** The voice of the teacher should be clear and loud. So that all the students will be easily follow the questions otherwise they may ask the teacher to repeat the question.

II. **Speed and pause:** The teacher should ask the question to the students neither too hurriedly nor too slowly. It is also very necessary to give a pause after asking a question because students need time to understand and think about the question and then to answer the question.

III. **Distribution of question:** The question is asked to whole class instead of any particular student. The question should

be asked to front benches as well as to backbenchers. The students who are interested to give responses should be involved but the students who don't take interest should all be involved so that each and every student of the class should remain active and alert and always be the part of interaction.

IV. **Teacher's Behavior:** The behavior of the teacher should be normal and soft and language should be easy and simple. He should not be in hurry or over excited. The body language of the teacher should be proper. He asks the questions in a normal and interesting way so that students will particular in they teaching-learning process.

SKILL OF QUESTIONING

Roll No.
Subject
Topic

Class
Duration
Session: Teach/Reteach

S. No.	Components	Tallies (frequency occurrence)	Rating Scale (Extremely poor-excellent)
1	Structure of the Question		
	(I) Relevancy		0 1 2 3 4 5 6
	(II) Conciseness		0 1 2 3 4 5 6
	(III) Clarity		0 1 2 3 4 5 6
	(IV) Specificity		0 1 2 3 4 5 6
2	(V) Grammatically Correctness		0 1 2 3 4 5 6
	Presentation of Question		
	(I) Voice		0 1 2 3 4 5 6
	(II) Speed and Pause		0 1 2 3 4 5 6
3	Distribution of Questions		
	(I) Whole Class		0 1 2 3 4 5 6
	(II) To Student Volunteers		0 1 2 3 4 5 6
	(III) To Student Non-Volunteers		0 1 2 3 4 5 6
	4	Teacher Behaviour	

0 - Exteremely Poor

1 - Very Poor

2 - Poor

3 - Average

4 - Good

5 - Very Good

6 - Excellent

Micro Lesson Plan-1

'Skill of Probing Questions'

Roll no :
 Subject : Physical science
 Topic : Air around us

Date :
 Class : 6th
 Duration : 6-8 min.

Pupil teacher's activity	Student's activity
1. Well students, tell me what is earth surrounded by ?	Air
2. Good, what is air made up of ?	Air is made of gases. Nitrogen, oxygen, CO_2 , water vapors etc.
3. Now tell me the name of main gases present in air	N_2 -78%, O_2 -21%, CO_2 -.03%, water vapours- 3%
4. What is the %age of these gases?	Dust particles Smoke, etc.
5. Good, any other particles which also present in air.	fresh air.
6. Children, what do we need to breathe in?	oxygen
7. Which gas is present in more quantity in inhaled air?	carbon di-oxide (CO_2)
8. Good, which gas is mainly present in exhaled air ?	

So we can say that air around us is very important for us.

✓ SKILL OF INTRODUCING THE LESSON/SET INDUCTION

Acc. to Allen & Ryan (1969) of standard university. Set induction or skill of introducing the lesson helps teacher to prepare students for the lesson in order to induce maximum learning in them.

The skill of introducing a lesson involves maximizing the use of previous knowledge of pupils. The lesson must be introduced in a problematic manner so that a student feel that they are going to learn something really worthy & useful. The teacher should always begin the lesson with some previous experience & incidents, simple & interesting way by telling a story. The teacher should always try to maintain interest of the student through out the lesson because the skill of introducing the lesson involves the use of verbal & non-verbal behavior, previous knowledge of students, using appropriate teaching aids etc.

The skill of introducing the lesson may be defined as proficiency in the use of verbal & non-verbal behavior, teaching aids & studying the lesson by establishing cognition & effective rapport with them.

Components of Skill

1. **Utilization of previous experience** : Life is a continuous experience & every activity of the individual whether physical,

emotional, social etc. give him some experience. Introduction of lesson is always based or completed with the previous knowledge & experience of pupils. Here the teacher has to sustain whether the experience are relevant for learning or not. There after the teacher should try to link the previous knowledge and experience with the new lesson and experience. Therefore, a teacher has to acquire the art of utilizing knowledge & experiences. Hence the teacher should kept in mind:

1. Previous knowledge of the subject of pupils.
 2. General awareness of the pupils with the physical & social environment.
 3. Devices & techniques of exploring the previous knowledge
 4. Techniques of establishing link between the previous & new knowledge.
 5. Ability of creating situations in the class for the utilization of previous experiences.
2. **Use of appropriate devices** : The teacher should use appropriate devices for introducing the lesson. The various devices used for this purpose are :
 1. Questioning
 2. Use of examples – analogies and similarities
 3. Describing /Narration /Lecturing
 4. Story telling
 5. Using audio- visual aids
 6. Demonstration or Experimentation
 7. Role-playing/Dramatization
 8. Visits or excursions.

The use of each of such devices depends upon the unit to be taught & also on its suitability to the maturity level, age level, interest of pupils.

3. **Maintenance of Continuity** : Continuity means the logical sequence of idea or information. Proper introduction requires the continuity in the ideas or information's presented to the pupil. There should be a logical sequence between the main parts of the introduction & also with the previous knowledge of pupils for the maintenance of continuity. A pleasing well modulated voice, clear pronunciation of teacher helps in attracting the attention & interest of the student. So it is necessary that the question asked once lead to other related question so there is continuity among the activities.

4. **Relevancy of Verbal & non – verbal behavior :** The teacher should try to observe relevancy in his verbal or non-verbal behavior. Verbal behavior includes the use of verbal examples, comprehension etc. which is very much useful in understanding difficult points & problem whereas non – verbal behavior acts directly through the sense. The teacher should contribute maximum towards the introduction of lesson in some of the following ways:

1. Testing of the students
2. Previous experiences of the students
3. Pin-pointing the aims of lesson
4. To clear the objectives of teaching a lesson
5. Need/ importance of the lesson to be taught.

Skill of Introducing the Lesson

Date : Roll no :
 Subject : Class :
 Topic : Duration : 6–8 min
 Skill to be practiced – introducing the lesson Session – Teach/Re teach

Announcement of the topic: Well students today we will study about the topic.

Observation schedule cum rating scale

It consists of three columns. The first column is specific having the components of the skill. The second column indicates the tallies against the occurrence of the different component of behavior of skill. The third one contains rating scale from 1-7 against each components of skill.

Components (Desirable Behavior)	Tallies (frequency Occurrence)	Rating scale (Externally poor-Excellent)
Desirable behavior		
1. Using previous knowledge of pupil.		0 1 2 3 4 5 6
2. Proper use of device or technique.		0 1 2 3 4 5 6
3. Overall impression about introducing a lesson.		0 1 2 3 4 5 6
Undesirable behavior		
1. Lack of continuity		0 1 2 3 4 5 6
2. Irrelevant verbal or non-verbal Behavior		0 1 2 3 4 5 6

- | | |
|-------------------|--------------|
| 0. Extremely poor | 4. Good |
| 1. Very poor | 5. Very good |
| 2. Poor | 6. Excellent |
| 3. Average | |

Micro Lesson Plan-2

Skill of introduction the lesson.

Roll no : Date :
 Subject : Physical science Class : 8th
 Topic : 'Conductors & Insulators' Duration : 6-8 min

Pupil Teacher's Activity	Student's Activity
1. Well students what are electrons?	Negatively charged particles are called electrons
2. Good what is electricity?	Motion of electrons is called electricity.
3. Name some sources of electricity?	Power house, invertors.
4. Good, name some electrical appliances?	T.V, fridge, press, fans etc.
5. Students, what happened when we touch a naked wire?	We get shock.
6. What will happen while we are standing on wooden stool & touch a naked wire?	We don't feel shock.
7. Why we don't fell shock?	No response.
8. They are insulators.	

So a problematic situation is arise and Announcement of the Topic : well students, Today 'conductors and insulators' we will study about the Topic.

SKILL OF EXPLAINING

Skill of Explaining

Explaining is an activity which shows the relationships among various, concepts, ideas, events or phenomenon.

A teacher has to learn the skill of explaining in order to make the pupils understand many ideas, concepts or principles which needs

statements. A teacher who can explain things well will go a long way in making his lesson effective. In this skill such terms or words used in the statements related to the subject matter which helps in clearing the statement.

A teacher is said to be explaining when he is describing 'how', 'why' & sometimes 'what' of a concept, principle, phenomenon, event, action or condition.

So skill of explaining is an art where a teacher uses the interrelated statements to explain the content. So it is the widely used skill by a teacher.

Explaining is essentially a verbal skill & has two main aspects:

1. **Selection of appropriate statements** : A teacher select the statement from the subject matter which is in accordance with the age, mental level and past experiences of the learner.
2. **Interrelating the selected statement** : And use them in teaching to make the concept clear.

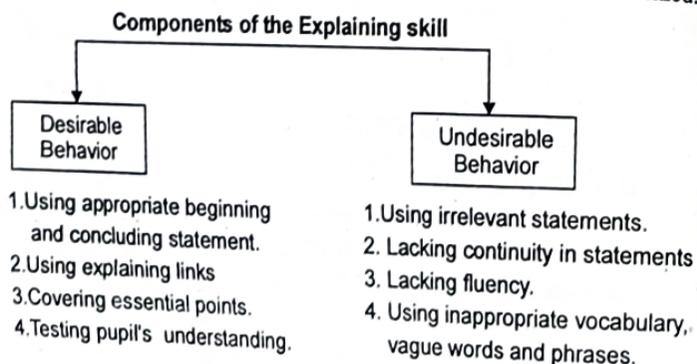
There are generally three type of statements;

1. Descriptive statements.
2. Interpretive statement (They usually meant for answering the questions like how, what & why of a concept or phenomenon as principle).
3. Reason giving statements

Components of Explaining skill

Explaining skill has behavioral components which can be divided into desirable & undesirable categories.

In the practice of the skill, it is needed that desirable behavior should be increased where as undesirable behaviors should be minimized..



Desirable Behavior

The desirable teaching behaviors to be practiced in order to develop the skill of explaining are:

- (A) **Using appropriate beginning statement** : Beginning statement is an opening statement in which a teacher should explain what he is going to teach in the classroom. These are made for setting the minds of the listeners. They create mental alertness & readiness in the class to listen to what is going to be explained. They give clue for the explanation. Such statements give the overall pictures or the structure of explanation.
- (B) **Concluding statement** : Concluding statements is very important as it summarizes or concludes the whole content. Concluding statement is also the inference drawn through logical reasoning in an explanation. So it is the concluding statement which gives the overall picture of the total content taught in the class.
- (C) **Using Explaining links** : When a teacher explains the content he uses the various terms or statements and to connect that statements or to maintain continuity explaining links are used. A teacher should use as many explaining links as possible to make his explanation effective. Some of explaining links are as follows: Therefore, hence, there, since, because, so that, the purpose of, that's why, is how, in order to, why, while, but, next, before, after, what, as a result, etc.
- (D) **Covering essential points** : The explanation given for a particular concept, idea, principle or phenomenon should be as complete as possible. So it is very necessary that all the essential points should be covered in explanation otherwise it is possible that learner will not be able to grasp the subject matter property.
- (E) **Testing pupil's understanding** : The teacher asks questions at the concluding stage, to get feedback to know how far he has been able to explain a phenomenon correctly. For these few questions but covering the whole content should be asked to students and it is essential that it is evenly covered the whole class to get the proper feedback.

Undesirable behavior

1. **Using irrelevant statement** : An explanation is effective when the statements made by the teacher are related to the concepts being explained by him. A statement becomes irrelevant when it is not related to concept. Such a statement instead of helping the pupils to understand the concept creates confusion & distract the attention of pupils. It is therefore, essential for the teacher to avoid the use of irrelevant statements.

2. **Lacking continuity in statements** : Explanation involves the continuity of the interrelated statements but if there is gap in the continuity the whole explanation becomes useless and students will not be able to understand the concept clearly.

During explaining, continuity breaks in the following situations-

1. Irrelevant statement.
2. Lack of sequencing in the content.
3. Lack of logically inter- related statements.

3. **Lacking fluency** : Fluency relates to the flow of uninterrupted statements for explaining a concept, principle or phenomenon. Lack in fluency may hinder pupil's understanding of the subject of explanation. It may results in pupil's lack of interest.

Lack in fluency occurs-

1. When a teacher does not speak clearly.
2. When a teacher doesn't complete the sentence.
3. When a teacher use inappropriate words or sentences.
4. When a teacher correct his statement again and again by saying "I think "or" I mean etc.
4. **Using inappropriate vocabulary** : Some times a teacher uses vocabulary which is not known to the pupil or it is not appropriate for the learners for whom he is using.
5. **Using vague words and phrases** : When a teacher himself is not clear about the subject matter then he uses such words or phrases like 'I mean to say', 'Actually', 'you know', 'infact' etc. These are obstacles in the path of learning for the learners and should be avoided.

Skill of Explaining

Date -

Subject - physical- science

Topic - Skill be practiced - Explanation

Roll No -

Class - 6th

Duration - 6-8 min

OBSERVATION SCHEDULE CUM RATING SCALE

The observation schedule cum rating scale for the skill of explaining, comprises three columns. The first column specifies the components of the skill. The second column indicates the tallies against different components of the skill showing the occurrence of component. The third column contains rating from 0 to 6 against each of the component. The points on the scale indicate the -

S. No.	Components (Desirable Behaviour)	Tallies (frequency Occurrence)	Rating scale from (Externally poor-Excellent)
1.	Using appropriate begining statement		0 1 2 3 4 5 6
2.	Using appropriate concluding statement		0 1 2 3 4 5 6
3.	Using explaining links		0 1 2 3 4 5 6
4.	Covering essential points		0 1 2 3 4 5 6
5.	Testing pupil's understanding		0 1 2 3 4 5 6
S. No.	Components (Undesirable Behaviour)	Tallies (frequency Occurrence)	Rating scale (not at all-very much)
1.	Using irrelevant statement.		0 1 2 3 4 5 6
2.	Lacking continuity in statement.		0 1 2 3 4 5 6
3.	Lacking fluency		0 1 2 3 4 5 6
4.	Using inappropriate vocabulary		0 1 2 3 4 5 6
5.	Using vague words and phrases		0 1 2 3 4 5 6

0- Extremely poor

1- Very poor

2- Poor

3- Average

4- good

5- very good

6- excellent

Micro Lesson Plan-3**'Skill of Explanation'**

Roll no :

Subject : Physical science

Topic : Solar System

Date :

Class : 9th

Duration : 6-8 min

Pupil teacher:- Well students, today we will study about 'our solar system. As we all know that we are living on the earth, and we saw many objects & organisms around us. On a clear night we can see many stars, with naked eyes. These appear to twinkle when we see them from earth. Apart from these stars & moon we can also sometimes see more other 'bright objects' in the night sky. These do not twinkle. They are the planets. In Hindi these planets are called grahas. They do not have their own light. Planets are those which revolved around the sun.

There are nine planets in our solar system. They move in a definite elliptical path called 'orbits' around the sun. The nine planets of our solar system are. Mercury, Venus, earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

This is all about our solar system.

Let us ask some questions from you.

Pupil Teacher : where do you live?

Students : On earth

Pupil Teacher : Good, what are planets?

Students : Planets are those who revolved around the sun & they do not have their own light.

Pupil teacher : how many planets are there in our solar system?

Students : Nine planets

Pupil teacher : Name all the planets.

Students : Mercury, Venus, earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

SKILL OF ILLUSTRATION WITH EXAMPLE

During teaching, a teacher explains a complex concept or idea but sometimes students are not able to understand it properly. In that situation to clear the certain point or subject matter, skill of illustration with example is used. It includes showing chart, models, picture or real objects or demonstrating any experiment related to the content taught by the teacher.

So we can say that skill of illustration with example is the art of selecting or presenting a suitable example of any idea, concept or rule so that students will be able to understand the concept or its application in better way.

By using examples from the real life or illustrating any event breaks the boredom of the class and makes the students more attentive and involved in the teaching.

Illustrations are of two types :

1. Verbal (verbal examples, comparisons, word pictures etc.)
2. Non-verbal (using specimens, charts, diagram on the blackboard, models, pictures etc.)

Components of the skill

The various components of the skill are discussed below :

1. Formulating relevant examples.
 2. Formulating simple examples.
 3. Formulating interesting examples.
 4. Using appropriate media for Examples.
 5. Making use of Inductive – Deductive Approach.
1. **Formulating relevant examples:** It means the examples used to explain the concepts should be related to content or subject matter. If it is not related with the content the purpose is not solved.
 2. **Formulating simple example:** The example given by the teacher to the students should be simple means it should be according to the maturity level of the students and based on the past experiences of the child. So a teacher selects such examples which the students will be able to understand easily.
 3. **Formulating interesting examples:** The examples should be interesting means it captures the interest and attention of the student. It arouses the curiosity of the child and they went to know more about it. So such examples which help in attracting the child towards the teaching of the teacher are said to be interesting.
 4. **Using appropriate media for examples:** Various media like verbal or Non- Verbal are used to give the examples. But it is very important that teacher should select the appropriate media to give examples depending upon the age, mental level and previous knowledge of the student. Various Medias are storytelling, pictures, models, concrete object etc.
 5. **Making use of inductive – Deductive approach:** Inductive approach means understanding a concept or establishing a rule/principle where as deductive approach means using or applying the established rule, principle or concept. But in the skill of illustration with example a combination of both the approaches means inductive- deductive approach for making or understanding the content.

OBSERVATION SCHEDULE CUM RATING SCALE

S. No.	Components	Tallies (frequency occurrence)	Rating (Externally poor-excellent)
1.	Relevancy of Examples		0 1 2 3 4 5 6
2.	Simplicity of Examples		0 1 2 3 4 5 6
3.	Interesting Examples		0 1 2 3 4 5 6
4.	Using Appropriate media		0 1 2 3 4 5 6
5.	Making use of inductive-deductive Approach.		0 1 2 3 4 5 6

0- Extremely poor	4- good
1- Very poor	5- very good
2- Poor	6- excellent
3- Average	

Micro Lesson Plan-4

"Skill of illustration with examples"

Roll no	:	Date	:
Subject	: Physical science	Class	: 8 th
Topic	: Types of mixtures	Duration	: 6-8 min

Pupil teacher's activity	Student's activity
1. Children, do you like lemon juice?	Yes
2. How is it prepared?	By mixing lemon juice & water.
3. Good, does it happen that it taste different at the Start & taste varies at the last?	No, it has same taste.
4. So these are called homogenous mixture i.e these have same composition through out the sample Note down in your copies.	Students note down in their Copies.
5. Can you give some more examples?	Sugar, salt dissolved in water. Co ₂ in water.
6. If we put chalk, powder in water its particles remain suspended in it i.e. they do mix with each Other. Such mixture is called Hetero-geneous Mixture. Give some more examples.	mixture of sand & water. Mixture of sand & iron fillings.
7. V. good now note down the definition.	Students note down in their copies.

SKILL OF USING CHALK BOARD

Blackboard is very important tool in the hands of the teachers. It is the basic teaching aid required by a teacher. It is like friend of a teacher because it is very simple, reliable, and widely used teaching aid. Classroom teaching is incomplete without using blackboard but to write properly on the blackboard is not easy it requires art, skill and lot of practice so it is very essential for a teacher to know how to use the Blackboard properly.

The utility of Blackboard is as follows.

1. It is a simple teaching aid.
2. It is quite cheap so used by anybody.
3. It helps in making the important point clear.
4. Teacher writes on the blackboard as well as attends the students simultaneously.
5. Pupils' participation can be encouraged by involving them in writing on the blackboard.

So the skill of using black board is a skill which helps the teacher to acquire training in using a blackboard effectively.

Components of skill using Chalk board

1. **Appropriate size and shape of the letters:** The letters written on the blackboard is of proper size and shape so that it should be visible even to the last bencher of the class so it should be in accordance with the class.
2. **Writing in straight line:** Words or sentences written on blackboard is in straight line.
3. **Legibility of handwriting:** The words or sentences written on the blackboard are capable of being read clearly by all the students of the class.
4. **Grammatically correct:** Whatever written on the blackboard should be grammatically correct.
5. **Clarity and distinctness of the sketching and drawing work:** Diagrams or any figure made on the blackboard should be clear.
6. **Side by side rubbing of unessential work:** When the students note down the points in their note-books teacher should rub the unessential point so that overcrowding on the blackboard should be avoided.

7. **Adoption of correct posture while writing:** Do not stand in the front of the blackboard so that student will not be able to see the points from the blackboard while writing stand on one side of the blackboard and never keep the back towards pupils.
8. **Appropriateness and relevancy of the blackboard work:** Always write the relevant and essential points on the blackboard, avoid writing irrelevant material.
9. **Side by side speaking and explaining:** "Talk and chalk should go together". It means speak and explain the points side by side so that students get attentive towards the teaching.
10. **Write after cleaning the blackboard properly:** Before writing clean the blackboard properly so that words should be properly visible to the students.
11. **Focusing important points:** To focus on the important points either underline it or use colored chalk to emphasis the important points.
12. **Brevity in expression:** Don't write everything on the blackboard so be brief and to the point and write only the important points on the blackboard.

Few precautions while writing on Chalk board

1. Write clearly and neatly.
2. Proper arrangement of light in the classroom.
3. Write logically or in sequence on the blackboard.
4. To maintain discipline keep on paying attention towards the class while writing on the blackboard.
5. Do not use your hand to rub the blackboard.
6. Overcrowding on the blackboard should be avoided.
7. Use duster in such a way so that dust particles don't spread in the classroom.
8. Involve students.
9. Diagrams made should be neat, clean and properly labeled.
10. Write all the points in continuity.

S. No.	Components	Tallies (frequency)	Rating Scale Externally for Excellent
1.	The size and shape of the letters was appropriate.		0 1 2 3 4 5 6
2.	Writing in straight line.		0 1 2 3 4 5 6
3.	Writing was quite legible		0 1 2 3 4 5 6
4.	Grammatically correct.		0 1 2 3 4 5 6
5.	Clarity and distinctiveness of the sketching and Drawing work.		0 1 2 3 4 5 6
6.	Side by side rubbing of unessential work.		0 1 2 3 4 5 6
7.	Adoption of correct posture while writing		0 1 2 3 4 5 6
8.	Appropriateness and relevancy of the black Board work.		0 1 2 3 4 5 6
9.	Side by side speaking and explaining of the Written things.		0 1 2 3 4 5 6
10.	Proper clearing of the blackboard		0 1 2 3 4 5 6
11.	Focussing important points		0 1 2 3 4 5 6
12.	Brevity in expression.		0 1 2 3 4 5 6

Skill of stimulus Variation

This skill is related to class-room attention based on the principle that 'Change in the stimuli in one perception captures the attention'.

Acc. to Sneha Joshi : What to change, when to change, how to change require skill on the part of the teacher for securing & sustaining attention of higher level. Such a skill is named as skill of stimulus variation".

For making his/her teaching effective a teacher gives variety in the stimuli so that students take interest in the teaching and sustain attention towards classroom activities. This is called as stimulus variation.

The skill of stimulus variation comprises of the following components

1. Movements
2. Gestures
3. Change in speech pattern
4. Focussing
5. Change in interaction styles
6. Pausing
7. Oral - visual switching
8. Physical involvement of the students

1. **Movement :** Moving objects capture the attention of students instead of Non- moving or static Objects. So it is wise on the part of teacher to have desirable movements in the class but

excessive movement instead of sustaining attention distract the attention of the students so it is necessary that teacher make purposeful movements in the class.

2. **Gestures** : Gestures are used as Non - verbal cues used by teachers to give oral message to the students. The movement of the teacher's body parts like facial expressions, movements of eye, hand, head helps in capturing attention of the students e.g. movements of hands to say sit or stand, signal to stop or start
3. **Change in voice** : In the delivery of the lesson the voice of teacher play an effective role. This attention capturing behavior of the teacher concerns with the art of bringing appropriate variation or change in the tone, pitch or speed of his voice.
4. **Focusing** : It is the other component that helps in attaining pupil attention towards specific points, work, idea, as event etc.

Such behavior may take the following forms

1. **Verbal focussing** : Use of verbal statement like look at blackboard. This is important note if down in your note-book etc.
2. **Gestural focussing** : The use of gesture.
3. **Verbal gestural focussing** : Use of both verbal statement & gesture.

For e.g. - The teacher drops a piece of chalk & explain the term gravitational force.

5. **Change in interaction style** : To make the teaching interesting or to break the monotony of the class it is essential that there is interaction among the teacher and students. A good teacher should change his style of interaction at short intervals. There are 3 main styles of interaction.

1. **Teacher - pupils or Teacher group interaction** : Teacher interacts with the whole class.
2. **Teacher - pupil interaction** : Teacher communicate with an individual pupil.
3. **Pupil - pupil interaction** : A teacher initiates the class to comment or discuss on the response received from one pupil.

For bringing effectiveness in his teaching a teacher should learn the art of bringing variation in interaction styles.

6. **Pausing** : It refers to the behavior related with introducing silence during talk. It gives time to the student for assimilation ideas & concept and also helps in attending the attention of the students.

The following precautions kept in mind when pausing-

1. It should be at appropriate time in lesson.

2. It should not be too long or short.
3. It should be given at an appropriate place so that teacher will be able to capture the attention of non- attending students.
7. **Aural- Visual Switching** : There is also change of variation in use of medium so that students remain attentive towards the teaching.

For example:

- a. From Aural & Visual
- b. From Visual to Aural.
- c. Combination of aural and visual.

For Example :

1. from speaking to doing.
2. from reading to writing.
3. from experiment to discussion.
4. from talking to blackboard.
5. From Listening to Looking
8. **Physical involvement of the student** : It means that students should be physically involved in the teaching-learning process of the class. They should be engaged either participating in the demonstration or experiment, to draw diagram on the blackboard or handling of any instrument etc.

SKILL OF STIMULUS VARIATION

Date:

Subject - Physical Science

Topic -

Skill to be Practice - Stimulus

Reteach

Roll No -

Class - 10th

Duration - 6-8 Min

Session - Teach/

Variation

The observation schedule cum rating scale for skill of stimulus variation may consist of three columns. The first column specifies the components of the skill. The second column indicates the tallies against the occurrence of different components of skill. The third one contains rating scale from 1-7 against each components of skill.

S. No.	Components	Tallies (frequency Occurrence)	Rating scale
1.	Movements		0 1 2 3 4 5 6
2.	Gestures		0 1 2 3 4 5 6
3.	Change in voice		0 1 2 3 4 5 6

4. Focussing	0	1	2	3	4	5	6
5. Change in interaction styles	0	1	2	3	4	5	6
6. Pausing	0	1	2	3	4	5	6
7. Aural - visual switching	0	1	2	3	4	5	6
8. Physical involvement of the pupils	0	1	2	3	4	5	6

- | | |
|-------------------|--------------|
| 0. Extremely poor | 4. Good |
| 1. Very poor | 5. Very good |
| 2. Poor | 6. Excellent |
| 3. Average | |

Micro Lesson Plan-6

'Skill of stimulus variation'

Roll no	:	Date	:
Subject	: Physical science	Class	: 6 th
Topic	: Air occupies space	Duration	: 6-8 min.

Pupil Teacher's Activity	Student's Activity
1. Students, you know the composition of air, can You tell it? (P.T writes the name of gases on the board	O ₂ , N ₂ , CO ₂ , water.
2. Showing on empty tumbler to the student, the PT Says, well students do you know this tumbler Contains air?	Vapours, dusts etc
3. Let's now try to prove that air occupies space. How Can it be done? (PT asks a student).	Uncertain about this.
4. For this, take a tub full of water and try to push the Glass upside down into the water. What happen to Glass. (PT asks the students)	The water does not enter into the glass.
5. Now PT asks the students to tilt the glass slightly and Press, what do you observed ?	Bubbles of air start coming Out of the glass & water Enter into it.
6. The PT tells the students that empty glass is not empty in reality. It contains air when we tilt the glass the air starts coming out in the form of bubbles. It's Place being taken by water. So what can we say ?	Air occupies space.

EVALUATE YOURSELF

1. What do you mean by the term Micro-Teaching? Discuss its meaning and concept in detail.
2. Prepare a Micro-Lesson Plan on the Skill of Probing Questions. Also discuss the components of this skill.
3. What do you understand by the 'skill of Introducing of the Lesson?' Discuss the various components of this skill.
4. Describe the Skill of Explaining in the teaching of Physical Sciences.
5. Discuss the various components of 'Skill of Illustration with the help of Examples.' Prepare a Micro-Lesson Plan on this skill.
6. What do you understand by the 'Skill of Blackboard/ Chalkboard Writing?' Explain the various components of this skill.
7. Describe the Skill of Stimulus Variation in detail.



CHAPTER 2

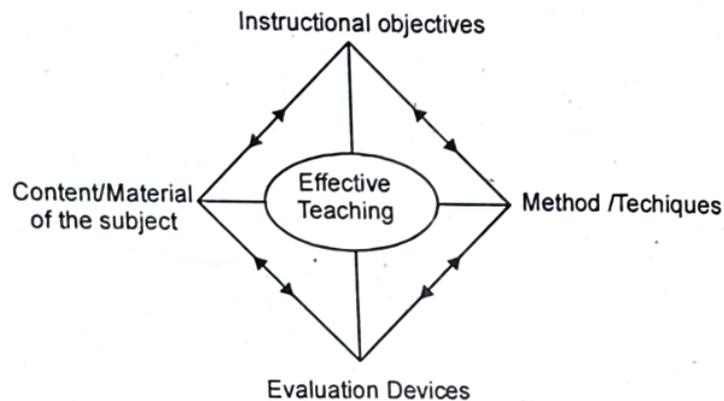
Methods of Teaching Physical Sciences (Lecture-cum-Demonstration Method, Project Method and Problem Solving Method)

"If science is poorly taught and badly learnt. It is little more than burdening the mind with dead information, and it could degenerate even into a new superstition".

– Kothari Commission Report

Though teaching is an art and there are some born teachers, yet a majority of teachers, who have no interest flair for teaching and are unable to arouse that much interest in the students to learn can improve upon by practice and by following the various methods of teaching devised from time to time. So it is very essential that every teacher should be acquainted with different methods of teaching.

There are four basic pillars on which teaching learning process depends.



A method is very important pillar for effective teaching. It is not an end itself but should be used as a means to achieve the aims of teaching.

"Even the best curriculum and the most perfect syllabus remain dead unless quickened into life by the right methods of teaching and right kinds of teachers."
–Secondary Education Commission

Definitions of Method

Acc to Dictionary "A method is a way of doing things. Method deals with how to teach. Thus method is an overall plan of teaching approach".

Acc to Chamber's Dictionary "Method is the mode or rule of accomplishing an end :

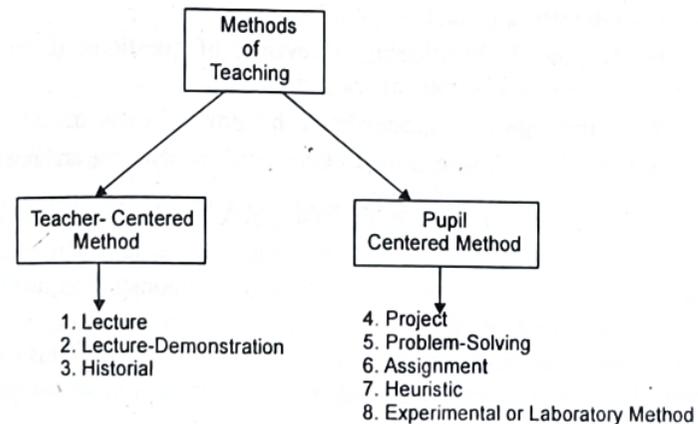
Orderly procedure... manner of Performance."

Acc to Anthony "Method is an overall plan for the orderly presentation of language material, no part of which contradicts and all of which is based upon the selected approach".

Acc to W.E. Mackey "A method determines when and how much is taught (selection), the order in which it is taught (grading) and how the meaning and form are conveyed (Presentation) and what is done to make its use.

Acc to Binning and Binning "Methodology should be conceived as a dynamic function of education and not as static aspect or the process of teaching".

There are various methods available; teacher is free to use the methods according to his own abilities, interest, experiences and according to the students. Here we are discussing some of the commonly used methods in teaching of physical science. We can classify the methods under the following categories



There is one more classification:

1. Traditional Method
 - ❖ lecture Method
 - ❖ Lecture cum – demonstration Method
 - ❖ Laboratory
 - ❖ Discussion
2. Discovery Method
 - ❖ Scientific Method
 - ❖ Project Method
 - ❖ Problems – solving Method
 - ❖ Heuristic Method

Criteria for the selection of Teaching Method

Each method has its advantages and disadvantages and it will be wrong to choose one particular method for teaching of physical science. A method which suits one teacher may not suit another successfully. There are certain criteria on which a method of teaching should be based.

1. **Based on Aims** : The method should be considered in terms of aims of teaching science.
2. **Rich Interaction** : The method should provide for rich interaction of the students with the environment in which they live.
3. **Active Participation** : The child must be provided opportunities for active participation.
4. **Learning by doing** : Science can be best learnt through experimentation.
5. **Introduction of Lesson** : The lesson should be started in interesting manner.
6. **Devise of Questioning** : Devising of questions, discussions etc. should be part of teaching.
7. **Language** : Language should be simple in any method used.
8. **Dynamic** : The teaching method should be dynamic and not static.

1. LECTURE-CUM-DEMONSTRATION METHOD

This method includes the merits of lecture method with that of a demonstration method. It is named as lecture demonstration method.

In this method, teacher not only gives the lecture but also simultaneously demonstrate the required steps of the lesson. This method involves the active participation of both teacher as well as learner.

The science teacher in the class generally follow this method because it emphasis on both theoretical learning skills and practical work and tries to combine their advantages and by removing their disadvantage. The active participation of the student is an important feature of this method and helps in making the concept of the subject matter clear. It also helps in sustaining the interest of the student because they draw conclusions when they observe the demonstration. It also helps in sustaining the interest. This method develops the skills of observation and analysis, reasoning and problem - solving attitude of the student (Learner). It makes the abstract concept easy to understand and employs teaching the concept from concrete to abstract.

In this method, the students can use both their eyes and ears simultaneously for the gaining of learning experiences. They can get opportunity for the active participation by asking questions or helping the teacher in the demonstration work.

Principle

This method is based on the principle : Truth is that which works.

The teacher has to work out something and then and only then the students will believe.

Characteristics for a Good Demonstration

This method is very popular and most widely used. The following point should kept in view by teacher, will assure that the demonstration will be a success.

1. Appropriate Arrangement

While performing an experiment the teacher must be sure that each and everything is clearly visible to the pupils. There are several ways of enabling the pupils to get a better view.

- (a) **Use of Mirror** : A large mirror erected at a suitable angle above the teacher's bench will enable the class to see what is going on if they look at the reflection in the mirror. This is very useful method of enabling the pupils to have a view of each and everything which otherwise is never possible.
- (b) **Use of Table** : The teacher may carry out the experiments on one of the front student's table and the class can view the demonstration by standing at some distance round the table.
- (c) **Disciplined class** : If the class is well disciplined, the students can sit on tables, stools or window seats. This will enable them to have a better view.

1. **Sufficient light** : There must be sufficient light on the demonstration table and on the back ground. Proper

background is very important. Black things should never be shown in front of blackboard.

2. **Demonstration Apparatus** : Demonstration apparatus should be as large as possible such as a big model of electrical bell, vernier calipers etc. and graduation on any instrument should be clearly visible.
3. **Arrangement of apparatus** : Everything must be placed in order before the demonstration starts. The apparatus to be used should be placed on the left hand side of the table and arrangement in the order in which it will be shown after a particular thing or apparatus has been used, it should be transferred to the right hand sides.
4. **Neat, Clean & Tidy** : The general order and tidiness of the demonstration table is very essential. Nothing looks worse than a demonstration table littered with other useless things. One thing related to lesson should be placed on demonstration table.
5. **Preparation by teacher** : The teacher must be sure that the experiments will succeed and are strikingly clear. Sometimes breakages occur during the lesson and therefore it is always good to have spare apparatus handy at the table. The teacher should not get nervous but try to find out the reason calmly if wrong.
6. **Well Rehearsed** : The teacher must do rehearsal of the experiments before performing in the class -room. Sometimes failure in a certain experiment enables a good teacher to draw useful conclusions from it.
7. **Precautions by Teacher** : The teacher should never complain about inadequate & faulty apparatus. It may provide the teacher a very good chance of sharing his skill.
8. **Use of common material** : The experiments must be connected with the common things seen and handled by the pupils in daily life.
9. **Sequence of experiment** : The demonstration must fit into the sequence of experiments which pupils do in their practical class.
10. **Student Co-operation** : The teacher must call individual members of the class to help him in the demonstration work.
11. **Development of Attention** : Attention of the class is very important. The teacher should know various methods of asserting and creating interest.

To inspire the class with a sense of dramatization and to arouse an atmosphere of suspense just before the critical point of an experiment is an art.

12. **Effect of Climate** : Proper account should be taken of time and season. Climatic conditions sometimes affect the apparatus. For example: Frictional electricity experiment should not be done during rainy season. Hot season is best for experiment with ice.
13. **Teaching Aids**: Demonstrations & experiments should be supplemented with teaching aids like charts, pictures, models, film, strips etc.
14. **Use of black board**: A large black - board behind the teacher's demonstration table is most essential. During the lesson the teacher can use it to great advantage. Necessary diagrams can be drawn on it.

Steps of a Demonstration Method

A vast majority of the science teachers follow the demonstration method.

1. Planning & Preparation

Demonstration method is a test of the teacher's ability and therefore he must be thoroughly prepared for it. While preparing he must bear in mind the following points

1. Subject matter
2. Lesson notes including the type of question to be asked i.e. lesson Planning
3. Rehearsal of experiments
4. Collection and assignment of apparatus required.

Drawing up a lesson - plan is equally necessary & this should include a list of the principles to be explained, a list of the experiments to be demonstrated and the type of questions to be put to the students, in an order to be followed, in the class.

This will make this very systematic. Each and every experiment should be rehearsed under the same conditions that prevail at the time of demonstration. Rehearsal of experiments will enable the teacher to collect all the requisites for the demonstration work. But it is all the more important that each & everything is arranged on the demonstration table in a wise & proper order so that no difficulty is felt at the time of demonstration.

In short, a teacher should prepare himself for the lesson as thoroughly as a girl prepares herself for her wedding.

2. Introducing the lesson

It is useless to start a lesson without properly motivating and preparing the minds of the students for it. The lesson should be introduced in a problematic manner so that the students can appreciate and realize the importance of the topic in hand. So when a teacher is able to awaken the curiosity and enthusiasm of his pupils, half the game is won.

The teacher should begin the lesson with some personal experience or incident,

- simple and interesting performance
- By telling a story

He should keep in mind the value of an interesting experiment. The experiment which will set his pupils talking in school and out of it, about the wonderful things they have seen as done in the science lesson.

1. **Transmission of Heat** : To introduce the methods, the teacher may bring toffees in the class & tell the students that he wants to distribute the toffees before starting the lesson. Let them give three possible methods of distribution in which the teacher does not move from his seat. These methods may then be related to conduction, convection, & radiation.
2. **Carbon dioxide** : To start the topic, the teacher may open a soda water bottle in the class and ask about the visible gas coming out of that.
3. **Hydrogen gas** : Hydrogen can be introduced by bringing two balloons of equal shape, size & color, one filled with air and the other with hydrogen. When both are left, one goes up & the other comes down. Why?

Because hydrogen gas is lighter than other gas.

3. Presentation of the subject matter

1. **Broader sense of Teaching** : Teaching, in fact, should be kept on as broad a basis as possible. The actual lesson may be concerning some prescribed topic, but the teacher is at liberty to treat it in narrow sense or to introduce into his teaching material and illustrations from a wide field of knowledge and experience.
2. **Use of Illustrations** : If the lesson deals with a particular branch of science, a widely-read and well-informed teacher will draw illustrations from all branches of science. In addition to this, whenever practicable, reference should be made to the names of great scientists and their works.

3. **Judicious Questions** : The questions should be so arranged that their answers form a complete teaching unit.

The method does not succeed if the teacher tells everything, because telling is not teaching. Questions may not bring forth the required answer. But it is enough if they have been able to create a desire in a student to know what he does not know.

4. **Pronunciation of the teachers** : Teaching cannot take place if a lesson is not properly delivered. In the delivery of a lesson the voice of the teacher plays an important role. The teacher should speak slowly, deliberately and with correct pronunciation.

Ambiguous terms should be avoided. The teacher should use his voice effectively. It should be neither too low nor too high. It should be pleasant. The tone of voice should be modulated according to the nature of the statement. Teachers should pose as if they are narrating some interesting experience in a very homely way & should give a feeling of friendliness to the students.

4. Performance of Experiments

The work at the demonstration table should be a model for the students. An unclean & untidy demonstration will lead to bad work in the practical class. The main points are

- (a) **Clear result** : The experiments must work & their results should be clear & striking.
- (b) **Simple experiments** : Experiments should be simple & speedy. Lengthy experiments should be avoided.
- (c) **Appropriate time of experiment** : Experiments should be well-spaced throughout the lesson. It is wrong to finish all the experiments at an early part of the lesson.
- (d) **Convincing experiments** : Large numbers of experiments do not always make the topic very clear. One big convincing & striking experiment is of more value than a dozen for experiments.
- (e) **Reserve apparatus** : Reserve apparatus should always be kept near the table so that much time is not wasted in case of breakages.
- (f) **Arrangement of apparatus** : Apparatus should be arranged in order in which the experiments are to be shown.
- (g) **Time Saving** : It is a wise policy to store the demonstration apparatus until it is to be used again. It results in time saving.

5. Chalk - board (Black - board) work

Chalk board is a very useful aid in a demonstration lesson. It is mainly used for two purposes-

- (a) For writing important result & principle in summarized form.
 (b) For drawing necessary sketches & diagrams
1. **Clear writing** : The writing on the chalk- board should be neat, clean, & legible.
 2. **Proper space between Words** : There should be proper spacing between different letters resorted to.
 3. **Method of writing** : Always start from the left hand corner, does not begin a second line until the first line has extended cross the chalk- board.
 4. **Writing of Paragraph** : Do not divide the words at the end of line, keep all the paragraph & similar signs in calculation under one another as far as possible.
 5. **Hand writing of teacher** : Students generally copy their teacher. A bad writing on chalk- board means bad writing in pupil's note books.
 6. **Use of Language** : Language used on the chalk board should be that of student with necessary correction.
 7. **Division of Chalk-board** : The chalk - board may be divided into two parts.
 - ❖ $\frac{1}{4}$ for diagram
 - ❖ $\frac{3}{4}$ for writing

The right hand side is preserved for sketches & diagrams.
 8. **Diagrams** : 'Single lined' diagrams should be preferred to 'double-lined' diagrams by turning the chalk.
 9. **Appropriate learning** : Every part of the diagrams must be properly labeled. Good lettering is essential for labeling drawings. While labeling a diagram let all the letters be horizontal. The labeling must be done on the right side of diagrams.

6. Copying & Supervisions

The demonstration method remain incomplete if the students do not copy the black-board summary & sketches drawn on black board. The teacher should frequently go to seats of the students & see if they are properly copying the notes.

Common Errors in the Demonstration Lesson

1. The apparatus may not be ready for use.
2. The teacher may not be able to focus the attention of the students to the important facts of experiment.
3. Chalk - board may not be used properly.
4. Proper set up apparatus may not be at good height.

5. The minor facts may be given as much importance as the major facts.
6. The language used by teacher may be difficult for the student to understand.
7. Inaccurate speed of demonstration.
8. The teacher may arrive at the generalization himself rather than getting done by the pupils.
9. The student interest for further study may have been overlooked.
10. Inadequate lighting & ventilation.

Purpose of a Lecture - cum Demonstration : This method is used in following Situation

1. Provide a problem
2. Explanation of the concepts.
3. Problem - solving
4. Verify the facts.
5. Demonstrate the process.
6. Develop the scientific skill.
7. Analysis of the process applies to general situation.
8. Economize the time.

Suggestions for the success of the demonstration methods

1. It is very essential to ensure that all the students of the class are able to observe the demonstration of the experiment properly. The lecture room should be in the form of gallery i.e. one step other; otherwise the students of the back benches will not be able to watch the demonstration properly. In this case following suggestion will be helpful.
 - (a) The teacher may allow the back benches to stand in a semicircle around the demonstration table.
 - (b) If the audience is large, a big mirror may be fixed in the demonstration table in such a way that a full view of the demonstration activities.
 - (c) The demonstration table should be well lighted so that the apparatus used is properly visible.
 - (d) The demonstration - apparatus should be large in size. The gradation on it should also be in bold letters & figures.
2. The teacher should be well aware of the aims & objectives of the demonstration he is showing to students.
3. The teachers should test all the parts of apparatus and chemicals before doing the experiments before the students.

4. The teacher should ensure the success of the experiment by trying it before hand.
5. The apparatus & instruments for demonstration should be stored in a definite order. Especially on the demonstration table the apparatus should be kept from left to right.
6. One experiment should be shown at a time.
7. The experiments to be shown must conform to the standard and mental ability of the students. The things known & familiar to the students should be used in the experiment.
8. The demonstration work should be directly connected & related to the topic currently taught in the class.
9. The teacher should attract the attention of the pupils during demonstration just like magician.
10. To make the demonstration meaningful and more effective it will be wise to make use of teaching aids like charts, pictures, slides etc.
11. Teacher should make use of the black board placed behind the demonstration table for writing out the summary & the result of the demonstrated experiment.

Advantages of Lecture Demonstration Method

1. **Psychological Method** : This method is psychological because the students have not to imagine anything, they are shown concrete things & living specimen. They take active interest in teaching learning process.
2. **Sensitive Apparatus** : It is very suitable when the apparatus is expensive as very sensitive to break.
3. **Useful in dangerous experiments** : It is helpful in case of dangerous experiments.
4. **Economical** : When apparatus is not sufficient for the students to do practical individually, the teacher may perform the experiment before the whole class. In this sense, this method is not only effective but also economical, as it saves a lot of time and energy.
5. **Time Saving** : It saves time when a number of experiments be performed in a short time.
6. **Based on activities** : The students do not remain passive at the time of demonstration. They kept engaged in various activities like observing, taking notes, answering questions, drawing diagram etc.
7. **Useful for everyone** : It is suitable for all types of students i.e. average, below- average & above- average.

8. **Helpful for the teacher** : This method is helpful for teacher as he can be in position to explain each & every step to ensure that all the students see and interpret all the work in uniform manner. A lot of time & efforts are saved.
9. **Clear & Permanent knowledge** : The knowledge obtained by observing the experiments & by understanding the working of apparatus at the time of demonstration, become quite clear & can be remembered for a long time.
10. **Helps in mental development** : In this method, the student watched the experiment & other teaching aids shown the teacher which excite his imagination for the correct inference. It gives the students chance to develop their faculties of observation, reasoning, thinking & other mental abilities.

Disadvantages

1. **Not based on Learning by doing** : Here is no scope of 'learning by doing' which is an important principle of learning is not followed in this method.
2. **Not child Centered** : It is not child centric. The pupils are not the active participants in the process.
3. **No Experience** : As the experiments are done by the teacher & the students do not get chance of performing them individually.
4. **Hinder Progress (obstacle in Progress)** : The desirable laboratory skills are not developed among the students.
5. **Not based on scientific Attitude** : It does not inculcate the most - needed scientific attitude & training in scientific method.
6. **Problem of Indiscipline** : There is a possibility of indiscipline in the classroom.
7. **Visibility** : All the students may not be able to see detail & result of demonstration.
8. **Not suitable for all subjects** : It is not suitable to teach all by this method.
9. **Required trained teacher** : It requires highly knowledgeable & trained teacher. The teachers should have knowledge of both aspects of subject matter i.e. theoretical as well as practical.

Role of Teacher

Teacher has an important role in this method. The teacher should possess knowledge of both the theoretical and practical skills in science. He/she should relate the theoretical principle with the practical

demonstration & make the students participation in the session by conducting question answer session on the demonstration. This method is a teacher – centered method, an effective teacher can make it highly interactive by involving the participation of the students.

Conclusion

Thus we have said that this method is a very effective method of teaching physical science. It makes the abstract content easy to understand & give practical knowledge also. So a teacher should adopt this method in his teaching learning process.

2. PROJECT METHOD

The project method is a result of John Dewey's philosophy of education which is known as pragmatism, or experimentation or instrumentation. It was developed and improved by Professor William Kilpatrick, a follower of John Dewey. According to him "Project is that activity which is performed with complete attachment in a social atmosphere to achieve the goal." Professor J.A Stevenson worked on it further and perfected it as a method of teaching. Now it is being followed in the progressive schools all over the world.

Definitions of Project Method

There are number of definitions given by educators. Some of the popular definitions are given below.

According to Kilpatrick : "A project is a whole – hearted purposeful activity, proceeding in a social environment".

According to Stevenson : "A project is a problematic act carried to completion in its natural setting".

According to Ballard : "A project is a bit of real life that has been imparted into the school."

According to Ryburn's : "A project is a purposeful activity which completed in vacuum with co-operation and understanding".

According to W.W charters : "In the topical organization principles are learned first while in the projects the problems are proposed which demands the solution of the development of principles by the learners as needed".

According to Thomas and Lang : "Project is a voluntary act in which there are constructive and creative attempts and ideas which have some definite concrete and tangible results".

According to Burton : "The problem is a project which results in doing. The motor element is not what makes the activity a project, but the problem- solving of a practical nature, accompanying the activity."

According to Snedden : "Project is a unit of educative work in which the most prominent features is some form of positive and concrete achievement."

From the above definitions we conclude that-

1. A project is a **purposeful activity**.
2. A project is a **problematic act**.
3. A project is a **whole hearted activity**.
4. A project is a **voluntary act**.
5. A project is a **bit of real life** introduced in school.
6. A project is a **positive and concrete achievement**.
7. A project is an activity in a **natural setting**.
8. A project is an activity in a **social setting**.
9. A project is an activity through which **solutions of various problems** are found.

Basic Principles of the project method

1. **Principle of purpose :** A project always have a purpose. The project which doesn't have any goal or purpose is aimless and meaningless because it is not able to arouse the interest of the pupils.
2. **Principles of Utility :** Project should be useful and practical because it acts as a stimulus to motivate the pupils.
3. **Principle of Activity :** Children love activity. Project should have a feature of physical and mental activity which is generally not present in the traditional methods.
4. **Principle of Reality :** A project is a bit of real life introduced in a school. There is no scope for teaching superfluous things in the project method. So it should present real- life situations to the children.
5. **Principle of freedom :** There should be freedom at all stages in a project so that a child should get an opportunity to express his abilities freely which helps in developing the personality of the child.
6. **Principle of Experience :** In project method child get the opportunity to get the first – hand experience. In this he got "learning by Experience" which is permanent and ever- lasting.
7. **Principle of laws of Learning :** The project method is soundly based on the psychological principle, namely, principles of readiness, exercise and effect evolved by Thorndike, principle of learning by doing, principle of self – experience, principle of self – learning and principle of motivated learning.

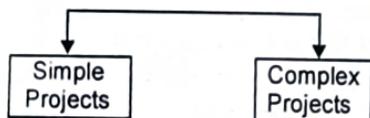
8. **Principle of Democratic Procedure** : This is a child-centered method. So here students are free to do the activity in their own way. No one is superior or inferior. All are equal and tries to utilize all their abilities and capabilities in their best way. Everything goes on in a democratic way.

Kinds of Projects

The projects can be of following types

1. **Creation Related Projects** : When students create something e.g. aquarium, a soap, construction of apparatus etc.
2. **Consumer Related Projects** : Where the students may get an experience and enjoy e.g. Agriculture, Horticulture etc.
3. **Collection Related Projects** : Collection of different types of plant and animals, birds, herbs, shrubs, etc from different places.
4. **Problem related projects** : When the main purpose is to solve a problem involving the intellectual process such as problems related to food and nutrition, determining the density of a liquid.
5. **Drill type** : When the aim of acquiring efficiency in some activity e.g. skill in swimming, dancing etc.
6. **Recognition related projects** : Classification of different flowers, fruits, seeds, roots, etc.

Project are also classified as



Simple project : There is only one work to do like collection of herbs or shrubs.

Complex Project : There is more than one work to do like: Arranging a science fair, building up of school museum etc.

Stages Involved in a project

1. **Providing a situation to propose a problem** : The teacher should provide such situations to the students which may create some suitable problems for them in which they are interested. The teacher can do so through libraries, laboratories and journals.
2. **Choosing and announcing the topic** : Students should be allowed to choose a project. The teacher should see that the project is well understood by pupil and of real need to them.

It should be acceptable to all. In case of wrong selection, the teacher should tactfully guide them to choose another project. The teacher can also propose a project from syllabus. The students should be asked to give reasons for the selection of their topic.

3. **Planning** : For the success of project proper planning is must which includes finding different phases of project, amount of work to be done for each phase, material and equipments needed.

It also includes:

1. Planning by the students under the guidance of teacher.
 2. Planning by the teacher (two or three plans) to give guidance to the student.
 3. Discussion among the students.
 4. Selecting the best plan after discussion.
 5. Recording the plan by the students in their note books.
4. **Execution** : The duties are assigned to the students according to their interests and abilities. Teacher have the full control over the activities. Work is assigned in such a way that every student fully participate in working of the project. Students interested in reading should be given an assignment of referring books and collecting data, one interested in physical work may be assigned a similar work or so on. It is the longest step in the project and requires patience.
 5. **Evaluation**: The project is reviewed by the students from time to time so that short coming should be found out and solved timely. Teacher will guide the students so that the objectives of the project have been achieved.
 6. **Recording**: Complete record of the work should be maintained by the students- how they plan the work, how the duties were distributed and finally the criticism of their own work and noting of important points for future reference.

Essentials of a good project

1. Project should be purposeful and useful. It should have some utility for the students.
2. Project should make the children active both physically and mentally.
3. Project should be economical. There should not unnecessary wastage of time and energy.

4. Project should be feasible. While selecting the project, it should be found out whether the project is feasible or not. Practicability of the project, Availability of the material should be taken into consideration.
5. Project should be timely. It should suit the age, interests, aptitudes, abilities and mental level of the students.
6. Project should give freedom to students to work according to their needs. They should not be forced by the teacher.
7. Project should be challenging. It is neither too simple and easy nor too long and difficult. Students love to do the task which are challenging in nature.
8. Active participation of both teacher and students are there so that project should achieve its goal.
9. There should be availability of resources in the school and in the neighborhood school. The students should be able to handle it without difficulty.
10. The project should have the aspect of independence as well as co-cooperativeness. Students got the opportunity to think and plan with independence and work in full cooperation.
11. Project should seek to have individual's life in its unity. Facts and experiences should be integrated rather than taught independently.

Role of Teacher

1. The teacher is not a dictator or a commander, but a friend, philosopher and guide in the true- sense.
2. He also learns along with the students and does-not claim that he knows everything.
3. He always provides the freedom and democratic environment in the class so that all the students express their talents and abilities.
4. He is always alert and active to see that the project is running in the right direction or not.
5. He himself reads books, collects information and taps resources to help the students for the successful completion of the project.
6. He should provide occasions for shy pupils to come forward and contribute something towards the success of the project.
7. He should have initiative, tact and zest for learning and should be well experienced.

8. He should have knowledge of every child, so as to allot them work accordingly.
9. He should develop the character and personality of the children by giving them responsibility and status to complete the project.
10. He explains to the students what are their weak points and what better method or techniques may be employed to overcome the short comings.

Project : Excursion to Ice Factory

General Science : Information on various principles of evaporation, condensation, freezing etc. for this they study the various books and collect the information.

Social studies : History of Refrigeration, Its invention and its various industrial applications

Home science : Use of refrigeration in preserving the food articles, preparation of Ice cream etc.

Language : Introduction to new words like condensation, evaporation, freezing, pressure. Writing of report on the experience of excursion.

Art Work : Draw the chart, model on the process of Refrigeration.

So in this way through this method we give the first hand information the students in different subjects in a correlated manner.

Few Examples of project in science

1. Laying a flower garden in school
2. Preparing a aquarium or vivarium in life sc Laboratory.
3. Conservation of soil
4. Organizing a Blood Donation Camp in school.
5. Polio awareness programs
6. Celebration of Environment day
7. Improvising science Apparatus
8. Organizing a science fair

Merits : These are some of the merits of the project method

1. This is based upon the laws of learning I.e.
 - (a) **Law of Readiness :** The students are motivated and make their minds ready for acquiring knowledge. They are now ready to participate in the execution of the project.
 - (b) **Law of Exercise :** There is 'Learning by Doing' students practice the things which leaves permanent impression on the mind of the students.

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- (c) **Law of Effect** : There is freedom and democratic environment is there. Students get the first hand experiences which gives him the feeling of pleasure and satisfaction.
- Development of Democratic way of life** : Children are free to think, plan, execute according to their own needs. They learn to work in cooperation and as a team member to achieve the common goal.
 - Correlation of Various subjects** : Subjects are not taught in isolation. There is no division of subjects into water-tight compartments. It gives unity to the curriculum.
 - Training in scientific method** : It helps in developing the scientific and problem solving attitude in the students. So cramming and rote - memory is discouraged.
 - Dignity of labour** : This method emphasizes dignity and love for labour. They learn that there is nobleness in working and doing things with their own hands.
 - Play- way method** : This provides education to the students by play- way method. There is no formal class or instructions are given to students. So children learn the things in playful environment.
 - Problem of Indiscipline can be Solved** : As all the children are busy in various activities of their own choice so there is no time for indiscipline or antisocial activity in the class.
 - Making Pupils Active** : This method is very beneficial for shy or slow learners. It helps to develop in them the qualities of self- initiative, self- confidence, keenness and accuracy of observations, development of interest towards the subject. So develop the constructive and creative thinking.
 - Economical** : It is economical because children learn the things without any strain. There is learning for the real life and life to come. Without least wastage of time, energy and effort children learn so many things.

Limitations : The project method has the following limitations.

- Systematic teaching is not possible** : In this method the whole teaching is unorganized and unsystematic. Teaching is haphazard and many important topics cannot be taught through this method because of which many desirable knowledge is not given.
- Much more expectations from Teacher** : There is much more expectations from teacher. It demands much more efficiency on the part of teacher. Teacher has to look at all the activities of the children. He/she should remain active, alert and vigilant

- throughout the process which adds too much strain on the teachers.
- Lack of competent teachers** : For the working of this method very competent teachers who are active, alert, efficient and resourceful are required, which are generally not available.
 - Expensive method** : It is expensive for the students who will have to bear the expenses of excursion, outdoor activities and purchase of material etc.
 - Upsetting of the Time-table** : Project upset the routine time-table of the school because fixed time-table of the school and projects cannot go together so for the organization of the project there is upsetting of the time-table of the school.
 - Non availability of Text-Books** : Text books written for various projects are not available. So the students don't get the important information related to the activities.
 - Not suitable for smaller children** : This method is not useful for small children as they are too young and inexperienced, for successful working of project mature students are needed.
 - Practically unsuitable** : There is so much practical difficulties in carrying out the project, arrangement of material, suitable amount of funds, interest and through knowledge of the content by the teacher are some of the practical problems which we normally feel during the project method.
 - Coverage of syllabus** : This is time - consuming method so it is very difficult for a teacher to over the whole syllabus in a limited period by this method.

In spite of all these limitations this method is quite useful and beneficial. It is used with some modifications.

These are some suggestions for the project method

Suggestions

- Along with formal classroom teaching, some projects may be undertaken by the students to be completed on certain fixed days of the week.
- The problems of expenditure can be easily solved by undertaking such projects in which we earn something or in other words project should be made economically self-sufficient
- To fill the gap in knowledge learnt, direct classroom lesson should be given

4. The problem of upsetting of time-table can be solved by utilizing first half of the day

For the formal schooling whereas the other half for carrying out the project.

3. PROBLEM-SOLVING METHOD

Problem solving is the ability to identify and solve problems by applying appropriate skills systematically.

Problem-solving is a process – an ongoing activity in which we take what we know to discover and what we don't know overcoming obstacles by generating hypo-theses, testing those predictions and arriving at satisfactory solutions.

Problem-solving involves three basic functions:

1. seeking information
2. generating new knowledge
3. making decisions

Problem-solving should be a very real part of the curriculum. It presupposes that students can take on some responsibility for their own learning and take personal action to solve problems, resolve conflicts, and discuss alternatives on thinking as a vital element of the curriculum. It provides students with opportunities to use their newly acquired meaningful real life activities and assists them in working at higher levels of thinking.

Definitions:

According to **Hammonds Carsie** "Problem solving in teaching refers to the task making decisions or doing things that learner wants to make or to do the nature of which he is able to understand but for which at the time he has no solutions."

According to **James Rodd L** "Problem solving is an educational device where by the teacher and the pupil attempts in a conscious, planned, purposeful manner to arrive at an explanation or solution to some educationally significant difficulty."

According to **Risk T.M.** "Problem solving may be defined as planned attack upon a difficulty or perplexity for the purpose of finding a satisfactory solution.

According to **Hiess, Oboourn and Hoffmann**, "Problem solving in all of its elements is closely associated with a group of attitudes or mind-sets which are as important as outcomes of instruction in science.

Characteristics of a Problem

1. The problem given should be according to interest and capabilities of the students.
2. Problem has relation with the previous knowledge of students.
3. Problem should have practical value.
4. Problem should have educational value.
5. Problem should be neither too difficult nor too easy.
6. Problem should be clear and concise.
7. Problem should be new one but preferably children possess basic information needed to solve it.
8. Problems given to the students should connect with their course of study.
9. Problem should be challenging.
10. Problem should fit in the administrative frame work of the institute.

Steps Involved in Problem- Solving Method

The method of problem-solving is a result of necessity. In this method the students put forth his topic related problem in front of other students and they start finding a solution to it according to their interest and capability. In this method the problem should be placed in front of the students in clear words and should be according to the understanding experiences of the students. The student does the synthesis and analysis of the problem with the help of the teacher and tries to find the solution.

For younger student, illustrations are helpful in organizing data, manipulating information, and outlining the limits of its possible solutions. Students can use drawings to help them look at a problem from many different perspectives.

1. **Understand the problem** : It's important that students understand the nature of a problem and its related goal. Students to frame a problem in their own words.
2. **Describe any barriers** : Students need to be aware of any barriers or constraints that may be preventing their goal. In short what is creating the problem? Encouraging students to verbalize these impediments is important step.
3. **Identify various solutions** : After the nature and parameters of a problem are understood, students will need more appropriate strategies to help resolve the problem. Students need to understand that they have many strategies available to them

and that no single strategy will work for all problems. Here are some problem solving possibilities.

- ❖ **Create visual images** : Many problem-solvers find it useful to create "mind pictures" of a problem and solutions prior to working on the problem. Mental imaging allows the problem-solvers to map out many problems and "see" it clearly.
 - ❖ **Guesstimate** : Give students opportunities to engage in some trial and error approaches to problems to be understood, however that this is not a singular approach to problem-solving but rather an attempt to preliminary data.
 - ❖ **Create a table** : A table is an orderly arrangement of data. When students have opportunities to designing of table of information, they begin to understand that they can group and organize most data relative to problem.
 - ❖ **Use manipulative** : By moving objects around on a table or desk, students can develop patterns and elements of a problem in to recognizable and visually satisfying components.
 - ❖ **Work backward** : It's frequently helpful for students to take the data presented at the end of a problem of computations to arrive at the beginning of the problem.
 - ❖ **Look for a pattern** : Looking for patterns is an important problem solving strategy because many problems fall in to predictable patterns. A pattern, by definition, is a regular, systematic repetition and may be visual or behavioral.
 - ❖ **Create a systematic list** : Recording information in list form is a process used quite frequently to map attack for defining and solving problems. Encourage students to record their ideas in lists to determine the patterns, or similarities between problem elements.
4. **Try out a solution** : When working through a strategy or combination of strategies, it will be important for students.
- ❖ **Keep accurate and up-to-date records of their thoughts, proceedings, and procedures** : Records collected the predictions made and the strategies used are an important part of the problem solving process.
 - ❖ **Try to work through a selected strategy or combination of strategies until it becomes evident till working, it needs**

to be modified, or it is yielding inappropriate data : As students become more problem solvers, they should feel comfortable rejecting potential strategies at any time during their quest for solving

- ❖ **Monitor with great care the steps undertaken as part of a solution** : Although it might be a natural that students rush through a strategy to arrive at a quick answer encourage them to carefully assess and progress.
 - ❖ **Feel comfortable putting a problem aside for a period of time and tackling it at a later time** : For scientist rarely come up with a solution the first time they approach a problem. Students should also letting a problem rest for a while and returning to it later.
5. **Evaluate the results** : It's vitally important that students have multiple opportunities to assess their own problem and the solutions they generate from using those skills. Frequently students are overly dependent upon teachers for their performance in the classroom. The process of self-assessment is not easy, however. It involves risk taking assurance and a certain level of independence. But it can be effectively promoted by asking students questions.
6. **Drawing conclusion and making generalization** : In this step conclusions are drawn. The results should support the expected solution. Drawn conclusions should be properly reported. When the same conclusions are drawn from different sets of experimentation under similar situations they may go for generalization of their conclusion.
7. **Application of generalization to new situations** : The students should be able to apply generalizations under new situations in their daily life and hence minimizing the gap between class room situation and real life situation.

Merits

1. **Development of scientific attitude** : It helps in developing scientific attitude among the students.
2. **Develop reflective thinking** : This method is useful in developing reflective thinking and hence increases student's mental ability.
3. **Individual attention** : Teachers can pay individual attention to every student which helps in the development of harmonious relationship between the teacher and the taught.

4. **Based on psychology** : This method is child centered and problem oriented. It is also based on the principle of 'Learning by doing' which motivates the child to solve the problems of their life.
5. **Self - evaluation** : It helps the child to find out their own mistakes and shortcomings. The child becomes so capable that he modifies his own shortcomings, which helps in developing the habit of self-assessment in the child.
6. **Solve the teaching-learning problems** : This method is especially helpful in getting rid of many teaching-learning problems like the problems of indiscipline, assigning the homework etc.
7. **Extra - reading** : This method encourages the students for extra study.

Demerits : In spite of so many merits there are some demerits also.

1. **Lack of trained and capable teachers** : Teachers who have research skills and capability to handle this method are rarely available.
2. **Curriculum** : The entire curriculum is not covered by this method, so this method has a partial usability in covering the physical science contents.
3. **Not economical** : This method is quite expensive as it requires well-equipped laboratories, adequate library, trained teachers and lots of time and energy.
4. **Not suitable for every students** : Every student doesn't have the scientific thinking and problem-solving ability, so it is very difficult to adopt this method for all the students because all the students can't be problem solvers.
5. **Too much practical work** : There is more emphasis on practical work which makes it dull and routine type work.
6. **Lack of study material** : Good text-books are not available for this method.

EVALUATE YOURSELF

1. What do you mean by Methods of Teaching? Explain the criteria for selecting a particular type of method for a science teacher.
2. What do you mean by Project Method? What are the various steps involved in Project Method?
3. What is Lecture-cum-Demonstration Method? Discuss its merits and demerits.
4. What is Problem Solving Method of Teaching Physical Sciences? How this method is useful for a Physical Science teacher?

CHAPTER 3

Aids, Equipments and Assistance in Teaching Physical Sciences

Note: This Chapter has been further sub-divided into following four Chapters:

CHAPTER 3-A

Need and Utilities of Physical Sciences Laboratory

INTRODUCTION

Newton won a stunning victory for the intellect and the democratization of science, because it became possible for students to have as much authority as teachers. By knowing proper methods, a youth could conduct an experiment whose results might confound his elders. Newton's program of "experimental philosophy" firmly and successfully established the central methods of physics, whereby inference from experience guides formulation of hypotheses, whose predictions are validated by experiment. Laboratory activities in high school physics provide experience with phenomena, a starting place for the systematic development of students' ideas, and a testing ground for the predictive power of their reasoning.

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UTILITIES FOR PHYSICAL SCIENCE LABORATORY ACTIVITIES

Laboratory activities must be designed to engage students' minds, so that students may acquire skill and confidence in their:

- measurement of physical quantities with appropriate accuracy
- recognition of factors that could affect the reliability of their measurements
- manipulations of materials, apparatus, tools, and measuring instruments
- clear descriptions of their observations and measurements
- representation of information in appropriate verbal, pictorial, graphical, and mathematical terms
- inference and reasoning from their observations
- ability to rationally defend their conclusions and predictions
- effective and valued participation with their peers and their teacher in a cooperative intellectual enterprise
- articulate reporting of observations, conclusions, and predictions in formats ranging from informal discussion to a formal laboratory report
- Ability to recognize those questions that can be investigated through experiment and to plan, carry out, evaluate, and report on such experiments.

NEED OF PHYSICAL SCIENCE LABORATORY

Science educators have believed that the laboratory is an important means of instruction in science since late in the 19th century. Laboratory activities were used in high school chemistry in the 1880s. In 1886, Harvard University published a list of physics experiments that were to be included in high school physics classes for students who wished to enroll at Harvard. Laboratory instruction was considered essential because it provided training in observation, supplied detailed information, and aroused pupils' interest. These same reasons are still accepted almost 100 years later.

Schulman and Tamir, in the *Second Handbook of Research on Teaching* listed five groups of objectives that may be achieved through the use of the laboratory in science classes:

1. **skills** - manipulative, inquiry, investigative, organizational, and communicative

2. **concepts** - for example, hypothesis, theoretical model, taxonomic category
3. **cognitive abilities** - critical thinking, problem solving, application, analysis, synthesis
4. **Understanding the Nature of Science** - scientific enterprise, scientists and how they work, existence of a multiplicity of scientific methods, interrelationships between science and technology and among the various disciplines of science
5. **Attitudes** - for example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, and liking science.

PLANNING OF PHYSICAL SCIENCE LABORATORY

While planning for the Physical Science Laboratory, the authorities must take into consideration as to what are the space requirements for a Physical Science laboratory? What is the maximum number of students you should have in your science laboratory? How much lab space should be available for each science student?

Many schools are experiencing budget problems. Most science laboratories are designed to accommodate 24 students, an accepted professional standard. When class sizes are larger than 24 students, it becomes very difficult for the science teacher to safely handle, transport and use laboratory chemicals and equipment. Many laboratory experiences require a high degree of student-teacher interaction. The fewer students there are in a laboratory, the greater the opportunity for students to ask questions and for teachers to clarify procedures and encourage the development of reasoning skills. **Therefore, planning for the Physical Science Laboratory must take into consideration the strength of the science students in the school and accordingly the area of the Physical Science Laboratory should be earmarked.**

EVALUATE YOURSELF

1. Write a detailed note on Need and Utilities of Physical Science Laboratory.
2. What is the importance of Physical Science Laboratory? What are its utilities?



CHAPTER 3-B

Preparation and Use of Teaching Aids

Teaching aids are tools that classroom teachers used to help their students learn quickly and thoroughly. A teaching aid can be as simple as chalkboard or as complex as a computer program. Because every individual learns in a different way, teachers rely on these tools to explain concepts to students with a wide variety of learning needs. Teaching aids are crucial for educators as they are key in differentiating instructions for all types of learners.

To make learning very effective it is not only necessary to utilize the factors and techniques that facilitates learning, the teachers are to create certain conditions in the classroom that may improve learning. These conditions are teaching aids which play a key role in teaching – learning situations. It works as the support to both teacher and taught in the pursuit of knowledge and curriculum transaction. Teaching aids are the tools purposefully designed to overcome verbal deficiencies in communication in a classroom situation.

Meaning of teaching aids

It consist of two words

1. Teaching
 2. Aids
1. **Teaching** : To give knowledge, to train or instruct someone.
 2. **Aids** : Sometimes that provides help or support. Thus we can say that teaching aids are those aids, which help the teacher to make all kinds of concepts, ideas or thoughts clear and create coordination in the them by inter relating them.

Other names of teaching aids

1. Audio – visual aids
2. Learning resources / Instructional material
3. Educational Aids / Media

Few Definitions of Teaching Aids

Good's Dictionary of Education : These aids are anything by means of which learning process may encouraged or carried on through the sense of hearing or senses of sight.

Burton : Audio-visual aids are those objects or image which initiate or stimulate or reinforce learning.

E.C Dent : All material used in the classroom or in other teaching situations to facilitate the understanding of the written or spoken words.

Carter V. Good : Audio –visual aids are those which help in completing the triangular process of learning I.e. motivation, classification and Stimulation.

So teaching Aids are those:

- Which reinforce the teaching
- Which present the realistic experience to the learner.
- Which provide stimuli to the learner.
- Which provide sensual experience to learner.

History : A Dutch humanist theologist and writer desretrious Erasmus (1466-1536) disclosed memorizations as a technique of learning and advocated that the children should learn through the aids of pictures or other visuals. While John Amos Comenius (1592-1670) prepared a book known as Orbis Sensilium pictus (the word of sense objects). Which contained near about 150 pictures on aspects of every day life. This is considered as a illustrated book for the children education. The term visual education was used by Nelson Greence in 1926. Aric identified four revolutions:

1. Education from home to school.
2. Written word as a tool of education.
3. Invention of printing and use of books.
4. Use of electronic media Radio, TV, Tape –Recorder and computer in Education.

Characteristics/ Features of Good Teaching Aids

- They should be meaningful and purposeful
- They should be accurate in all aspects

- They should be simple
- They should be cheap
- As far as they should be uptodate
- They should motivate the learner as well as the teacher also
- They save time and increases interest.
- They make the students more active and learn the lesson easily
- As far as possible, they should be improvised.
- They should have the proper size.
- They should develop curiosity towards exploration of various subjects.
- Makes use of variety of media.
- Helpful for the teacher in useful teaching.

Principles of Audio Visual Aids

For effective teaching to take place a good method must be adopted by the teacher. The teacher is always free to choose effective audio visual aids in the class room. Of course there are also certain principles of Audio –visual aids in teaching methodology. They are as follows:

1. **Principle of selection:** 1. The age level 2. Other personality angles 3. They should have specific educational values 4. They should help in the realization of learning desired objectives.
2. **Principle of preparation:** 1. As far as possible, the local material should be used in the preparation of aids. 2. The teacher also must receive training in the preparation of aids. 3 The teacher him/herself can prepare some aids or can take help of students also.
3. **Principle of physical control:** This is concerned with the arrangement of teaching aids safely
4. **Principle of proper presentation:** 1. Teacher should carefully visualize the use of teaching aids before their actual presentation. 2 They should be well acquainted themselves with the use & manipulation of the aids to be shown in the class room. 3. The aids should be displayed properly. So that, all the students can see it, observe it, and can derive maximum benefits from it.
5. **Principle of Response:** This is the important principle. This tells the teacher guide the students to respond actively to the audio visual stimulus so that they derive the maximum benefits in learning.

6. **Principle of Evaluation:** This principle stipulates that there should be continuous evaluation of audio visual aids materials & accompanying techniques in the light of desired objectives.

Audio visual aids or devices or technical devices or technological medias or learning devices that helps the teacher to clarify, establish, correlate & co-ordinate accurate concepts, interpretations, appreciation and enable him to make learning more concentrate, effective, interesting, inspirational, meaningful, vivid, etc. The audio-visual aids always helps in completing the triangular process i.e. Motivation, clarification, stimulation. The aims of teaching with technological medias is clearing the channel between the learner and the things that worth learner. The teacher must show as "well" as "tell". The audio-visual aids provides significant gains in informal learning, retention and recall, rethinking and reasoning, activity, interest, imagination, personal growth & development.

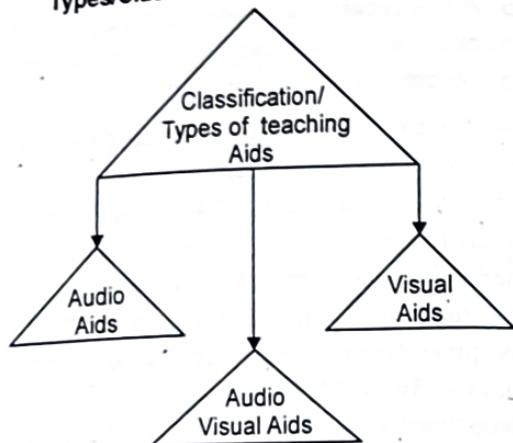
Here are values/importance of teaching aids:

1. **Best motivator:** They are the best motivator. The student works with more zeal & interest.
2. **Clear image:** Clear image takes place when we touch, handle, experience it.
3. **Variety :** "Mere chalk & talk" do not help. Audio – visual aids gives variety & provides different tools in the hand of teacher.
4. **Freedom :** When audio – visual aids are employed, there is a great scope for children to move about talk, laugh & comment upon. Under such atmosphere the students work because they want to work & not because the teacher wants them to work.
5. **Opportunities to Handle:** Many students always get a chance to handle the aids.
6. **Helpful in attracting the attention :** Attention is the true factor in any process of learning & teaching audio – video aids helps the teacher in providing proper environment for capturing as well as sustaining the attention and interest of the students in class room.
7. **Savings in energy & time :** Due to effective implementation of "principle of presentation", a good deal of energy & time of both the teacher & students can be saved.
8. **Realism:** The audio – visual aids gives the real touch to the learning situation.

9. **Encouragement to healthy class room interaction :** Audio-visual aids through variety of stimuli, motivational, provision of active participation of students, a good experience always encourage healthy class interaction between teacher and the learners.
10. **Scope of education at a mass scale :** The audio- visual aids like radio, tape, television etc. always plays role in spreading mass education.
11. **Positive environment for creative discipline :** A balanced, rational, scientific use of audio – visual aids develops, motivate, experience, attract the attention of the students and provides a variety of creative outlets for the utilization of their tremendous energy & keeps them busy in class room work. This overall classroom environment becomes conducive to creative discipline. Grossly, we can say that there are various types of audio – visual aids i.e. traditional as well as modern aids of audio –visual aids. But at the same time it is important to take into account that the audio-visual aids do not play role up to disseminate the information, data, facts, clues, but also they influence the mentality, psychology, grasping level of the students in the class room. On the other hand they gratefully motivate, inspire the teachers to adopt the latest, creative, innovative aids. The scope of audio – visual aids in not only up to procure & make presentation. Of course it is technical part of teaching. But otherside also it conveys us that it is a tool to know through effective communication in triangular process i.e motivation, stimulation, clarification. Apart from this it is also important that to think about difficulties and problems in the use of aids. There are certain problems like lack of motivation for the use of teaching aids by the teacher, non availability of aids in school, lack of facilities for the use of aids – electricity, room, furniture etc, lack of training on the part of teacher in the use of aids, costly nature of aids, lack of storage facility & non availability of suitable teaching aids in the regional languages.
12. **Change in traditional teaching :** The traditional teaching is changed with the help of teaching aids. Now there is interaction between the student and teacher. Students participate effectively in class, they talk, ask questions or discuss things with teacher.

13. Useful for exceptional children : When we use different teaching aids like charts, pictures, diagrams etc to clarify the concept. It helps the slow – learners and backward children to learn more easily. So it is useful for special children.

Types/Classification of Teaching Aids



14. **Direct experiences** : When the various processes are shown to students in the films or when shown the live experiences e.g visiting a milk plant, botanical Garden or showing the working of different systems with the help of models add the real life experiences to the children.

1. The aids that involve the sense of hearing are called Audio aids e.g radio, tape-recorder, gramophone etc.
2. The aids which use sense of vision are called visual aids. E.g charts, models, actual objects, maps, flash cards, chalkboard, bulletin board, flannel board, overhead projector etc.
3. The aids which involve the sense of vision as well as hearing are called audio –visual aids e.g. television, film projector, film strips etc.

Teaching aids are also classified according to way they are projected.

1. **Projected Aids** These are the aids that are projected with the help of the screen. E.g film projector, overhead projector, slides etc.
2. **Non –projected** All the aids that are not projected with the help of screen e.g chalkboard, models, charts, aquarium, diagrams, flannel boards etc.

Edger Dale classified these teaching aids. He described it as the "cone of experience" (fig. 5.1 and 5.2)

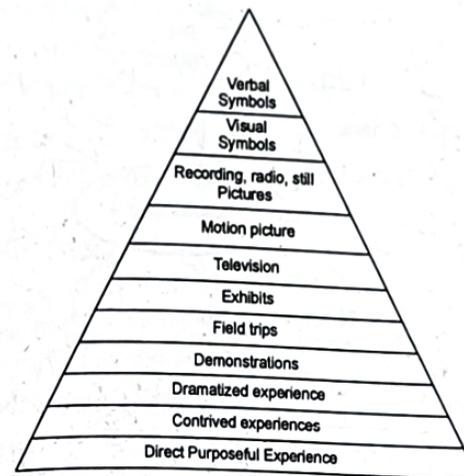


Fig. 5.1. Showing Cone of Experience

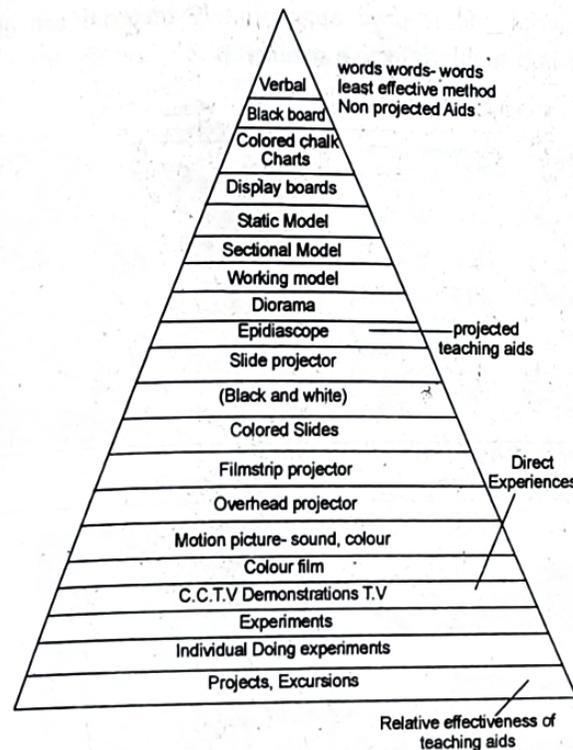
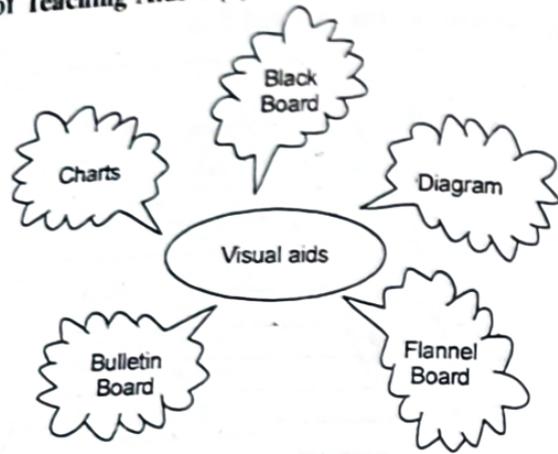


Fig. 5.2. Edger Dale's cone of experience in Teaching Aids

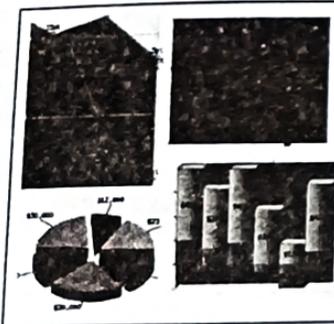
Types of Teaching Aids : (1) Visual Aids



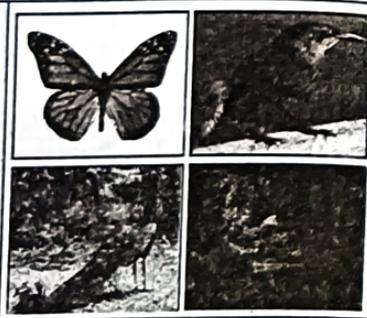
1. Charts

A chart is a combination of pictorial, graphical, numerical or vertical material which presents a clear visual summary. It is a simple flat pictorial display material and is used appropriately material and displaced information in a highly effective manner.

Graphic Chart



Picture Chart



Collage (Fruit)



Tree Chart



PREPARATION AND USE OF TEACHING AIDS

Preparation of charts

- Selection of the material :** Charts should be prepared for longer life. The selection of the material depends upon:
 - The size of the chart.
 - The time it has to remain service.
 - The use of charts.
- Material for preparing charts :** Thick paper boards, cloths, stationary etc. are used for preparing charts. According to **K. Sampath and his associations**. Following points to be kept in mind while preparing them.
 - Concept or theme to be developed.
 - Analysis of the main theme in various relationships.
 - Visualization and illustration of idea by sketching.
 - Transferring rough sketches to the charts.
 - Coloring of necessary.
 - Lettering.
- Types of charts.**
 - Picture charts :** In pictorial charts various pictures are collected and shown e.g. Mean of transport, irrigation etc.
 - Time chart :** These are in the form of tables and used to indicate the time sequences of a series of events chronologically e.g. Production in different years.
 - Graphic chart :** With the help of graphic charts statistical data e.g. increasing or decreasing birth rate, death rate etc.
 - Tree charts :** In tree chart the figures drawn resemble a tree while the several roots of the tree leading in to a single trunk account represent the origin of a concept for e.g. development of a plant in biology.
 - Flow chart :** They represent the systematic representation of trends movements and organization of different concepts. E.g. economic environment pollution.
 - Collage :** When information, pictures and photographs from other sources such as newspapers magazines are pasted together it is known as collage.
 - Circle chart :** This can be used to represent the relative size of components in aggregate by dividing a circle in to segments. E.g. numbers of men in total population.

4. Advantages :

- They make the learning process effective as interest of the students is increased in the lesson.
- Students become more active and knowledge becomes appropriate.
- They present the material in brief.
- They prove a constant source of information and are useful for revision.

2. Chalk board

Chalk board represents the oldest and most commonly used visual material for the classroom teaching. A class can function without the aid of a chalk board. A chalk board is used for recording the progress of the work for outlining the topic, for drawing diagrams and for summarizing. In the national education policy tremendous emphasis has been put over the necessity and use of chalk board as an instructional aid in the name of 'Operation Blackboard'

(a) **Procedure :** For making proper use of the chalk board the teacher should take-care of the following points:

- The teacher should use the parts of the chalk board which can be properly seen by all the students of the class.
- Start writing on a clean black board and leave it clean after using.
- Writing should be neat and clean.
- Distance between line to line and word to word should be adequate.
- Do not cover up the material on the black board by standing in front of it.
- Talk to the class while writing.

(b) Advantages :

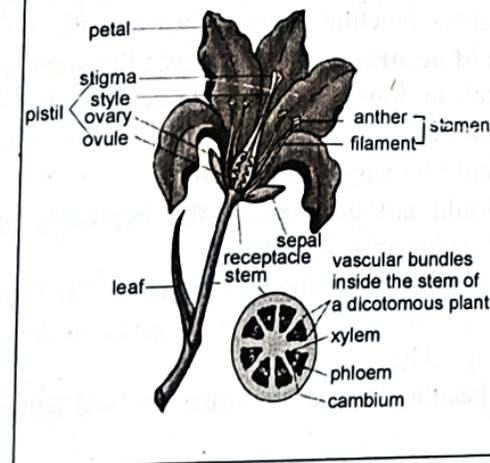
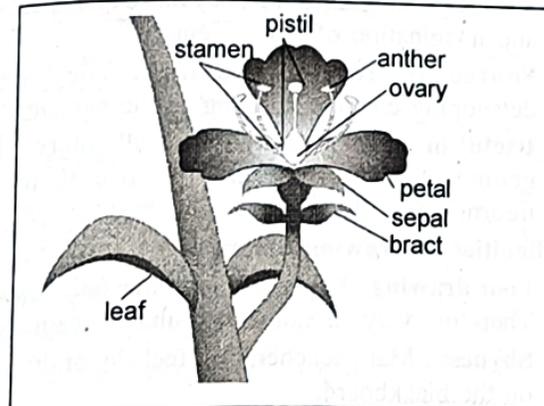
- It can be used as a source of motivation for arousing interest of the students in the learning.
- It can be used for highlighting the main points, summarizing the topic, providing assignments, and also to test their understanding of the subject matter.
- It provides opportunity to the students not only to understand the subject matter but also help them to draw sketches, diagram etc. themselves.

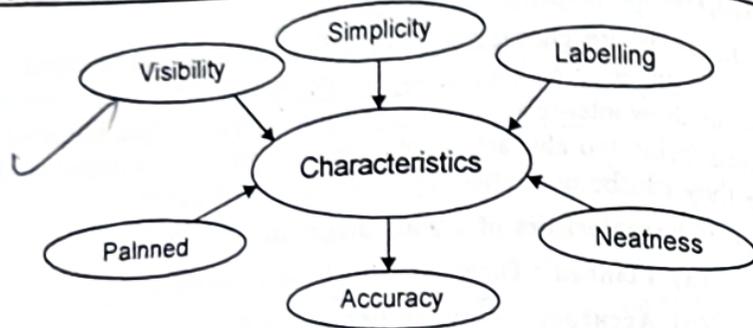
3. Diagrams

Diagrams are cheapest kind of aid in the effective teaching of almost all subjects. A diagram can be defined as simplified drawing defined to show inter-relationship by means of lines, symbols and labels. Diagrams being too abstract in nature require careful foundation work before they can be used effectively with a class of pupils.

I. Characteristics of a good diagrams

- Planned :** Diagrams must be well planned.
- Accuracy :** They must be accurate.
- Neatness :** They must be neatly drawn in proper proportion.
- Labeling :** They must be correctly labeled and explained.
- Simplicity :** Diagrams should be simple not complicated.
- Visibility :** They should be drawn at such angles that can be seen by the whole of the class.



**Advantages:**

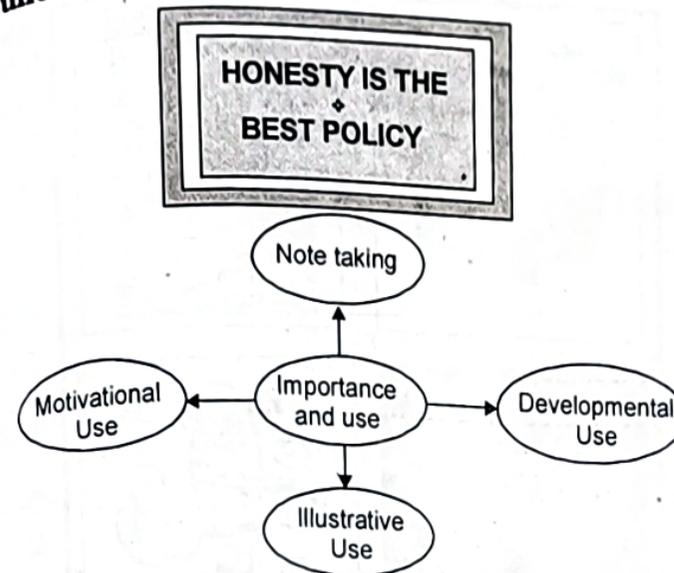
- Source of attention and interest :** Diagrams arouse attention interest and curiosity of the students.
- Source of motivation :** They are source of motivation for the students.
- Source of imagination :** They make an appeal of the senses and imagination of the students.
- Source of creative thinking :** They are source of developing creative thinking of the students.
- Useful in all subjects :** Almost all subjects like science, geometry languages, art etc. use them for precise information.

II. Difficulties in drawing diagrams.

- Poor drawing :** Many teachers have poor drawing capacity. Therefore they cannot draw suitable diagrams.
- Shyness :** Many teachers just feel shy of drawing diagrams on the blackboard.
- Lack of will :** Either the blackboard or chalk is not available; sometime there is lack of will.
- Lack of accuracy and neatness :** For some teachers, it is difficult to draw accurate and neat diagrams.

III. Precautions :

- It should be very clearly drawn.
- It should not be used at the beginning stage of the presentation of a lesson.
- The symbols used should be on familiar lines.
- The teacher must process the ability of drawing diagram very quickly.
- Full heading should be written in bold letters.

4. Bulletin Board

Bulletin board is a kind of display board for bulletins, news, item, announcements and much other visual display. According to good's dictionary of education. "it is a board to which can be fastened pictures or other material that are intended for display. It is used :

- To motivate and arouse curiosity in students.
- To display work done by students.
- To introduce or summarize a unit of work.
- To provide basic means of general communication.

Importance and uses :

- Motivational use :** It provides motivation.
- Illustrative use :** It is used to illustrative ideas with help of photographs etc.
- Note-Taking :** It helps in taking notes.
- Development :** Develops and unfolds the creativity potential of students.

5. Flannel Board

It is commonly known as felt-graph. It is a stationary or portable flat-surface covered. With a rough flannel like cloth usually in black or grey colour. The material to be displayed on flannel board may be backed with sand paper blotter material etc. it serves as an ideal medium for display of prepared items that is stories, poems, diagrams etc.



Purpose of flannel board :

- To attract and motivate the learner.
- To save time during class representation.
- To develop creative activities.
- To present view and consolidate the lesson.

Advantages :

- Easy and economical to handle and operate.
- To hold the interest of the students.
- It enables the teacher to develop illustration and recapitulate a lesson.

Suggestions :

- Use of colours :** The use of colour should be made to bring main points in to prominence.,
- Selection of topic :** The subject matter should be related to the unit of work under study.

6. Models

A model means an imitation a replica or a copy of a thing act or process. It is a 3-dimensional representation of the real objects. The original size or shape of the actual things is changed i.e. enlarge or reduced to suit the learning group. That is why models are more

advantages and more convenient than actual objects or process e.g. to show the various parts of motor or to show the various organs of digestive, respiratory or excretory system an model shown. Its structure and various organs properly.

Preparation of models :

- Decide the objectives and scope of preparing the model.
- Decide what material to be used, collect all the material carefully.
- Model is the replica of any real object so to make proper arrangement of the picture or photograph of it so that exact model should be prepared.
- Make a rough sketch of model and then highlight the important parts, you want to show and then finalize the model.

Quality of a good model :

- Accuracy
- Simplicity
- Utility
- Solidity i.e. inherent strength to resist
- Ingenuity i.e. must be an expression of the innate capacity and personality of a child.

7. Specimens

Preserved specimens of living things are good visual aids that can be employed in teaching physical sciences. By seeing the actual things, students develop adequate concepts about them regarding, size, shape, structure and colour etc. so that students are able to study these organisms and also know how to prepare these specimens. The teacher can deliver the topic along with dissections of animal and plant material. He can also set up some physiology experiments to demonstrate some phenomena of making some quantitative study while the lesson is in progress.

8. Slides and film strips

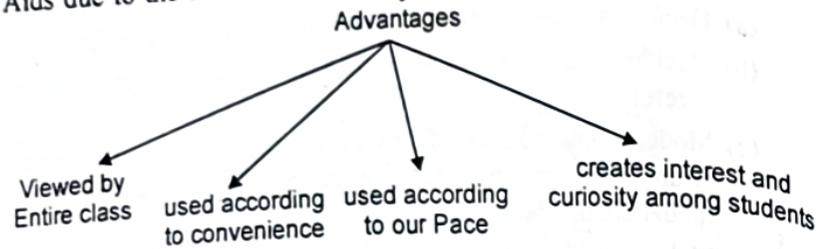
Slides are transparent pictures projected by shining light through them. The commonly used sizes of slides are $2" \times 2"$ and $3.5" \times 4"$. Slides are used on a variety of materials glass coated or clear or sensitized. Generally slides are of two kinds.

(I) Handmade slides

(II) Photographic slides.

Slides in series or linked together in a sequence make a film-strip or film slide or slide film. Film strip is a roll of 35mm positive film which has sprocket holes in both sides and contains a sequence of pictures

like slides. By arranging the slides and film strips in required sequence we can present the topic systematically. Structure and parts of flower, the process of reproduction, all division etc. can be illustrated very well through slides and films strips. These are used as very effective teaching Aids due to the advantages.



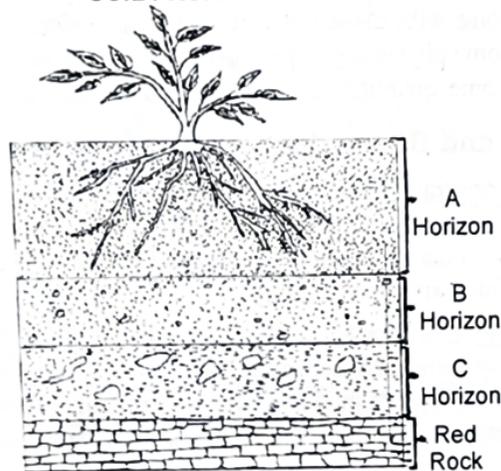
9. Transparencies.

Overhead projector is an important electronic teaching Aid which projects an image from a transparency which is transparent. The graphic picture and message of transparencies are reflected on a screen. Transparencies are made by teacher to draw figure/diagram to write something on the cellophane sheet. Readymade transparencies are also available.

Procedure of making transparencies.

1. **Single-Transparency :** It can be prepared by writing on the cellophane sheet with the help of an OHP pen. Even graphs, figures, diagrams can be easily shown in different colors. Generally black, blue, red and green colors are used as they are more visible on projector screen. Colored transparency can also be used in the classroom to give variety and attraction.

SOIL PROFILE



2. **Roll transparency :** In this we can use the roll of transparency on which writings and pictures can be made in a sequence and can be projected on OHP and teacher explains it. The roll of transparency can be moved backward and forwarded as required.

Advantages :

1. A large group can be taught with this.
2. It enhances the interest of the students.
3. Teachers don't require drawing figures/diagrams on black board.
4. Preparing transparency by the teachers and students adds creativity in the students.

Presentation slides. Teachers create their own presentation slides to add personality to lessons. They can use graphics, music, photos and charts as needed for each component of a topic. Computer programs that create slides includes Microsoft PowerPoint, Google presentation etc.

2. AUDIO AIDS

The aids involving the sense of hearing are called audio aids. Typical elementary and secondary students spend 50 percent of their school time just listening. The importance of audio media in the classroom should not be underestimated.

Audio Media are the various means of recording and transmitting the human voice and other sounds for instructional purposes. The audio aids are radio tape recorder, audio compact disc-player, language laboratory, gramophone etc.

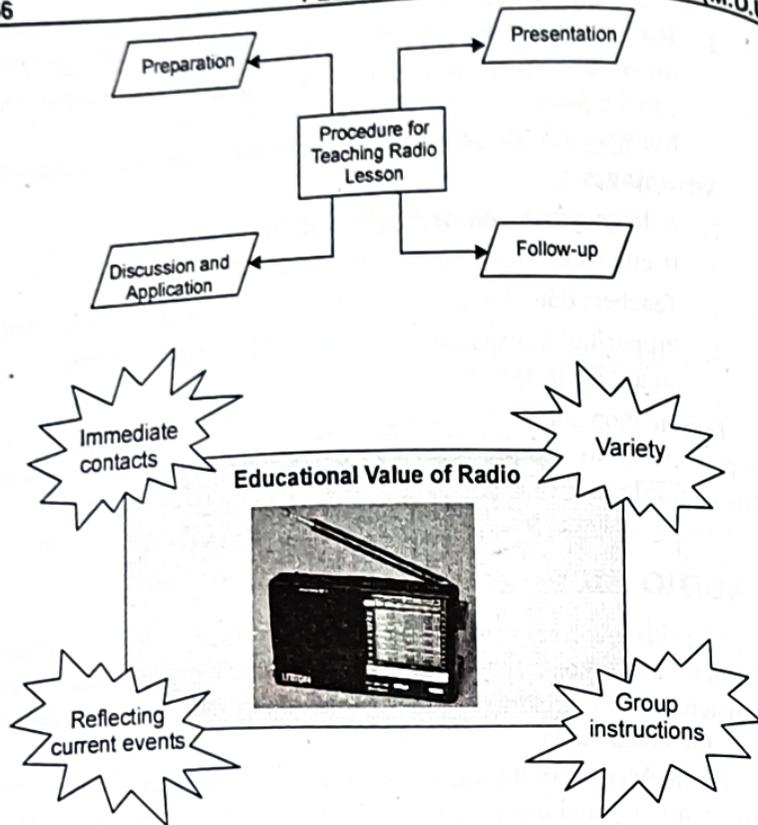
(1) Radio

Though originally devised for entertainment purpose, radio is now being widely utilized for education. "the radio is full of promise for the future of our education." By K.N. Srivastva.

By utilizing the rich educational and cultural offering of radio, children and adults can communicate. How ever remote people also have access to the best of the world's store of knowledge with the help of radio.

Procedure for teaching radio lesson : The following steps should be involved in all the lesson.

1. **Preparation :** Preparation regarding best location, seating arrangement, illustrative aids, clear objectives gathering advance information and motivating the students required on the part of teacher.
2. **Presentation :** The teacher should watch the time till the students close their book a minute before.



- 3. Discussion and application :** The teacher should discuss the major points of programme immediately after the broadcasting using other visual aids to clarify idea.
- 4. Follow up :** It is done for checking the students understanding for programme. A short objective test covering the main points of the presentation will improve errors and misunderstandings.

Educational value of radio : The educational values of radio are as a follows:

- 1. Immediate contacts :** Immediate contacts with lecturers, talks and addresses of the journalist, author etc. it is also an addition to teaching staff.
- 2. Reflecting current events :** Running comments on the proceedings of parliament session, a cricket game etc. have attraction of their own.
- 3. Group discussion :** Radio is useful to deliver a talk to a particular group for e.g. Students of commerce science mathematics etc.

- 4. Variety :** Radio is novel as compared to the teacher and eliminates day to day monotony.

Limitations of radio broadcasts : Limitations of radio broadcasts are as follows:

- 1. One way communication :** You cannot stop the broadcaster, cannot ask questions, cannot clarify doubts during the broad casts.
- 2. Uniformity :** Radio broadcasts donot look after the individual interests and difference. There is uniformity of treatment which is unpsychological
- 3. No preview :** The teacher cannot preview the broadcast and therefore, cannot find out the points to be stressed or explained by him.
- 4. Inconvenient time :** The time for broadcast may not suit the teacher and the class. Such non-availability of the programme when the class is in session is a great handicap.

(2) Tape recorder

A tape recorder is a portable electro nic gadget to record, reproduce, erase and record sound on a magnetic tape. It calls for the use of auditory senses to convey the educational message to the learners.

Procedure and suggestions for using tape recorder :

1. Choose a room with proper acoustics. A heavily curtained room in the school will be an ideal one.
2. Place the tape-recorder on a steady table and insert the cassette. Plug in the power cord of the tape recorder and not to run on the battery, check the working of the tape recorder before recording the lesson.
3. Locate the microphone input socket and plug in the microphone. It is advisable to use eternal microphone placed 25 to 30 cm away from the person whose voice is recorded.
4. Press the record button, speak with the microphone, watch the sound level indicator and appropriately adjust the volume control.
5. After testing and setting the tape recorder rewind the cassette completely and the recorder on the stop before actual recording.
6. Record the actual material spoken in to the microphone by pressing the record and play button.
7. After the recording is over, rewind and play the tape-recorder for editing, auditing and evaluation before it is used in class room.

(3) Audio compact disc

The audio compact disc (CD) was introduced in 1983. Physically the compact disc is like a small, silver phonograph record, without grooves. The disc is only 4.72 m (12 cm) in diameter. This small disc rotating much faster than phonograph record, stores an incredible amount of information. Some CD contains as much as 75 minutes of music.

Advantages :

1. The technology of CD makes it an attractive addition to the educational programmes.
2. Teachers can quickly locate the selection on the disc and even programme. It plays the contents in any desired sequence.
3. Information can be selectively retrieved by students.
4. A major advantage of the CD is its resistance to damage.
5. Strains be washed off.
6. Ordinary scratches do not affect play back of the recording.

(3) Audio-visual aids

The aids which involve the sense of vision as well as hearing are called audio-visual aids, for example television, film projector, computer, film strips etc. audio-visual aids are assets in the hands of a beginner teacher. This occupy unique position in the teaching of a foreign language many visual aids like models, charts, film-strips etc. become excellent.

1. **Television :** It represents a projector representation of reality and can be used to present past, the present and the future. Simplicity and immediate are two of the main characteristics of the television image. It has been described as the 'queen of audio-visual aids'. It combines photo and voice. It is said to be the "electronic black board of the future." It has now become powerful means of communication of ideas all over the world. The teacher indicates among the pupils good viewing habits critical and attentive listening.

Procedure : (a) The presentation stage:

1. The teacher should make himself familiar with the telecast programmes and their schedules on the different channels beforehand.
2. He should guide the students by telling them how they can be benefited and what important points they have to observe and remember.
3. He should keep in mind the number of students to be accommodated on the basis of nature of telecast.

4. He should take care of the proper environment in the classroom.

(b) The follow up stage :

1. After the programme is over there should be a lively discussion in the class.
2. Each students should be given an opportunity to clear his doubts.
3. The programme should be follow up by a test to assess the understanding of the pupils.
4. The weakness of the students should be correlated immediately through the teacher.

Advantages :

1. It helps the students to understand the subject deeply and clearly.
2. A large number of students can be benefited at a time.
3. The students as well as the teacher can get the advanced knowledge related to the subject.
4. It is a motivation device and creates interest among the students to gain knowledge.
5. It may bring equality of opportunity for all pupils.

(2) Multi-media

It combines elements from a variety of medias, allowing a teacher to use his own materials with other. Multimedia is the combination of text, graphics audio, video and animation. Teachers can use websites, slide shows, computer based training courses and TV in one teaching session. Multimedia offers an arrangement of communication tools for an audience that may include several teaching styles. Various multimedia packages on physical science teaching are available for various classes or teacher with the help of students can develop their own package.

Difficulties in the Use of Teaching Aids :

1. The main problem is of finance. Mostly schools in India do not get enough financial aid for the preparation of teaching aids. The latest technology based aids are costly so it is difficult for schools to purchase them.
2. In rural places there is problem of electricity. Even the minimum requirement of electricity was not fulfilled. So use of television, films and computers are not possible in these places.
3. Many teachers don't understand the value of teaching aid. They believe in the traditional method of teaching so they don't want to adopt the new methodologies.
4. Lack of trained teachers for the preparation, selection and use of teaching aids.

5. Proper maintenance of teaching aids in schools is also a big problem.

Conclusion

Though Teaching Aids are crucial to successful teaching, they are not a replacement for quality teaching strategies. Instead of relying upon teaching Aids to do the instruction, these tools are used as supplementary resources for education. Many students cannot perform to their fullest potential without the use of teaching aids, but no students can produce their best work without a skilled teacher behind them. With a plethora of multiple resources available, it's important to remember that teaching aids are meant to enrich student learning, not provide it.

EVALUATE YOURSELF

1. Discuss the need and importance of teaching aids in teaching life- science.
2. Which are the effective teaching aids in physical science teaching. Illustrate your answer with the help of suitable examples.
3. Discuss the various visual aids with its merits and demerits.
4. What are the characteristic of teaching Aids. Discuss the principles in the selection and use of Teaching Aids.
5. Discuss the advantages and limitations of teaching aids in physical science.
6. Write short note on:
 - (i) Flannel Board
 - (ii) Overhead Projector
 - (iii) Models
 - (iv) Auditory Aids
7. Write short note on Preparation of teaching aids.

(M.D.U. 2010, 2011)



CHAPTER 3-C

Unit and Lesson Planning

UNIT-PLANNING

Planning is very essential for any task. The success or failure of any task depends upon its planning. In the same way for effective teaching a science teacher has to plan before hand. As it is rightly said- "Quality Education is the result of good planning." So it is very important that a Science teacher concentrate on wise planning of his teaching. A Science teacher planned his classroom instructions in two ways:

- (1) Unit Planning
- (2) Lesson Planning

Meaning of Unit

Professor H.C. Morrison of Chicago University is the exponent of this approach. In the words of Morrison, 'Unit is a comprehensive and significant aspect of the environment of an organized science and art.'

"A unit consists of a comprehensive series of related and meaningful activities so as to achieve pupil's purposes, provide significant educational experiences and results in appropriate behavioural changes."

—Bossing

"A unit is as large a block of related subject matter as can be overviewed by the learner."

—Preston

"The unit is an organized body of information and experience designed to effect significant outcomes of the learner."

—Wesley

In this way we come to know that the term unit means break up the course into meaningful segments and organized around a single problem or topic.

After understanding the term unit now we try to understand the term Unit Planning.

Morrison Advocates the division of the subject-matter into small but meaningful units. Each unit is derived from the previous knowledge related to a particular unit and deals with it thoroughly. They move to the second unit when they find that the students have acquired mastery over the subject matter of the unit and are able to generalize and apply the ideas of the learnt material. So we define Unit Planning as a plan of a particular unit mentioning the whole teaching-learning process which includes the learning experiences provided, method/techniques used related to that particular unit of the science in view of the proper realization of its teaching-learning objectives.

Features of a Unit Lesson Plan

- (1) **Proper Formulation of Objectives** : A science teacher properly write down the objectives of a particular unit or sub-unit. Formulation of objectives writing them in behavioural terms is very necessary in unit planning.
- (2) **Content/Syllabus** : A unit planned should be part of the syllabus and all the sub-units should be correlated.
- (3) **Deciding the Learning Experiences** : For teaching unit/sub-units teacher should decide the best Learning Experiences or Activities provided so that pre-determined instructional objectives should be realized.
- (4) **Proper division of syllabus** : Science Teacher should properly divide the syllabus of science into meaningful units and sub-units. But sub-unit appears as a whole.
- (5) **Methodology or Techniques Used** : A science teacher write down all the methods, techniques and aids required for teaching the unit or the sub-unit.
- (6) **Selection of Evaluation Procedure** : A science teacher mention the Evaluation procedure as well as devices used in assessing the outcomes after completing the task of teaching a unit.

Unit Plan	Lesson Plan
1. The scope is much wider.	1. The scope of daily lesson plan is narrower.
2. It covers the objectives for the whole unit so they are long-term objectives.	2. These are strictly limited to the time of a particular classroom period.
3. It details with the prescribed syllabus covered during the whole session	3. It deals with the daily lesson delivered in a particular period.
4. It includes the number of lesson plans	4. It is a daily action plan.
5. Its duration is of several days.	5. It has fixed duration of a particular period of 35-40 minutes.
6. It contain a brief mentioning of methods, techniques and evaluation devices to be used.	6. The specific method, technique or evaluation devices to be used are mentioned.

Steps of a Unit Plan

Subject : Science **Topic** : Heading of the Unit

Class : To Whom the Unit is to be Taught **Time** : No. of periods to complete the unit

Aid : Aids to be used for teaching Sub-Unit : No. and Name

Objectives : To be achieved after completion of the unit.

Steps for Developing a Unit Plan

- (1) **Preparation or Motivation** : The teacher motivates the students for learning. He explains the importance and scope of that particular unit which motivates the students for learning.
- (2) **Knowledge of Previous Experiences** : This is very important to find out the level of students. It is done by asking some questions or presenting any problem among them. When we move from known to unknown it helps in motivating the students to take interest in teaching. So start with the previous experiences of the child.
- (3) **Presentation** : At this stage, the teacher remains more active. They perform the following activities :
 - (I) Presenting the content in the small units in the sequence and maintaining a continuous rapport with the class.

- (II) Diagnosing the areas of weakness.
 (III) Repeating the content until most of the students acquire the understanding.
- (4) **Organisation** : In this step students are given the opportunity to understand the depth of the content. For this they consult the different books, perform, individual experiments and try to organize their learning together.
- (5) **Summarization** : This usually done at the end of each unit as well as at intervals during the progress of a unit. Organisation and summarization together.
- (6) **Review and Drill** : During teaching it is quite possible that students are not able to memorize all the things, some teaching unit is forgotten or not completely understood. So for this there is repetition or revision of some content which is called Drill. So Review and Drill is also required at many places during the teaching.
- (7) **Evaluation** : This is very important step, in this a teacher come to know what the students have achieved or what they don't able to achieve. Various evaluation devices oral, written test, performance test etc. after a short interval of time are used. At the end of the unit, a Unit Test is taken in which grades are given to the students according to their performance.

Advantages

- (1) **Psychological** : The unit lesson plan is psychological in the sense that it is based on Gestalt psychology. The importance is given to the 'whole' instead of the 'part'. The contents of a syllabus are divided into suitable broader units, teaching units and sub-units as complete wholes in themselves.
- (2) **Clarity of Objectives** : There is formulation of objectives in unit planning which makes teachers and students more clear about their goals and give them right direction.
- (3) **Encourages Independent Learning** : Unit Planning help in developing the habits of self-study and independent learning among the students.
- (4) **Selection Method/Techniques/Aids** : A teacher is well-informed about the adequate methods, techniques or teaching aids to be used. This help the teacher in making the arrangements of proper methods, techniques and aids before hand.
- (5) **Healthy Interactive Environment** : In Unit planning teachers and students both actively participate in various activities of teaching-learning process which creates a healthy Interactive Environment in the classroom.

- (6) **Teaching is more systematic and Organized** : As unit planning is done in advance. All the methods, learning experiences, activities are organized timely. So there is no confusion in the mind of teacher and teaching is done step by step. Thus, the learning becomes sequential, systematic, organized and effective.
- (7) **Helps in Remedial Teaching** : With the help of Unit Planning we come to know the strengths and weaknesses of a child which helps in planning the Remedial Instruction for the students.
- (8) **Mastery** : The unit lesson plan aims at the complete mastery over the learning material presented in a particular unit. All the steps are directed to achieve the desired mastery.
- (9) **Proper Evaluation** : At the intervals of time evaluation is done in the form of oral/written tests. Also at the completion of the unit there is Unit Test in which grades are given to students according to their performance. So proper evaluation is also done in unit planning.
- (10) **Proper provision for Revision and Drill Work** : There is proper provision for the review, practice and drill work which helps in mastery over the content.
- (11) **Helps in Lesson Planning** : A unit planning is a guide to the formation of lesson planning thus represents a cohesive view of many inter-related lessons.
- (12) **Helpful for Teachers** : Unit planning provides opportunity to the teacher to innovate and implement new ideas which adds confidence in the teacher to teach in the class.

Disadvantages :

- (1) **Unit Planning is a complex task** : The division of syllabus into units and subunits is really a complex task. The division into meaningful and organized sub-units is a tough task.
- (2) **Requires Trained and Efficient Teachers** : It requires a too much hardwork and training on the part of Science teacher to plan a unit because science is the logical and systematic study of the subject and divide them into organized and systematic units and sub-units demands a trained and efficient teachers who are not always available.
- (3) **Not Child Centred** : In unit planning the process of teaching-learning is planned in advance and teacher is bound to follow that plan. So the needs, abilities and interests of the child are sacrificed. So it is planning centred rather than child-centred.
- (4) **Lesser Scope for Freedom** : In unit planning objectives, methods, learning experiences, evaluation devices all are

predetermined so there is less freedom to teachers and students to change or innovate something new/creative which adds more rigidity in the teaching of Science which is not its characteristic.

Proforma 'A'

Subject

Class

Name of the Unit

Major Objectives of the Unit:

S. No.	Concepts (Topics)	Number of Lesson required	Time required (periods)	Scope of Subject Content	Procedure to be adopted (indicate the method of teaching)	Teaching Aids

After completing proforma 'A', detailed unit plan should be prepared according to proforma 'B'.

Proforma 'B'

Concepts: (From Proforma 'A')

Lesson No.:

S. No.	Sub-Concepts	Behavioural Objectives	Procedure (Pupil-Teacher Activity)	Pupils' Assignments	Evaluation

Unit Plan

Name of the Unit : Motion, Force and Work

Objectives of the Unit : The pupils are expected to :

- Define Motion
- Explain Motion and its types
- Understand the meaning of force
- Define the three Laws of Motion
- Demonstrate activities explaining the laws of motion
- Application of Universal Law of Gravitation

S. No.	Concepts (Topics)	Number of Lesson required	Time required (periods)	Scope of Subject Content	Procedure to be adopted (indicate the method of teaching)	Teaching Aids
1.	Motion and its types. Difference between distance and displacement	One	40-45 minutes (Two Periods)	Concept of motion, Linear and circular motion, distance and displacement	Lecture method solving numerical, Giving Illustrations	Electric Fan
2.	Speed, velocity, Difference between speed and velocity	One	One Period	Concept of Speed and Velocity	Explanation with showing objects	Speed of car(Speedo meter) Throwing a ball(velocity)
3.	Force and its Types	One	Two Periods	Definition of force muscular, magnetic and gravitational force	Explanation by taking examples from real life experiences	Pulling of a Bench

4.	First law of Motion	One	Four Periods	Give statement and explaining, first law of motion	Demonstration to Explain	Picture or Charts depicting 1st law.
5.	Second law of Motion	One	Two Periods	Statement and concept of second law of motion.	Explanation and solving numerical	Computer slide $F=m.a$
6.	Third law of Motion	One	Two Periods	Concept of third law of motion living examples	Showing activity and giving illustrations	Firing of bullet, blow of punch
7.	Gravitation	One	One Period	concept of gravitation and gravitational force	Lecture method	Falling of an object on earth
8.	Newton's law of Gravitation	One	Two Periods	Meaning and definition stating the formula	Explanation and derivation formula	
9.	Importance of universal law of gravitation	One	One Period	Role of gravitational force in nature	Discussion method and taking examples from real life.	Roots of plants are always below the surface.

Performa B

Objectives of the Unit: The pupils are expected to -

S. No.	Sub-Concepts	Behavioural Objectives	Pupil Teacher Activity	Assignment Given	Evaluation
1.	Meaning and Definition	Define the term force	Explain the meaning of force and give its definitions.	What are the effects of force?	Define force.
2.	Types of forces. 1) Balanced Forces. 2) Unbalanced Forces.	Name the two types of forces. Explain balanced forces. Explain unbalanced force.	Explain the two types of forces. Differentiate between balanced and unbalanced force.	Distinguish balanced and unbalanced force.	What is balanced force? What is unbalanced force?
3.	First law of motion. (I) Inertia of Rest. (II) Inertia of motion. (III) Inertia of Directions	state the first law of motion	Explain the two types of forces. Differentiate between balanced and unbalanced force.	State Newton's first law of motion. What do you mean by inertia	Newton's first law of motion is also known as_____.
4.	Second law of motion and its applications	Explain second law of motion. State application of second law of motion.	Describe second law of motion. State applications of second law of motion.	State Newton's first law of motion. What do you mean by inertia	Newton's first law of motion is also known as_____.
5.	Third law of motion.	State the third law of Motion.	State third law of motion.	State Newton's third law of motion.	State Newton's second law of motion.
6.	Examples to illustrate Newton's third law of motion.	Explain and illustrate some examples of third law of motion.	Illustrate some examples of third law of motion.	Why a fireman struggles to hold a hose-pipe?	Action and reaction are equal and opposite between they don't cancel each other. Explain why?

LESSON PLANNING

Failing to Plan is Planning to Fail

Good Lesson Planning is essential for the process of teaching and learning. A teacher who's prepared well on his/her way to a successful instructional experience. The development of interesting lessons takes a great deal of time and effort.

Classrooms are busy places with many things happening all at once. Teachers are challenged to monitor multiple classroom events simultaneously while at the same time collecting and analyzing data on student performance. In the course of teaching lessons, teachers must make important instructional decisions almost continually: What question should I ask next? Should I call on a particular student or not? What does this student's answer reveal about their understanding or skill? Are my students showing that they are ready to move on, or do I need to clarify information for them?

Clearly, just remembering how the lesson should unfold can be challenging when teachers are simultaneously trying to monitor student learning while also making significant instructional decisions. Lesson planning – well in advance of the actual class meeting – allows for the luxury of time.

Meaning and Definitions

Theoretical knowledge of teaching concept does not provide any guideline for classroom instructional procedure. Every teacher who intends to teach something has to prepare an outline of his subject or topic in written form or at his cognitive level that is known as lesson planning. A teacher has to apply his theoretical knowledge in planning and administering his lesson plan. A practical outline of a topic to be taught in a period is called the lesson plan. It is designed during the student teaching or teaching practice.

A lesson plan is the instructor's roadmap of what students need to learn and how it will be done effectively during the class time.

Definitions

According to Bossing : A lesson plan is an organized statement of general and specific goals together with the specific means by which these goals are to be attained by learner under the guidance of the teacher on a given day.

"A lesson plan is a teaching outline of the important points of lesson arranged in order in which they questions to be asked, references to materials, assignments etc." —Carter V. Good

"A lesson plan is an organized statement of general and specific educational goals together with the specific means by which these goals are to be attained by the learner's under the guidance of the teacher on a given day."

—James Michael Lee's

"A lesson plan is actually a plan of action. It therefore, includes the working philosophy of the teacher, his knowledge, philosophy, his information and understanding his pupils, his comprehension of the objectives of education, his knowledge of the material to be taught and his ability to utilize effective methods."

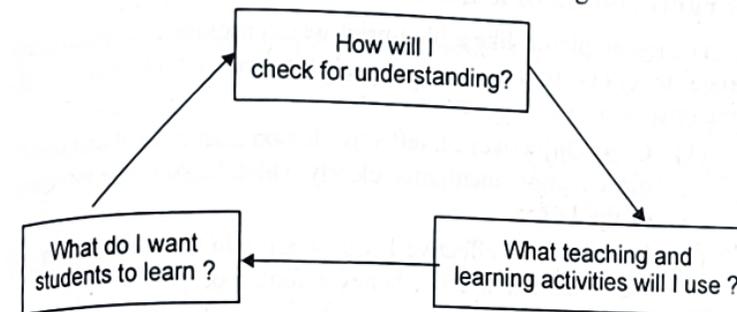
—Lester B. Stands'

Lesson plan involves defining the objectives, selecting and arranging the subject matter and determining the teaching methods."

—Binning and Binning

So we can say that a successful lesson plan addresses and integrates these key components :

- (1) Objectives for Student Learning
- (2) Teaching / Learning Activities
- (3) Strategies to check student understanding.



Importance/Need of Lesson Planning

1. Lesson planning is required to achieve the goals. The teacher thinks the various ways and means by which he/she will be able to achieve his/her aims.
2. Lesson planning helps a science teacher visualize what kind of Instructional activities to be emphasized and how these activities should be directed.
3. Lesson planning is helpful for a science teacher to select and organize the subject matter according to needs and mental abilities of his students.
4. Lesson planning helps the science teacher in facing the class with full confidence as he plans the things in advance.
5. Lesson planning helps the science teacher in selecting the appropriate methods and techniques required for his teaching.

- He arranges his equipments or set his laboratory in advance according to his requirement.
6. Lesson planning helps in developing new, creative and constructive ideas in a teacher. He can give his ideas a practical shape.
 7. Lesson planning avoids unorganized or haphazard teaching, as all the things are planned in advance so it saves the time and energy of the teacher.
 8. Lesson planning provides adequate lesson summaries and ensures a definite assignment for the class which helps in developing insight and understanding.
 9. Lesson planning helps in preparing a permanent record which can be used for future reference also.
 10. Lesson planning helps in evaluating the instructions as well as the outcomes of the teaching. Should we achieve the aims or objectives.

Characteristics of a Good Lesson Plan

The lesson plan is like a blue-print which provides the guideline to science teachers to teach in the classroom. Following are the characteristics of a Good Lesson Plan.

- (1) **Clear Objectives** : In effective lesson plan general and specific objectives are mentioned clearly which helps in the evaluation of the lesson.
- (2) **Written** : An effective lesson plan is in the written form. So that a teacher use it whenever required.
- (3) **Flexibility** : Whenever needed a teacher is free to make changes in the lesson plan to create attraction and interest in the lesson.
- (4) **Division of Units** : A good lesson plan is properly divided into units and sub-units. It simplifies the teaching and learning.
- (5) **Clarity about Previous Knowledge** : While preparing the lesson plan, the teacher should know the previous knowledge of the pupils because the new knowledge imparted on the basis of previous knowledge, is easily stabilized.
- (6) **Selection of Subject Matter** : The contents/subject matter selected for the lesson plan should be according to the needs, capabilities and mental level of the students to be taught. It should be properly selected and well-organized.
- (7) **Suitable Selection of Methods, Techniques and Aids** : While preparing the lesson plan, it should be decided what method

or technique should be the most suitable. It should also be decided at what step the aids i.e. charts, models, diagrams should be used and what is to be clarified with that aid. This makes the lesson interesting.

- (8) **Pupils Activity and Participation** : An effective lesson plan indicates the pupils' activity and participation to be made in classroom. It indicates the questions to be asked, the problems to be solved and the experiments to be performed.
- (9) **Evaluation** : An effective lesson plan contains questions to evaluate the knowledge gained by the students.
- (10) **Level of Students'** : Lesson plan is prepared keeping in mind the age and mental level of the students'. So that effective teaching-learning should be possible.
- (11) **Proper Opening and Closing of the Lesson** : There should be interesting start and closing of the lesson is there. Teacher should give an outline or summary of the whole lesson at the end. Due place is given to practice and home work in the lesson plan.
- (12) **Correlation with other Subjects** : The content is correlated with the previous knowledge of the students. For this known to unknown approach should be there. It is also correlated with other subjects, activities and real life situations so that a student will apply the theoretical knowledge in his practical life.

Pre-requisites of Lesson Planning

Pre-requisites of lesson planning are as follows :

- **Knowledge of Aims and Objectives** : The teacher should have a basic understanding of the aims and objectives of teaching science. He should have an ability and skill for writing the objectives in behavioral terms. He should have the knowledge of various teaching skills and ability to use them in real class situations.
- **Knowledge of Subject-Matter** : The teacher must be master of his subject. He should have the thorough knowledge of the subject-matter.
- **Knowledge of Methods and Techniques** : The teacher should also have the knowledge of various methods and techniques as well as the ability to select the right method/technique for teaching a particular topic.
- **Knowledge of Child Psychology** : Teacher should understand the needs, abilities, feelings and mental level of the students.

He doesn't show his knowledge but present the subject matter in accordance with the level of his students.

- **Knowledge of Feedback and Evaluation Devices :** Feedback and Evaluation is very essential. As these tell the teacher about the strength and weaknesses of his lesson. So proper selection and usage of feedback as well as evaluation devices gives the right direction to his teaching.

Steps of Lesson Planning

J.E. Herbart gives the following steps of Lesson Planning known as Herbartian Steps of Planning :

- | | |
|---------------------------------------|--------------------|
| (i) General Aims | (ii) Specific Aims |
| (iii) Previous knowledge | (iv) Introduction |
| (v) Development | (vi) Presentation |
| (vii) Exposition | |
| (viii) Recapitulation and Arrangement | |

There are many schemes and lesson plans are suggested by various Educationists. But with certain changes in the Herbetarian Approach and the modification done by Regional College of Education, Mysore (RCEM Approach) today we are planning the lesson with the following steps :

- (1) **Preliminary Information :** Before presenting the lesson Pupil-Teacher writes the following Information on the Blackboard.: Roll No. of the Pupil Teacher, Class to be Taught, Subject and Topic (Written after Announcing the Topic), Date on which Lesson Taught and Duration (generally 35-40 minutes).
- (2) **Instructional Objectives :** In the traditional planning we used to write General Aims and Specific Aims but today we use the term Instructional Objectives. With the help of Bloom's Taxonomy pupil-teacher write the Instructional Objectives of all the domains in his Lesson Planning Note-Book. Formulation of Objectives is a complex task which needs knowledge of Taxonomies of Instructional Objectives as well as guidance of the science teacher with practice of formulating objectives clearly of the lesson taught by him.
- (3) **Instructional Aids :** These are also written on the Lesson Planning Note Book. It gives the information about the various types of Aids used by the pupil-teacher for teaching the particular topic.

Following types of Aids are usually used in Teaching of Physical

Science :

- (1) Black Boards, Chalk, Duster, Pointer (General Aids)
- (2) Charts, Models, Real Objects, Slides, Transparencies, Specimens
- (3) Demonstration of Practical Activities
- (4) **Previous knowledge Assumed :** Before teaching the lesson it was assumed by the pupil-teacher that students' have the idea or have basic knowledge in that discipline upto a particular extent.
- (5) **Previous Knowledge Testing or P.K. Testing :** Before teaching any concept a teacher expect that his students' have some idea of that topic to a particular extent. So find out the level of the previous knowledge a teacher asks some questions to the students or he narrates some story, give them any puzzle or problem to solve. These all questions or activities are noted down in the Lesson-planning Note-Book as well as done by the pupil-teachers. This helps in testing the previous knowledge of the students as well as when we move from Known to Unknown Approach. It helps in motivating the students also.
- (6) **Announcement of the Topic :** After testing the level of knowledge the teacher came to that point where students' are not able to answer the questions clearly and completely. Its time is for the Announcement of the Topic. He write the name of the topic on the Black Board and announces 'Well students, Today we shall study in detail about the topic :
- (7) **Presentation :** Actual lesson a teacher wants to teach is started from this step. In Lesson-planning Note-Book the subject matter is written in organized, systematic and logical way. This step is the Heart of the whole Lesson Plan. There are four column made in Presentation : Teaching Points, Pupil Teacher's Activity (Learning Activities or experiences provided by the pupil teacher to his students), Pupil Activity (Students' Response, Answers given or any activity performed) are mentioned in this step. The last column is of Black Board Work (B.B. Work)/A.V. Aids used. In this all the important points mentioned on the Black-Board or the Chart, Picture, real object etc. used for explaining the content are mentioned in this step. So overall planning of the teaching is done in this step.

- (8) **Generalization and Application** : After teaching the lesson teacher usually generalize certain rules or principles or he summarizes or concludes his lesson by one or two concluding statements. So in this step pupil-teacher with the help of students came to some appropriate conclusions and generalization. He further includes some statements and particular phenomenon or principle is applicable in the real life situation.
- (9) **Recapitulation** : At the end of the lesson to revise the lesson teacher asks certain questions to the students. This helps in evaluating the students' that how much they grasp from the subject-matter. A pupil-teacher should cover questions from the whole subject-matter.
- (10) **Home Work/Home Assignment** : This is the last step of the lesson-plan. Here the teacher give some Home-Assignment. The purpose behind it that student acquire the permanent knowledge of the subject-matter. It also helps in finding out the problems faced by the students regarding that particular topic taught in the class. Home-Work given should be multiple task so that a student doesn't feel bore in doing it.

So a good lesson-plan helps a Science teacher to provide a guideline for the right path.

So a well-planned lesson-plan helps a Science Teacher to achieve his goals. But its implementation depends upon the teacher. A teacher should take them as a means for attaining the desired teaching-learning objectives and not as an end in themselves. It is also important to realize that the best planned lesson is worthless if interesting delivery procedures along with good classroom management techniques are not in evident.

So here are some practices mentioned for effective Lesson Planning in a classroom.

Suggested Practices for effective Lesson Planning in a Classroom:

- Establish a positive classroom environment
 - Make the classroom a pleasant, friendly place
 - Accept individual differences
 - Learning activities should be cooperative and supportive
 - Create a non-threatening learning environment
 - Organize physical space; eliminate situations that may be dangerous or disruptive
 - Establish classroom rules and procedures and consistently reinforce them

- Begin lessons by giving clear instructions
 - State desired quality of work
 - Ensure that everyone is paying attention
 - Ensure that all distractions have been removed
 - Describe expectations, activities and evaluation procedures
 - Start with a highly motivating activity
 - Build lesson upon prior student knowledge
- Maintain student attention
 - Use random selection in calling upon students
 - Vary who you call on and how you call on them
 - Ask questions before calling on a student; wait at least five seconds for a response
 - Be animated; show enthusiasm and interest
 - Reinforce student efforts with praise
 - Vary instructional methods
 - Provide work of appropriate difficulty
 - Provide guided practice for students; monitor responses and deliver immediate corrective feedback.
- Evaluate what has taken place in your lesson
 - Summarize the lesson and focus on positive gains made by students; use surprise reinforcers as a direct result of their good behaviour
 - Determine if the lesson was successful; were goals accomplished?
- Make a smooth transition into next subject
 - Have materials ready for next lesson
 - Maintain attention of students until you have given clear instructions for the next activity
 - Do not do tasks that can be done by students (i.e. passing out paper or collecting assignments); use monitors
 - Move around and attend to individual needs
 - Provide simple, step-by-step instructions
- Develop positive teacher/student relationships
 - Set a good example; be a positive role model
 - Create an exciting learning environment for all students
 - Reward good behavior; create special activities that children will enjoy doing

- Handling disruptions
- Use a warning system
- Defer disruptive behavior proactively (eye contact, close space between you and student, use head/hand gestures)
- Help students be successful
- Use planned ignoring (and teach other students to also ignore).

Lesson Plan-1

Roll no

Date

Subject – Physical science

Class- 6th

Topic – Our Solar System

Duration – 40min

Instructional Objectives : After studying the lesson, students will be able to.

- Knowledge :**
1. Recall the Solar System
 2. List all the planets
- Understanding :**
1. Explain all the planets of our solar system
 2. Justify how day and night is formed.

Skill : 1. Draw a well labelled diagram of solar system.

Class room teaching aids

1. **General teaching aids :** Duster, black board, chalks etc.
2. **Specific teaching aids :** A model showing the solar system.

Previous knowledge assumed : The Students are aware aware about sun, earth, moon etc.

Previous knowledge testing :

Pupil Teacher Activity	Student Activity
1. Well students tell me where do you live?	on earth
2. Good, now tell me what is earth?	Earth is Planet
3. Is Earth is the only planet name of other plants?	No, there are some other planets also
4. Right, can you tell me the name of other planets	No Response

B.B. Work



Student's Activity

Students note down the definition in their note books.

Students note down the definition in their note books.

Pupil Teacher's Activity

What is Planet?

Definition:- All light heavily bodies that revolve round the sun is called planet. There are 9 planets in our solar system

- 1) Mercury, 2) Venus, 3) Earth,
- 4) Mars, 5) Jupiter, 6) Saturn,
- 7) Uranus, 8) Neptune, 9) Pluto. We discuss all these planets one by one it is also called budh. It is closed to the sun. It is dry, hot and virtually airless planet. It is much smaller in size than the earth. It is often morning or evening star it is the bright object in our sky after the sun and moon. Venus is even hotter than Mercury though. It is relatively farther away

Teaching Point

Definition of planet

List of planets

1) Mercury (Budh)

2) Venus (Shudra)

MERCURY (

VENUS 2

Announcement of the topic : Well students today we will study about 'our solar system'.
Presentation :

3) Earth (Prithvi)	<p>from the sun. This is because of high of age of CO_2 in its atmosphere. it is a special planet of our solar system. Can you tell me how day & night are formed on earth?</p> <p>Good, similarly earth rotates or revolves around the sun also. Can you tell me in how many days it completes its one revolution? Right.</p>	<p>When earth revolves (rotates) about an axis of its own then day and night forms. around 365/4 days</p>	EARTH
4) Mars (mangal)	<p>It is also called as mangal or red planet. It consists primarily of CO_2, along with small amount of N_2, O_2, Water vapor and other gases. Its surface temperature and pressure are both very low. So due to these conditions water cannot exist in liquid. So there is no life on mars.</p>		MARS
5) Jupiter (Brahspati)	<p>It is the largest of all planets. It has its own colourful bands. It contains mainly of H_2O and He. Its cloud cover is made up CH_4 (gaseous) & some ammonia in (crystalline form.)</p>	<p>students listen care fully</p>	JUPITOR
6) Saturn (shani)	<p>Saturn is quite similar to Jupiter in size, mars and composition. It is the second largest planet. It is distinguished by its very unique and</p>	<p>Students note down the points in their note books.</p>	SATURN

7) Uranus	<p>special system of rings. This planet has the largest no. of moons. it is the third largest planet of the solar system. Hydrogen and Methane have been detected in atom of the planet. It is observed to have blue green colour.</p>	<p>Students look in to the model very keenly.</p>	URANUS
8) Neptune	<p>it is very far away from the sun and is visible through a telescope only. It has been named after the roman god Neptune. We do not have much information about this.</p>		NEPTUNE
9) Pluto	<p>it is the farthest planet of the solar system. It is the only planet whose orbits cut through that of another planet.</p>	<p>Students note down in their note books.</p>	PLUTO

Recapitulation :

1. Define, what is a planet?
2. Names are the planets of the solar system.
3. Which planet has beautiful rings around it?

Home work

Long answer type :

1. Explain all the planets of our solar system in order of their increasing distance from the sun.

Short answer type :

1. Why is Venus the hottest planet even though nursery is closest to the sun?
2. Name the planet where do you live?

Objective type :

1. The planet nearest to the sun is _____.
2. The natural satellite of the earth is _____.
3. The brightest planet of our solar system is _____.

Lesson Plan-2

Roll no

Subject - Physical science

Topic - The Water Cycle

Date

Class- 6th

Duration- 40min

Instructional objectives:- After studying the lesson students will be able to :

(A) Knowledge :

1. Define the term 'water cycle'.
2. State the importance of water cycle.
3. State how it occurs in nature.

(B) Understanding :

1. Explain the water cycle.
2. Justify its presence.
3. Summarize the process of water cycle.

(C) Skill :

1. Draw a well labeled diagram of 'water cycle'.

Classroom teaching aids:

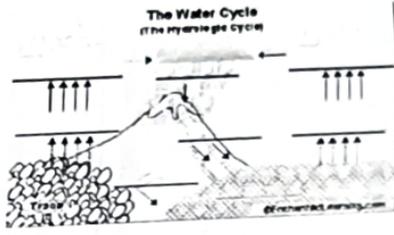
1. General teaching aids : Roller board, chalk, duster etc.
2. Specific teaching aids : Model showing 'the water cycle'.

Previous knowledge assumed : Student are aware about water, mountain, clouds, river, etc.

Pupil teacher's Activity	Student's Activity
1. Children what do you do when you fell thirsty?	Drink water.
2. Good, what is the ultimate source of this water?	Rain.
3. Right, from where does rain come?	From Clouds
4. Ok, how are clouds filled with water?	-No response-

Announcement of the topic : Well students today we will study about. 'The water cycle'.

Presentation :

Teaching Point	Pupil Teacher's Activity	Student's Activity	B.B. Work
Definitions of water	The movement of water between the environment and land water is called water cycle or hydrological cycle.	Students note down the definition in their copies.	<p>Water Cycle Sources of water : Rain, River, Lakes, Oceans etc.</p> 
Sources of Water	Children tell me which the main sources of water on land are. GOOD, What happens to the snow if it kept in high temperature? Similarly, the snow on mountains tops melt and flow in to the rivers.	Rivers, Lakes and Sea. It melts.	
Evaporation	This water also evaporates, children do you know what is evaporation? Good, all types of surface undergoes slow evaporation. Even we dry our cloths what is it? These evaporated water vapors form clouds in atmosphere when these clouds, Condense there is rain fall, snow fall. What is condensation?	Change of liquid state in to vapor is called evaporation. Evaporation Condensation:- Changes of vapors in to water	
Condensation	GOOD, A part of rain water is observed by upper crust of earth, to be used by plants, animals, and human race. Remaining water flows back to oceans, lakes and rivers.	Change of gaseous state of water in to liquid.	

Explaining the water cycle	The water evaporates by sunlight, condenses to form droplets. It falls down in the form of rain or snow again the same process continues, snow melts or rain water comes in ponds, lakes while flowing evaporation them condensation takes place.	Students observe keenly and note down in their copies.	Showing the model of water cycle
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Recapitulation :

1. What is the other name for water cycle?
2. What are the main sources of water on land?
3. What is evaporation?

Home work

Long answer type :

1. Define water cycle in nature.

Short answer type :

1. Why does snow melts?
2. What is condensation?

Objective type :

1. Change of state from gaseous to liquid is called.
2. Change of state from liquid to gaseous is called.

Lesson Plan-3

Roll no

Subject – Physical Science

Topic – Measurements

Date

Class- 6th

Duration- 40min

Instructional objectives:

(A) Knowledge :

1. Recall measurements
2. Select correct measurements.

(B) Understanding :

1. Distinguish between various measurements
2. Explain the need of measurements.

(C) Application :

1. Use and correlate various measurements in their day to day life.

Classroom teaching aids:

1. **General teaching aids :** Chalk, black board, duster.
2. **Specific teaching aids :** Scale, glass, tape, balance for activity.

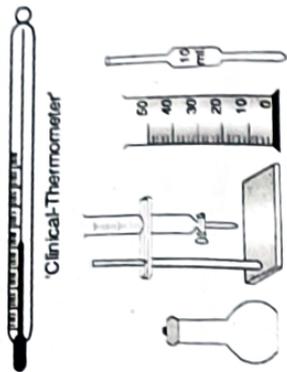
Previous knowledge assumed : Students are aware about term measurements.

Pupil teacher's Activity	Student's Activity
1. Children at what time do you get up In the morning	at 5.30a.m
2. Well, what is the distance between your school and House.	7 K.m
3. What is your weight?	20 kgs
4. Can you tell what is the normal body temp?	96°-98°C
5. Are all the above measurements have some units.	No responses

Announcement of the topic : Well students, today we will study about 'Different measurements'.
Presentation :

Teaching Point	Pupil Teacher's Activity	Student's Activity	B.B. Work
definitions of water	To makes our judgments more relate relative and accurate. Measurements are taken. There are measurements of length, volume, mass, time and temperature.	Note down the Need of measurement in their note-books.	Length: - Standard unit of length- Meter.
(1) Length	Pupil teacher takes a piece of cloth and asks how will you measure its length? Good, if we draw a line then? What's the length of this cloth and line? GOOD, the standard unit of length is meter. Ok, now tell me when you buy vegetable, fruits or grains how do you measures them? GOOD, the standard unit of mass in Kilograms.	By a meter tape. By a Scale. 1.5 mt. and 6 inches.	 Scale
(2) Mass		In gms or Kilograms	 Beam Balance, Mass Standard Unit - Kilogram

<p>(3) Time</p>	<p>How much time does, it take for you to come to School? How much time do you remain in school? YES, so we measure time in minutes, seconds and hours. The standard unit of time is second.</p>	<p>15-20 minutes 5 hours.</p>
<p>(4) Temperature</p>	<p>Do you know what our normal body temperature is? GOOD, temperature can be measured in c or Kelvin. The standard unit of temperature is Kelvin.</p>	<p>96-86°C</p>
<p>(5) Volume</p>	<p>Now you tell me how much water is there in a Jar? How do you measure Milk, water, oil. Yes all the liquid are measured in liters and ml.</p>	<p>Its 1 ltr. In LTR. Students note down in their copies</p>



Clinical-Thermometer

Devices to measure volume

UNIT AND LESSON PLANNING

Recapitulation :

1. Give the units of measurement.
2. How will you measure a piece of cloth?
3. What is the standard unit of volume?

Home work

1. Standard unit of length is _____.
2. Standard unit of time is _____.
3. What is our normal body temperature?
4. How will you measure grains, sugar etc.
5. Give the standard units of length, mass, volume and temperature?

Lesson Plan-4

Roll no
Subject - Physical science
Topic - Dispersion of Light

Date
Class- 6th
Duration- 40min

Instructional objectives:

- (A) Knowledge :
1. Recognize dispersion of light.
 2. Narrate the process & define dispersion.
- (B) Understanding :
1. Explain the process.
 2. Justify the formation of rainbow.
- (C) Application :
1. Relate the formation of rainbow with dispersion.
- (D) Skill Draw the Flash Cards showing Dispersion of Light

Classroom teaching aids :

1. General teaching aids : Black board, chalk, duster etc.
2. Specific teaching aids : Flash cards showing dispersion of light.

Previous knowledge assumed : Students are aware about term measurements.

Pupil teacher's Activity	Student's Activity
1. Children do you like rainy season.	yes
2. Which colorful thing appears in the sky in this Season	Rainbow
3. How many colours are there in a Rainbow?	7
4. Do you know how it is formed?	No response

Announcement of the topic : Well students today we will study about the formation of rainbow i.e. Dispersion of light.

Recapitulation :

1. Why do we see the rainbow?
2. Which is the top most color in rainbow, why?
3. How many colors are these in a rainbow? Name.

Home Work :

1. Define dispersion of light.
2. Give full form of VIBGYOR.
3. Give reason: why a blue book appears blue?
4. In rainbow the color with highest frequency is.

EVALUATE YOURSELF

1. Discuss Unit – Planning in detail. What are its merits and demerits.
2. What do you mean by lesson planning. Prepare a lesson plan by selecting a topic of class VIII.
3. Explain unit planning. What is the importance of unit Planning (M.D.U., 2011)
4. Prepare a Lesson plan for 9th class in physical sciences. Discuss the principles and steps involved in lesson planning. (M.D.U., 2012)

**CHAPTER 3-D**

Popularization and Propagation of Physical Sciences through Science Exhibition, Science Magazine, Science Trip and Science Quiz

Major objectives of Co-curricular Activities in Physical Sciences

are:

1. Propagation of fundamentals of Science & technology among the masses
2. To dissolve the barriers between school, home and community and accelerate the diffusion of the message of science to all
3. Creation of awareness in the individual as well as the community about the impact of Science & Technology
4. Creation of a feeling in children that science is fun
5. Involving teachers, students, NGOs in S&T training programmes/ activities to spread the message of science.

SCIENCE EXHIBITIONS

Many times in the school, Science Department of the school or a class put up their work for showing it to the people outside the school, and such a show called exhibitions. The pieces of work done by the students for an exhibition are called exhibits.

REQUISITES FOR EXHIBITION:

- The exhibition should have a central theme with a few sub themes to focus attention to a particular concept.
- The exhibits should be clean, labeled properly.

- The concepts of contrast in color and size should be used for laying out the exhibitions.
- The exhibits should be so placed so the most visitors can see them.
- The place and exhibits should be well lighted.
- To capture attention and interest of visitors, both motion and sound should be utilized
- The exhibition should have some exhibits with operative mechanism such as switches, handles, to be operated by the visitors to observe some happenings.
- The exhibition should include lot of demonstrations as they involve deeply the students and the visitors
- The exhibition should be able to relate various subjects' areas to provide integrated learning.

ADVANTAGES

- Exhibitions inspire the students to learn by doing things themselves and they get a sense of involvement
- Exhibitions give students a sense of accomplishment and achievement
- Exhibitions develop social skills of communication, cooperation, coordination
- Exhibitions foster better school community relations and make community members conscious about the school
- Exhibitions couple information with pleasure
- Exhibitions foster creativity among students

DISADVANTAGES

- Requirement of thorough preparation
- Time consuming
- Requirement of funds or budget

SCIENCE MAGAZINE

The world of research involves quite a few aspects and amongst them there's the consideration of Science Magazines as well. Actually researchers and students are known to publish their works and experimental findings in Science Magazines. In fact, there are so many research designs

from which the academic researchers can choose. These come in various forms and cater to various subjects and domains. If it's a scientific journal, then it's expected you'll find more of empirically based studies including sound methodologies.

THE ADVANTAGES OF SCIENCE MAGAZINES

Science Magazines have multiple factors associated with them but at the same time there are certain advantages and disadvantages involved as well. The following are the advantages of Science Magazines:

More options for Researching: Science Magazines mostly come with more than one option for researching. This actually widens the scope for exploring your chosen subject. In general, the two kinds of research commonly used include quantitative and qualitative researches. As for quantitative research, then it's known to focus only on the measurement and conversion bit. It deals with a lot of information and statistical data. As for qualitative research, then it's mostly to do with opinions, impressions and verbal data of sorts.

Provision of case studies or in-depth knowledge: Science Magazines also prove to be a great mode to gain in-depth knowledge. This is essential because of the fact that case studies are available for you to base your research on when it comes to a Science Magazine. As a researcher you can very well make use of the case studies to form a hypothesis. Be it specific people or any particular situation, an in-depth analysis can be reached with its aid.

There's the Scope for Fluent Writing: Science Magazines also gives you the scope to exercise fluent writing. After all as a student you've got your own thoughts and ideas to express and that can only find fruition when you're given the scope to write at length. Journal writing is known to create a particular zone or niche that's judgment free. You can practically shut off your internal editor here and write error free. Good writing can never rear its head without the scope for fluency and that's exactly what academic journals pave the ground for.

Active Reading and Reinforcing Knowledge: Writing in a Science Magazine proves to be all the more advantageous simply because of the fact that it promotes active reading. This active reading obviously stems from the need to write enriching facts. In fact, current educational research shows journal writing provides an impetus for deeper thinking. Reading and writing put together serves as the right concoction for promoting active and constructive thinking.

Aids Reflective Learning While Calling For Attention: There are instances and projects wherein you might be required to pen down reflections so that you can share or put forth learning experience through a particular project. Having said so, such personalized learning experiences call for individualized attention as well. This plays a rather important role considering the fact that this is the age of heterogeneously grouped classrooms where it's a challenge for the teachers to constantly meet out individual attention.

SCIENCE TRIP

DEFINITION

According to Hedger ken Science Trip may be defined as "an educational procedure by which the student studies firsthand objects and materials in their natural environment."

ADVANTAGES OF SCIENCE TRIP

- Science Trip provides learning experience in the real life situation by direct contact with objects, process, and systems and thus has many advantages which are enumerated as follows:
- It provides accurate information objects, process, and systems in their real life setting.
- It provides meaningful direct experience and hence results in lasting learning.
- The students learning can be easily diverted towards effective learning.
- Science Trips are valuable aids to what students are curious about the natural and man-made process and objects.
- Science Trips can effectively supplement the classroom learning through application and reviewing the experiences of student.

LIMITATIONS OF SCIENCE TRIP

- 1) A Science Trip may be occasional activity which at best supplement some learning segments of the syllabus.
- 2) They can be expensive and out of reach for many disadvantaged and poor students.
- 3) Science Trips require proper and detailed planning to make them meaningful otherwise the trip leads to confusion, and fails to fulfill the requirement.

SCIENCE QUIZ

A Science Quiz is a form of game or mind sport in which the players (as individuals or in teams) attempt to answer Science questions correctly. It is also a brief assessment used in Science education and similar fields to measure growth in knowledge, abilities, and/or skills. Quizzes are usually scored in points and many quizzes are designed to determine a winner from a group of participants – usually the participant with the highest score. Science quiz basically consists to a set of question with following characteristics.

- Answer to each question requires usually a short objective answer. Quizzes do not include question which require subjective answers, or answers that require long descriptions.
- Usually the questions are such that it does not take lengthy calculation or other lengthy analysis to find the correct answer. Person answering a quiz may use paper and pen to do some rough calculations, but most of the calculation and analysis is expected to be done mentally.
- Quiz usually involves a large number of questions to be solved in a relatively short period.
- Quizzes are intended to assess the knowledge, understanding, and capabilities of the respondents of the subject covered, independent of their ability to express their ideas clearly and impressively.
- Quizzes are formulated in such a way that the correct answers to a question are predetermined, and there is no scope of personal bias of the assessor of a quiz affecting scores of participants.
- Quiz may be administered in a written form or oral form. Quizzes may also be organized as an open public competition.

Main advantages of Science Quizzes for students include the following.

- The quizzes evaluate the knowledge, understanding and mental skills of the students irrespective of their ability to express it. In this way the assessment by quizzes is likely to represent the knowledge and understanding of participants in the subject covered by quiz more accurately.
- Because of large number of question included in the quiz, the performance of participants is less dependent on the probability of question on specific topics know to individual students better

being included or excluded from the question. Large number of question in quizzes ensure that the question cover more topics.

- A quiz eliminates personal bias of the assessor. The score of quiz participants remains same irrespective of who assesses it. As a matter of fact many quizzes these days are administered through computer and also assessed by computer system.
- Usually participants have to spend less time answering quizzes as compared to examinations involving subjective types of answers.

CONCLUSION

In a nutshell, it can be said that Science Exhibitions, Science Magazines and Journals, Science Trips and Science Quizzes play a significant role in the popularization and propagation of Physical Science. Thus, the administrators of the teaching institutions must promote them in their institutions so that the study of Physical Sciences attracts more and more students and the subject becomes popular for the generations to come.

EVALUATE YOURSELF

1. What is the role of Science Quizzes in the popularization and propagation of Physical Sciences?
2. Discuss the utility of a Science Magazine in the study of Physical Sciences.
3. How Science Trips and Science Exhibitions prove out to be really helpful in the popularization and propagation of Physical Sciences?



CHAPTER 4

E-teaching of Physical Sciences using Technology for Self-Learning and Collaborative Learning of Science

E-teaching of Physical Sciences using Technology for Self-Learning and Collaborative Learning of Science has enjoyed a meaningful partnership across most of this century. The work of scientists embraces an array of technologies, and major accomplishments in science are often accompanied by sophisticated applications of technology. As a result, a complete science education has, in principle, involved a commitment to the inclusion of technology, both as a tool for learning science content and processes and as a topic of instruction in itself.

Science education has generally involved teaching not only a body of knowledge but also the processes and activities of scientific work. This view has linked the scientific uses of technology with hands-on experiences. The term "hands-on science" was descriptive of the major curriculum reform projects of the 1960s and became a label for a revolution in teaching science through the next two decades.

The explosion of digital technology has created a revolution similar to the "hands-on" movement of the 1960s. The flexibility, speed, and storage capacity of contemporary desktop computers is causing science educators to redefine the meaning of hands-on experience and rethink the traditional process of teaching. The challenge facing both science educators and science teacher educators is to evaluate relevant applications for information technologies in the science curriculum. At the same time, instruction utilizing information technologies must reflect what is known about the effectiveness of student-centered teaching and learning.

The impact of digital technologies on science teacher education is more pervasive than any curricular or instructional innovation in the past. The impact can be felt on three fronts. First, as with the hands-on science movement, digital technologies are changing the ways teachers interact with students in the classroom. Psychological theories based on the importance of language to learning, the ways organizing and relating information facilitates understanding, and the influence of social factors in the classroom are all impacted by digital technologies.

Second, teacher education courses are not only influenced by new content and curriculum, they are also influenced by instructional approaches, fueled by the National Science Education Standards that incorporate a variety of digital technologies. Technological applications that go beyond curriculum to the delivery of college level content. For instance, faculty and students explore web resources for educational statistics or education-related reports and course resources.

Third, faculty and students alike are interacting in new ways afforded by digital technologies. Faculty and students have virtual discussions related to course content, advice, and counseling in a wide variety of times and places through via email, cell phones, pagers, and features of the web. Faculty and students now produce documents with more information and in far more diverse formats as a result of desktop publishing, online libraries and databases, and file transfer capabilities. The pervasiveness of digital technologies motivates a thorough review of technological impacts on curriculum and instruction in science teacher education.

Proposed Guidelines for Using Technology in the Preparation of Science Teachers

The following technology guidelines for science education are intended to provide assistance in designing instruction and to guide applications of technology to support science teacher education reform.

- Technology should be introduced in the context of science content.
- Technology should address worthwhile science with appropriate pedagogy.
- Technology instruction in science should take advantage of the unique features of technology.
- Technology should make scientific views more accessible.
- Technology instruction should develop students' understanding of the relationship between technology and science.

1. TECHNOLOGY BE INTRODUCED IN THE CONTEXT OF SCIENCE CONTENT

The first principle is centered on the notion that technology should not be taught merely for its own sake in the preparation of science teachers. Features of technology should be introduced and illustrated in the context of meaningful science. In other words, technology should be presented as a means, not an end. This principle has implications for teaching science content, as well as for science teacher preparation. For example, pre-service teachers in science education programs are often required to take a generic educational technology course taught by an instructional technology expert. In this class, the pre-service teachers are supposed to develop a variety of technology-related skills, including the ability to use word processors, presentation software, spreadsheets, and the Internet.

2. TECHNOLOGY MUST ADDRESS SCIENCE WITH APPROPRIATE PEDAGOGY

Much has been learned about effective science instruction since the emergence of science education as a field in the 1950s. Teaching science for understanding, instead of rote memorization, requires students to be active participants who are engaged in asking questions, observing and inferring, collecting and interpreting data, and drawing conclusions. In essence, teacher education courses should emphasize methods for providing students with opportunities to do science, in addition to learning the facts and concepts of science. Content-based activities using technology should be used in the process of modeling effective science teaching for new teachers.

3. E-TEACHING OF PHYSICAL SCIENCES SHOULD TAKE ADVANTAGE OF THE UNIQUE FEATURES OF TECHNOLOGY

Technology modeled in science education courses should take advantage of the capabilities of technology and extend instruction beyond or significantly enhance what can be done without technology. New teachers should experience technology as a means of helping students explore topics in more depth and in more interactive ways. An evaluation study of the Technology-Enhanced Secondary Science Instruction documented the impact of technologies integrated at many levels. A pre-service methods course could critically examine the content and outcomes of this

study as a way of applying unique features of technology for learning science.

4. TECHNOLOGY SHOULD MAKE SCIENTIFIC VIEWS MORE ACCESSIBLE

Many scientifically accepted ideas are difficult for students to understand due to their complexity, abstract nature, and/or contrariness to common sense and experience. A large body of literature concerning misconceptions supports the notion that learning science is often neither straightforward nor consistent with the conceptions students typically construct from everyday experiences. New teachers may not even recognize that these instructional puzzles exist unless they are made explicit through their teacher education course work. Developing the skills for making scientific views more accessible is an example of developing "pedagogical content knowledge."

5. UNDERSTANDING RELATIONSHIP BETWEEN TECHNOLOGY AND SCIENCE

Despite Western society's heavy dependence on technology, few teachers actually understand how technology is used in science. Nor can they adequately describe the relationship between science and technology. A more appropriate understanding of technology for inclusion in teacher education courses is the concept of technology as knowledge applied to manipulate the natural world and emphasizes the interactions between science and technology. Using technologies in learning science provides opportunities for demonstrating to new teachers the reciprocal relationship between science and technology.

EVALUATE YOURSELF

1. Write a detailed note on e-teaching of Physical Sciences using technology for self-learning and collaborative learning of science.
2. What should be the proposed Guidelines for Using Technology in the Preparation of Science Teachers? Elaborate those guidelines.



UNIT - III

PEDAGOGICAL ANALYSIS OF CONTENTS IN PHYSICAL SCIENCES

- Contents Analysis, Pedagogical Analysis and their comparison.
- Study of items: Division of units into sub-units, Teaching requirements, Instructional objectives, Teaching strategies, Previous knowledge testing, Topic announcement, Concepts of contents, Presentation, Teaching aids use, Demonstration experimental verification, Thought provoking questions and Criterion based tests.
- Pedagogical analysis of any one of the following topics:
 - Atomic Structure
 - Energy and its types
 - Environment and Pollution
 - Water as a Universal Solvent
 - Transmission of Heat
 - Magnetism
 - Friction

CHAPTER 1

Contents Analysis, Pedagogical Analysis and their Comparison

WHAT IS CONTENT ANALYSIS?

Content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material. By systematically evaluating texts qualitative data can be converted into quantitative data. Although the method has been used frequently in the social sciences, only recently has it become more prevalent among organizational scholars.

CONDUCTING A CONTENT ANALYSIS

According to Krippendorff (1980), six questions must be addressed in every content analysis :

- 1) Which data are analyzed?
- 2) How are they defined?
- 3) What is the population from which they are drawn?
- 4) What is the context relative to which the data are analyzed?
- 5) What are the boundaries of the analysis?
- 6) What is the target of the inferences?

TEN STEPS INVOLVED IN CONTENT ANALYSIS

- 1) Copy and read through the transcript - make brief notes in the margin when interesting or relevant information is found.
- 2) Go through the notes made in the margins and list the different types of information found.

- 3) Read through the list and categorize each item in a way that offers a description of what it is about?
- 4) Identify whether or not the categories can be linked any way and list them as major categories and/or minor categories.
- 5) Compare and contrast the various major and minor categories.
- 6) If there is more than one transcript, repeat the first five stages again for each transcript.
- 7) When you have done the above with all of the transcripts, collect all of the categories or themes and examine each in detail and consider if it fits and its relevance
- 8) Once all the transcript data is categorized into minor and major categories/themes, review in order to ensure that the information is categorized as it should be.
- 9) Review all of the categories and ascertain whether some categories can be merged or if some need to them be sub-categorized.
- 10) Return to the original transcripts and ensure that all the information that needs to be categorized has been so.

The process of content analysis is lengthy and may require the researcher to go over and over the data to ensure they have done a thorough job of analysis.

PEDAGOGICAL ANALYSIS

Pedagogical analysis is not a new concept in the field of education. The word 'Pedagogy' comes from the Greek word "paidagogos" in which 'Paida' means "child" and 'agog' means "Lead" literally translated "to lead the child"

Pedagogy is the science and art of education specifically instructional theory. So pedagogy is

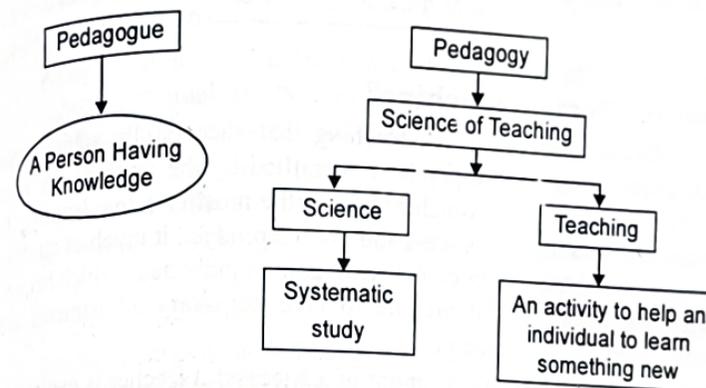
1. The art or profession of teaching
2. Preparatory training or instruction

Pedagogy is the art and as well as science of teaching. It is a master-plan that includes a detailed analysis of what is to be done by a teacher.

According to Webster's New World Dictionary. "Pedagogy is the art or science of teaching; especially instructions in teaching methods."

According to Oxford Advanced Learner's Dictionary. "Pedagogy means the study of teaching methods. It seems to derive from the Greek word 'pedagogue'. In Denmark a pedagogue is a practitioner of pedagogy. The term is primarily used for individuals who occupy jobs in pre-school education (such as kindergartens and nurseries). They occupy various kinds of jobs e.g. in retirement homes, prisons, orphanages etc. They perform their duties on behalf of society.

There work also consists of supporting the child in his or her mental and social development. In Hungary the word pedagogue is synonymous with teacher; teachers of both primary and secondary schools.

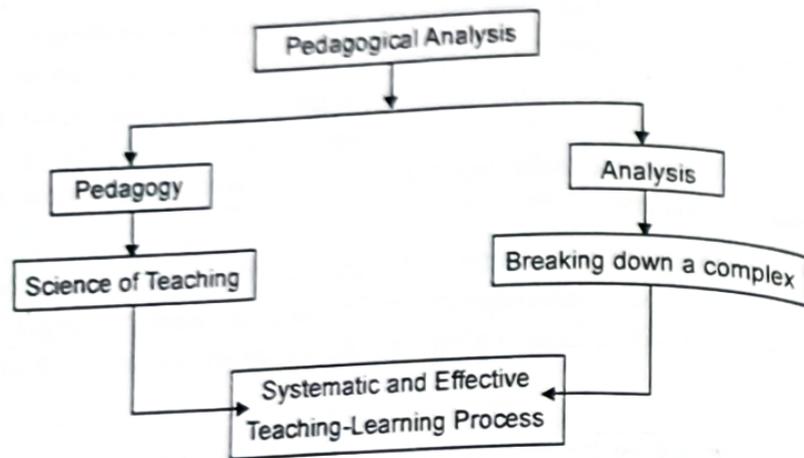


Pedagogical Analysis

In its simple meaning the term pedagogical analysis (a composition of two words pedagogy and analysis) stands for a type of analysis based on pedagogy. For its further understanding let us try to be acquainted with the term analysis and pedagogy.

Analysis is a term stands for a process of breaking or separating a thing in to its smaller parts, elements or constituents. We break a teaching unit in to its constituents-subunit, topics or single concepts etc. through the process of unit analysis. In additions, we can break the contents of the prescribed course in a subject into its various constituents-major and minor sections, sub-sections, units and sub-units, major concept and minor concepts, topics etc. by carrying out a process of content analysis.

Therefore "the analysis of a given content material in any subject, any topic carried out well in the spirit of science of teaching (pedagogy) is known by the term Pedagogical Analysis of the contents.

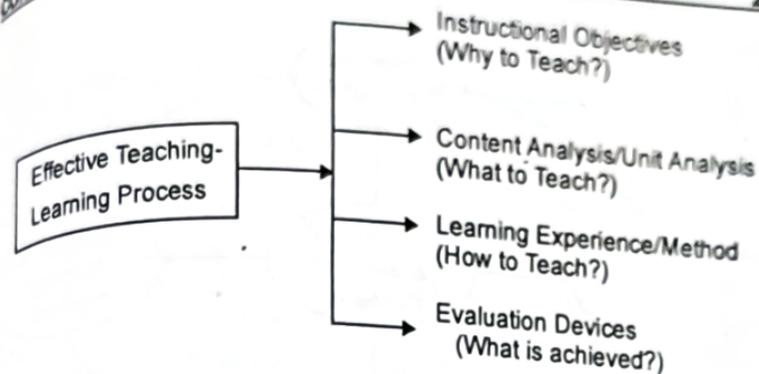


What is effective teaching?

Effective teaching is the teaching that successfully achieves the learning objectives by the pupils as identified by the teacher. The most effective teaching is that which results in the most effective learning. In addition the learning is a process and not the product, it involves all those experiences and training through teaching of an individual, which helps to change the behavior and prepare to take necessary adjustments and adaptation in change situations.

The root of effective teaching of a successful teacher is evolved in the following points:

1. Pupils learn best in a positive and nurturing environment established by teachers who believe that every pupil is capable of learning.
2. All pupils have areas of strengths and interests that can be useful in advancing pupil learning. Effective teachers establish an instructional environment that will draw on these strengths.
3. Teachers take in to account the whole pupil, in other words they attend to cognitive, affective, social and physical dimension when developing an instructional program.
4. Active engagement and interaction facilitate pupil learning.
5. Pupil learning is both individually and socially constructed; it is influenced by cultural, familial and social context.
6. Measuring assessment is both formative and summative; it relies on multiple measures including informal observations.



Components and operations involved in the task of pedagogical analysis

Pedagogical analysis is based on four essential pillars along with their inherent mutual relationships and interdependence for being considered essential in the effective teaching-learning process.

- A. Content analysis of the unit/topic/concept being taught by the teacher in the subject.
- B. Setting of the teaching or instructional objectives of the content material of the topic in hand by writing them in specific behavioral terms.
- C. Suggesting methods, techniques, teaching-learning activities aids and equipments helpful for the teaching-learning of the topic in hand quite in tune with the realization of the set instructional objectives.
- D. Suggesting appropriate evaluation devices in the form of oral, written or practical activities and test questions etc. for evaluating the outcomes of the teaching-learning process carried in relation to the teaching-learning process carried in relation to the teaching of the topic in hand.

In the light of the relationship and interdependence existing among the above mentioned four components of the pedagogical analysis, operations of the content material in the subject may then be properly illustrated through the following diagram. Fig. 3.1. In this way where teacher is asked to perform pedagogical analysis of the contents of a subject/unit/or topic to be taught in the class he has to go through the cycle of the above mentioned four components namely 1) content analysis 2) objective formulation 3) selection of the teaching methods and materials used 4) selection of the evaluation devices..

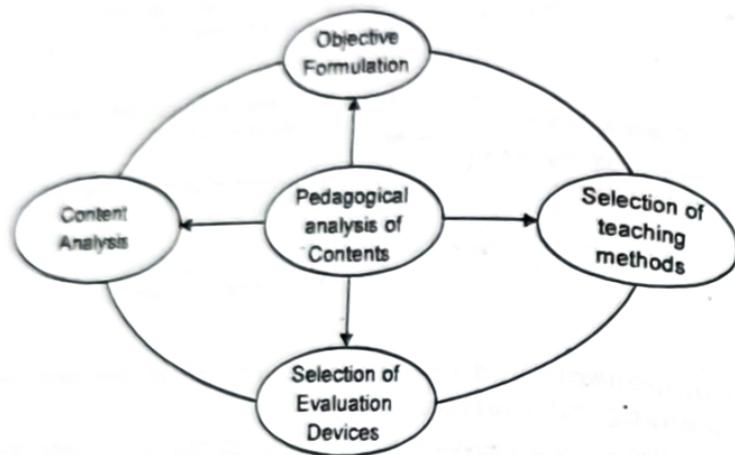


Fig. 3.1. Showing Four Pillars of Pedagogical Analysis

Explanation of the four pillars of pedagogical analysis.

- 1. Unit analysis/content analysis:** Content means subject matter of any subject and Analysis means breaking down complex units into smaller sub-units/sub-topics. So before starting teaching a teacher go through the whole content and break the major concepts into systematic and meaningful minor concepts or simple-concepts. So it is the very essential component in pedagogical analysis because in doing so a teacher should have good knowledge of the maxims of teaching and through knowledge of the content.
- 2. Instructional objectives:** After the content analysis a teacher formulate the instructional objectives. This is the second pillar of pedagogical analysis. A teaching process should be effective based upon its instructional objectives, so it is very important to formulate these objectives very carefully.
A teacher should consider following points in mind.
 - (a) A teacher should have thorough knowledge of the different approaches of behavioral objectives i.e. Bloom's Taxonomy of teaching and learning, Robert Mager's Approach, Robert Millar's approach and RCEM approach.
 - (b) Teacher's approach of formulating instructional objectives into behavioral terms should be learner-centered.
 - (c) Teacher should have a good knowledge of the content that's why he/she can put the subject-matter in progressive

sequence and should know the domains or levels of teaching-learning.

3. Learning experiences/methods/techniques: This is the third pillar of pedagogical analysis. In this the students came in to the contact of teacher and subject matter. Teachers give the knowledge about the content or concept by selecting the methods, techniques or methods which are best for the teaching of science. The instructional objectives are achieved only when there is right selection of the methods/techniques. It is an artistry of a teacher that which method and how he used this method in his teaching. By utilizing various skills and giving best learning experiences a teacher will be able to achieve his aims. A teacher performs the following activities.

- ◆ Use of various teaching skills in his teaching.
- ◆ Selection and use of best teaching method/technique for teaching of science.
- ◆ Use of various teaching aids, activities and equipments e.g. charts, models, real objects, specimens, multimedia presentations etc.

4. Evaluation Devices: This is the fourth step of pedagogical analysis. In this we come to know whether the objectives are achieved or not. The outcomes are measured with the help of evaluation devices. So the selection of appropriate evaluation device in the form of oral, written or practical activities are carried out in relation to the teaching of topic. So these 4 pillars constitute the pedagogical analysis.

Steps of pedagogical analysis

1. Divide the contents of the selected unit into suitable sub-units and arrange the selected sub-units in to a number of required periods.
2. Briefly write the essence of the content of the selected sub-unit.
3. Write appropriate previous knowledge required for the sub-unit.
4. Write appropriate instructional objectives to be selected for the sub-unit.
5. Select appropriate teaching strategies for the sub-unit according to the following instruction:
 - (i) Write the name of the method applied.

- (2) Mention the teaching aids required.
 - (3) Briefly illustrate the necessary demonstration and /or experimentation required.
 - (4) Mention the necessary board work required.
 - (5) Write probing questions related to the sub-unit and provide appropriate answers for them.
 - (6) Prepare a work sheet for the sub unit.
6. Give suitable examples/illustration/analogies for the sub unit.
 7. Prepare a table of specification for the sub unit. Write at least six criteria reference test-items each with specific criteria of the sub unit.

Need of Pedagogical analysis

Pedagogy i.e. the science of teaching is a master plan that includes a details of what is to be done by a teacher, the instructional strategies, instructional equipments and the cardinal objectives of instruction. Depending on what can actually learn and what are the expectations sets for learners of a particular stage of development, specific instructional objectives are determined and appropriate sets of activities provided.

The teacher decides instructional objectives, equipments and strategies with every aspects of learning conditions to be created. Favorable conditions for positive learning cell for knowledge of various factors operating in different conditions. Pedagogical analysis is selection of appropriate objectives and strategies in various instructional situations to assess the levels of actual learning at the end. A comprehensive vision of required tasks, strategies for realization of specific goals facilitates effective teaching. So pedagogical analysis offers enormous potential for improving the delivery of information in all form of education. It involves various logical steps to arrive at logical inference. It also helps the students to understand concepts, principles or phenomena.

Again the learning environment created accordingly enables to-

1. Relate individuals fragment of knowledge to real experience in life and work.
2. Develop skills and relate facts as a part of a larger organized completely. Realization of specific goals, facilitated by a detailed planning result in effective teaching.

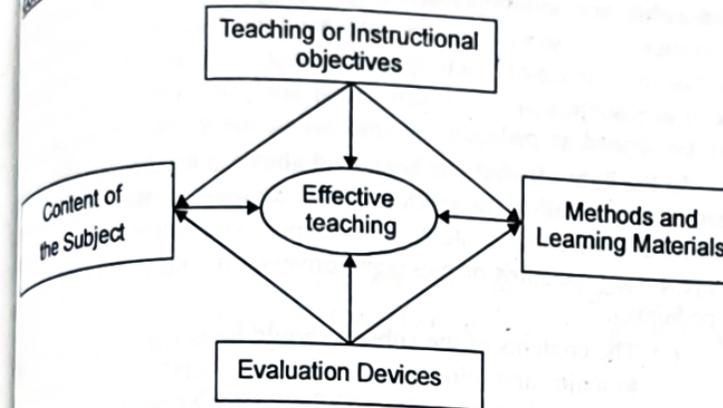


Fig. 3.2. Effective teaching learning process

How pedagogy serves effective Teaching

In this way in the light of what has been said already above the science of teaching pedagogy is found to serve the following two main objectives in the schedule task of a teacher's teaching.

- (i) Teaching should be carried out as smoothly as possible and
- (ii) It should result in to the maximum output in terms of the expected better teaching outcomes.

What is suggested by the science of teaching on pedagogy for the realization of its above said two main objectives now carries a wide significance at this stage. Let us briefly describe it.

A teacher has before him content material and learning experiences related to that subject in a particular class. In this way his success in his teaching task depends upon the extent to which he is successful in realization of the teaching instructional objectives. He can go on smoothly in his teaching task only if he follows suitable method, devices, techniques and aid materials etc. for providing the fruits of his teaching to his students. How properly is he proceeding in his teaching tasks and how will he is trying to achieve the set teaching objectives, that now needs the help of a continuous system of testing and measurement known as evaluations of teaching outcomes. The result of such evaluations provides an appropriate feedback to the teacher for bringing alteration in setting of instructional objectives. In this way science of teaching or pedagogy advocates a total mutual relationships and interdependence among the following four pillars of the teaching learning process for attaining best possible results in the task of teaching i.e. effective teaching. Fig. 3.2

Science of teaching or pedagogy in this way lays down the above mentioned four essentials pillars along with their inherent mutual

relationship and interdependence for being considered essential in the realization of the desired success in a teaching task. It is the message and spirit of the science of teaching or pedagogy that needs to properly carry out in any subject and then only such analysis of the content material may be termed as pedagogical analysis of the given content material.

In the light of what has been said above, a teacher may proceed in the way given below for analyzing the contents of the syllabus of his subjects as well as the contents of the topic to be taught in the classroom by preserving the spirit or message conveyed by the science of teaching or pedagogy.

- (i) The contents of the subject should be got analyzed properly in to major and minor sections/unit/concepts etc. and sequenced as well as organized as methodically as possible.
- (ii) Only a desirable amount of the content material enabled to be covered properly in the scheduled period should be taken in to hand at a time in the shape of a topic to be taught by the teacher for his scheduled classroom.
- (iii) The topic in the hand should also be analyzed properly in the form of major and minor concepts/single concepts etc.
- (iv) The teacher should now clearly lay down the teaching or instructional objectives related to the topic in hand by writing them in to the specific behavioral terms.
- (v) How can these stipulated instructional objectives be achieved properly by teaching contents of the topic in hand should now be made a point of consideration for proceeding further on the path of pedagogical analysis. Definitely, in this situation it needs the better employment of men material resources by the teacher. Science of teaching (pedagogy) can help him here to think about the best possible methods, strategies, tactics and techniques to be employed, aid material and likewise sources to be utilized for the teaching of the topic in hand in the existing teaching learning situations. All of the possible things and factors helpful in the teaching of the topic in view of the proper realization of the set teaching objectives then should be properly analyzed and classified in any of the scheme of pedagogical analysis of the topic or contents of subject.
- (vi) In the last there arises a need of exercising proper control over the different components of the teaching-learning process. Such control can only be possible through a well-organized scheme of evaluation well in tune with the contents of the topic in hand, stipulated teaching objectives and methods and material employed for teaching.

Content Analysis, Pedagogical Analysis and their Comparison

Shulman (1986) advanced thinking about teacher knowledge by introducing the idea of pedagogical content knowledge. He claimed that the emphases on teacher's subject knowledge and pedagogy were being treated as mutually exclusive domains in research concerned with these domains. The practical consequence of such exclusion was production of teacher education programs in which a focus on either subject matter or pedagogy dominated.

There's a difference between Content and Pedagogy. Content is all about what we teach. Pedagogy is about how we teach it.

There's also a difference between knowing how to do something and understanding what you're doing. In Physical Sciences there are all kinds of "how-to", or computation skills, that kids learn and promptly forget right after the test; sometimes they forget before the test. Through a suitable combination of Content analysis and Pedagogical Analysis it becomes difficult to forget something once you understand it.

This knowledge includes knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching. This knowledge is different from the knowledge of a disciplinary expert and also from the general pedagogical knowledge shared by teachers across disciplines. PCK is concerned with the representation and formulation of concepts, pedagogical techniques, and knowledge of what makes concepts difficult or easy to learn, knowledge of students' prior knowledge and theories of epistemology. It also involves knowledge of teaching strategies that incorporate appropriate conceptual representations to address learner difficulties and misconceptions and foster meaningful understanding. It also includes knowledge of what the students bring to the learning situation, knowledge that might be either facilitative or dysfunctional for the particular learning task at hand. This knowledge of students includes their strategies, prior conceptions (both "native" and instructionally produced); misconceptions students are likely to have about a particular domain and potential misapplications of prior knowledge.

Summary

Effective teaching necessitates making difficult and principled choices exercising careful judgment, and honoring the complex nature of the educational mission. In addition to the technical knowledge and skills teachers have to use in their daily practice, they must also be aware of the ethical dimensions of their profession. In this light the primary mission is to foster the development of skills, dispositions and

understanding, while acknowledging thoughtfully and responsibly a wide range of human needs and conditions. Thus, teachers must master a repertoire of instructional methods and strategies, yet remain critical and reflective about their practice.

Based on the latest developments in pedagogy, teaching has become more than an activity that conserves valued knowledge and skills by transmitting them to succeeding generations. Therefore, teachers also have the responsibility to challenge existing structures, practices and definitions of knowledge; to invent and test new approaches; and where necessary to pursue organizational change in a constant attempt to improve the school.

Effective teaching through pedagogy display skills at creating curricula designed to build on students' present knowledge and understanding and move them to more sophisticated and in-depth abilities, knowledge, concepts and performances. In addition, pedagogy helps to make a range of instructional strategies and resources to match the variety of student skills and to provide each student several ways of exploring important ideas, skills and concepts. Pedagogy makes a teacher: how to work as facilitators, coaches, models, evaluators, managers and advocates. Moreover teachers know how to utilize various forms of play, different strategies for grouping learners and different types of media and materials.

Through pedagogy teachers observe and assess students in the context of ongoing classroom situation like collecting and interpreting a variety of types of evidence to evaluate where each students is in a sequence or continuum of learning and development and know how to move from assessment to decisions about curriculum, social support and teaching strategies, to increase the prospects for successful learning.

EVALUATE YOURSELF

1. What are the Pedagogic activities? What are the Pedagogic experiments? What is their significance?
2. How to specify contents after Pedagogical Analysis has been done for a specified subject-matter based on the principles of Pedagogical Analysis?
3. What is Pedagogical Analysis? What are the principles involved behind its analysis?
4. Explain the principles of Pedagogical Analysis in detail and what is the significance of these principles in the field of education?
5. Explain the concept of Pedagogical Analysis in detail, describing therein the principles of Pedagogical Analysis.



Water as a Universal Solvent

INTRODUCTION

Water we drink and utilize for doing a number of tasks essential for preserving and enriching our life is most important and essential commodity and properties which have made it quite indispensable and most useful thing on the earth not only to the human beings but also to all the living beings including birds, animal and plants. One such useful and unique property of water lies in its being described as a universal solvent. Let us see what we mean by it.

What is a Solvent

In terms of a definition, a solvent is a medium provided by a substance in which other substances can be dissolved. Or

Solvent is a substance that dissolves a solute resulting in a solution.

Or

Solvent is a medium provided by a substance in which other substances can be dissolved.

In a solution, solvent is present in larger amount as compare to solute.

Examples : There are several examples of solvent like: water, ammonia, ethanol, urea, acetone etc.

NOTE : Solutions containing water as solvent are called aqueous solutions, whereas others are called non-aqueous solutions.

Let us try to make the terminology of this definition clear through an experimental activity.

Activity

Take a beaker and fill it half with water. Add a small quantity of salt with the help of a spoon and shake it. You will find that the salt dissolves in the water completely leaving no solid particles of salt visible to you. As a result of your activity you get a mixture of water and salt. In case you add a little more salt in this mixture it will also soon be a part of that mixture.

In scientific language this mixture is named as solution. Water and salt are definitely two components of this mixture i.e. solution. Water is present in larger quantity in this mixture or solution, while salt has its invisible presence in a smaller quantity. Now think and answer the following questions:

- What is that which has been dissolved and now remains invisible to us in this solution of water and salt?
- What is that which is responsible for dissolving salt in it resulting in the formation of such type of mixture or solution?

With the answer of the above question you can very well conclude that water is that substance which has provided medium for getting dissolved the other substance, salt in it for the formation of a mixture or solution of water and salt. It may also lead us to conclude that a solvent, like water here, is that component of a solution which besides being present in larger quantity in the solution also acts as the medium of solution for getting dissolved in it the other substance like salt in the present case.

The other substances, like salt in this case, present in similar quantity in the solution and having a characteristic of being dissolved (becomes invisible) are named as solute.

If you repeat this experiment by taking sugar as a solute you may experimentally verify the following observations recorded in the table given below :

Types of the solution	Name of the solvent	Name of the solute
Solution of sugar in water	Water	Sugar
Solution of common salt in water	Water	Common salt
Solution of common salt and sugar in water	Water	Sugar and common salt

Water as solvent

We have just seen in the above mentioned experimental activity that water has an adequate capacity of acting as a good medium for dissolving in it the substances like sugar and salt. If we go on experimenting in such a way, we can find that water may act as a good solvent for dissolving in it many such other substances (not only in the form of solids but liquids and gases also). The scope of dissolving the substances in water by making it to act as a solvent is quite wide. However, let us give some examples of the substances which dissolve in water.

WATER AS A UNIVERSAL SOLVENT

Solids : Common salt or sodium chloride, sugar, glucose, urea, potassium chloride, potassium nitrate, ammonium chloride and potassium permanganate etc.

Liquids : Alcohol, acetone, glycerine, acetic acid, hydrogen chloride, Ethanol etc.

Gases : Ammonia, chlorine, carbon dioxide, hydrogen chloride, sulphur dioxide and nitrogen dioxide etc.

WATER AS UNIVERSAL SOLVENT

Universal solvent

A solvent which dissolves almost all the substances like solids, liquids and gases.

Water as we have seen above is a good solvent for many of the substance belonging to all of the three varieties of the substances, solids liquids and gases. Similarly it equally holds well as a perfect solvent for many of the inorganic substances (like sodium chloride, ammonia, hydrogen chloride and sodium hydroxide etc.) and organic substances (like sugar, glucose, urea and acetone etc.). Besides water, although we have other liquid solvents like ether, acetone, ethanol, benzene, chloroform and carbon tetrachloride (all of them are organic in nature) they can't compete with water in terms of its wide coverage as a good solvent. The organic solvent pointed out above may be used only for dissolving the organic matter like fats, oils, grease and wax etc. they are unable to work as a solvent for dissolving inorganic matter like sodium chloride, ammonia, hydrogen, chloride etc.

Since water has no such limitations as possessed by organic solvents and it proves quite good as a solvent for dissolving maximum number of substances falling in the categories of solids, liquids and gases, it may be very well named as universal solvent.

Why water is a universal solvent?

Water is highly suitable and convenient medium for carrying out chemical reactions in solution at room temperature.

Also, water is called the universal solvent because more substances dissolve in water than in any other chemical.

Water is readily available as compare to other solvent and it is cheap also.

Properties of water which makes it a universal solvent

The most important and unique characteristics and properties of water which enable it to become a universal solvent may be named as under;

1. The polarized nature of its molecules.
2. Its capacity to dissolve the products formed as a result of its chemical reactions with a variety of substances.
3. High dielectric constant

The effect of the Polarized Nature of water Molecules :

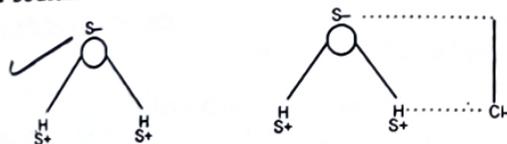
A molecule of the water (H_2O) as we know possesses atoms of hydrogen and oxygen.

It is characterized with a high electronegative nature of Oxygen atom as compared to H atom. As a result negative and positive electric charges are developed around the atoms of oxygen and hydrogen of a molecule of the water. It makes water to develop the characteristic of a polarized substance enabling it to dissolve many of the inorganic and organic compounds as discussed below.

Note : Due to presence of two hydrogen atoms water is a diprotic solvent.

1. The polarized nature of water helps it in proving a good solvent for the ionic compounds like sodium chloride ($NaCl$) and potassium chloride (KCl) etc.

When we allow to mix sodium chloride and water, water enters between the Na^+ and Cl^- ions. Its negative pole (oxygen side) is attracted by positive Na^+ ion and positive pole (hydrogen side) is attracted by negative Cl^- ion. In this way both the positive and negative ions of sodium chloride are separated from each other for being dissolved (called hydrated in the language of the chemistry) in water to form a solution of water and sodium chloride.



2. The polarized nature of water also helps it in proving a good solvent for the covalent organic compounds like urea, ammonia, glucose, alcohol etc.

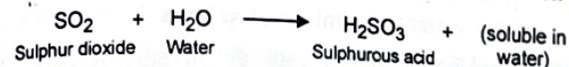
In case we try to add a little amount of glucose or urea in the beaker filled up half with the water and stir it with the help of a spoon the molecules of water will at once start reacting with the molecules of the organic compound. During such chemical reaction the positively charged hydrogen atom of the water molecule tries to form a bond called a hydrogen bond with highly charged electronegative atom of the organic compound

molecule. For example, in the case of the organic covalent compound urea, the positively charged atom of H_2O (water) tries to form a hydrogen bond with the negatively charged O atom of urea molecule $[(NH_2)_2C=O]$

In this way, water gets its way in dividing the molecules of the urea into two parts first by separating its O atom with the attraction of its positively charged atom H and then making a bond with it named as hydrogen bond. This bond is quite a weak bond which can be broken at any time for allowing the whole of the molecule of the urea to get dissolved in water resulting in a mixture or solution of the water and urea.

The effect of its chemical reactions with a variety of substances: In the case of a variety of substances like sulphur dioxide, nitrogen dioxide etc., water first engages in certain type of chemical reactions with these substances. As a result of these chemical reactions, the substance gets dissolved resulting into the formations of certain type of solutions which becomes part and parcel of the greater constituent of the mixtures i.e. water.

- (i) Take the case of sulphur dioxide (SO_2). Here sulphur dioxide gets dissolved in water due to a chemical reaction resulting into the formation of sulphurous acid. The sulphurous acid. The sulphurous acid as we know is well soluble in water.



- (ii) Similar is the case of Nitrogen dioxide (NO_2). Here in a chemical reaction, nitrogen dioxide dissolves in water resulting into the formation of nitric acid (well soluble in water).



High dielectric constant

Water has high value of dielectric constant (i.e. 78)

Dielectric constant is the property of a solvent which determines the amount of forces operating between different ions of a solute in the solvent.

Cheap and readily available

Water is readily available and very cheap as compare to other costly solvent like ether, alcohol, acetone etc.

Pedagogical Analysis of the Topic : Water as Universal Solvent

Consists of four steps :

Step 1 : Content Analysis – Topic – Water as Universal Solvent

It consists of two parts :

(A) Major Concept

(B) Minor Concept

(A) Major Concept

1. What is a solvent ?
2. Water as solvent.
3. Water as universal solvent.
4. What properties makes water a universal solvent ?

(B) Minor Concept

1. What is a solvent ?
 - ◆ Definition of the term solvent.
 - ◆ Examples of different types of solvent.
2. Water as solvent
 - ◆ Examples of mixtures having water as solvent.
3. Water as Universal solvent
 - ◆ Definition of universal solvent
 - ◆ Why water is a universal solvent ?
4. What properties makes water as universal solvent ?
 - ◆ High Dielectric constant
 - ◆ Polar nature of water
 - ◆ Undergo chemical reactions with a variety of substances
 - ◆ Readily or easily available

Step 2 : Objective Formulation (Behavioral Outcomes)

Students after going through the teaching of the topic "Water as Universal Solvent" will be able to

1. Define the term solvent.
2. Cite examples of different kinds of solvents.
3. Explain the role of water as a solvent.
4. Give atleast two examples of mixture where water act as a solvent.
5. Recall the term universal solvent.
6. Analyze the properties of water.
7. Predict the dipolar nature of water.
8. Explain the chemical reactions of substances with water.

9. Illustrate the polar nature of water.
10. Explain why water is a universal solvent.
11. Name characteristics and properties of water responsible for making it a universal solvent.
12. State and explain dielectric constant of water.

Step 3 Methods, devices, activities and aid materials used.

Methods : Lecture method, Demonstration method, Discussion method and Observation method.

Devices : Narration, explanation, illustration and observation devices.

Activities and aid materials used

1. While teaching the topic help of blackboard writing and sketching, charts and pictures will be used.
2. Slides and transparencies may be used to show the solvents other than water.
3. Films and computer presentation may be used to show the polarized nature of water.
4. Overhead projectors, charts and pictures may be utilized for presenting chemical reaction of water with a variety of substances.
5. Practical opportunities like solution formation will be provided for understanding the universal nature of water.

Step 4 Evaluation Procedure and Devices Used

Evaluation can be done through oral, written and Practical mode.

- **In oral method**, students will be asked questions during teaching process or after completion of the topic and students are required to respond orally to the asked questions.
- **In Practical mode**, students may be asked to form solutions [mixtures] of ionic compound and covalent compounds with water and asked to interpret the result.
- **Written mode** consists of :

(a) Essay type questions

1. Explain the meaning of the term solvent.
2. Illustrate the statement 'water is a universal solvent'.
3. Explain in detail, the properties which make water a universal solvent.
4. Give any two reactions in which water act as solvent.

(b) Short Answer type Questions

1. Define the term solvent.
2. Name any two solvents other than water.

4. Properties of water which makes it a universal solvent :

High dielectric constant : water has high value of dielectric constant (i.e. 78)

Dielectric constant is the property of a solvent which determines the amount of forces operating between different ions of a solute in the solvent.

Polar nature of water molecule: Water molecule consists of two hydrogen atoms and one oxygen atom. Due to electronegative nature of oxygen it has slightly negative charge and hydrogen atoms acquire slightly positive charge. So, in water molecule, basically there are two poles (one -ve other +ve) are present which makes water a polar solvent.

Note : Due to presence of two hydrogen atoms water is a diprotic solvent.

During the dissolution of a substance, positive end of water attracts negative pole of solute

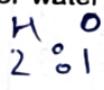
Define dielectric constant

Lecture method, Narration device

Dielectric constant of water is

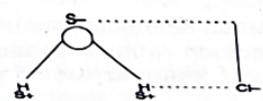
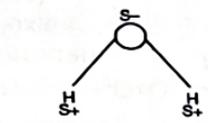
- (a) 72
(b) 74
(c) 78

Analyze the polar nature of water



Demonstration method, observation device, explanation device, slides and transparencies will be used to show the polar nature of water

Water is a solvent.



2. Water as Solvent.

Water has the ability to dissolve almost all the substances like solid, liquids and gases at room temperature. So, water acts as a good solvent at room temperature.

Examples Solids - Salt, Sugar, Potassium chloride, glucose, urea.

Liquids - Alcohol, acetone, ethanol, acetic acid

Gases - Ammonia, chlorine, carbon dioxide, sulphur dioxide.

3. Water as universal solvent.

Universal solvent : A solvent which dissolves almost all the substances like solids, liquids and gases.

Why water is a universal solvent?

Water is highly suitable and convenient medium for carrying out chemical reactions in solution at room temperature.

Cite examples of different solutes capable of dissolving in water.

Demonstration method, illustration device.

Name the two solutions in which water act as solvent.

Experiment Take a beaker containing water and try to dissolve glucose in it.

In another beaker add acetic acid and shake it.

In 3rd beaker try to dissolve potassium chloride.

Analyze the observation in each beaker.

Interpret the term universal solvent.

Lecture method; Narration device

Define the term universal solvent.

Understand the universal nature of water.

Lecture method, Narration device

Explain the statement water is a universal solvent.

<p>and negative end attract the positive part of the sulfate.</p> <p>Undergo chemical reactions with a variety of substances: like ionic substances, covalent substances, gaseous substance.</p> <p>$H_2O + NaCl \rightarrow$ Salt solution</p> <p>Water Salt</p> <p>(ionic compound)</p> <p>$SO_2 + H_2O \rightarrow H_2SO_3$</p> <p>Sulphur Water Sulphurous acid dioxide</p> <p>(gas)</p> <p>Water is readily available and very cheap as compare to other costly solvent like ether, alcohol, acetone etc.</p>	<p>Observe the chemical reactions of water.</p>	<p>Lecture method, Black-board writing, computer presentation may be used to show various chemical reactions.</p> <p>$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$</p> <p>Nitrogen Nitric acid</p> <p>(gas)</p>	<p>Give atleast three chemical reactions of water.</p>
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Transmission of Heat

Transmission of heat is the process of exchange of heat between physical systems until both the systems will attain the same temperature. When we dip a spoon in a beaker filled with hot water, it becomes hot due to the transfer of heat from hot water to spoon. This transfer took place until both the objects will attain the same temperature.

MODES OF TRANSMISSION OF HEAT

Heat can be transmitted from one place to the other by four modes.

These are:

- (i) Conduction,
- (ii) Convection,
- (iii) Radiation and
- (iv) Advection.

Conduction

It is the phenomenon of transfer of heat through one part of the body to another, from particle to particle in the direction of fall of temperature without any actual movement of the particle. For example, when we heat one end of a solid, its other end becomes hot. Heat goes from one end of the rod to other end by conduction. All solids are heated through conduction.

Infect, when one end of a solid is heated, the atoms or molecules of the solid at the hotter end start vibrating with greater amplitude. The disturbance is transferred to the neighboring molecules. This results in the rise of temperature, as heat energy shows itself in the form of molecular motion.

APPLICATION OF CONDUCTIVITY IN DAILY LIFE

Some of the applications of conductivity in everyday life are:

1. Cooking utensils are provided with wooden handles, because wood is a poor conductor of heat. The hot utensils can be easily handles and our hands are saved from burning.
2. In winter, metallic handles of a wooden door appear colder because it is a good conductor. Heat flows from our body to the handle.

3. A new quilt is warmer than an old one. This is because the new quilt encloses a large amount of air which is a bad conductor of heat. This air does not allow heat of our body to flow to the surroundings. For exactly the same reason, two thin blankets of their combined thickness, the layer of air enclosed in between the two blankets makes the difference.
4. In winter, birds often swell their feathers. Air enclosed between their body and feathers does not allow flow of heat from the body of the birds to the cold surroundings.
5. Saw dust is a poorer conductor of heat than the wood of which it is made. This is again due to air trapped in the saw dust.
6. Ice is packed in gunny bags or saw dust prevents transfer of heat from the surroundings to the ice. Hence ice does not melt.
7. Eskimos make double walled houses of the blocks of ice. Air enclosed in between the double walls prevents transmission of heat from house to the cold surroundings.

CONVECTION

It is the phenomenon of transfer of heat with the actual movement of particles of the body. For example, when we heat a liquid in a flask, the particles of the liquid at the bottom get heated, become lighter and actually rise up. The cold liquid particles from above come down and receive the heat. The process is repeated. In fact all liquid and gases are heated by convection.

In the mode of transmission, heat is transferred in the substances from one place to another with the help of the movement of the molecules. Liquids as well as gases get heated through this mode of heat transmission. Convection of heat is that mode of transmission of heat in which molecules of the liquids and gases are able to transmit heat from the hotter parts of their volume to the colder parts through their actual movements and exchange of place.

Application of the Convection of Heat

We may make use of mechanism in liquids and gases in our day life in many ways illustrated as below:

1. Convection currents produced in the water of the pipes lying in the wall of the room may be utilized for heating the room in winter.
2. The ventilators in the room for the exit of the foul air work on the mechanism of convection. The air inside the room gets heated due to our respiration and so many other reasons. The warm air rises upward on account of its becoming light. This raised air

then gets its exit from the ventilators and the fresh air rushes from outside through the doors and windows.

3. The mechanism of land and sea breezes studied by you in your geography lessons can be explained easily through the convection currents produced in the air.
4. Exhaust fans installed in the kitchens, laboratories, rooms, stores and offices for the exit of the foul air work on the mechanism of convection. Similar is the case with the installation of big chimneys at opening of huge furnaces of the brick kilns or industrial establishments. Here foul air gets its exit from these exhaust fans and chimneys and fresh air rushes through the windows, doors and other.

RADIATION

It is the phenomenon of transfer of heat from source to the receiver without any actual movement of source or receiver and also without heating the intervening medium. For example, heat from the sun comes to us through radiation. On standing near fire, we feel hot as heat comes to us through radiation.

Note : Radiation is the fastest mode of heat transfer, having velocity in vacuum

$$c = 3 \times 10^8 \text{ m/s}$$

Thermal radiations are those which produce in us the sensation of warmth. They are emitted by a body on account of its temperature. It was established later that every body whose temperature is above 0k (Zero Kelvin) emits thermal radiations. Radiation as a mode of heat transfer helps all types of matter solids, liquids and gases in the task of receiving and transmitting the heat.

It depends upon :

- (1) The temperature of body
- (2) Nature of radiating surface of the body.

Some of the basic characteristics of thermal radiations are :

1. They travel along straight lines with the speed of light.
2. They require no medium for their propagation i.e. they can pass through vacuum too.
3. They do not heat the intervening medium through which they pass.
4. They obey inverse square law i.e. their intensity varies inversely as the square of the distance from the source.
5. They can be reflected and refracted according to the law of reflection and refraction of light.

6. Thermal radiations also exhibit the phenomena of interference, diffraction and polarization as do the light radiations.

Application of the Radiation of heat:

- The firemen wear caps of bright alloy to help them in reflecting the radiation received through fire.
- Bottom of the cooking utensils are blackened because darker body absorbs more heat through radiation than bright objects.
- We wear light coloured clothes in the summer and black coloured in winter. Radiation depends on the temperature of the body radiating the heat.

ADVECTION

The transfer of energy from one location to another as a side effect of physically moving an object containing that energy.

By transferring matter, energy including thermal energy – is moved by the physical transfer of a hot or cold object from one place to another. This can be as simple as placing hot water in a bottle and heating a bed or the movement of an iceberg in changing ocean currents.

Application of the Advection of heat : Steam generation in power plants.

Pedagogical Analysis of the Topic : 'Transmission of Heat'

Consists of four steps:

Step 1 : Content Analysis – Topic – Transmission of Heat

It consists of two parts:

(A) Major Concept

(B) Minor Concept

(A) Major Concept

- What is transmission of heat?
- Modes of transmission of heat.
- Conduction of heat
- Convection of heat
- Radiation
- Advection of heat

(B) Minor Concept

- What is transmission of heat?
 - ❖ Defining the term transmission of heat.
 - ❖ Meaning of the term transmission of heat.
- Modes of transmission of heat
 - ❖ Conduction or diffusion

- ❖ Convection
 - ❖ Radiation
 - ❖ Advection
- Conduction of heat
 - ❖ Defining conduction of heat
 - ❖ Meaning of the term conduction
 - ❖ Application of the conduction process
 - Convection of heat
 - ❖ Defining the term convection
 - ❖ Meaning of the term convection
 - ❖ Application of the convection process
 - Radiation of Heat
 - ❖ Definition of the term radiation of heat
 - ❖ Meaning of the term radiation of heat
 - ❖ Application of the radiation of heat
 - Advection of heat
 - ❖ Definition of the term advection of heat
 - ❖ Meaning of the term advection of heat
 - ❖ Application of the advection of heat in daily life.

Step 2 : Objective Formulation (Behavioral Outcomes) :Students after going through the teaching of the topic "Transmission of Heat" will be able to :

- Define the term transmission of heat.
- Interpret the meaning of the term transmission of heat.
- Give the methods of transmission of heat.
- Explain and illustrate conduction of heat.
- Differentiate between good and bad conductors of heat.
- Give examples from daily life illustrating conduction of heat.
- Define the term Convection/Radiation/Advection.
- Discriminate between conduction and convection.
- Provide examples from day to day life about the application of convection method of transmission of heat.
- Tell the methods used for the transmission of heat in the case of solids, liquids and gases.
- State and explain with example radiation of heat.
- Define the term advection of heat.
- Give an experimental activity showing conduction of heat.
- Differentiate between radiation and convection / advection and convection.

- 15) Explain why should we wear light coloured clothes in summer and dark coloured in winter?

Step 3 : Methods, devices, activities and aid materials used:

Methods : Lecture method, Demonstration method

Devices : Narration, observation, explanation, illustration and experimentation devices.

Activities and aid materials used :

- 1) While teaching the topic help of blackboard writing and sketching, charts and pictures will be taken.
- 2) Slides and transparencies may be used to show the process of conduction of heat.
- 3) Films and computer presentation may be used to show the radiation of heat.
- 4) Overhead projectors, charts and pictures may be utilized for presenting various modes of transmission of heat.
- 5) Verbal examples and illustration from daily life will be provided for explaining concepts related to transmission of heat.
- 6) Experimental activities will be performed for illustrating concepts related to transmission of heat like how heat is transferred in the solids through conduction etc.
- 7) Audio recordings, video films will be used to show the applications of modes of transmission of heat in day to day life.

Step 4 : Evaluation Procedure and Devices Used:

Evaluation can be done through oral, practical and written mode.

- 1) **In oral mode**, students will be asked questions during teaching process or after completion of the topic and students are required to respond orally to the asked questions.
- 2) **In practical mode**, students will be asked to perform the experimental activities showing how solid objects conduct heat and how solid objects differ in the capacities of the conduction of heat.
- 3) **Written mode consists of :**
 - A. Essay type questions
 - a) Explain the meaning of the term transmission of heat.
 - b) Differentiate with examples the different modes of transmission of heat.
 - c) What are the different modes of transmission of heat?
 - d) Differentiate between conduction and convection / convection and radiation.

- e) What do you mean by good and bad conductors of heat? Explain with suitable examples.
- f) Give day to day application of the process of conduction /convection/radiation/advection of heat.
- g) How solids get heated by conduction and liquids and gases heated through convection?
- h) State and explain Advection of heat.

B. Short Answer type Questions :

- a) Define the term transmission of heat.
- b) Give at least two examples of transmission of heat.
- c) Name different modes of transmission of heat.
- d) How solids conduct heat?
- e) What are good and bad conductors?
- f) Define the advection of heat with example.
- g) Give at least two examples each of the substances that may be heated respectively through conduction, convection, radiation and advection.
- h) Why it is better to wear bright clothes in summer and dark clothes in winter?
- i) Define Radiation of heat giving at least one example from day to day life.

C. Objective type Questions:

1. Match the column

Column I	Column II
(i) Transfer of heat from one particle to another without any actual movement.	(a) good conductors
(ii) involves actual movement of particles	(b) conduction
(iii) Black surfaces	(c) convection
(iv) Substances which allow heat to pass through them.	(d) good absorber of heat

2. Multiple choice Questions:

- (i) Transfer of heat without heating the intervening medium,
 - (a) Conduction
 - (b) convection
 - (c) radiation

- (ii) Fastest mode of heat transfer,
 (a) Radiation (b) Conduction
 (c) Convection (d) Advection
- (iii) Transfer of heat with actual movement of particles,
 (a) Conduction (b) convection
 (c) radiation
- (iv) Black body
 (a) Good absorber (b) bad absorber
 (c) do not absorb at all
3. Fill in the blanks :
 (i) Liquids and _____ convect heat.
 (ii) Silver is a _____ conductor of heat.
 (iii) _____ transfer heat without actual movement of particles.
 (iv) _____ is the fastest mode of heat transfer.
 (v) In convection, water moves from _____ region to _____ region.
4. True-False Statements :
 (i) Black body is bad absorber of heat.
 (ii) Heat flows from hotter end to cooler end.
 (iii) Aluminum is good conductor of heat than rubber.
 (iv) Medium is not required for transfer of heat by radiation.
 (v) We receive heat from sun through conduction.

Pedagogical Analysis – 'Transmission of Heat'

Content Analysis	Behaviour Outcomes	Method, devices, activities and aid material used	Evaluation, Procedure and Devices
<p>1. What is the transmission of heat?</p> <p>□ Definition : It is the process of exchange of heat between physical systems until both the systems will attain the same temperature.</p> <p>□ Meaning : When we dip a spoon in a beaker filled with hot water, it becomes hot due to the transfer of heat from hot water to spoon. This transfer took place until both the objects will attain the same temperature.</p> <p>2. Modes of transmission of Heat : There are several methods of heat transfer like conduction, convection, Radiation and Advection.</p>	<p>After going through the topic students will be able to :</p> <p>Recall the term transmission of heat.</p> <p>Understand the meaning of transmission of heat.</p> <p>Generalize the different modes of heat transfer.</p>	<p>Lecture method, Narration device</p> <p>Demonstration method, Experimentation device</p> <p>Lecture method, Narration device, Slides and blackboard written may be used to show different modes of heat transfer.</p>	<p>Define the term transmission of heat.</p> <p>Explain the meaning of transmission of heat.</p> <p>Name the different modes of heat transfer.</p>

- (a) Tea is served in cups made of china clay, a bad conductor of heat.
- (b) Cooking utensils are usually made of metals and alloys because they are good conductor of heat.
- (c) Woolen clothes, blankets keep our body warm because they are bad conductors of heat.

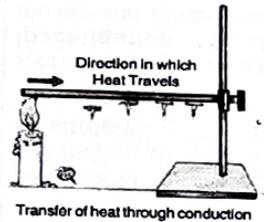
4. Convection of heat :

- **Definition:** Phenomenon of transfer of heat with the actual movement of particles of the body.
- **Meaning:** When we heat a liquid in a flask, the particles of the liquid at the bottom get heated.

Recognize the convection heat transfer

Analyze the convection heat transfer.

rod about 25 cm long. Fix thumb tacks along the length of the rod, using wax heat one end of the rod, what do you see? As the rod gets heated, the wax melts and the thumb-tacks fall off (fig.). You will find that the thumb - tack nearest to the end



Lecture method, Narration device

Demonstration method, explanation device, experimentation device

Define the term convection.

Explain the process of convection of heat.

3. Conduction of Heat :

- **Definition :** It is the phenomenon of transfer of heat through one part of the body to another, from particle to particle in the direction of fall of temperature without any actual movement of particle.
- **Meaning :** When one end of a solid is heated, the atoms of the solid at the hotter end start vibrating with great amplitude. The disturbance is transferred to the neighboring atoms. This results in the rise of temperature, as heat energy shows itself in the form of molecular motion.
- Conduction take place only when two objects are differ in temperature.
- Conduction takes place only when two objects lie in contact with each other.
- **Application :** All solids are heated through conduction, therefore:

Interpret the term conduction of heat.

Understand the conduction process.

Cite examples from day to day life.

Lecture method, Narration device

Demonstration method, explanation device Computer presentation may be used to clear the concept.

Demonstration method, illustration method Charts and pictures may be used to show the process of conduction

Activity-Experimental Investigation

To show the process of conduction, Take an iron

Define the term conduction of heat.

In conduction actual movement if particle is there (T/F)

Write any two applications of conduction of heat.

5. Radiation of Heat :

- ❑ **Definition :** Phenomenon of transfer of heat from the source to the receiver without any actual movement of source or receiver and also without heating the intervening medium.
- ❑ **Meaning and Example :** Radiation does not need any intervening medium i.e. it may occur even in vacuum. Heat from the sun comes to us through radiation. On standing near fire, we feel heat as heat comes to us through radiation.
- ❑ **Application :** Radiation is the fastest mode of heat transfer.

Recall the term radiation of heat.

Understand the meaning of radiation of heat.

Analyze the applications of radiation of heat.

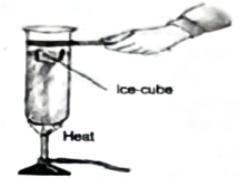


Fig. Heat easily flows upwards in water

Lecture method, Narration device

Experimentaldemonstration: Activity: Light up the candle and now try to take your hand near the flame, your hand feel warmth of flame.

Lecture method, Illustration device. Computer

Define radiation of heat.

Radiation does not need any intervening medium (T/F).

List out the application of radiation of heat.

become lighter and actually rise up. The cold liquid particles from above come down and receive the heat. The process is repeated.

- ❑ **Application :** All liquids and gases are heated by convection. Therefore,
 - (a) Exhaust fans used in the rooms and labs for exit of the foul air work on convection mechanism.
 - (b) The ventilators in the room also work on this mechanism.

Recognize the application of convection of heat.

Activity: Heating of water taken in a beaker.

Lecture method, Explanation device .

Slides and transparencies may be used to understand the process of convection of heat more accurately.

Convection

Activity-Experimental Investigation : To show the process of convection, Fill a test tube with cold water. Drop an ice - cube in this water. Now heat the water from below (fig.) you will find that the ice melt quickly.

This show that though water is a bad conductor of heat, heat easily flows upwards in it.

Give one application of convection of heat.

6. Advection of Heat :

- **Definition :** The transfer of energy from one location to another as a side effect of physically moving an object containing that energy.
- **Meaning :** By transferring matter, energy including thermal energy – is moved by the physical transfer of a hot or cold object from one place to another. This can be as simple as placing hot water in a bottle and heating a bed or the movement of an iceberg in changing ocean currents.

Application : Steam generation in power plants.

Recall the term advection of heat.

Understand the heat transfer by advection.

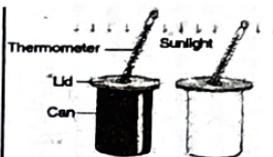


Fig. A black object absorbs more radiant heat than a white object in the same time period.

Lecture method,
Narration device

Define the term advection of heat.

Explanation device,
Illustration device

What do you mean by advection of heat?

Radiation as a mode of heat transfer helps all types of matter, solid, liquids and gases in the task of receiving and transmitting the heat.

- (a) The firemen wear caps of bright alloy to help them in reflecting the radiation received through fire.
 - (b) Bottom of the cooking utensils are blackened because darker body absorbs more heat through radiation than bright objects.
 - (c) We wear light coloured clothes in the summer and black coloured in winter.
- Radiation depends on the temperature of the body radiating the heat.

presentation and slides may be used to analyze the applications of radiation of heat.

Activity Experimental investigation : To show that dark-coloured objects absorb and lose radiant heat more quickly than light coloured objects. Take two identical tin cans. Paint one of them black and the other white. Half-fill both of them with cold water. Cover them with cardboard lids and insert thermometers through the lids. Place both the cans in the sun. Note the thermometer readings. After about 15 minutes note the reading again. Now heat both the cans to the same temperature and keep them in shade. Note the temperature after every minute. Which can cools down faster?

Magnetism

Have you seen stickers that remain attached to iron surfaces like almirahs or the doors of refrigerators? In some pin holders, the pins seem to be sticking to the holder. In some pencil boxes, the lid fastens tightly when we close it even without a locking arrangement. Such stickers, pin holder and pencil boxes have magnets fitted inside. If you have any one of these items, try to locate the magnets hidden in these.

Defining the Term "Magnet" and "Magnetism"

Magnet : A piece of the material or object that attracts pieces of iron and tends to align itself along the north-south direction, when suspended freely is called as Magnet.

Magnetism : This property of attracting iron and aligning in north-south direction is called Magnetism.

How Magnets were Discovered

It is said that, there was a shepherd named Magnes, who lived in ancient Greece. He used to take his herd of sheep and goats to the nearby mountains for grazing. He would take a stick with him to control his herd. The stick had a small piece of iron attached at one end. One day he was surprised to find that he had to pull hard to free his stick from a rock on the mountainside. It seemed as if the stick was being attracted by the rock. The rock was a natural magnet and it attracted the iron tip of the shepherd's stick. It is said that this is how natural magnets were discovered. Such rocks were given the name magnetite, perhaps after the name of that shepherd. Magnetite contains iron. Some people believe that magnetite was magnesia. The substances having the property of attracting iron are now known as magnets. This is how the story goes.

The types of Magnets

Magnets can be divided into two major heads, namely:

- (1) Natural Magnet and
- (2) Artificial Magnet

The magnet in the form of the mineral extracted from the mines is called natural magnet whereas a piece of iron or steel capable of exhibiting properties of a magnet after its magnetization with the help of a natural magnet or electrification is termed as artificial magnet.

In any case, people now have discovered that certain rocks have the property of attracting pieces of iron. They also found that small pieces of these rocks have some special properties. They named these naturally occurring materials magnets. Later on the process of making magnets from pieces of iron was discovered. These are known as artificial magnets.

Types of artificial magnets

Nowadays artificial Magnets are prepared in different shapes. For example, bar magnet, horse-shoe magnet, cylindrical or a ball-ended magnet. Fig. 3.13 shows a few such magnets.



Fig. 3.13. Magnets of different shapes

- Bar magnet – available in rectangular shape
- Horseshoe magnet – having the shape like horseshoe or U-shaped
- Cylindrical magnet – Cylindrical in shape

We understand that magnet attracts certain materials whereas some do not get attracted towards magnet. The materials which get attracted towards a magnet are **magnetic** – for example, iron, nickel or cobalt. The materials which are not attracted towards a magnet are **non-magnetic**. What materials did you find to be non-magnetic from table 3.1 Is soil a magnetic or a non – magnetic material?

Table: 3.1-Finding the objects attracted by magnet

Name of the objects	Material which the object is made of (cloth/ plastic/aluminium/ wood/glass/iron/any other)	Attracted by magnet stick / magnet (Yes/ No)
Iron ball	Iron	Yes
Scale	Plastic	No
Shoe	Leather	?

Properties of magnets

Poles of Magnet : Magnet has two poles. One pointing towards north is called north pole, other pointing towards south is called south pole.

Activity : Spread some iron filling on a sheet of paper. Now place a bar magnet on this sheet. What do you observe? Do the iron filling stick all over the magnet? Do you observe that more iron fillings get attracted to some parts of the magnet than others. Remove the iron fillings sticking to the magnet and repeat the activity. Do you observe any change in the pattern with which the iron filling get attracted by different parts of the magnet? You can do this activity using pins or iron nails in place of iron fillings and also with magnets of different shapes.



Fig. 3.14. Iron filings sticking to a bar magnet

We find that the iron fillings are attracted more towards the region close to two ends of a bar-magnet. Poles of a magnet are said to be near these ends. Try and bring a few magnets of different shapes to the classroom. Check for the location of the poles on these magnets using iron fillings.

Attraction and Repulsion between Magnets

Like poles of a magnet repels each other while unlike poles attract each other.

Activity 1 : Put or take two bar magnets. Now put the north poles of each magnet towards each other and in the next case put magnets such that north pole of one magnet face south pole of the other magnet. And observe the result.



Attraction



Repulsion

Activity 2 : Let us play another interesting game with magnets. Take two small toy cars and label them A and B. Place a bar magnet on top of each car along its length and fix them with rubber bands. In car A, keep the south pole of the magnet towards its front. Place the magnet in opposite direction in car B. Now, place the two cars close to one another. What do you observe? Do the car remains at their places? Do

the cars run away from each other? Do they move towards each other and collide? Record your observations in a table. Now place the toy cars close to each other such that the rear side of car A faces the front side of car B. Do they move as before? Note the direction in which the cars move now. Next, place the car A behind car B and note the direction. In which they move in each case. Repeat the activity by placing cars with their rear side facing.

Position of the cars	How do the cars move? Move towards/away from each other/not move at all
Front of car A facing the front of car B	
Rear of car A facing the front of car B	
Car A placed behind car B	
Rear of car B facing rear of car A	

Record your observations in each case.

When suspended freely, points to north-south direction

Activity : Suspend a bar magnet from a string tied to its middle for enabling it to rotate freely. Now mark the direction in which it comes to rest. It will be north-south. Now turn the magnet gently in another direction and leave it for coming to rest. You will see that again it is pointing out in some direction i.e. north-south.

Loss of Magnetism

Magnets lose their properties if they are heated, hammered or dropped from some height. Also, magnets become weak if they are not stored properly. To keep them safe, bar



Fig. 3.15. Magnets lose their property on heating, hammering and dropping

Magnets should be kept in pairs with their unlike poles on the same side. They must be separated by a piece of wood while two pieces

of the soft iron should be placed across their ends. For horse-shoe magnet. One should keep a piece of iron across the poles. For horse-shoe magnet. One should keep a piece of iron across the poles. Keep magnets away from cassettes, mobiles, television, music system, compact disks (CDs) and the computer.

Formation of Artificial magnets

There are several methods of making magnets. Let us learn the simplest one. Artificial magnets can be formed by the following methods:

Rubbing : Take a rectangular piece of iron. Place it on the table. Take a bar-magnet and place one of its poles near one edge of the bar to iron. Without lifting the bar magnet, move it along the length the iron bar till you reach the other end. Now, lift the magnet and bring the pole (the same pole you started

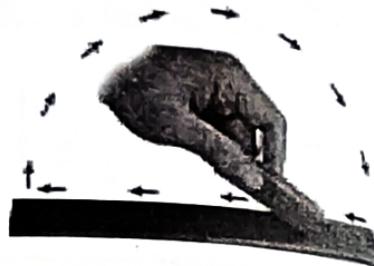


Fig. 3.16. Making your own magnet

with) to the same point of the iron bar from which you began. Move the magnet again along the iron bar in the same direction as you did before. Repeat this process about 30-40 times. Bring a pin or some iron filings near the iron bar to check whether it has become a magnet. If not, continue the process for some more time. Remember that the pole of the magnet and the direction of its movement should not change. You can also use an iron nail, a needle or a blade and convert them into a magnet.

Electrification : When current is passed through a conductor, a magnetic field is produced round it. The magnetic field is that area found the magnet where it keeps its magnetic effect, magnetic field can be trace with the help of a magnetic needle. It shows that on passing current through a conductor, a magnetic field is produced round it.

Activity : Take an iron rod, wrap it with an insulated copper wire and connect the ends of the wire with a battery and observe the findings.

Uses and application of Magnetism

Finding Directions : As the magnet always point in north-south direction when suspended freely, it is used to find direction. Magnets were known to people from ancient times. Many properties of magnets were also known to them. You might have read many interesting stories about the uses of magnets. One such story is about an emperor in China named Hoang Ti, it is said that he had a chariot with a statue of a lady that could rotate in any direction. It had an extended arm as if it was

showing the way (fig 3.17.). The statue had an interesting property. It would rest in such a position that its extended arm always pointed towards South. By looking at the extended arm of the statue, the Emperor was able to locate directions when he went to new places in his chariot.

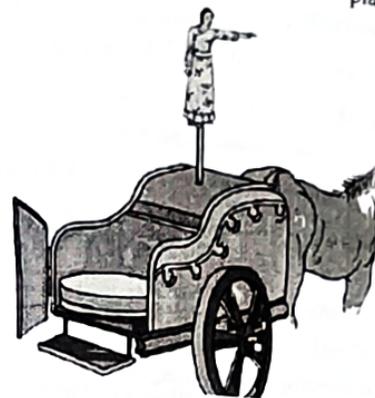


Fig. 3.17. The chariot with direction finding statue

A compass is usually a small box with a glass cover on it. A magnetized needle is pivoted inside the box, which can rotate freely. The compass also has a dial with directions marked on it. Its needle indicates the north-south direction when it comes to rest.

In Industries : On electrification, iron rod behaves as magnet. This property is used in industries to lift the heavy load.

Household Applications : Door of refrigerator closes at their own due to magnetic effect, pin box used at houses is another example showing magnetism use.



Fig. 3.18. A compass

Summary

- Magnetite is a natural magnet.
- Magnet attracts materials like iron, nickel, cobalt. These are called magnetic materials.
- Materials that are not attracted towards magnet are called non-magnetic.
- Each magnet has two magnetic poles – North and South.
- A freely suspended magnet always aligns in N-S direction.
- Opposite poles of two magnets attract each other whereas similar poles repel one another.

Pedagogical Analysis of the Topic : 'Magnetism'

Consists of four steps :

Step 1 : Content Analysis – Topic – Magnetism

It consists of two parts :

- (A) Major Concept (B) Minor Concept

(A) Major Concept

1. What is magnet and magnetism ?
2. How magnet was discovered?
3. Types of Magnets – Natural and Artificial.
4. Types of Artificial magnets.
5. Properties of magnet.
6. Formation of artificial magnets.
7. Uses and applications of magnetism.

(B) Minor Concept

1. What is magnet and magnetism ?
 - ❖ Definition of magnet.
 - ❖ Meaning of the term magnetism.
2. How magnet was discovered ?
 - ❖ Discovery of the rock magnetic.
 - ❖ Discovery of magnet.
3. Types of magnet
 - ❖ Natural magnet
 - ❖ Artificial magnet
4. Types of Artificial magnets
 - ❖ Bar magnet
 - ❖ Horseshoe magnet
 - ❖ Cylindrical or ball ended magnet
 - ❖ Electromagnet
5. Properties of magnet
 - ❖ Poles of magnet
 - ❖ Attraction between unlike poles and repulsion between like poles.
 - ❖ When suspended freely, points to north-south direction
 - ❖ Loss of magnetization when heated hammered or dropped from some height.

6. Formation of artificial magnet

- ❖ By rubbing
- ❖ Through electrification

7. Uses and application of magnetism

- ❖ Finding direction
- ❖ In industries
- ❖ In house hold appliances.

Step 2 : Objective Formulation (Behavioral Outcomes) :

Students after going through the teaching of the topic "Magnetism"

will be able to :

1. Recall the term magnetism.
2. Give the meaning of the term magnets.
3. Differentiate between magnetic and non-magnetic materials.
4. Explain how magnets were discovered.
5. Explain and illustrate the different properties of magnet.
6. Discriminate between natural and artificial magnets.
7. Mention the types of artificial magnets.
8. Analyze the process of artificial magnets formation.
9. Demonstrate the electrification method used for making artificial magnet.
10. Tell about why like poles attract each other whereas, unlike poles repel each other.
11. List out the uses and applications of magnetism.
12. Tell how magnets help in finding direction.
13. Give the conditions under which magnetism can be destroyed.
14. Classify the artificial magnets.

Step 3 : Methods, Devices, activities and aid materials used :

Methods : Lecture method, Demonstration method

Devices : Narration, illustration, explanation, observation and experimentation devices.

Activities and aid materials used

1. While teaching the topic help of blackboard writing and sketching, charts and pictures will be taken.
2. Slides and transparencies may be used to show the historical evolution of magnets.
3. Verbal explanation will be given for narration and illustration of concepts related to 'Magnetism'.

4. Films and computer presentation may be used to show the application of magnetism in various fields.
5. Experimental activities will be performed to show the concept of repulsion and attraction by the magnets.
6. Overhead projector may be used to show the methods of forming artificial magnets.
7. Chart and pictures may be used to show the process of loss of magnetization on heating and hammering.
8. Use of audio and video recordings, internet information etc. may be taken for explaining the various properties of magnets.

Step 4 : Evaluation Procedure and Devices Used :

Evaluation can be done through oral, practical and written mode.

- In oral mode, students will be asked questions during teaching process or after completion of the topic and students are required to respond orally to the asked questions.
- In Practical method, students will be asked to perform experiments like artificial magnet formation, finding direction and asked to analyze or observe the results.
- Written mode consists of :

(a) Essay type questions

1. Explain the meaning and concept of magnet and magnetism.
2. Give the historical background of magnet discovery.
3. What do you understand by natural and artificial magnets? Give examples of each type.
4. Differentiate between natural and artificial magnets.
5. Explain and illustrate the process of forming artificial magnets in detail.
6. Explain the properties of magnets.
7. Discuss the uses and application of magnetism in daily life.
8. List out the conditions under which magnetism can be destroyed.

(b) Short Answer type Questions :

1. What do you mean by magnet.
2. Define the term magnetism.
3. Point out two differences between artificial and natural magnets.
4. Name two poles of a magnet.
5. Give different types of artificial magnets.
6. List out the methods of making artificial magnets.
7. What happens on hammering or heating a magnet ?
8. Name the properties of magnet.
9. How magnets are helpful in finding direction?

10. Give two differences between natural and artificial magnet.
11. Give atleast three uses and application of magnetism.

(c) Objective type Questions :

1. Multiple choice Questions :

- (i) When freely suspended, magnet points in
 - (a) north-south direction
 - (b) south-north direction
 - (c) west-south direction
- (ii) Bar magnet is an example of
 - (a) Natural magnet
 - (b) Artificial magnet
 - (c) Temporary magnet
- (iii) Magnet can attract
 - (a) Iron
 - (b) Wood
 - (c) Rubber
 - (d) Plastic

2. Match the column

Column I

- (i) Bar magnet
- (ii) Like poles
- (iii) Unlike poles
- (iv) Iron pieces are attracted

Column II

- (a) by magnets
- (b) repels
- (c) attracts
- (d) artificial magnet

3. Fill in the blanks :

- (i) Like poles _____ each other and unlike poles _____ each other.
- (ii) _____ is an artificial magnet.
- (iii) On suspending freely, magnet points in _____ direction.
- (iv) Magnet has _____ poles.
- (v) Horseshoe magnet is an example of _____ magnet.

4. True False (T/F) Statements,

- (i) Electrification is one of the method of magnetizing a substance.
- (ii) Magnet has two poles.
- (iii) When freely suspended, magnet points in south-north direction.
- (iv) Like poles attract each other whereas unlike poles repel each other.
- (v) Nickel and Cobalt are attracted by magnet.

North poles → End which indicates towards north
 South poles → End which indicates towards south.

The stick was being attracted by the rock. After that such rocks were given the name magnetite, perhaps after the name of that shepherd.

□ **Discovery of Magnet :** Magnetite contains iron. The substances having the property of attracting iron are now known as magnets.

3. **Types of magnet :** Magnets are mainly of two types :

(a) **Natural magnets :** Natural magnets are small pieces of magnetic rock having some special properties of attracting iron.

(b) **Artificial magnets :** Pieces of iron made to exhibit the property of magnetism by some process like rubbing or electrification are called artificial magnets.

Understand the discovery of magnet.

Lecture method, Narration device

How rock magnetite was named ?

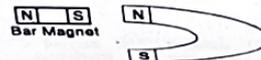
Recognize the natural and artificial magnets.

Demonstration method, illustration devices, Charts and pictures may be used to show the natural and artificial magnets.

Differentiate between natural and artificial magnets.

Demonstration method, illustration device.

Picture or real magnets will be shown to the students.



MAGNETISM

Pedagogical Analysis – 'Magnetism'

PEDAGOGY OF PHYSICAL SCIENCE (M.D.U.)

Content Analysis	Behaviour Outcomes	Method, devices, activities and aid material used	Evaluation, Procedure and Devices
<p>1. What is a magnet and magnetism ?</p> <p>□ Magnet : A piece of the material that attracts pieces of iron and tends to align itself along the north-south direction, when suspended freely is called as magnet.</p> <p>□ Magnetism : This property of attracting iron and aligning in north-south direction is called magnetism.</p>	<p>After going through the topic students will be able to:</p> <p>Recall the term magnet and magnetism</p>	<p>Lecture method, Narration device</p> <p>Example : In pin holders, the pins seem to be sticking to the holder. more clear.</p>	<p>Give the meaning of the term magnet and magnetism.</p>
<p>2. How magnet was discovered?</p> <p>□ Discovery of the rock magnetite:</p> <p>There was a shepherd named Magnes. He used to take his herd of sheep to nearby mountain for grazing. One day when he put his stick having iron attached at one end, on a rock.</p>	<p>See how magnetite was discovered.</p> 	<p>Lecture method, Narration device</p>	<p>How rock magnetite was discovered ?</p>

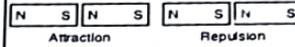
(c) When suspended freely, points to north-south direction.

Analyze this property.

(d) Loss of magnetization : Magnets lose their properties if they are heated, hammered or dropped from some height. Also, magnets become weak if they are not stored properly. To keep them safe, bar magnets

Identify the methods which affects magnetic strength.

the other magnet. And observe the result.



Demonstration experiment
Activity : Suspend a bar magnet from a string tied to its middle for enabling it to rotate freely. Now mark the direction in which it comes to rest. It will be north-south. Now turn the magnet gently in another direction and leave it for coming to rest. You will see that again it is pointing out in some direction i.e. north-south.

Prove that when suspended freely, magnets always rest in north-south direction.

Demonstration method

Activity : Take a bar magnet and hammer it for some time. Now put some iron nails around it and observe the result.

Name the factors responsible for loss of magnetization.

4. Types of artificial magnets :
- Bar magnet - available in rectangular shape
 - Horseshoe magnet - having the shape like horseshoe or U-shaped
 - Cylindrical magnet - Cylindrical in shape

5. Properties of magnet :

(a) Poles of magnet : Magnet has two poles. One pointing towards north is called north pole, other pointing towards south is called south pole.

(b) Attraction and repulsion between magnets : like poles of a magnet repels each other while unlike poles attract each other.

Classify artificial magnets.

Identify the poles of a magnet.

Identify the cause of repulsion and attraction between magnets.



Lecture method, narration device

NOTE : The poles of a magnet can never be separated. If we divide or break a magnet then both the pieces have their individual poles.

Experimental demonstration

Activity : Put or take two bar magnets. Now put the north poles of each magnet towards each other and in the next case put magnets such that north pole of one magnet face south pole of

Differentiate between natural and artificial magnets.

Name different types of artificial magnets. Magnet has _____ poles.

Like poles repel each other while unlike poles attract each other. (T/F)

(b) **Electrification** : An iron piece behaves like a magnet when electricity is passed through it.

Generalize this electrification concept.

Demonstration experiment

Activity : Take an iron rod, wrap it with an insulated copper wire and connect the ends of the wire with a battery and observe the findings.

Give an experiment showing that electrification leads to magnetization.

7. Uses and application of Magnetism :

(a) **Finding direction** : As the magnet always point in north-south direction when suspended freely, it is used to find direction.

Analyze the magnetic property used to find direction.

Lecture method, Narration device

How magnets are used to find direction.

(b) **In Industries**: On electrification, iron rod behaves as magnet. This property is used in Industries to lift the heavy load.

Apply this concept in daily life.

Computer presentation or visit to an Industrial area helps in understanding this concept easily.

On passing current, Iron rod behaves as a magnet (T/F)

(c) **Household applications** : Door of refrigerator closes at their own due to magnetic effect, pin box used at houses is another example showing magnetism use.

Analyze the refrigerator and find other examples from daily life.

Lecture method, Narration device
Slides and posters may be used for making it more clear.

Give atleast two examples where magnetism is used.

should be kept in pairs with their unlike poles on the same side. They must be separated by a piece of wood while two pieces of soft iron should be placed across their ends.

6. **Formation of Artificial magnets**: artificial magnets can be formed by the following methods:

Verify the fact that rubbing leads to magnetization.

Demonstrate method, illustration, observation, experimentation device.

Explain how rubbing leads to magnetization.

(a) **Rubbing** : Take a rectangular piece of iron and a bar magnet. Place the bar magnet near one edge of the bar of iron. Without lifting the bar magnet, move it along the length of the iron bar till you reach the other end. Now, lift the magnet and bring the pole (the same pole you started with) to the same point of iron bar from which you began. Move the magnet again along the iron bar from which you began. Repeat this process about 30-40 times. Bring a pin or some iron filling near the iron bar to check whether it has become a magnet or not.

Friction

You might have seen a driver of a car or a truck slowing down the vehicle at a traffic signal. You, too slow down your bicycle whenever needed by applying brakes. Have you ever thought why a vehicle slows down when brakes are applied? Not only vehicles, an object moving over, the surface of another object slows down when no external force is applied on it. Finally it stops. Have you not seen a moving ball on the ground stopping after some time? Why do we slip when we step on a banana peel? Why is it difficult to walk on a smooth and wet floor? Let's try to find out the answers to these questions.

Force of Friction

Gently push a book on a table. You observe that it stops after moving for some distance. Repeat this activity pushing the book from the opposite direction. Does the book stop this time, too? Can you think of an explanation? Can we say that a force must be acting on the book opposing its motion? This force is called the force of friction. In both cases the force opposes the motion of the book. Thus force of friction always opposes the applied force.

In the above case, the force of friction acts between the surface of the book and the surface of the table. So the force which always opposes the motion of body over another body in contact with it is called the force of friction or just friction. Thus, the force of friction is always opposite to the direction of motion of the body.

FACTORS AFFECTING FRICTION

There are several factors which affects the force of friction. Among them some are listed below:

Roughness of surface

Activity : Tie a string around a brick. Pull the brick by a spring balance. Apply some force. Note down the reading on the spring balance when the brick just begins to move. It gives a measure of the force of friction between the surface of the brick and the floor.

Now wrap a piece of polythene around the brick and repeat the activity. Observe any difference in the readings of the spring balance in the above two cases? What might be the reason for this difference? Repeat this activity by wrapping a piece of jute bag around the brick. Observe carefully?

Irregularities on the surface

Friction is caused by the irregularities on the two surfaces in contact. Even those surface which appear very smooth have a large number of minute irregularities on them. Irregularities on the two surface lock into one another. When we attempt to move any surface we have to apply a force to overcome interlocking. On rough surfaces there are larger numbers of irregularities. So the force of friction is greater if a rough surface is involved.

The way bodies move over each other

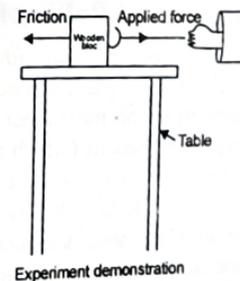
We see that the friction is caused by the interlocking of irregularities in the two surfaces. It is obvious that the force of friction will increase if the two surface are pressed harder. Experience it by dragging a mat when nobody is sitting on it. And when a person is sitting on it.

TYPES OF FRICTION

Static Friction and Dynamic Friction

The static friction (or limiting friction) is the friction between any two bodies when one of bodies just tends to move or slip over the surface of another body. There is no actual movement of the body in static friction (or limiting friction). If however, one body moves slowly or slides over another body, then the frictional force is called dynamic friction (or sliding friction). This will become clearer from the following example.

Consider a wooden block kept on a table top. Fix a light string to the wooden block with the help of a hook. Let us hold the string in the hand and pull the block with a small force (called applied force). The wooden block does not move because its motion is being opposed by the force of friction. Which act in the opposite direction. Now according to Newton's third law of motion, the force of friction should be equal and opposite to the force applied. So, the force applied by us in pulling the block is a measure of the force of friction.



The block just tend to move or slip is equal and opposite to the force of friction (present between the table top and the block of wood). The maximum frictional force present when a body just tends to slip over the surface of another body is called static friction or limiting friction. It should be noted that in this case the body is not actually moving or sliding. It only tends to move or slide.

Now increase the force applied in pulling the block a little more. It is seen that the block begins to slide or move slowly on the surface of table. The frictional force present when one body move slowly or slides over another body is known as dynamic friction or sliding friction. It has been found that the force required to keep the block sliding. Once it has started sliding, it is less than the static friction or limiting friction. In other words when a body starts sliding the friction is less.

The static friction or limiting friction (when the body just tends to slide) is more than the dynamic friction or sliding friction (when the body is sliding slowly). Please note that when a body has already started moving or sliding, the interlocking of the two surfaces is less and hence the dynamic friction is less.

The four important laws of friction are given below;

1. Friction opposes the motion.
2. Friction depends on the nature of the two surfaces in contact. In other words, friction depends on the kind of materials, smoothness and degree of lubrication.
3. Friction is independent of the area of contact between the two surfaces.
4. Frictional force is directly proportional to the weight of the body which tends to move. This is why it is difficult to move heavier objects but easier to move light objects.

Sliding and Rolling friction

Let us now place four or five round pencils below the wooden block and then pull the block from its string. It is much easier to pull the block now. This means that when the block of wood is moved by keeping over round pencils (which act as rollers). Then the friction is much less. In this case, when we pull the block of wood from its string, then the round pencils kept below start rolling (like wheels). And this rolling action of the pencils reduces the friction. The friction which acts in this case is called **rolling friction**. Thus, when a body (like a roller or wheel) rolls over the surface of another body, the friction is called rolling friction. When we pull the block of wood surface of another body, the friction is called rolling friction. When we pull the block of wood on the table top

(without keeping pencils) then we have **sliding friction**. But when we pull the same block of wood by keeping round pencils below it, then we have **rolling friction**. In this way, the rollers (here pencils) convert sliding friction into rolling friction which is much less.

The rolling friction is due to two reasons :

1. The rolling body deforms the surface a little bit on which it rolls and
2. The rolling body itself gets deformed at its point of contact with the surface.

Rolling friction is much less than sliding friction : Since the rolling friction is much less than the sliding friction, therefore, it is easier to roll a heavy drum than to drag it. The purpose of attaching rollers (or wheels) to the bodies is to convert the sliding friction into rolling friction so that these bodies can be moved easily. For example, it quite difficult to move a heavy body by dragging it due to the high value of sliding friction. But if the same body is provided with rollers, (or wheels), then the sliding friction is converted into rolling friction (which is much less), and it becomes easy to move the body with rollers or wheels.

FRICTION EXERTED BY LIQUIDS AND GASES

The liquids and gases, however, exert much less friction as compared to solid surfaces. The most common liquid around us is water and the most common gas around us is air. So, we can also say that even water and air exert friction on solid bodies moving over them or moving through them. But the friction exerted by water and air is much less than that exerted by solid surfaces.

When a person swims in water, the water opposes his motion. This is because water exerts a force of friction on the swimmer (in a direction opposite to his motion). Similarly the boats and ships which move in water experience the friction of water. But the friction exerted by water is much less than that exerted by solid surfaces.

If we drop a coin and a feather from the same height simultaneously. We find that the coin reaches the ground first but the feather takes a little more time to reach the ground. The feather reaches the ground a little later because the friction of air opposes its motion and slows it down.

Another point to be noted is that the friction in liquids is much less than the friction between two solid surfaces. For example, the force of friction between a ship and the sea water is very small. It is because of very small friction exerted by water on the ship that it requires much more time and force to stop a moving ship in water. On the other hand, due to large friction between car tyres and the road, it takes much less time and force to stop a moving car on the road.

FRICITION: A NECESSARY EVIL

Recall now some of your experience. Is it easier to hold a kulhar (earthen pot) or a glass tumbler? Suppose the outer surface of the tumbler is greasy, or has a film of cooking oil on it: would it become easier or more difficult to hold it? Just think: would it be possible to hold the glass at all if there is no friction?

Recall also how difficult it is to move on a wet muddy track, or wet marble floor. Can it be possible to walk at all if there were no friction? You could not write with pen or pencil if there was no friction.

Where friction is useful

- (a) We are able to walk because friction prevents us from slipping. When we push the ground with our foot, the friction provides a forward reaction to our push and sends us forward. If there were no friction between the ground and the soles of our shoes, it would not be possible to walk. Walking on slippery ground is difficult because the frictional force is not great enough to prevent slipping. It is also difficult to walk on a road covered with green algae in the monsoon because algae make the road surface very smooth and hence the friction is not great enough to prevent us from slipping. When we step on a banana skin thrown on the road, our foot slips because the friction gets reduced because of the smoothness of the banana skin.

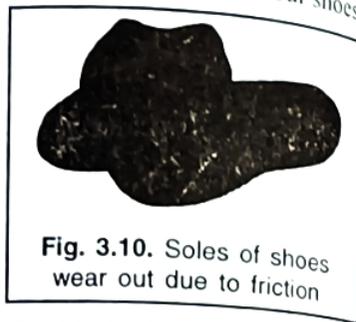


Fig. 3.10. Soles of shoes wear out due to friction

- (b) Without friction, belts could not drive machines and the brakes could not be applied to cars or other vehicles. Friction between the brake-shoe and the brake-drum slows down the wheels and friction between the tyres and the road brings the car to a stop. If there were no friction between the tyres of a car and the road, the wheels of a car would spin at one place and the car would not move. Without friction, nails and screws could not be used to hold things together and knots could not be tied.

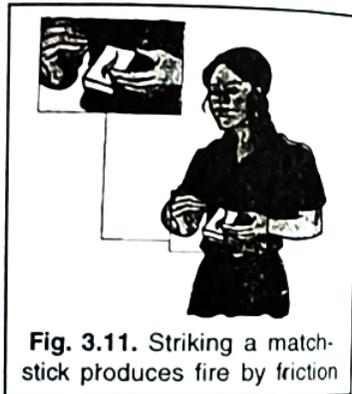


Fig. 3.11. Striking a matchstick produces fire by friction

- (c) Friction also enables us to write on paper. We are able to write because there is friction between the tip of pen and paper. Writing with a pen would have been impossible without friction. The lighting of a match stick is another useful application of friction.

Where Friction is Harmful

There are a large number of situations on our everyday life, where friction is harmful or causes inconvenience to us. Friction is particularly harmful to those machines which have moving parts in them. Friction is harmful in machines because of the following reasons:

1. **Friction reduces the efficiency of machines:** Some of the force applied to run a machine is wasted in overcoming the friction between its moving parts. This reduces the efficiency of the machine. The friction increases the energy consumption in the operation of machines.
2. **Friction produces heat which could damage the machine:** When the moving parts of a machine rub together, a lot of heat is produced due to friction between them. This heat can damage the machine gradually. In some cases, the excessive heat, generated due to friction is often removed continuously by circulating cold water around the moving parts of the machine.
3. **Friction wears out the rubbing machine parts gradually:** There are many moving parts in machines (like gears etc.) which rub against each other constantly. Due to friction, the rubbing parts of a machine wear out gradually. These worn out parts have to be replaced by new ones periodically.

METHODS OF ENHANCING FRICTION

In some situations we have to even increase the friction. The friction is increased by increasing the roughness of surfaces. For examples, the surface of the head of a matchstick and the sides of the match-box are deliberately made rough to increase the friction. Due to increased friction, greater frictional heat is produced on rubbing the head of matchstick against the side of the match box because of which the matchstick lights up easily.

The tyre surfaces are made corrugated and rough so that the

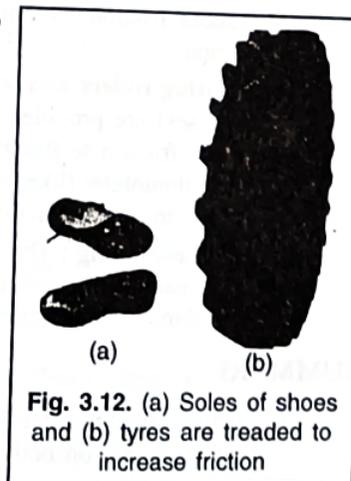


Fig. 3.12. (a) Soles of shoes and (b) tyres are treaded to increase friction

friction between the tyres and the road increases. Due to greater friction, the tyres get a better grip on the road which prevents skidding of the vehicle. Smooth tyres and wet roads have very small friction which can make the motion of a vehicle uncontrollable and lead to accidents.

Spikes are provided in the shoes of players and athletes to increase friction and prevent slipping. The machine belts are also made of special materials to increase friction. Vigorously rub your palms together for a few minutes. How do you feel? When you strike a matchstick against the rough surface. It catches fire.

METHODS OF REDUCING FRICTION

Friction is due to the roughness of surfaces. The smooth surfaces have much less friction. Thus, any process which makes the two surfaces smooth will reduce the friction. Please note that we can only reduce the friction between two surfaces, it can never be made zero.

- (1) **By polishing** : If we polish the rough surfaces. They become smooth and friction is reduced.
- (2) **By applying lubricants (oil or grease) to surfaces** : when we apply some lubricant, oil or grease, to surface, some of the lubricant sticks to the sliding surfaces. In this way the sliding surfaces are separated by thin layers of oil. Now the friction will be between the layers of the oil and this is much less. In some cases graphite, due to its softness, is used as a dry lubricant in machines.
- (3) **By using ball-bearings** : Ball-bearing is a hollow, circular device containing small metal balls which is fitted around the moving part of a machine (like an axle). The ball-bearing reduces friction by converting sliding friction into rolling friction.
- (4) **By using rollers and wheels** : Many heavy objects (like big suitcases) are provided with small wheels (called rollers) to reduce friction so that they may be carried easily by pulling. The automobiles (like car, buses and trucks) are provided with wheels to reduce friction so that they can be moved easily.
- (5) **By streamlining** : The bodies of cars, aeroplanes and rockets are streamlined to reduce air friction. And the bodies of boats and ships are streamlined to reduce the friction of water.

SUMMARY

- Friction opposes the relative motion between two surfaces in contact. It acts on both the surfaces.

- Friction depends on the nature of surfaces in contact.
- For a given pair of surfaces friction depends upon the state of smoothness of those surfaces.
- Friction depends on how hard the two surfaces press together.
- Static friction comes into play when we try to move an object at rest.
- Friction is important for many of our activities.
- Friction can be increased by making a surface rough.
- The sole of the shoes and the tyres of the vehicle are treaded to increase friction.
- Friction is sometimes undesirable.
- Friction can be reduced by using lubricants.
- When one body rolls over another body, rolling friction comes into play. Rolling friction is smaller than sliding friction.
- In many machines, friction is reduced by using ball bearings.

PEDAGOGICAL ANALYSIS OF THE TOPIC: 'FRICTION'

It consists of four steps

Step 1 : Content Analysis – Topic – Friction

It consists of two parts:

(A) Major Concept

(B) Minor Concept

(A) Major Concept

1. What is friction?
2. Causes of friction or factors affecting friction.
3. Types of Friction.
4. Friction exerted by liquids and gases.
5. Friction a necessary evil or where friction is useful?
6. Where friction is harmful?
7. How to enhance and reduce friction.

(B) Minor Concept

1. What is Friction?
 - ◆ Definition of the term Friction.
 - ◆ Meaning of the term Friction.
 - ◆ Examples from daily life.
2. Causes of Friction or Factors affecting friction
 - ◆ Roughness of the surface.
 - ◆ The way by which the bodies move over each other.

3. Types of Friction
 - ❖ Static friction and Dynamic friction
 - ❖ Sliding friction and rolling friction.
 - ❖ Limiting friction.
4. Friction exerted by liquids and gases.
 - ❖ Friction in liquids.
 - ❖ Friction in gases.
5. Friction : a necessary evil
 - ❖ Where friction is useful ?
 - ❖ Where friction is harmful ?
6. Enhancing and Reducing Friction
 - ❖ Methods of enhancing friction.
 - ❖ Methods of reducing friction.

Step 2 : Objective Formulation (Behavioral Outcomes)

Students after going through the teaching of the topic "Friction" will be able to:

1. Define the term friction.
2. Interpret the meaning of the term friction.
3. Cite examples of friction from daily life.
4. Illustrate the causes of friction.
5. Explain limiting friction with example.
6. State and explain sliding and rolling friction with example.
7. Differentiate between the static and dynamic friction.
8. Elaborate the statement "Friction: A necessary evil."
9. Give examples of different kinds of friction
10. Explain the friction exerted by liquids and gases.
11. Give importance of friction in daily life.
12. Cite examples, where friction is harmful.
13. Explain and illustrate the ways and means for exercising control over friction.
14. Perform an experiment for the demonstration of the concept of limiting friction.
15. Demonstrate through an experiment that in comparison to sliding friction, rolling friction is always much smaller for the same body.

Step 3 : Methods, devices, activities and aid materials used :
Methods : Lecture method, Demonstration method, experimentation

method
Devices : Narration, illustration, explanation and observation
devices.

Activities and aid materials used:

1. While teaching the topic help of blackboard writing and sketching, charts and pictures will be taken.
2. Slides and transparencies may be used to show the examples of different kinds of friction and to classify the friction into the various categories.
3. Verbal examples and illustrations from day to day experiences will be given for the explanation of various concepts related to the topic 'Friction'.
4. Experimental activities will be performed to show that liquids and gases also exert friction on the bodies, friction increases with the increase in the roughness of the surfaces; a body can be moved only when the applied force overcomes the limiting force of friction.
5. Audio recordings, video films and computer presentation may be used to show the usefulness of friction in daily life.
6. Overhead projectors, charts and pictures may be utilized for making the concept of friction more clear or showing the methods of exercising control over friction.

Step 4 Evaluation Procedure and Devices Used:

Evaluation can be done through oral, practical and written mode.

- In oral method**, students will be asked questions during teaching process or after completion of the topic and students are required to respond orally to the asked questions.
- In Practical mode**, students may be asked to perform certain experimental activities proving that static friction is always found to be greater than the dynamic friction of force of friction increases with the increase in the roughness of the surfaces.
- Written mode** consists of:

(a) Essay type questions,

1. Explain and illustrate the meaning of friction with examples.
2. List down the factors responsible for the friction.
3. Illustrate different types of friction with example.
4. Explain the statement: Friction is a necessary evil.

5. How friction increases with the increase in roughness of surface in contact.
6. Explain the concept of static and dynamic friction with examples.
7. Differentiate between sliding and rolling friction, static and dynamic friction.
8. Explain the limiting friction giving a suitable example from daily life.
9. Give the usefulness and harmfulness of friction in daily life.
10. Explain and illustrate the concept of friction exerted by liquids and gases.
11. List out the methods of exercising control over the friction.

(b) **Short Answer type Questions:**

1. Define the term friction.
2. Give the meaning of the term friction and cite some examples from daily life.
3. List down the causes of friction.
4. Illustrate limiting friction with example.
5. Differentiate between static and dynamic friction.
6. Give the usefulness of friction in daily life.
7. Give two methods of reducing friction.
8. Cite an example showing liquids and gases also exert friction.
9. Why static friction is always greater than the dynamic friction?
10. Illustrate or throw some light on the statement 'Friction is a necessary evil.'

(c) **Objective type Questions:**

1. Multiple choice Questions:

- (i) _____ is a necessary evil.
(a) Friction (b) Power (c) Heat
- (ii) Dynamic friction is also known as
(a) Rolling friction (b) Kinetic friction
(c) Limiting friction
- (iii) With increase in the roughness of surface in contact, friction will
(a) decrease (b) no change (c) increase
- (iv) Rolling friction is _____ the sliding friction.
(a) greater than (b) smaller than (c) same as

2. Fill in the blanks:

- (i) _____ is the minimum force opposing the movement of the body.
 - (ii) Friction is a necessary _____
 - (iii) Lubricants help in _____ friction.
 - (iv) The tyres of a vehicle are corrugated for increasing _____
 - (v) Friction _____ the efficiency of machines.
3. True-False Statements (T/F),
- (i) Friction produces heat which could damage the machine.
 - (ii) Friction is due to roughness of surfaces.
 - (iii) Lubricants increase the force of friction.
 - (iv) The ball-bearing reduces friction by converting sliding friction into rolling friction.
 - (v) Dynamic friction is also known as limiting friction.

4. Match the column

Column I	Column II
(i) Ball bearings	(a) limiting friction
(ii) Friction	(b) necessary evil
(iii) Dynamic friction	(c) reduces friction
(iv) Static friction	(d) kinetic friction

2. Factors affecting Friction :

(a) Friction is due to the roughness of surfaces and it will increase with the increase in the roughness of surface.

List out the factors responsible for friction.

the book opposing its motion. This force is called frictional force.

Demonstration method, illustration device.

Activity: Tie a string around a brick. Pull the brick by a spring balance. You need to apply some force. Note down the reading on the spring balance when the brick just begins to move. It gives you a measure of the force of friction between the surface of the brick and the floor.

Now wrap a piece of polythene around the brick and observe the difference while repeating the activity.

Explain the statement friction increases with increase in roughness of the surface.

(b) The friction depends on the way the bodies move over each other and how much contact a body is making with the other. Pulling, dragging, rolling, sliding and

Try to analyze the different ways of moving body over other to reduce friction.

Lecture method, explanation device, demonstration method, illustration device.

Friction does not depend on how much contact a body is making with the other (T/F)

Pedagogical Analysis – 'Atomic Structure'

Content Analysis	Behaviour Outcomes	Method, devices, activities and aid material used	Evaluation, Procedure and Devices
<p>1. What is friction?</p> <p>□ Definition: The force which always opposes the motion of one body over another body in contact with it is called the friction or the force of friction.</p> <p>□ Meaning: Have you ever thought why a vehicle slows down when brakes are applied? Why is it difficult to walk on a smooth and wet floor?</p> <p>If we apply the force along the left of an object, friction acts along the right. If we apply the force along the right, the friction acts along the left direction. So we can say that the force of friction always opposes the applied force.</p>	<p>After going through the topic students will be able to: Recall friction.</p> <p>Understand the concept of friction.</p> <p>Recognize the concept of friction.</p>	<p>Narration method, Lecture method</p> <p>Demonstration method, illustrative device, experimentation device.</p> <p>Activity – Gently push a book on a table. You will observe that it stops after moving for some distance. Repeat this activity pushing the book from the opposite direction. Book stop this time too. We can say that a force must be acting on</p>	<p>Frictional force is always opposing in nature (T/F)</p> <p>What do you mean by frictional force?</p> <p>Give one example of friction from daily life.</p>

of sliding, the friction between them is called Rolling Friction.

(c) **Limiting Friction :**

The maximum force of friction which may come into play when one body moves or tries to move over the surface of another body is called the limiting friction.

4. **Friction exerted by liquids and gases :**

□ Friction by liquids: when a person swims in water, the water opposes his motion. This is because water exerts a force of friction on the swimmer (in a direction opposite to his motion).

Similarly, the boats and ships which move in water experience the friction of water.

Analyze the limiting friction.

Cite some example of friction exerted by water.

Sliding Friction Rolling Friction

NOTE : Sliding friction is always greater than rolling friction.

Lecture method, Narration device

NOTE : A body only tends to move when applied force overcomes the frictional force.

Demonstration method, Slides and transparencies may be used to understand the concept.

Explain limiting friction.

Give some examples of friction exerted by water.

pushing of one body over the other body or surface exhibit a lot of difference in the exertion of the amount and nature of frictional force.

3. **Types of friction :**

Friction is mainly of following types :

(a) **Static and Dynamic Friction:**

The static friction is the friction between two bodies when one of the bodies just tends to move or slip over the surface of another body. There is no actual movement of the body in static friction. If, however, one body moves slowly over another body, then the frictional force is called dynamic friction.

(b) **Sliding and Rolling Friction :**

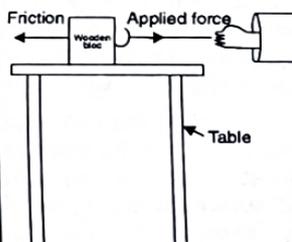
When a body slides over another body or a surface, the friction between them is called as sliding friction. However, whenever a body rolls over the surfaces of other body instead

Differentiate between static and dynamic friction.

Differentiate between sliding and rolling friction.

Computer presentation may be used to analyze this factor.

Experiment demonstration



Experiment demonstration

Explain static and dynamic friction.

NOTE : Static friction is always greater than the dynamic friction.

Experimental demonstration, Computer slides showing static and rolling friction.

Illustrate sliding and rolling friction with example.

(v) A nail is fixed into the wall due to friction.

(b) **Where friction is harmful?**

(i) Friction reduces the efficiency of machine.

(ii) Friction produces heat which could damage the machine.

(iii) Friction wears out the rubbing machine parts gradually.

6. **Increasing and decreasing friction:** We can put limit on the frictional force.

(a) **Methods of increasing friction:**

(i) By making the surface more rough.

(ii) By corrugating the tyres of vehicles to avoid slipping.

(iii) By changing the way by which the bodies move over each other.

(iv) By increasing the weight of the body because friction is directly proportional to the weight of the body.

Understand the harmful effect of friction.

Lecture method,
Explanation device,
Narration device

List out the harmful effects of friction.

Recognize the way of increasing friction.

Demonstration method,
Illustration device,
Explanation device.

Friction is a _____ evil.
Friction increases with _____ in the roughness of the surface.

↳ **Friction by gases:** Air exerts the force of friction on all the bodies which move through it and opposes their motion. Like if we drop a coin and a feather from the same height simultaneously, we find that the coin reaches the ground first but the feather takes a little more time to reach the ground. The feather reaches the ground a little later because the friction of air opposes its motion and slows it down.

5. **Friction :** A necessary evil
Friction plays an important role in our daily life.

(a) **Where friction is useful :**

(i) We are able to walk because friction prevents us from slipping.

(ii) Without friction breaks could not be applied to cars or other vehicles.

(iii) Friction enables us to write on paper.

(iv) Friction enables us to light the matchstick.

Understand the concept of friction by gases.

Demonstrate method, observation device.

Arrange in increasing order of friction by gas, friction by solid, friction by liquid.

NOTE : Friction due to air is smaller than liquids which in turn is smaller than friction by solids.

Analyze the usefulness of friction.

Lecture method,
Narration device,
explanation device

Give the examples where friction is useful.

Overhead projector can be used to show the usefulness of frictional force.

<p>(b) <i>Methods of decreasing friction:</i></p> <ul style="list-style-type: none"> (i) By making the surface smooth (polishing) (ii) By applying lubricants (oil or grease) to surfaces. (iii) By using ball bearings. (iv) By using rollers and wheels. (v) By streamlining of vehicles shape to reduce air friction. 	<p><i>Understand the methods of reducing friction.</i></p>	<p><i>Demonstration experiment.</i></p> <p>Slides showing use of rollers, wheels, ball bearing in reducing the friction.</p>	<p>Ball bearings will reduce the frictional force (T/F).</p>
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CHAPTER 2

Study of Items: Division of Units into Sub-Units, Teaching Requirements, Instructional Objectives, Teaching Strategies, Previous Knowledge Testing, Topic Announcement, Concept of Contents, Presentation, Teaching Aids Use, Demonstration Experimental Verification, Thought Provoking Questions and Criterion Based Tests.

Pedagogical Analysis of Any One of the Following Topics:

- Atomic Structure
- Energy and its Types
- Environment and Pollution
- Water As a Universal Solvent
- Transmission of Heat
- Magnetism
- Friction

Atomic Structure

Atoms are the smallest indivisible ultimate particles of which all substances are made of. A molecule is the smallest part of any element in which all the properties of substance are present. The molecules themselves are made up of small particles called atoms.

For Example : One molecule of oxygen is made of two atoms of oxygen.

THE PARTICLES OF AN ATOM

The three main particles of atom are electron, proton and neutrons. Their properties are as following:

- 1. Electrons :** These are always in a state of continuous motion in the circular tracks called orbital's. Each electron has unit negative charge. The mass of one electron is $1/1840$ th part of one hydrogen atom and thus is negligible in comparison to the total mass of an atom. The flow of charge in an electric circuit is due to the motion of these electrons. These are denoted by the word 'e'. The electrons are located outside the nucleus in an atom. Only hydrogen atom contains one electron. All other atoms contains more than one electron.
- 2. Protons :** The mass of one proton is approximately equal to the mass of one hydrogen atom. It has unit positive charge. It is found in the nucleus. A proton is nothing but an hydrogen atom whose one electron has been removed. Proton is denoted by 'P'. The protons are located in the nucleus of an atom. Only hydrogen atom contains one proton in its nucleus, atoms of all other elements contain more than one proton.
- 3. Neutron :** The mass of one neutron is approximately equal to the mass of one proton. It is electrically neutral. Neutrons lie in the nucleus and are denoted by 'N'. After the discovery of protons and electrons. It was noticed that all the mass of an atom cannot

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be accounted for on the basis of only protons and electrons present in it. For example, a carbon atom contain 6 protons and 6 electrons. Now, the mass of electrons is so small that it can be ignored. So, the atomic mass of carbon should be only 6, which is the mass of 6 protons. This, however, is wrong because the actual atomic mass of carbon is 12. Then, how do we explain this extra mass of 6 units? This problem was solved by the discovery of another fundamental particle by Chadwick. This particle is called neutron. The neutron is a neutral particle found in the nucleus of an atom. Atoms of all the elements contain neutrons except ordinary hydrogen atom which does not contain any neutron. Thus, the fundamental particle not present in a hydrogen atom is neutron. A hydrogen atom contains only one proton and one electron.

DISCOVERY OF ATOM

Dalton's hypothesis postulates regarding the structure of atom:

- (a) Matter is made of small indivisible particles called atoms.
- (b) All the combining atoms of a compound are alike.
- (c) Atoms combine in whole number ratio.
- (d) Atoms are neither created nor destroyed.

Rutherford's experiment - Discovery of Nucleus

After the discovery of electron, proton and neutrons, it becomes clear that an atom is made up of these three fundamental particles. Experiments were then carried out to find out how electrons, protons and neutrons were arranged in an atom. It was Rutherford's alpha particle scattering experiment which led to the discovery of a small positively charged nucleus in the atom containing all the protons and neutrons. Before we describe this experiment, we should know the meaning of alpha particles (also written as α - particle). Alpha particle is a positively charged particle having 2 units of positive charge and 4 units of mass. It is actually a helium atom, He. Alpha particles are emitted by radioactive elements like radium and polonium. They can penetrate through matter to some extent. We will be using a gold foil in the following experiment. A gold foil is a very thin sheet of gold. It is also known as gold leaf. We will now describe the Rutherford's experiment.

When alpha particles are allowed to strike a very thin gold foil, it is found that:

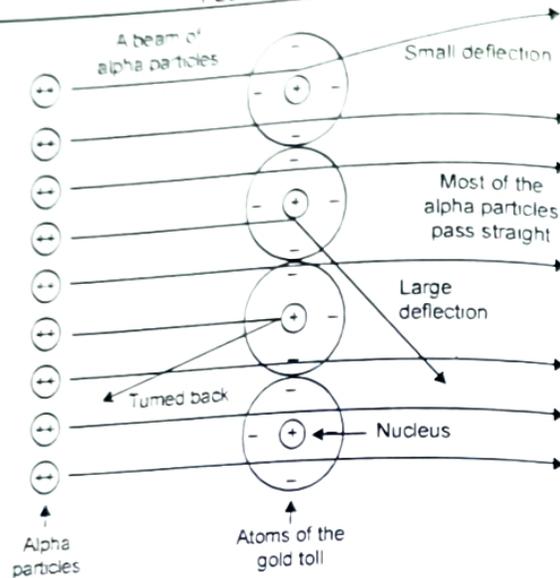


Fig. 3.3. Scattering of alpha particles by the atoms of a gold foil (or gold leaf)

- Mass of the alpha particles passes straight through the gold foil without any deflection from their original path (see fig.3.3).
- A few alpha particles are deflected through small angles and a few are deflected through large angles.
- A very few alpha particle completely rebound or hitting the gold foil and turn back on their path (just as a ball rebounds on hitting a hard wall).

From the above discussion we conclude that Rutherford's α -particle scattering experiment gives the following important information about the nucleus of the atom.

- Nucleus of an atom is positively charged.
- Nucleus of an atom is very dense and hard.
- Nucleus of an atom is very small as compared to the size of the atom as a whole.

PARTS OF AN ATOM

Nuclear Part : The nucleus is a small positively charged part at the centre of an atom. The nucleus contains all the protons and neutrons, therefore, almost the entire mass of an atom is concentrated in the nucleus (the electron, which are outside the nucleus, have negligible mass). The

negative charge on the nucleus is due to the presence of protons in it. The number of protons in the nucleus determines the number of positive charges on the nucleus. The neutrons which are also present in the nucleus have no charge, they are neutral. The volume of the nucleus of an atom is very small as compared to the volume of the extra nuclear part of the atom. The existence of positively charged nucleus in an atom was shown by the alpha particle scattering in the experiment of Rutherford.

Non-Nuclear Part : Electron are negatively charged, so they form a cloud of negative charges outside the nucleus. In this cloud, the electrons are arranged according to their potential energy in different energy levels or shells. The energy levels of the electrons are denoted by the numbers 1, 2, 3, 4, 5 and 6 whereas shells are represented by the letters K, L, M, N, O and P.

- 1st energy level is K shell
- 2nd energy level is L shell
- 3rd energy level is M shell
- 4th energy level is N shell, and so on

The energy levels or shells are represented by circles around the nucleus. The shells are counted from the centre outwards (see fig.3.4). For example, K shell having the minimum energy is nearest to the nucleus; L shell which has a little more energy is a bit farther away from the nucleus and so on. It is obvious that the outermost shell of an atom is the highest energy level.

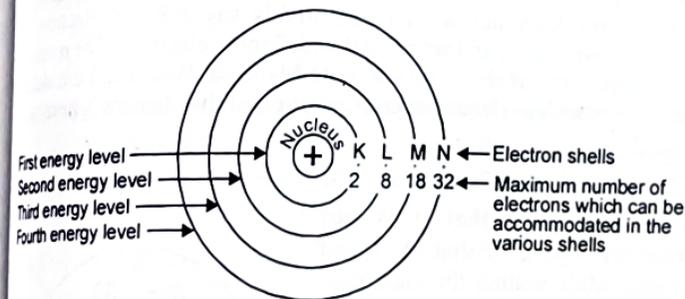


Fig. 3.4. Energy levels or electron shells in an atom (This Fig. shows only first four shells K, L, M and N)

(a) The maximum number of electron which can be accommodated in any energy level of the atom is given by $2n^2$ (where n is the number of that energy level). Let us calculate the maximum number of electrons which can be put in the first four energy levels of an atom.

- For 1st energy level, $n = 1$

So, The maximum number of electron in 1st energy level

$$= 2n^2 = 2 \times (1)^2$$

$$= 2$$

(ii) For 2nd energy level, $n = 2$
 So, The maximum number of electron in 2nd energy level
 $= 2n^2 = 2 \times (2)^2 = 2 \times 4 = 8$

(iii) For 3rd energy level, $n = 3$
 So, The maximum number of electron in 3rd energy level
 $= 2n^2 = 2 \times (3)^2 = 2 \times 9 = 18$

(i) For 4th energy level, $n = 4$
 So, The maximum number of electron in 4th energy level
 $= 2n^2 = 2 \times (4)^2 = 2 \times 16 = 32$

Electron shell	Maximum capacity
1. K shell	2 electron
2. L shell	8 electron
3. M shell	18 electron
4. N shell	32 electron

Sample Problem 1 : Written the electron configuration of an element X whose atomic number is 12.

Solution: Atomic number of the element X is 12 which means that one atom of X has 12 electrons. First of all the electrons will go to K shell can take a maximum of 2 electrons. Thus, the first 2 electrons will occupy K shell, the electrons will go to L shell. Now, L shell can take a maximum of 8 electrons for which we write L₈. In this way 2+8 = 10 electron have been accommodated, and we are left with 2 more electrons. The remaining 2 electrons go to M shell and we write M₂ for it. Writing all the electron shells together, the electronic configuration of the element X becomes:

K L M
 2, 8, 2

Please note that it is not necessary to write the shells K, L and M etc., while writing the electronic configuration of the elements. For example, the electronic configuration of the element X of atomic number 12 can be simply written as 2, 8, 2. It is, however, better to indicate their shells also. Another point to be noted is that we have given so many details in the solution of this problem just to make you understand the things clearly.

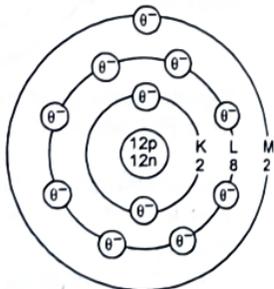


Fig 3.5. For Sample Problem 1

There is no need to write so many details in the exam. The arrangement of electrons in the atom of element X has been shown if Fig 3.5

Electronic configuration of some important elements

Element	Symbol	Atomic number	Electronic configuration (or Electron arrangement)			
			K	L	M	N
1. Hydrogen	H	1				1
2. Helium	He	2				2
3. Lithium	Li	3				2,1
4. Beryllium	Be	4				2,2
5. Boron	B	5				2,3
6. Carbon	C	6				2,4
7. Nitrogen	N	7				2,5
8. Oxygen	O	8				2,6
9. Fluorine	F	9				2,7
10. Neon	Ne	10				2,8
11. Sodium	Na	11				2,8,1
12. Magnesium	Mg	12				2,8,2
13. Aluminium	Al	13				2,8,3
14. Silicon	Si	14				2,8,4
15. Phosphours	P	15				2,8,5
16. Sulphur	S	16				2,8,6
17. Chlorine	Cl	17				2,8,7
18. Argon	Ar	18				2,8,8
19. Potassium	K	19				2,8,8,1
20. Calcium	Ca	20				2,8,8,2

Position of electrons, protons and neutrons in an Atom

Electrons are present in electronic shell around the nucleus. Whereas, protons and neutrons are present in the nucleus. Due to the presence nucleus, nucleus has positive charge.

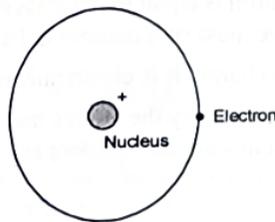


Fig. 3.6. Structure of Hydrogen Atom

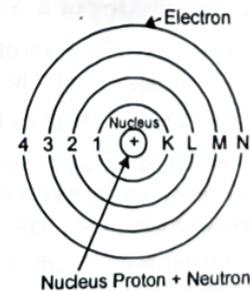


Fig. 3.7. Electron Shells

Characteristics of An Electron

- (i) **Mass** : The mass of an electron is about $1/1840$ of the mass of hydrogen atom (which is the atom of lowest mass). Since the mass of a hydrogen atom is 1 a.m.u., we can say that the relative mass of an electron is $1/1840$ a.m.u. The absolute mass of an electron is, however, 9×10^{-28} gm.
- (ii) **Charge** : The absolute charge on an electron is 1.6×10^{-19} coulomb of negative charge. Now 1.6×10^{-19} coulomb has been found to be the smallest negative charge carried by any particle. So, this is taken as the unit of negative charge. This means that an electron has 1 unit of negative charge. In other words, the relative charge of an electron is 1 (minus one).

Characteristics of a Proton

- (i) **Mass** : The proton is actually a hydrogen atom which has lost its electron. Since the mass of an electron is very small, we can say that the mass of a proton is equal to the mass of a hydrogen atom. But the mass of a hydrogen atom is 1 a.m.u, therefore, the relative mass of a proton is 1 a.m.u. If, however, we compare the mass of a proton with that of an electron, then the mass of a proton is 1840 times that of an electron. The absolute mass of a proton is 1.6×10^{-24} gram.
- (ii) **Charge** : The large of a proton is equal and opposite to the charge of an electron. So, the absolute charge of a proton is 1.6×10^{-19} coulomb of positive charge. Now 1.6×10^{-19} coulomb has been found to be the smallest positive charge carried by any particle. So, this is taking as unit of positive charge. This means that proton carries 1 unit positive charge. In other words, the relative charge of a proton is +1 (plus one).

Characteristics of a Neutron

- (i) **Mass** : The mass of a neutron is equal to the mass of a proton. In other words, the relative mass of a neutron is 1 a.m.u.
- (ii) **Charge** : Neutron has no charge. It is electrically neutral.

We are now in a position to explain why the atomic mass of carbon is 12. It is now known that a carbon atom contain 6 protons and 6 neutrons, each having a mass of 1 a.m.u. now

Atomic mass of carbon

$$= \text{Mass of 6 protons} + \text{mass of 6 neutrons}$$

$$= 6 \times 1 + 6 \times 1 = 12$$

We will now compare a proton, a neutron and an electron in respect of their relative masses.

Comparison between Proton, Neutron and Electron

Fundamental particle Or Sub-atomic particle	Relative mass	Relative charge	Location in the atom
(i) Proton	1 a.m.u.	+ 1	In the nucleus
(ii) Neutron	1 a.m.u.	0	In the nucleus
(iii) Electron	$1/1840$ a.m.u.	- 1	Outside nucleus

ATOMIC REACTIONS

Nuclear fission and Nuclear fusion

Atom of He bombarded the neutrons on the nucleus of uranium and obtained two equal parts approximately. Three neutrons were released and a huge amount of energy was produced. This process of splitting a nucleus of heavier atom in two or more parts producing energy is known as **Nuclear Fission**. When there is fission in the Uranium oftenly 3 neutrons were released. These released neutrons further strike the other nuclei and in this way chain of splitting is started which is called **chain reaction**.

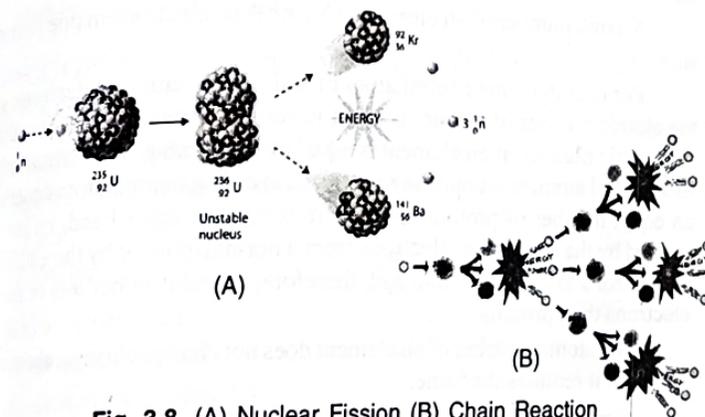


Fig. 3.8. (A) Nuclear Fission (B) Chain Reaction

After it, the scientists tried to fuse two lighter nuclei and ultimately they were successful in it. This fusion of lighter nuclei to obtain a heavier nucleus is known as **Nuclear fusion**.

Four nuclei of Hydrogen atoms are fused to form a bigger nucleus of Helium. In this process the mass of Helium is slightly lesser than the

total mass of four hydrogen nuclei. This mass difference changes into energy. The scientists have the opinion that the source of energy of the sun is nothing but nuclear fusion. There is unlimited stock of hydrogen in the sun and the high temperature of the sun helps in the fusion of hydrogen nuclei. We use the energy of the sun on our earth.

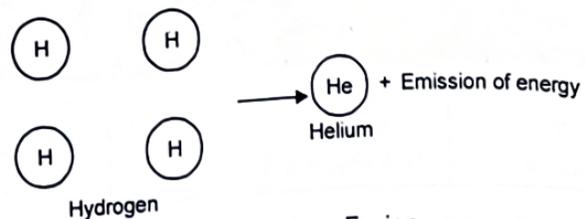


Fig. Nuclear Fusion

ATOMIC NUMBER

The number of protons in one atom of an element is known as atomic number of that element. That is,

Atomic number of an element = Number of protons in one atom of element.

In a normal atom (or neutral atom), the number of protons is equal to the number of electrons in it. So, we can also say that the atomic number of an element is equal to the number of electrons in a neutral atom of that element. That is,

Atomic number of an element = Number of electrons in one neutral atom.

For example, one neutral atom of sodium contains 11 electrons, so the atomic number of sodium is 11. It is very important to note here that the atomic number of an element is equal to the number of electrons only in a neutral atom, and not in an ion. Because only a neutral atom contains an equal number of protons and electrons. On the other hand, an ion is formed by the removal of electrons from a normal atom or by the addition of electrons to a normal atom and, therefore, contains either less or more electrons than protons.

The atomic number of an element does not change during a chemical reaction, it remains the same.

MASS NUMBER

An atom consists of protons, neutrons and electrons. Since the mass of electron is negligible, the real mass of an atom is determined by the protons and neutrons only. The total number of protons and neutrons present in one atom of an element is known as its mass number. That is,

Mass number = No. of neutrons

ATOMIC STRUCTURE

Now, Mass of proton = 1 a.m.u.

And Mass of a neutron = 1 a.m.u.

So, Mass number = No. of Proton \times 1 + No. of neutrons \times 1

Or Mass number = Mass of protons + Mass of neutrons

But the total mass of protons and neutrons is called atomic mass, so:

Mass number = Atomic mass

Sample Problem : Calculate the atomic number of an element whose atomic nucleus has mass number 23 and neutron number 12. What is the symbol of the element?

Solution : We know that :

Mass number = No. of protons + No. of neutrons

But No. of protons is called atomic number.

So, Mass number = Atomic number + No. of neutrons

And $23 = \text{atomic number} + 12$

So, Atomic number = $23 - 12$

= 11

The element having atomic number 11 is sodium and its symbol is Na. If, however, we indicate the atomic number and mass number, then the symbol becomes ${}^{23}_{11}\text{Na}$, where 11 is the atomic number and 23 is the mass number.

PEDAGOGICAL ANALYSIS OF THE TOPIC: 'ATOMIC STRUCTURE'

Consists of four steps:

Step 1 : Content Analysis – Topic – Atomic Structure

It consists of two parts:

(A) Major Concept

(B) Minor Concept

(A) Major Concept

1. What are atoms?
2. Discovery of atom?
3. Parts of an atom?
4. Positions of electrons, protons and neutrons in the nucleus?
5. Characteristics of electrons, protons and neutrons?
6. Atomic reactions: Nuclear fission and nuclear fusion
7. Atomic mass and Atomic number of an element

(a) Essay type questions :

1. What is an atom? Explain its nature.
2. Throw light on Dalton and Rutherford's work in the discovery of atom.
3. Give atleast three characteristics of electrons, protons and neutrons.
4. Give the structure of atom having atomic number 19, 8.
5. Discuss the nuclear and non-nuclear part of atom.
6. Explain the term nuclear fission and nuclear fusion.
7. What do you mean by atomic mass and atomic number?

(b) Short Answer type Questions :

1. Discuss the term atom.
2. Give the composition of nuclear part of an atom.
3. Differentiate between atom and element.
4. What do you mean by Nuclear Fusion?
5. Give examples of atoms showing nuclear fission and fusion.
6. Draw diagram of Hydrogen atom.
7. Give the atomic number of Sodium (Na) and Chlorine (Cl).
8. Discuss the term atomic mass.

(c) Objective type Questions :

1. Fill in the blanks:

- (i) Atoms are made up of three fundamental particles: electrons, _____ and neutrons.
- (ii) Atoms are neither created nor _____
- (iii) Electrons are present in _____ shells.
- (iv) Protons are _____ charged particles whereas neutrons have _____ charge.
- (v) Atomic number of Boron (B) is _____.

2. Multiple Choice Questions:

- (i) Charge on electron is
(a) Positive (b) no charge (c) negative
- (ii) Neutrons are present in
(a) nucleus (b) electronic shell (c) non-nuclear part

- (iii) Atomic number of chlorine is

- (a) 7 (b) 27 (c) 17

- (iv) Which atom undergo nuclear fusion reaction

- (a) Hydrogen (b) Sodium (c) Uranium

3. Match the column

Column I

- (i) Atomic number of Helium
- (ii) Charge on neutron
- (iii) Protons are present in
- (iv) electron are present in
- (v) Undergo nuclear fission

Column II

- (a) electronic shells
- (b) uranium
- (c) 2
- (d) Nucleus
- (e) no charge

4. True-False (TF) Statements,

- (i) Protons are positively charged.
- (ii) Electrons are present in nucleus
- (iii) K, L, M, N, are the electronic shells around the nucleus.
- (iv) Sodium (Na) consists of 11 electrons.
- (v) Nucleus of an atom is negatively charged.

- (a) Matter is made of small indivisible particles called atoms.
- (b) All the combining atoms of a compound are alike.
- (c) Atoms combine in whole number ratio.
- (d) Atoms are neither created nor destroyed.

□ Rutherford's experiment: Alpha particle scattering experiment leads to the discovery of nucleus.

Points given by Rutherford,

- (a) Nucleus of an atom is positively charged
- (b) Nucleus is very dense and hard
- (c) Nucleus is very small as compared to the size of the atom as a whole

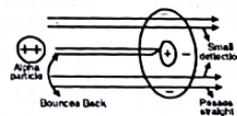
□ Parts of an atom :

Nuclear Part: It consists of nucleus of an atom which is positively charged and protons

Recognize the Rutherford's work in discovery of Nucleus of an atom.

Demonstration method, illustration device, Charts, slides and transparencies can be used to show Rutherford's experiment.

Nucleus is positively charged (T/F)



Identify the nuclear and non-nuclear part of an atom.

Lecture method, Narration device.

Nucleus consists of protons.

Pedagogical Analysis - 'Atomic Structure'

Content Analysis	Behaviour Outcomes	Method, devices, activities and aid material used	Evaluation, Procedure and Devices
<p>1. What are atoms?</p> <ul style="list-style-type: none"> □ Definition: Atoms are the smallest indivisible ultimate particles of which all substances are made of. □ Nature of atom: A molecule is the smallest part of any element in which all the properties of substance are present. The molecule themselves are made up of small particles called atoms. For example: One molecule of oxygen is made of two atoms of oxygen. 	<p>After teaching process students will be able to :</p> <p>Recall the term atom.</p> <p>explain the nature of atom</p>	<p>Lecture method</p> <p>Demonstration method Chart showing the oxygen molecule.</p> <div style="text-align: center;"> O_2 $O + O$ Oxygen molecule Oxygen atom Oxygen atom </div>	<p>Name the smallest indivisible particle of which substances are made of.</p> <p>Name the atoms present in water molecule (H₂O)</p>
<p>2. Discovery of Atom</p> <ul style="list-style-type: none"> □ Dalton's hypothesis Postulates regarding the structure of atom : 	<p>Recognize the work of Dalton in atom discovery</p>	<p>Lecture method, Narration device</p>	<p>Give the points given by Dalton.</p>

neutrons are present in the nucleus.

NOTE : Due to presence of protons in the nucleus, nucleus has positive charge.

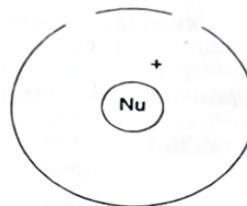
5. Characteristics of electrons, protons and neutrons :

- Electron: (a) Relative mass of electron is 1/1840 a.m.u.
(b) relative charge of an electron is, -1 (minus one)
- Proton : (a) The relative mass of a proton is 1 a.m.u.
(b) The relative charge of a proton is +1
- Neutron : (a) Relative mass of a neutron is 1 a.m.u.
(b) Neutron has no charge i.e. they are electrically neutral.

Identify the mass and charge on atomic particles i.e. electron, proton and neutron.

Fundamental Particle

Proton
Neutron
Electron



Structure of Hydrogen atom

Demonstration method, Comparison chart between Proton, Neutron and Electron

Fundamental Particle	Relative Mass	Relative Charge
Proton	1 a.m.u.	+1
Neutron	1 a.m.u.	0
Electron	1/1840 a.m.u.	-1

Give different characteristics of electron, proton and neutron.

Location in the atom

in the nucleus
in the nucleus
outside nucleus

and neutrons are present in the nucleus.

Non-Nuclear part: It consists of electronic shells in which electrons are present. Electrons are negatively charged.

First electronic shell around nucleus is called K shell.

2nd is L shell, 3rd M shell and so on.

NOTE : Number of electrons in a shell is given by the formula $2n^2$ where, n = number of shells.

For K, n=1 so $2(1)^2 = 2$ electrons that is, K shell can accommodate 2 electrons

For L, n=2 so $2(2)^2 = 8$ electrons, i.e., L shell can accommodate 8 electrons and so on.

4. Position of electrons, protons and neutrons in the atom.

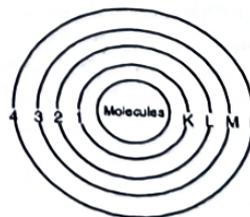
- Electrons are present in electronic shell around the nucleus whereas, protons and

Identify the electronic shells

Find out the number of electrons in different shell.

Give the position of protons and electrons.

Demonstrate method, Illustration device, Charts can be used to show the electronic shell of different atoms



Lecture method, Chart can be used to show the position of electrons, protons and neutrons.

How many electrons are present in L shell ? or L shell can accommodate maximum of how many electrons ?

Nucleus is positively charged (T/F)
• Electrons are _____ charged.

- It is represented by (M)
- Atomic number : The number of protons present in the atom determines the atomic number of the element
 Note : Atomic Number (N) = No. of electrons = No. of protons
 Atomic Mass (M) = No. of protons + No. of neutrons
- Atomic weight is also known as atomic mass

Students will be able to recognize the atomic number of different elements

Lecture method, illustration devices. Periodic table showing atomic number of various elements, like H=1, He=2, Cl=17

Atomic number of Neon is _____
 C has atom number 6. (T/F)
 C = Carbon
 Table showing Atomic Structure of Few Elements

6. Atomic Reactions :

- Nuclear Fission : The process of splitting a nucleus of heavier atom into two or more parts producing energy, after bombarding with neutron. In this process, three new neutrons are also generated.

For example : Uranium-235

- Nuclear Fusion: The fusion of lighter nuclei to obtain a heavier nucleus producing enormous energy is called nuclear fusion.

For example : Nuclei of hydrogen atoms are fused to form a bigger nucleus of Helium

NOTE : The scientists have the opinion that the source of energy of the sun is nothing but nuclear fusion.

7. Atomic mass and Atomic number

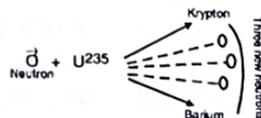
- Atomic mass: Atomic mass of an element is the number of times it is heavier than the mass of one Hydrogen atom.

Students will be able to define nuclear fission reaction.

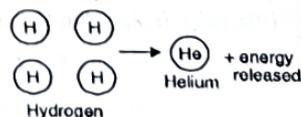
Cite example of atom undergoing nuclear fusion reaction

Recognize the atomic mass of different elements

Lecture method, Charts having nuclear fission reaction



Computer presentation showing nuclear fusion process,



Define nuclear fission with example.

Distinguish between nuclear fission and nuclear fusion

Give the atomic mass of Hydrogen and Chlorine.

Content Analysis	Symbol	Atomic No. (Z)	Atomic Mass (M)	No. of Protons	No. of Neutrons	No. of Electrons	Electronic distribution		
							K Shell	L Shell	M Shell
Hydrogen	H	1	1	1	0	1	1	-	-
Helium	He	2	4	2	2	2	2	-	-
Lithium	Li	3	6	3	3	3	2	1	-
Berellium	Be	4	8	4	4	4	2	2	-
Boron	B	5	10	5	5	5	2	3	-
Carbon	C	6	12	6	6	6	2	4	-
Nitrogen	N	7	14	7	7	7	2	5	-

Table showing Atomic Structure of Few Elements

Energy and its Types

If a person can do a lot of work we say that he has a lot of energy or he is very energetic. In physics also, anything which is able to do work is said to possess energy. Thus, energy is the ability to do work. Let us take one example to understand it more clearly. To cut a log of wood into small pieces, we have to raise the axe vertically above the log of wood and some work has to be done in raising the axe. If the axe is now allowed to fall on wood. It can do work in cutting the wood. Thus the work done in raising the axe has been stored up in it, giving it the ability for doing work. Now, when the axe is resting on the log of wood. It can no longer do any work. To give it the ability to do work again, work has to be done in raising it above the log of wood once again. We say that the raised axe has the energy or ability for doing work. The amount of energy possessed by a body is equal to the amount of work it can do when its energy is released.

TYPES OF ENERGY

Energy is of several types, but basically it is divided into two categories:

(A) Mechanical energy

The mechanical energy (E) of a body is the sum of kinetic energy (K) and potential energy (U) of the body.

$$E = K + U$$

i.e.

(B) Forms other than Mechanical Energy

- Heat energy** : It is the energy possessed by a body by virtue of random motion of the molecules of the body.
- Internal energy** : It is the total energy possessed by the body by virtue of particular configuration of its molecules and also their random motion. Thus internal energy of a body is the sum of potential and kinetic energies of the molecules of the body. P.E is due to configuration of the molecules against

intermolecular forces and K.E is due to random motion of its molecules.

3. **Electrical energy** : Arises on account of work required to be done in moving the free charge carriers in a particular direction through a conductor.
4. **Chemical energy of a body** : is the energy possessed by it by virtue of chemical bonding of its atoms. The chemical energy becomes available in a reaction.
5. **Nuclear energy** : It the energy obtainable from an atomic nucleus. Two distinct modes of obtaining nuclear energy are 1. Nuclear fission 2. Nuclear fusion.
Nuclear fission involves splitting of a heavy nucleus into two or more lighter nuclei, whereas nuclear fusion involves fusing of two or more lighter nuclei to form a heavy nucleus.
6. **Muscular energy** : The type of energy stored in the muscles of our body is known as muscular energy. We obtain this energy from the chemical energy stored in the food which we eat in our diet.
7. **Heat energy** : The type of energy available through generation of heat by burning of material substances especially water and fuels like petrol, diesel, kerosene oil, LPG (Liquefied petroleum gas) etc. is known as heat energy.
8. **Light energy** : The type of energy available through generation of light either by burning of the material substances or some other suitable means helping in doing one or the other things directly or as a result of its conversion into a kind of mechanical energy is called light energy.
9. **Sound energy** : The type of energy available through generation of sound may be helpful to us in our oral communications – speaking and listening etc. In its other form when converted into mechanical or electrical energy it is made into use in the working of various musical instruments and audio devices like microphone and audio tape, recorders etc. vibration of a thin plate of microphone diaphragm caused on account of the sound energy is a glaring example of the conversion of sound energy into mechanical and electrical energy.
10. **Magnetic energy** : The type of energy available in the form of magnetized bodies capable of attracting or repelling other objects may be termed as magnetic energy.

11. **Electrical energy** : The type of energy available in the form of electric current flowing in the objects called good conductors of electricity and in the bodies providing resistance to its flow for converting it into heat; light and mechanical energies etc. may be termed as electrical energy.
12. **Wind energy**: Wind energy in simple words is the energy contained in the moving air called wind. Moving objects as we have already known are found to possess kinetic energy.
13. **Hydro energy**: Moving water by virtue of its motion contains kinetic energy and this energy in turn can be used for doing mechanical work much in the same way as performed through wind energy.
14. **Solar energy**: The energy available to us directly from the sun rays can be technically termed as solar energy.

KINETIC ENERGY

A moving cricket ball can do work in pushing back the stumps; moving water can do work in turning a turbine for generating electricity; and moving wind can do work in turning the blades of wind mill. Thus a moving body is capable of doing work and hence possessed energy. The energy of a body due to its motion is called kinetic energy.

The kinetic energy of a body is the energy possessed by the body by virtue of its motion. For example,

1. A bullet fired from a gun can pierce through a target on account of kinetic energy of the bullet.
2. Wind mills work on the kinetic energy of air.
3. Water mills work on the kinetic energy of water.
4. A nail is driven into a wooden block on account of kinetic energy of the hammer striking the nail.

Mathematical Formulation

The kinetic energy of a body of mass m and moving with a velocity (or speed) v is given by the formula :

$$\text{Kinetic energy} = \frac{1}{2} mv^2$$

From this formula it is clear that:

1. The kinetic energy of a body is directly proportional to the mass of the body, and
2. The kinetic energy of a body is directly proportional to the square of velocity of the body (or square of the speed of the body).

Sample problem 1. Calculate the kinetic of a body of mass 2 kg moving with a velocity of 0.1 meter per second.

Solution: The formula for calculating kinetic energy is

$$\text{Kinetic energy} = \frac{1}{2} mv^2$$

Here mass $m = 2$ kegs

And, Velocity, $v = 0.1$ m/s

So putting these values in the above formula, we get:

$$\begin{aligned} \text{Kinetic energy} &= \frac{1}{2} \times 2 \times (0.1)^2 \\ &= \frac{1}{2} \times 2 \times 0.1 \times 0.1 = 0.01 \text{ j} \end{aligned}$$

Thus the kinetic energy of the body is 0.01 joule.

POTENTIAL ENERGY

The potential energy of a body is defined as the energy possessed by the body by virtue of its position or configuration in some field.

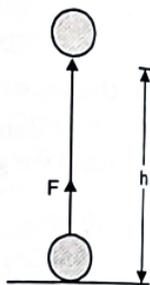
Thus potential energy is the energy that can be associated with the configuration (or arrangement) of a system of objects that exert forces on one another. Obviously if configuration of the system changes then its potential energy changes.

For example, when we wind the spring of our watch, potential energy is stored in the spring on account of configuration of the turns of the spring. As the spring unwinds, it works to move the hands of the watch. Thus the wound spring has the potential to do the work.

Similarly, when a spring is compressed or stretched, work done in compressing or stretching the spring is stored in the spring in the form of potential energy.

Mathematical Formulation:

Infact, the amount of work done in carrying the body from surface of earth to its present position against the gravitational force of earth is stored in the body in the form of its gravitational potential energy. When the body is allowed to fall from that position it can do the amount of work equal to its gravitational potential energy. For example gravitational potential energy of water stored to great heights in dams is used to run turbines and produce electric energy at hydroelectric power stations.



To calculate gravitational potential energy suppose

M = mass of a body

G = acceleration due to gravity on the surface of earth.

H = height through which the body is raised

Note : The energy associated with state of separation of charged particles that interact electrically is called electric potential energy.

Hence {Gravitational P.E of the body = $W = mgh$ }

At the surface of earth, $h = 0$

Gravitational P.E = Zero.

Types of Potential Energy

Two important types of potential energy are:

1. Gravitational potential energy.
2. Elastic potential energy.

Gravitational potential energy

Gravitational potential energy of a body is the energy possessed by the body by virtue of its position above the surface of the earth.

Elastic Potential Energy

Potential energy of a spring :

Springs can be of many types. Important among these are helical springs as shown in fig.a and spiral springs, as shown in fig.b

Usually we assume that the springs are massless. Therefore, restoring elastic forces in a spring is same everywhere.

Sample problem 1. If acceleration due to gravity is 10 m/s^2 , what will be the potential energy of a body of mass 1 k.g kept at a height of 5 m?

Solution : The potential energy of a body is calculated by using the formula;

$$\text{Potential energy} = m \times g \times h$$

Mass, $M = 1 \text{ K.g}$

Acceleration due to gravity, $G = 10 \text{ m/s}^2$

Height $H = 5 \text{ m}$

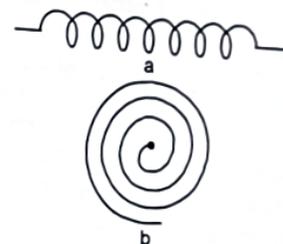
So putting these values in the above formula, we get

$$\text{Potential energy} = 1 \times 10 \times 5 = 50 \text{ j}$$

Thus, the potential energy of the body is 50 joules.

TRANSFORMATION OF ENERGY

Energy is like money, it is useful because it can be changed into so many different forms. The change of one form of energy into another form of energy is known as transformation of energy. We will now take some examples to show how the transformation of energy takes places.



Transformation from P.E to K.E : Suppose a stone is lying on the roof of a house. In this position all the energy of the stone is in the form of potential energy. When the stone is dropped from the roof it starts moving downwards towards the ground and the potential energy of stone starts changing into kinetic energy. As the stone continues falling downwards, its potential energy goes on decreasing because its height goes on decreasing but its kinetic energy goes on increasing (because its velocity goes on increasing). In other words, the potential energy of the stone gradually gets transformed into kinetic energy. And by the time stone reaches the ground its potential energy becomes zero and entire energy will be in the form of kinetic energy. From this we conclude that when a body is released from a height then the potential energy of that body is gradually transformed (or changed) into kinetic energy.

Other Energy Transformation: At a hydroelectric power house the potential energy of water is transformed into kinetic energy and then into electrical energy. At a thermal power station coal is used to produce electricity. When coal is burnt, the chemical energy of coal changes into heat energy. This heat energy converts water into steam and steam runs electricity generators. Thus at a thermal power station, the chemical energy of coal is changed into heat energy which is further changed into electrical energy. Let us take the case of a steam engine used to pull a train. When coal is burnt, the chemical energy of coal changes into heat energy. This heat energy converts water into steam and steam moves the railways engine. Thus the heat energy is converted into kinetic energy by the steam engine.

We come across such changes in day to day life. For example:

1. In an electric bulb, electric energy is converted into light energy and heat energy.
2. In an electric iron, electric heater, geyser etc. electric energy is converted into heat energy.
3. In an electric fan, electric motor, electric energy is converted into mechanical energy.
4. In a nuclear reactor, mass is being converted into energy.
5. In the sun and other stars, mass is being converted into energy and so on.

PRINCIPLE OF CONSERVATION OF ENERGY

According to this principle, the sum total energy of all kinds in an isolated system remains constant at all times. This means that energy can neither be created nor be destroyed. Energy can only be changed from one form to another. The amount of energy appearing in one form is always equal to the amount of energy disappearing in some other form.

To prove this principle we restrict ourselves to the conservation of mechanical energy. Let us calculate kinetic energy K.E, potential energy P.E and total energy T.E of a body falling freely under gravity.

Some other examples of conservation of energy are:

1. Vibrations of a simple pendulum

In fig. 3.9 OA is normal position of rest of a simple pendulum when the bob of the pendulum is displaced to B, through a height h , it is given $P.E = mgh$, where m is mass of the bob. On releasing the bob at B, it moves towards A. P.E of the bob is being converted into K.E. On reaching A, the entire P.E has been converted into K.E. The bob therefore, cannot stop at A. on account of inertia it overshoots the position A and reaches C at the same height h above A. The entire k.e of the

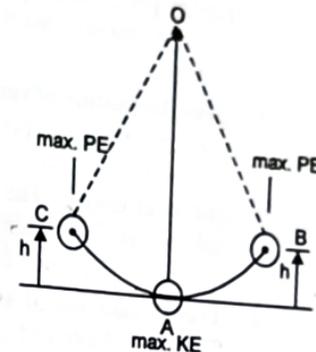


Fig. 3.9. Vibration of a simple pendulum

bob at A is converted into P.E at C. The whole process is repeated and the pendulum vibrates about the equilibrium position OA. At extreme position B and C, the bob is momentarily at rest. Therefore its $K.E=0$. The entire energy at B & C is potential energy. At A there is no height and hence no potential energy. The entire energy at A is kinetic energy.

ENERGY FROM THE SUN (OR SOLAR ENERGY)

The sun is a big store-house of energy. The sun's energy is produced by the nuclear reactions going on inside it all the time. All of our energy come or has come from the sun. The sun's energy (or solar energy) gets transformed into many other forms of energy which are useful to us let us discuss this in a little more detail.

1. **Transformation of sun's energy into wind energy :** The sun's heat causes uneven heating of land and produces different air pressures at different places. These different air pressures produce wind having kinetic energy. In this way the sun's energy is transformed into kinetic energy (of wind). In other words, the sun supplies us the energy of wind. We use this wind energy for many purposes.
2. **Transformation of sun's energy into electrical energy :** The sun's heat evaporates the water from seas and lifts the water vapour high into the sky (and gives it potential energy). When this water falls back to the earth in the form of rain (or snow), then some of it is stored behind high dams. When this water is

allowed to fall from high dam, its potential energy is converted into kinetic energy. The kinetic energy of flowing water turns the turbines which drive the generators to produce electrical energy (or electricity). This is done at a hydroelectric power plant. In this way, the sun's energy is transformed into electrical energy.

3. **Transformation of sun's energy into food energy :** The plants use sun's energy to prepare food (like starch) by the process of photosynthesis. The food stores sun's energy in the form of chemical energy. The plants are eaten up by man and other animals as food. This plant food supplies energy to man and other animals. Some foods supply us more energy than others.
4. **Transformation of sun's energy into energy of fossil fuels**
The dead plants and animals buried under the earth long, long ago have been converted into fossil fuels like coal, petroleum oil and natural gas. The energy of fossil fuels can be used to produce thermal energy (heat energy). Electrical energy and mechanical energy (as in automobiles). The energy stored in fossil fuels came originally from the sun.

PEDAGOGICAL ANALYSIS OF THE TOPIC : ENERGY AND ITS TYPES

Consists of four steps:

Step 1 : Content Analysis – Topic – Energy and its Types

It consists of 2 parts:

(A) Major Concept (B) Minor Concept

(A) Major Concept

1. What is energy?
2. Types of energy?
3. Kinetic energy?
4. Potential energy?
5. Conversion or transformation of energy/
6. Principle of conservation of energy?

(B) Minor Concept

1. What is energy?
 - ◆ Defining the term energy.
 - ◆ Meaning of the term energy.
2. Types of Energy?
 - ◆ Mechanical energy – Kinetic and Potential Energy

◆ Other than mechanical energy

- Heat energy
- Internal energy
- Electrical energy
- Chemical energy
- Nuclear energy
- Muscular energy
- Solar energy
- Magnetic energy
- Light energy
- Hydro energy
- Wind energy

3. Kinetic energy

- ◆ Meaning of kinetic energy
- ◆ Mathematical formulation of kinetic energy

4. Potential energy

- ◆ Meaning of potential energy
- ◆ Mathematical expression of potential energy
- ◆ Types of Potential energy
 - Gravitational Potential energy
 - Elastic Potential energy

5. Conversion or transformation of energy

- ◆ Conversion from kinetic to potential and vice-versa
- ◆ Conversion from electrical to chemical and vice-versa
- ◆ Conversion from one form of energy to other

6. Principle of conservation of energy.

Step 2 : Objective Formulation (Behavioral Outcomes) :

Students after going through the teaching of the topic "Energy and its Types" will be able to:

1. Define the term energy.
2. Explain the meaning of the term energy.
3. Differentiate between kinetic and potential energy.
4. Give the forms of energy.
5. Mathematically derive the kinetic and potential energy equation.
6. Discriminate between elastic and gravitational potential energy.
7. Explain the term solar energy and nuclear energy.

8. Give the mechanism of transformation of energy from one form to the other.
9. State the principle of conservation of energy.
10. Recall the formula for potential and kinetic energy.
11. State examples of potential and kinetic energy.
12. Name forms of energy other than mechanical energy.
13. Solve the numerical problems related with kinetic and potential energy.

Step 3 : Methods, devices, activities and aid materials used.

Methods : Lecture method, Demonstration method, Discussion method and Observation method.

Devices : Narration, explanation, illustration and observation devices.

Activities and aid materials used :

1. While teaching the topic help of blackboard writing and sketching, charts and pictures will be taken.
2. Slides and transparencies may be used to show the mathematical formulation of potential and kinetic energy.
3. Audio video recording, films and computer presentation may be used to show the transformation and conservation of energy.
4. Overhead projectors, charts and pictures may be utilized for the presentation of concept, facts and principles related to energy types.
5. Practical opportunities will be provided for transformation of energy like electrical to chemical energy, potential to kinetic energy transformation while swinging the pendulum.

Step 4 : Evaluation Procedure and Devices Used:

Evaluation can be done through oral, written and Practical method.

- **In oral method**, students will be asked questions during teaching process or after completion of the topic and students are required to respond orally to the asked questions.
- **In Practical mode**, students may be asked to perform experiments showing the transformation of energy like swinging the Pendulum, Chemical reactions to generate heat energy.
- **Written mode** consists of :
 - (a) Explain the meaning of the term energy giving suitable examples.
 1. Explain the meaning of the term energy by giving suitable examples.

2. Discuss kinetic and potential energy in detail.
 3. Formulate the mathematical expression of kinetic and potential energy.
 4. Differentiate between gravitational and elastic potential energy.
 5. Explain five other types of energy which are not mechanical.
 6. Illustrate how sun is the ultimate source of all forms of energy available on the earth.
 7. Give in detail the transformation of energy with example.
 8. State and explain Principle of conservation of energy.
- (b) Short Answer type Questions
1. Define the term energy.
 2. Name the type of energy mechanical as well as other forms.
 3. Give formula for kinetic energy.
 4. State example of transformation of energy.
 5. What is gravitational potential energy?
 6. Define elastic potential energy with example.
 7. State law of conservation of energy.
 8. Define heat and light energy.
 9. Name other non-mechanical types of energy.
- (c) Objective type Questions
1. Match the column

Column I	Column II
(i) Chemical cell	(a) energy transformation from sound to electrical
(ii) Kinetic energy	(b) mgh
(iii) Energy in a string	(c) Chemical energy to electrical energy
(iv) Potential energy	(d) $\frac{1}{2} mV^2$
(v) Microphone	(e) elastic potential energy
 2. Fill in the blanks:
 - (a) _____ is the ability to do work.
 - (b) Energy can neither be _____ nor destroyed.
 - (c) Electric fan transform electric energy to _____ energy.
 - (d) Potential energy is given by the equation _____
 - (e) Steam engine transforms _____ energy to mechanical energy.

3. Multiple choice Questions:

- (a) Ability to do work is,
 (i) Power (ii) energy (iii) capacity
- (b) Kinetic energy is given by the formula:
 (i) $\frac{1}{2} mv^2$ (ii) $\frac{1}{2} mv$ (iii) $\frac{1}{2} mv^3$
- (c) Electrical energy to chemical energy conversion done by
 (i) Chemical cell (ii) Photo cell (iii) electric cell
- (d) Energy generated from sun is
 (i) Solar energy (ii) Chemical energy
 (iii) Electrical energy

4. True False (T/F) Statements:

- (a) Sun is the ultimate source of energy.
 (b) Energy can neither be created nor destroyed.
 (c) Electric fan transform mechanical energy to electric energy.
 (d) Electric motor converts electric energy to mechanical energy.
 (e) Energy can be transformed from one form to the other.

Pedagogical Analysis - 'Atomic Structure'

Content Analysis	Behaviour Outcomes	Method, devices, activities and aid material used	Evaluation, Procedure and Devices
<p>1. What is Energy?</p> <p><input type="checkbox"/> Definition: Energy of a body is defined as the capacity or ability of the body to do the work.</p> <p><input type="checkbox"/> Unit: S.I. unit of energy is Joule.</p> <p><input type="checkbox"/> Meaning : The amount of energy possessed by a body is equal to the amount of work it can do when its energy is released or</p> <p>When a body is capable of doing more work, it is said to possess more energy. The reverse is also true.</p>	<p>After teaching process students will be able to: Recall the term energy and its unit.</p> <p>Explain the meaning of the term energy.</p>	<p>Lecture method, Narration device</p> <p>Explaining device</p> <p>For example: To cut a log of wood into small pieces, we have to raise the axe vertically above the log of the wood and some work has to be done in raising the axe. If the axe is now allowed to fall on the wood, it can do work in cutting the wood. Thus the work done in raising the axe has been stored up in it, giving it the ability for doing work. Now, when the axe is resting on the</p>	<p>Ability of doing work is called _____</p> <p><input type="checkbox"/> Give the S.I. unit of energy.</p> <p><input type="checkbox"/> What do you mean by the term energy? Prove it with example.</p>

- **Internal energy** : Energy possessed by the body by virtue of particular configuration of its molecules and also their random motion.
- **Electrical energy** : arises on account of work required to be done in moving the free charge carriers in a particular direction through a conductor.
- **Chemical energy** : Energy possessed by the body by virtue of chemical bonding of its atoms.

Students will be able to define Internal energy.

Give application of electrical energy.

Analyze the chemical cell.

doing various types of work.

- Burning of fuel like Petrol, diesel, kerosene oil, LPG etc. also produce heat energy.

NOTE : Internal energy of a body is the sum of potential energy, kinetic energy, heat energy, magnetic energy, chemical energy etc.

Computer presentation may be used to show the application of electric energy in the industries and world of transports to drive big motors and engines.

Charts and pictures may be utilized for demonstrating chemical energy stored in the fuels and how it can be converted to heat, mechanical or electrical energy.

Internal energy is the sum total of all the energies (T/F) (True/False)

Define electrical energy.

In photosynthesis, chemical energy is stored in the plants (T/F)

2. Types of Energy

Energy is of several types, but basically it is divided into two categories :

(A) **Mechanical Energy** : Kinetic and Potential

(B) **Forms other than mechanical energy** like Heat energy, internal energy etc.

- **Heat energy** : It is the energy possessed by a body by virtue of random motion of the molecules of the body.

Classify the energy into mechanical and non-mechanical type.

Cite example of heat energy.

log of wood, it can no longer do any work. To give it the ability to do work again, work has to be done in raising it above the log of wood once again. We say that the raised axe has the energy or ability for doing work.

Lecture method, Narration Device

Help of the blackboard writing will be taken.

Explanation device

Example: Prolonged heating of water may turn it into steam which can be used in steam engines for converting heat energy into mechanical energy for

Give different types of energy and cite at least one example for each type of energy.

Explain heat energy with example.

energy available on the earth. The energy available to us directly from the sun is called solar energy.

□ **Magnetic energy** : Energy available in the form of magnetized bodies capable of attracting or repelling other objects may be called as magnetic energy.

□ **Light energy** : Energy produced when radiation is emitted by a source into surrounding environment is called light energy.

□ **Hydro energy** : energy produced through the use of the gravitational force of falling or flowing water.

□ **Wind energy** : energy produced by the moving air used to rotate the wind mill is called wind energy.

generalize the magnetic nature of earth

Differentiate between heat and light energy

Understand the working of hydro power plant.

Construct the wind mill model

Explanation device, Earth is said to be a big magnet in the sense that it exercises its magnetic energy gravitational power to pull down any object projected in the air back to its surface.

Lecture method, Narration device

Computer presentation showing the working of hydropower plant.

Demonstration method, model showing wind energy generation through wind mill.

Explain the statement that earth is said to be a big magnet.

Give the meaning of the term light energy.

Define Hydro energy

Define the term wind energy.

□ **Nuclear energy** : Energy obtainable from an atomic nucleus. Two distinct modes of obtaining nuclear energy are

- (a) Nuclear fission
- (b) Nuclear fusion

□ **Nuclear fission** : It involves splitting of a heavy nucleus into two or more lighter nuclei on bombarding with neutron.

For example : Uranium-235

□ **Nuclear fusion** : It involves fusing of two or more lighter nuclei to form a heavy nucleus. For example : Hydrogen bomb or atom bomb

□ **Muscular energy** : energy stored in the muscles of body is called as muscular energy.

□ **Solar energy** : All of our energy comes from the sun. Therefore, directly or indirectly sun is the ultimate source of all forms of

Give two modes of nuclear energy

Understand the nuclear fission process.

Understand the nuclear fusion process.

See relationship between food intake and muscular energy.

Recognize the importance of sun in the universe.

Slides and transparencies may be used to show the nuclear fission and fusion process.

Demonstration method, computer presentation may be used to show the nuclear fission process.

Computer slides may be used to show the animated pictures of atom bomb working or nuclear fusion process.

Explanation device We obtain this energy from the chemical energy stored in the food which we eat in our diet.

Observation method : Devices like solar cooker, solar water heater, solar cell etc. can be shown to the students.

Hydrogen bomb is used on _____ principle.

Explain nuclear fission reaction.

Nuclear fission technology is utilized in the preparation of atom bomb (T/F)

Define muscular energy.

_____ is the ultimate source of energy.
(a) Food (b) Sun
(c) Plants

4. Potential energy :

□ **Meaning** : The energy possessed by the body by virtue of its position or configuration in some field is called potential energy.

□ **Mathematical expression :**

Potential energy is given by the expression,

$$\text{Potential energy} = m \cdot g \cdot h.$$

where,

m = mass of the body

g = acceleration due to gravity (10 m/s^2)

h = height of a body above a reference point, say the surface of earth.

□ **Types** : Potential energy is of two types

- (a) Gravitational potential energy
(b) Elastic potential energy.

Apply potential energy concept in day to day life.

Recognize the potential energy equation

Classify the potential energy

Explanation device,

For example : When a spring is compressed or stretched, work done in compressing or stretching the spring is stored in the spring in the form of potential energy.

Calculating device

Example: If acceleration due to gravity is 10 m/s^2 , what will be the potential energy of a body of mass/ kg kept at a height of 5 m ?

$$\text{P.E.} = mgh$$

In this case,

$$m = 1 \text{ kg}, g = 10 \text{ m/s}^2$$

$$h = 5 \text{ m}$$

$$\text{So, P.E.} = 1 \times 10 \times 5 = 50 \text{ joules}$$

Lecture method,
Narration device,
Blackboard writing.

Define potential energy.

A bag of wheat weighs 200 kg . To what height should it be raised so that its potential energy may be 9800 joules ($g = 9.8 \text{ ms}^{-2}$)?

Name the potential energy

3. Kinetic energy (K.E.)

□ **Meaning** : K.E. of a body is the energy possessed by the body by virtue of its motion.

□ **Mathematical formulation :**

$$\text{K.E.} = \frac{1}{2} mv^2$$

whereas, m = mass of the body and v = uniform velocity.

Observation made, K.E. is directly proportional to mass of the body.

K.E. is directly proportional to square of velocity with which object is moving.

Students will be able to define the term kinetic energy.

Recognize the kinetic energy equation and able to solve numerical problem related to this equation.

Explanation device

For example: (a) A bullet fired from a gun can pierce through a target on account of kinetic energy of the bullet. (b) Water mills work on the kinetic energy of water. (c) Wind mills work on the kinetic energy of air. (d) A nail is driven into a wooden block on account of kinetic energy of hammer striking the nail.

Lecture method, blackboard writing and slides showing the kinetic energy equation may be used.

Give atleast 2 examples of kinetic energy.

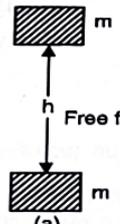
Calculate the kinetic energy of a body of mass 2 kg . Moving with a velocity of $0.1 \text{ metre per second}$.

suitable device like electric motor, steam engine, microphone etc.

(a) Conversion from kinetic to potential and vice-versa: During the swinging of a pendulum, during the free fall of a body.

Understand the process

Demonstration method, Explanation device.



During the free fall of a body of mass, m from a height (h). At position (a), it has maximum potential energy (by virtue of its position) as it comes down potential energy starts decreasing and kinetic energy starts increasing. At position (b) it has maximum kinetic energy and zero potential energy because whole of

State one example of transformation from potential to kinetic energy.

(a) **Gravitational Potential Energy:** Energy possessed by the body by virtue of its position above the surface of earth is called gravitational potential energy.

Students will be able to recall the term gravitational potential energy.

Explanation device,

For example: gravitational potential energy of water stored to great heights in dams is used to run turbines and produce electric energy at hydroelectric power station.

□ The energy of stone lying on the roof-top is known as gravitational potential energy because it has been acquired by doing work against gravity.

types.

State two examples of gravitational energy.

(b) **Elastic potential energy:** Energy possessed by the body by virtue of change in the shape of the body is called elastic potential energy.

Define the term elastic potential energy.

Demonstration method, explanation device, illustration device.

For example: The energy stored in a stretched rubber band, spring or string of a bow is elastic potential energy.

Explain elasticity potential energy with example.

5. **Transformation of energy :** Energy can be converted from one form to the other by using a

Understand the transformation concept.

Lecture method
Narration device

Explain transformation of energy

6. Principle of conservation of energy:

According to this law, whenever energy changes from one form to another, the total amount of energy remains constant i.e. energy can neither be created nor destroyed but only can be transformed from one form to the other

- This law is given by a German Scientist Robert Mayer.

Understand the utility of this law.

Lecture method, Narration device, Explanation device.

Example: Any of the example cited above in the transformation of energy.

State and explain principle of conservation of energy.

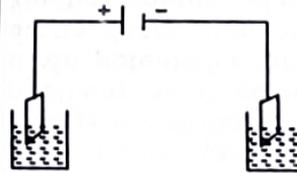
(b) Conversion from electrical to chemical energy and vice-versa: Electrical cell convert electric energy to chemical energy to electrical energy whereas, chemical energy convert chemical energy to electrical energy.

Apply this concept in laboratory work.

the energy is converted to kinetic energy.

Demonstration method, illustration device

_____ convert electric energy to chemical energy.



Energy Transformation

From	To	Device used
Electric	Mechanical	Electric motor
Electric	Chemical	Electric cell
Solar	Electrical	Solar cell
Light	Electrical	Photo cell
Electric	Sound	Loundspeaker
Heat	Mechanical	Steam engine
Sound	Electric	Microphone

NOTE : The sum of potential and kinetic energies of a body is called its mechanical energy.

Mechanical energy $K.E. + P.E.$

Environment and Pollution

The National Curriculum framework (NCF) 2005 and its overall perspective of environmental education a resume – and its treatment in different levels of school textbooks of different states and CBSE boards were analyzed. NCF envisages a structure that articulates required experiences and address some basic questions like:

- What educational purposes should the schools seek to achieve?
- What educational experiences in Environmental Education (EE) can be provided that help to achieve these goals?
- How these educational experiences can be meaningfully organised to achieve the objectives?
- How do we ensure that these educational purposes are indeed being accomplished?

Status of Environmental Education in School Education:

The education system in India had incorporated certain aspects of environment in school curricula as early as 1930. The Kothari commission (1964-66) also suggested that basic education had to offer EE and relate it to the life needs and aspirations of the people and the nation. At the primary stage, the report recommended that “the aims of teaching science in the primary schools should be to develop proper understanding of the main facts, concepts, principles and processes in physical and biological environment” Environmental education at primary, secondary, higher secondary levels was treated in a different way. Environmental education is an essential part of every pupil’s learning. It helps to encourage awareness of the environment, leading to informed concern for active participation in resolving environmental problems. It was introduced without any delay from class –1 as Environmental Studies (EVS), as a subject so that right from their childhood, the right attitudes towards environment will be nurtured in the young minds.

The curricular, cross-curricular attempt of environmental education should be a joy for the learner. In this direction, NCERT has published in collaboration with the Centre for Environmental Education, Ahmedabad a book titled “Joy of learning” with lot of environmental activities, a handbook for teachers. Similarly, several workshops were conducted to orient school teachers and educational functionaries of the state boards on various aspects of environmental education.

A Curricular Framework of Environmental Education:

- It envisages the place of EE in the school curriculum.
- Place of EE vis-à-vis other subjects of study.
- Mode and strategy of inclusion of chapters at different levels.
- EE in terms of time and allocation of marks.
- Development of syllabi and instructional material for dissemination at different levels of school education.

In order to supplement the analysis of individual and institutional consultations it was decided to organize two face-to-face National Consultations on Environmental Education in Schools. The First Consultation on the academic aspects of Environmental Education (EE) in schools was organised by NCERT on 13-14 February 2004 in New Delhi. Seventy participants comprising eminent scientists, environmentalists, officials of central and state govt. departments dealing with environment, senior academicians attached to Departments/Centers of environmental studies, environmental science, environmental ecology, botany, regional development, geography, marine biology, etc. of different universities, teacher educators, principals of teacher training colleges, prominent Non-Governmental Organizations (NGOs) and NCERT faculty took part in deliberations. The second consultation on the implementation of EE in schools was held on 13th March 2004. Seventy-two officials comprising Presidents/Chairpersons of Boards/Councils of school education, Directors of State Councils of Educational Research and Training (SCERTs), Directors of Education in the states, eminent scientists, environmentalists and NCERT faculty participated. The initial draft prepared by NCERT faculty presented in the First Consultation was revised as per the suggestions received. This revised version was presented in the Second Consultation and suggestions for further improvement were received.

Aims & Objectives of Environmental Education:

The objectives of environmental education are to increase public awareness about environmental issues, explore possible solutions, and to

lay the foundations for a fully informed and active participation of individual in the protection of environment and the prudent and rational use of natural resources. The resolutions provide the following guiding principles for environmental education:

- The environment as a common heritage of mankind.
- The common duty of maintaining, protecting & improving the quality of environment, as a contribution to the protection of human health and safeguarding the ecological balance;
- The need for a prudent and rational utilization of resources;
- The way in which each individual can, by his own behavior and action, contribute to the protection of environment;
- The long-term aims of environmental education are to improve management of environment and provide satisfactory solutions to environmental issues.
- Provide opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment.
- Encourage pupils to examine and interpret the environment from a variety of perspectives-physical, geographical, biological, sociological, economic, political, technological, historical, esthetic and ethical.
- Arouse pupil's awareness and curiosity about the environment and encourage active participation in resolving environmental problems.
- Environmental education is closely linked to the other cross circular themes of other subject areas.

For effective transaction of environmental education following objectives related to knowledge, skill, and attitudes are essential:

Knowledge:

As a basis for making informed judgments about the environment people should develop knowledge and understanding of:

- The natural processes which take place in the environment.
- The impact of human activities on the environment.
- The comparison between different environments both in the past and present.
- Environmental issues such as: (i) Greenhouse effect. (ii) Acid rain and (iii) Air pollution.

- Local, national and international legislative controls to protect and manage the environment;
- How policies and decisions are made about the environment.
- How human life and livelihood are dependent on the environment.
- The conflicts, which can arise about environmental issues like river water sharing.
- How the environment has been effected owing to past decisions and actions.
- The importance of planning and design and an esthetic consideration.
- The importance of effective action to protect and manage the environment.

Skills:

Six specific skills have been identified which are necessary for environmental education. They are:

- Communication skills.
- Numerical skills.
- Study skills.
- Problem solving skills.
- Personal skills.
- Social skills & information technology skills.

Attitudes:

Promoting positive attitudes towards the environment is essential if pupils/students are to value it and understand their role in safeguarding it for the future. Encouraging the development of attitudes in personal qualities listed below will contribute to the process.

- Appreciations of care and concern for environment.
- Concern for other living things on earth.
- Independent thought on environmental issues.
- Respect for others opinion.
- Respect for rational argument and evidence.
- Tolerance to face others views.

Environmental Education can be thought of as Comprising Three Linked Components:

- Education about the environments (Knowledge).
- Education for the environment (Values, Attitudes & Positive actions).
- Education through the environment (A Resource).

Environmental education is a process that aims at the development of environmentally literate citizens who can compete in global economy, who have the skills and knowledge and inclinations to make well informed choices concerning the environment, and who exercise the rights and responsibilities of the members of a community. Environmental knowledge contributes to an understanding and appreciation of the society, technology and productivity and conservation of natural and cultural resources of their own environment.

Environmental education has an ability to solve the societal needs, the needs of a community problem and their solutions and workforce for tackling cooperative minds. We need the school children to share and develop the motivation from school about various environmental issues, which are the challenges of today and prepare them for the future.

Environmental education must become a vehicle for engaging young minds in the excitement of first hand observation of the nature and understanding the patterns and processes in the natural and social worlds in order to take care of the habitat and its surroundings which becomes a major part of EE in both Primary, Upper Primary, Secondary and Senior Secondary Stages of School Education.

Primary Stage:

EE is imparted as EVS, which forms a common component of syllabus, prescribed by the States and CBSE. The contents and concepts covered in these books are as follows:

- Familiarization with one's own body;
- Awareness about immediate surroundings;
- Need for food, water, air, shelter, clothing and recreation;
- Importance of trees and plants;
- Familiarization with local birds, animals and other objects;
- Interdependence of living and non-living things;
- Importance of cleanliness and sanitation;
- Importance of celebration of festivals and national days;

- Awareness of sunlight, rain and wind;
- Caring for pet animals;
- Awareness about air, water, soil and noise pollution;
- Need for the protection of environment;
- Knowledge about the source of energy;
- Importance of the conservation of water resources and forests and
- Indigenous and traditional knowledge about the protection of environment.

The textbooks lay emphasis on raising awareness levels and sensitizing children about environmental concerns. Emphasis has also been laid on the need to organize learning in local specific contexts, which will provide more meaningful experiences to children. Aspects of indigenous knowledge have also been introduced. There are references and suggestions for conducting activities in and outside the classroom. The NCERT textbooks for environmental studies generally take a comprehensive view of the natural, physical, social and cultural environment. It is evident that the textbooks represent relevant ideas commensurate with the age and developmental level of children so as to provide them the necessary understanding about their immediate environment.

Upper Primary Stage:

The contents of textbooks present an extension and elaboration of the concepts introduced at the primary stage. The NCERT textbooks of 'Science' and 'Social Science' have incorporated such concepts in the textbooks. The major concepts dealt with in these textbooks are:

- Adaptation of living beings in environment;
- Natural resources;
- Water cycle;
- Food chain;
- Importance of plants and trees in keeping the environment clean;
- Classification of plants;
- Role of plants and animals in environmental balance and soil conservation;
- Ecosystems;
- Necessity of clean air for healthy living;
- Animals and their characteristics;

- Effects of environmental pollution and the consequences of air pollution-(i) Greenhouse effect, (ii) Ozone layer depletion and, (iii) increase in carbon dioxide;
- Role of microorganisms in the environment;
- Dependence of the community on the environment;
- Basic knowledge about the Earth and its atmosphere;
- Physical features of the country;
- Population and environment;
- Care and protection of livestock;
- Necessity of wildlife protection;
- Impact of deforestation;
- Impact of industrialization on environment; and
- Role of civic society in protection of the environment, personal and public property including monuments.

While most of the areas of EE have generally been covered, there is a need for the inclusion of more individual and group activities and project work in order to promote both the effective and cognitive domains of learning. Co-scholastic activities including organization of plays, cultural programs, debates, mock parliament, discussions and community activities may help further in achieving the objective.

Secondary Stage: The concepts covered are:

- Biosphere;
- Greenhouse effect;
- Ozone layer depletion;
- Use of fertilizers and pesticides;
- Wildlife protection;
- Soil chemistry;
- Management of domestic and industrial waste;
- Pollution of noise, air, water and soil and control measures;
- Ecosystem;
- Management of non-degradable substances;
- Edible and ornamental plants;
- Sewage disposal and cleaning of rivers;
- Nuclear energy;

- Radiation hazards;
 - Gas leak;
 - Wind power;
 - Bio-energy; and
 - Environmental laws and acts.
- Environmental concepts also extend to subject areas like languages and social sciences, which reinforce learning and internalization of all such concepts.

Senior Secondary Stage:

Students opt for either the academic stream or the vocational stream. The treatment of concepts becomes deeper and more discipline oriented since the content caters to the demands of the concerned subject, as an independent discipline. Majority of the concepts are found in the textbooks of biology, chemistry and geography, which are optional subjects. Students opting for any one of these subjects would accordingly benefit in different aspects of EE. The coverage of EE concepts in the textbooks of various subjects includes:

- Environment and sustainable development;
- Atmospheric pollution- global warming,
- Greenhouse effect,
- Acid rain,
- Ozone layer depletion;
- Water pollution- international standards of drinking water,
- Importance of dissolved oxygen in water,
- Bio-chemical oxygen demand,
- Chemical oxygen demand,
- Land pollution,
- Pesticides,
- Ecology.

Some of the activities pertaining to EE from Primary, Upper Primary, Secondary & Senior Secondary classes on a sample basis a few have been give here.

ACTIVITY 1: All Organisms need an Environment to live

Materials: A note book and pencil.

Target Group: Class IV – VI

The Task: Critically observe over a week the various activities of a bird or a domestic animal such as a cow/sheep/goat/buffalo or a pet animal such as a dog/cat. Specific answers for the following questions must be obtained:

- Where does it live?
- What does it eat?
- What does it drink?
- What does it wear?
- When and how does it sleep?
- Can it live only on natural things?
- Does it use man-made things?
- What are its activities during daytime?
- What are its activities during nights?
- Does it make any noise? Does it disturb us?

The Teacher: The teacher opens a discussion about the observations made by children and summarizes that all organisms need a 'home' and environment is the home for most of the organisms. We must care not only for the organism but also for the environment because a good environment means a good home for all the organisms.

ACTIVITY 2: Human beings obtain several materials from the environment.

Materials: Notebook, Pencil

Target groups: IV to VIII

The Task: Ask children to make a list of all the people living in their house. Let them also list all the things (at least fifteen) which they use/need daily. Help them to categorize them into naturally available things and man-made things and arrange them in a table as shown below:

Man made things	Naturally occurring things
Tooth paste	Water
.....
.....

The Teacher: Analyse the items in the table and emphasize that all the naturally occurring things come from the environment. Unless we care for the environment and use these materials carefully, some materials will get depleted gradually and get exhausted one day!

ACTIVITY 3: Environment consists of both living and non-living things.

Materials: Notebook, pencil

Target Groups: VI to IX

The Task: Take children to a garden/park or to an open area within the school premises. Divide them into groups of 4-5 children. Critically observe the surrounding environment air, water, and soil. Dig the soil a little and observe the soil below the surface; list as many things. Care must be taken to classify only things that are naturally available and not manmade.

The Teacher: Teacher examines the list and leads the discussion to conclude that environment consists of both living and non-living things. Non-living things should not be construed, as things are not necessary or less important.

Living things	Non-living things
Bird	Water
.....
.....

ACTIVITY 4: Biodegradable and Non-Biodegradable materials.

Materials: Dry leaves, flowers, fruits, a few plastic covers, used refills, buttons, water.

Target Group: VIII to X & XI to XII

The Task: Dig 2 Shallow pits at a distance of a foot from each other. The pits should be approximately

6" X 6" X 6" into pit 1, put the dry leaves, flower, and fruits and into pit 2 put the plastic covers and refills. Cover both pits with mud such that the materials are completely buried.

Water the pits every day. After 15 days, dig up the pits and carefully observe the materials.

- Have the materials undergone any change?
- What changes do you observe?
- Is there a change in colour?
- Is there a change in shape?
- Are the materials intact?
- Is the plastic torn?

- Has the plastic changed colour?
- Has it crumpled into small bits?
- Does the plastic smell?
- Do the materials in pit 1 smell foul?
- What causes the smell?
- What happens to materials in pit A ultimately?
- What happens to material B ultimately?

Conclusion: Though there has been a long history of EE component in our school curriculum; it has always been treated as secondary to other scholastic areas like sciences, social-sciences, mathematics, etc. The first aggressive thrust for EE at school level came in NCF 1986 and the document, Plan of Action, 1992. Environmental issues, environmental concerns and conservation were identified as core areas in the curriculum. Although, many state boards and CBSE emphasized the need to educate children about our environment, there was very little perceptible change in our approach to EE transaction. NCF-2000 & NCF 2005 has laid enormous emphasis on EE to the extent that it is projected as of grave concern in school curriculum that is as important as other school subjects.

The attainment targets and programs and activities of study for science present opportunities for learning about environment through science, geography, civics, and social environmental aspects can be understood to a great extent. For example, energy sources, the process of life and the effect of human activity on the environment. The following attainment targets are particularly relevant in class III to XII science & social science curriculum of NCF-2005.

They can be listed as:

- Exploration of Science
- The variety of life.
- Process of life
- Human influence on Earth
- Types and uses of materials
- Explaining how materials behave
- Earth & atmosphere
- Energy
- The natural resources & conservation



UNIT - IV

EVALUATING OUTCOMES OF PHYSICAL SCIENCES TEACHING

- Indicators of Quality Learning and Major Issues in Classroom Learning with special reference to Physical Sciences.
- Concept of Test, Measurement and Evaluation.
- Differentiate between the terms 'Examination' and 'Evaluation'.
- Qualities of a good test, Principles and steps in construction of an achievement test, Blue Print and Question Paper, Item analysis, Construction of multiple choice questions, Diagnostic test, Remedial teaching in physical sciences.
- Continuous and Comprehensive Evaluation, Formative and Summative Assessment, Grading Pattern.
- Selection of Appropriate Evaluation Technique.

CHAPTER 1

Indicators of Quality Learning and Major Issues in Classroom Learning with Special Reference to Physical Sciences

“Real education has to draw out the best from the boys and girls to be educated. This can never be done by packing ill-assorted and unwanted information into the heads of the students. It becomes a dead weight crushing all originality in them and turning them into mere automata” - Mahatma Gandhi (Harijan 1. December, 1933)

Guidelines Provided by Sarva Shiksha Abhiyan (SSA) for the Cause of Quality Learning:

Sarva Shiksha Abhiyan will make efforts to take a holistic and comprehensive approach to the issue of **Quality Learning**. Efforts to decentralize the whole process of curriculum development down to the district level will be made. Reducing the load of non-comprehension by facilitating child-centered and activity-based learning will be attempted. Learning by doing, learning by observation, work experience, art, music, sports and value education shall be made fully integral to the learning process. Appropriate changes will be made in the evaluation system to make it more continuous and less threatening. Performance of children will be constantly monitored in consultation with parents but shall not be restricted only to cognitive areas. Teachers' role in preparation of textbooks and secondary learning materials will be enhanced. School timings will be made contextual. Based on a broad curriculum framework, districts would be free to define their content areas in their local contexts. State and national level institutions will facilitate this process of decentralized

arrangements for development of curriculum and evaluation systems. Some guiding principles in curriculum and evaluation reform will be as follows:

- (a) Teacher/ community participation in material preparation and in developing a school vision;
- (b) Focus on good quality printing, illustrations for books alongside improvement in content; freedom from 'cheapest syndrome' in matters of children's books;
- (c) Use of local dialects as language' in classes one and two;
- (d) Community-based and school-based projects for work experience;
- (e) Association of local artisans/workmen in school activities;
- (f) Primacy to cultural activities, art, sports, etc.
- (g) Content based and motivational training for teachers;
- (h) Continuous assessment of students for all round development;
- (i) Facilitating child-to-child learning;
- (j) Looking upon quality improvement as integral to a holistic School Improvement Programme.

Teacher as Resource Persons: Efforts to identify teachers as resource persons will be attempted through adoption of objective criteria. Teachers as resource persons could then interact with pedagogy experts and other teacher educators to develop useful learning approaches for children. Efforts to recognize the unique learning needs of children must be made. The diversity of learning environments and learning approaches should be encouraged and teachers should have the freedom to experiment on a much larger scale.

Interface of Teachers and Teacher Educators: Interface of Teachers and Teacher Educators is critical for developing a context specific intervention. Study tours of teachers will be encouraged. NGOs with experience in pedagogy will be associated in developing capacity among teachers for innovative practices.

Key Indicators of Quality Learning: Hereunder listed are certain key indicators of quality learning especially as regards the subject of Physical Sciences:

1. Development of Appropriate Curriculum: This domain includes the development and assessment of developmentally appropriate curriculum, the interactions between teacher and child, and attention to children with special needs and diverse language and cultures. Indicators

of quality learning in this section include daily and weekly lesson plans, ongoing professional development and feedback to ensure faithfulness to the curriculum model.

2. Safe, Healthy Indoor and Outdoor Environments: Program environments provide the framework for children's learning and development. They support the implementation of the curriculum through the use of space, materials and opportunities for children to experiment, practice their skills, analyze, socialize, and problem solve. Quality environments also provide support for the health, safety and nutrition of young children. **Indicators of quality learning in this section include the designation of both indoor and outdoor spaces for play and learning that are used on a daily basis; variety of materials for study of nature and science, especially the study of Physical Sciences.**

3. Workforce Qualifications and Professional Development: To ensure children's healthy development, the workforce must have formalized training in early childhood education and content knowledge, along with ongoing professional development that is linked to enhanced classroom activities, increased understanding of children's social emotional development and its impact on development and learning. **Indicators of quality learning in this section include lead teachers who meet the minimum prescribed qualifications along with the minimum prescribed experience to their credit.**

4. Family and Community Engagement: High-quality learning programs recognize the interconnectedness between the child, the family, the community and the program itself. Relationships with families are built on mutual trust, respect and a willingness to involve them as full partners, while providing them with information, resources and support. **Indicators of quality learning in this section include the presence of an active parent Advisory Board; the capacity of the program to connect families to resources and to the assistance required for children's development, early literacy, the teaching of Physical Sciences and approaches to learning.**

5. Leadership, Management and Administration: High quality learning programs require effective leadership with management and administrative practices that ensure a stable work environment. Other indicators include a system of technology that allows for data collection and tracking of children's health, services, absenteeism and educational information, staff qualifications and professional development and financial record keeping. **Leadership, Management and Administration - all three are good indicators of quality learning.**

Major Issues in Classroom Learning:

1. Lack of Time: This is by far the most common problem cited by teachers. They are not only working during school hours but also take back a lot of work home. Paperwork, testing, class interruptions, attention to students with special needs, and researching for lesson material and class activities were the common time-consuming activities. One problem that Physical Science teacher has to face in the classroom learning is the number of interruptions. These interruptions come from a variety of sources. Parents picking up their children early, announcements from the office, club meetings, bathroom breaks, phone calls, pictures, fire drills, intruder drills and most distressingly student misbehavior. These things add up to a real problem and consume most of the precious time.

2. Students Get Bored Easily: Children today are exposed to all forms of media including music, video, and images instantly thanks to Smartphone and social media. Social media platforms popular with the young generation are designed to be highly engaging and addictive. When children are exposed to such an interactive environment at home, they get easily bored and distracted if the lesson in class is not engaging or interactive enough. Gone are the days when teachers could teach a lesson using through the prescribed text books. Physical Science teachers now have to use a mix of text, audio, video, and movement-based activities to ensure that all students are engaged and learning.

3. Lack of Discipline: Distractions such as talking, fighting, using Smartphone is really making it difficult for teachers to keep the focus on the lesson. The situation is so bad that any small incident can trigger a fight in the class. Thus, it becomes quite difficult for a teacher especially a Physical Science teacher on concentrate on his lecture. The energy of the teacher is more consumed nowadays in disciplining the students rather than in the teaching-learning process.

4. Students in the Same Section at Different Academic Levels: A teacher is often faced with a situation where the academic levels vary for many students. It is particularly so for the Science teacher as almost each and every topic of Physical Sciences is linked to the other topics in one way or the other. This is a major challenge that results in more attention to students lagging behind and complaints from children and parents who find class lessons too easy.

5. Over Involvement of Parents: At times, parents get so involved in day-to-day activities of their students and it becomes difficult for the teachers to manage them. Parents go out of control when the class teacher puts restrictions on children. These challenges are real and school teachers

are facing them every day especially the Science teachers who really wish to have pin-drop silence in the classroom for effective teaching learning process.

EVALUATE YOURSELF

1. What are the indicators of Quality Learning by the students in general and especially for Science Classes?
2. What are the major issues in the Classroom learning that a teacher has to face especially if the concerned class belongs to Science Group?
3. Write a brief note on indicators of Quality Learning and the major issues in the Classroom that a teacher faces.



CHAPTER 2

Concept of Test, Measurement and Evaluation

- Test is used to gather information.
- Information collected through tests is presented in the form of measurement.
- That measurement is then used to make evaluation.

CONCEPT OF TEST

What is a Test? A test is an assessment intended to measure test-takers knowledge, skill, aptitude, physical fitness, or classification in many other topics. A test may be administered verbally, on paper, on a computer, or in a confined area that requires a test taker to physically perform a set of skills. Tests vary in style, rigor and requirements. For example, in a closed book test, a test taker is often required to rely upon memory to respond to specific items whereas in an open book test, a test taker may use one or more supplementary tools such as a reference book or calculator when responding to an item. A test may be administered formally or informally. An example of an informal test would be a reading test administered by a parent to a child. An example of a formal test would be a final examination administered by a teacher in a classroom or an I.Q. test administered by a psychologist in a clinic. Formal testing often results in a grade or a test score. A test score may be interpreted with regards to a norm or criterion, or occasionally both. The norm may be established independently, or by statistical analysis of a large number of participants.

Concept of Test: An instrument or systematic procedure for measuring a sample of behaviour by posing a set of questions in a uniform

manner. Because a test is a form of assessment, tests also answer the question, "How well does the individual perform – either in comparison with others or in comparison with a domain of performance tasks?"

Standardized Testing: Standardized tests are often referred to as assessments. An assessment is generally defined as the collection and analysis of information about one or more students. When tests are standardized, this means that a particular group of students will take the same test that will be scored and analyzed the same way. Score results for each student is then compared to the rest of the group to see how well the students performed.

Concept of Measurement

Oftenly evaluation is confused with measurement. But there is a slight difference between them. Measurement is the numerical representation of an object whereas evaluation represent both measurement and non-measurement. It answers the question "How much"? Whereas evaluation answers the question "How good"? ! In the case of measurement we say that students secured 7 marks out of 10 it refers to measurement; however evaluation tells how good student secured in the class. Take another example if we say that a new born baby has a weight of 3.5 Kg. it is measurement. Evaluation tells us how good it is? Was he weak or strong? Was the Weight is normal or abnormal?

There are some definitions to clear the meaning of measurement:

"Measurement refers to observations that can be expressed quantitatively and answers the question "how much".

—Remmers, Gaze and Rummel

"Measurement is the process of assigning symbols or numerals to observations objects or events in some meaningful or consistent manner according to rule".

—Mahesh Bhargava

"Measurement may be understood as the comparison of a quantity with an appropriate scale for the purpose of determining (within the limits of accuracy imposed by the nature of the scale) the numerical value on the scale that corresponds to the quantity to be measured".

—Carter V.Good

So in the process of measurement we assign numerals value or express the result of our observations in a quantitative term.

Difference between Measurement and Evaluation.

Evaluation	Measurement
1. It is broader in concept. It is more comprehensive.	1. It is narrow in concept.
2. It provides the quantitative as well as qualitative description of the outcomes of a teaching-learning process.	2. It is limited to quantitative description of the outcomes of a teaching-learning process.
3. It deals the questions "how good?"	3. It deals the questions "how much?"
4. It deals with numerals values.	4. It deals with the bringing modification in the behavior of the student.
5. Evaluation does not depend upon the measurement for its results.	5. Measurement is the part of the evaluation.
6. It includes the value-judgment.	6. It does not always include value-judgment.
7. A variety of means and techniques are used.	7. It is limited to certain tools and techniques
8. It is a means to an end.	8. It is a means not an end.

In the end we can say that evaluation involves the measurement techniques (quantitative) and non-measurement techniques (Qualitative) as well as the value judgement of the progress of the pupils.

$$\boxed{\text{Evaluation}} = \boxed{\text{Measurement (Quantitative)}} + \boxed{\text{Non-Measurement (Qualitative)}} + \boxed{\text{Value judgement}}$$

CONCEPT OF EVALUATION

Introduction :

Evaluation must help us to achieve an education aim with a greater inspirational quality and a new dimension of power

Evaluation is needed every time, when we consider some kind of change. As all sides of education are in a continuous change now a day, we need evaluation. The process of evaluation has over the years acquired a certain mystique which causes apprehension among many continuing educators. Of all the elements in educational planning, evaluation is the most misunderstood and maligned. In its simplest form, evaluation can

be described as making informed judgments on the overall value of the learning program and whether or not the program accomplished what is set out to do. Evaluation is a logical, straightforward process that is an integral part of any educational program. The teaching-learning process will not be completed without evaluation. Its main objective is qualitative improvement. In other words, evaluation is a process of making value judgment over the level of performance or achievement, but also concerned with its improvement. Evaluation is a continuous process, all pervasive and dynamic in a situation where the objectives of a course or a program relating to total development call for a variety of cognitive and non-cognitive experiences.

MEANING AND CONCEPT OF EVALUATION

According to the booklet of NCERT named "Concept of Evaluation" the process of evaluation decides about the following three thing-

1. To what extent the objective has been achieved ?
2. The Learning Experiences provided in the class have been effective to what extent?
3. How well have the teaching objectives been accomplished/ completed?

These three facts complete the cycle of evaluation. Teaching, objectives, learning experiences and behavioral changes are linked with each other in the process of evaluation.

Evaluation means

- A systematic process.
- Collecting, analyzing and interpreting data.
- Assignment of symbols.
- Achievement of instructional objectives.
- Answers the question "how good".

Definitions of Evaluation

In the words of Kothari commission Evaluation is a continuous process. It forms an integral part of the total system of education, and is intimately related to educational objectives. It exercises a great influence on the pupils study habits and teachers methods of instruction and thus helps not only to measure educational achievement but also to prove it.

The techniques of evaluation are means of collecting evidences about the students development in desirable directions.

“Evaluation as a continuous and comprehensive process which takes place in the school and outside school, and involves the participation of the pupils, teachers, parents and community with a view to make changes in the child and in the whole education process”.

—R.C. Sharma

“Evaluation assumes a purpose or an idea of what is “good” or “desirable” from the stand-point of the individual of society or both”.

—Remmers and Gage

National Curriculum Framework (NCF) ‘For school education 2005’. Evaluation is a systematic process of collecting, analyzing and interpreting evidences of students progress and achievement both in cognitive and non- cognitive areas of learning for the purpose of taking variety of decision.

“Evaluation is a process of making judgments that are used as a basis for planning. It consists of establishing goods, collecting evidence concerning lack of growth towards goals, making judgments. It is a procedure for improving the product, the process and even the goals themselves.”

—Wiles

“Evaluation is an never ending cycle of formulative goals, measuring progress towards them and determining the new goals which merge as a result of new warning”

—Clara M. Brown

Evaluation involves measurement, which means objective quantitative evidence. However, it is broader than measurement and implies that considerations have been given to certain values, standards and that interpretation of the evidence has been made in the light of the particular situation.

“Evaluation as a systematic process of determining the extent to which educational objectives are achieved by pupils”. —Dandekar

“Evaluation is the process of gathering and interpreting evidences on change in the behavior of the students as they progress through school”.

—Quillen and Hanna

Characteristics of Evaluation

1. Evaluation is a systematic and continuous process.

CONCEPT OF TEST, MEASUREMENT AND EVALUATION

2. Evaluation means both scholastic and non-scholastic aspects of a child's development.
3. Evaluation employs variety of methods and techniques to measure student's behavior.
4. Evaluation is both qualitative and quantitative in nature.
5. Evaluation is scientific and systematic. The activities of the individual student are analyzed by the experts making it scientific and systematic.
6. Evaluation helps teachers to assess his methods and teaching activities.
7. Evaluation tries to equalize performance and objectives framed.
8. Evaluation helps in grading students and deciding remedial action.
9. Evaluation is a comprehensive term as it involves objectives, content, learning activities and evaluation procedure.
10. Evaluation is a cooperative process involving students, teachers, parents and peer groups.
11. Evaluation is child- centered as it gives importance to learning and not the teaching process.

From the diagram it is clear that the different components or we can say pillars of a teaching-learning process influence and affect the working and results of each other. In this way there lies an intimate relationship and interdependence among the different components or pillars of a teaching learning process.

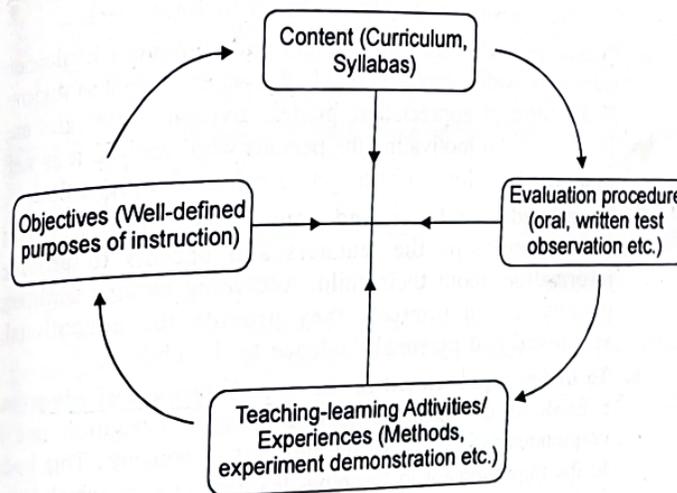


Fig 12.1 Aspects of Evaluation

PURPOSE/NEED/FUNCTIONS OF EVALUATION

1. **Helpful in the improvement of the program** : One of the most laudable reason for conducting evaluation is to improve the quality and content of a given program or specific learning activity. The course could be updated and enhanced as a result of the evaluation efforts employed by the planners. Based on such communication; control over the whole program is possible.
2. **Promotion to higher grades** : At the end of a term, teachers conduct tests which will help them to rank the students of a class. The quarterly, half-yearly and annual exams are meant for grading.
3. **Selection of the students** : It helps the students in selecting the various courses or areas for further study.
4. **Program Planning** : Closely related to program improvement is the use of evaluation for program planning. Comments from course participants can lead not only to improvements in a current educational offering but also can be the stimulation for developing new learning activities on related or totally different areas. In Addition, if evaluation data indicate that the objectives of the program were not achieved, a decision might be made to repeat the course or offer a similar one with minor alterations.
5. **Identification of problem areas** : A teacher like a doctor identifies the problem areas and weaknesses of his students. For this identification evaluation plays an important role. We find out the various problems and try to solve them.
6. **Providing motivation to teachers and students** : Evaluation helps in providing motivation to both teachers as well as students in the form of appreciation, grades, division, certificates etc. These helps in motivating the persons who received it as well as a challenge for others to get such incentives next time.
7. **To provide guidance and counseling** : The results of evaluation helps the teachers and parents to provide information about their child. According to their abilities, potentials and interests they provide the educational, vocational and personal guidance to the child.
8. **To bring improvement in the overall process of education** : Evaluation implies objective- based instruction and a continuous assessment of the progress of students. This leads to the improvement in teaching- learning process which helps in improving the overall process of education.

9. **Helpful in the selection of methods of teaching** : It provides the feedback to the teachers regarding the effectiveness of their methods and strategies of teaching so that teacher selects the appropriate method of teaching.
10. **To achieve the objectives** : It is only through evaluation we are able to find out that we achieved our objectives or not. So the success of teaching and whole educational system depends upon the evaluation.

Aims of Evaluation

These are the aims of evaluation related to the teaching of physical-science:

1. To evaluate the overall development of child.
2. To help students with respect to their problems and their solutions.
3. To evaluate achievement, interest, attitude of the students to provide timely educational, personal and vocational guidance and counseling to the needy students.
4. To provide base for remedial work by diagnosing the learning difficulties of the students.
5. To help in the selection and organization of learning experiences for the teaching of physical-science related to a particular grade and teaching- learning situation.
6. To analyze the teaching- learning methods and strategies for the teaching of specific topics of physical-science.
7. To help the science teacher for better planning and organizing his teaching task according to the needs of his students and prevailing teaching- learning situations.
8. To analyze the teacher-student behavior and help the teachers in better planning and organization of his task according to the needs of the students.
9. To analyze the effectiveness of teaching aids and various equipments used in the teaching of physical-science.
10. To help in examining the curriculum and syllabus of teaching of physical-science.

Scope of evaluation

Evaluation is a broad term. It talks about overall development of the children. The following aspects of a child's personality can be included in the scope of evaluation.

1. **Knowledge** : It includes how much subject-matter the student has learnt.

2. **Comprehension** : It talks about whether the student is able to explain and describe the learnt matter in his own language and thought.
3. **Information** : It includes his abilities to search and accumulate the required information regarding a particular topic.
4. **Skills** : It includes the entire practical in the subject and work experiences that are provided to the students which are to be practiced.
5. **Tendencies, attitudes and values** : With the methodology of teaching leaning experiences (provided by the teachers to the students.) and general classroom environment develops tendencies, attitudes and values.
6. **Mistakes of students** : Evaluation tells why mistakes are repeated. It provides remedial work and helps in reduction of mistakes in future.
7. **Physical health** : Evaluation of health determines a student's abilities and capabilities of hard work.

Advantages of evaluation

1. **Helps in the improvement of students** : Evaluation is an index of student's achievement. Its outcomes tells that there are some improvement or progress is there in a child. It also asses its qualitative value. So the assessment of the progress of the child is its main function.
2. **It reveals the strengths and weaknesses of the child** : Evaluation is a continuous process so it reveals the strengths and weaknesses of learners more frequently, so that the learners have better opportunity to understand and improve themselves.
3. **It has the twin purpose** : The syllabus provides a statement of purpose, means and standards against which one can check the effectiveness of the program and the progress made by the learners. Evaluation not only measures the progress and achievement of the learners but also the effectiveness of teaching materials and methods used for transaction. Hence evaluation should be viewed as a component of curriculum with the twin purpose of effective delivery and further improvements in the teaching-learning process.
4. **It is the fearless examination** : Evaluation is seen as an integral part built into the teaching-learning process; it will become continuous like both teaching and learning when evaluation is subsumed into teaching learning., learners will not perceive test and examination with fear, so it is the fearless examination

- which lead to diagnosis, remediation and enhancement of learning.
5. **Classification of students** : Evaluation helps in classifying the students into different grades or categories. Which student is suitable for what type of course and which students is at what level is decided through evaluation.
 6. **Helps in goal attainment** : Evaluation is goal directed and educational outcomes are judged in terms of goal attainment. Every educational programme should aim for all round development of the personality of the child. Therefore evaluation helps in the achievement of these goals by considering both scholastic and co-scholastic aspects of the child so that desirable behavioral changes should be done in the child.
 7. **Improvement in methodology** : The teacher makes use of many methods or techniques of teaching. Which is good for the learner or helps in attaining goal is decided through evaluation.
 8. **Preparation for future life** : Evaluation helps in their learners the ability to take risks, to be adaptable, to be flexible, to cope with constant change and become lifelong learners. In this context, learners become dynamic leaders with teachers as enablers.

EVALUATE YOURSELF

1. What do you mean by the Concepts of Test, Measurement and Evaluation in the field of teaching-learning process?
2. Define the concept of Evaluation in context with the field of Education. What are its various characteristics?
3. What do you mean by Evaluation? Explain the need and devices of testing students' performance in the subject of Science.
4. What do you mean by Evaluation? Explain the importance of Evaluation in teaching of Science.
5. What are the various kinds of Evaluation techniques in the Teaching Learning Process? Enlist them.
6. What do you mean by Evaluation? Discuss the need and importance of Evaluation.



CHAPTER 3

Differentiate between the terms 'Examination' and 'Evaluation'

Examination is not a continuous process; rather it a process which occurs after a period of 3 or 4 months. On the other hand Evaluation is a long and continuous process.

The two terms of evaluation and examination not only deserve to be understood but more so distinguished for being appreciated. While the *purpose* of the Examination is to identify the level of attainment at a particular point of time, that of the Evaluation is to further improve the level of attainment. With regard to *coverage*, while the latter tends to mainly focus on the academic and scholastic aspects of personality, the former attempts to bring within its purview the total personality of the student including the co-scholastic aspects. With regard to *periodicity*, while examination consists of events at fixed points of time, the former assumes the form of a process spread over the total span of the teaching and learning. The *techniques and tools* pressed into service by the latter are just a few; the former uses a wide variety of them.

Evaluation in Ancient Days and Modern Times: Our system of judging pupils in ancient times was evaluation, unlike the present one which is examination oriented. Being built into the total teaching-learning process as an integral part, our ancient system of judging student abilities was comprehensive as compared to being segmental, flexible as compared to being rigid, pupil centric as compared to being system centric.

Those who used to teach also used to test. Evaluation used to be, thus, based upon its judgments on the basis of the focused observation of the day-to-day progress and behaviour of the students, which was

DIFFERENTIATE BETWEEN THE TERMS 'EXAMINATION' 353
monitored in its varied ramifications. The judgments, though subjective, were most certainly valid and reliable. These no doubt were informal evaluations but surely more authentic than the formal ones, which the British implanted in India. The teacher was trusted and treated with respect and his assessment was *honoured* by everybody. The British system of external examinations was imposed and based rather on the mistrust of the teacher; and dubbed our ancient system as subjective. They shackled our valuable approaches with systemic and impersonal controls which robbed us of a time tested cultural heritage of accurate, dependable and just evaluation.

The newly introduced examination system, no doubt, appealed to the common man as a more methodical and systematic one. This also made its acceptance smooth. It was indeed a politically motivated decision for linking examination certification for jobs as an economically viable factor.

With the separation of pre-university education and examination, suiting the needs of the Universities (of Bombay, Calcutta and Madras) necessitated an increasing number of Secondary Schools and the establishment of school education Board, the first of which was started in U.P in 1921. While it was responsible for developing the courses of study, enunciation, teaching and learning approaches and evaluation strategies for what they are now termed as secondary and senior secondary examinations, external examinations earlier than class X were also started by the states.

Post independence Era: Developments after 1947 have been valuable and nation/local specific. The first University Education Commission, 1948, chaired by Dr. Radhakrishnan stated in unambiguous terms that if they had to suggest just one reform in the system it would be that of examination. The Commission further expressed its dissatisfaction with the cognizance to only the performance at external examinations and sidelining of class work in the final overall assessment of student abilities. It, therefore, recommended that 1/3 of the total marks be devoted to internal assessment.

This was followed by the Secondary Education Commission, 1952, chaired by Mudaliar. This commission carried forward the recommendation of the Radhakrishnan Commission still further and recommended that "the certificate awarded (to students) should contain besides the results of public examination in different subjects, the results of school tests in subjects and evaluation of personality attributes not included in the public examination as well as the gist of school records".

The work of the NCERT in Examination Reform received wide acceptance in different parts of the country. It was praised by the Kothari Commission in the following words:

"During the seven years of its existence, the Central Examination Unit has made a multi-pronged attack on the popularization of the new concept and techniques of evaluation. It has worked with thousands of secondary school teachers in seminars and workshops, introduced hundreds of training college lecturers to the new techniques, established a large pool of test items, trained paper setters attached to different Boards of Secondary Education, published a good deal of literature on evaluation and carried out and sponsored several studies and investigations on various practical problems in examination."

A less known Committee constituted just before the NPE, 1986, was the Narasimha Rao Committee on Examination Reform. The most important aspect of this report is that for each measure of examination reform suggested by it gives the benefits that it will yield to education. In fact this report laid the foundation of the NPE 1986 related to Examination Reform. The two in fact can be called mirror images of each other.

Issues Related to Evaluation

Some of the basic issues in Curriculum and Evaluation do also need to be addressed. Curriculum deserves to be treated as a coherent whole and not segmental, in spite of its distinct division's viz. Objective, Curriculum Content, Curriculum Transaction, Curriculum Material and Educational Evaluation.

Examination: Examination focuses on high-stakes educational tests, such as the central examinations in secondary education, and entrance examinations in higher education. Research topics are standard setting, linking and equating of assessments, test bias and differential item functioning, optimal test construction, and the use of innovative testing formats. Special attention is given to the methodological and psychometric foundation of these applications.

The term 'Examination' originated in the 1610s, meaning "test of knowledge."

The term Evaluation originated in 1755, meaning "action of appraising or valuing."

Evaluation: Evaluation focuses on the development and implementation of methods for educational evaluation at the extra-individual level. Important applications are large-scale national and international educational surveys and quality assurance systems.

Evaluation is perhaps the most complex and least understood of the terms. Inherent in the idea of evaluation is "value." When we evaluate, what we are doing is engaging in some process that is designed to provide information that will help us make a judgment about a given situation. Generally, any evaluation process requires:

a) Information about the situation in question. A situation is an umbrella term that takes into account such ideas as objectives, goals, standards, procedures, and so on. When we evaluate, we are saying that the process will yield information regarding the worthiness, appropriateness, goodness, validity, legality, etc., of something for which a reliable measurement or assessment has been made.

b) Temperature of the classroom they would need to get a thermometer and take several readings at different spots, and perhaps average the readings. That is simple measuring. The average temperature tells us nothing about whether or not it is appropriate for learning. In order to do that, students would have to be polled in some reliable and valid way. That polling process is what evaluation is all about. A classroom average temperature of 75 degrees is simply information. It is the context of the temperature for a particular purpose that provides the criteria for evaluation. A temperature of 75 degrees may not be very good for some students, while for others, it is ideal for learning. We evaluate every day. Teachers, in particular, are constantly evaluating students, and such evaluations are usually done in the context of comparisons between what was intended (learning, progress, behavior) and what was obtained.

EVALUATE YOURSELF

1. Differentiate between the terms "Examination" and "Evaluation" while evaluating outcomes in teaching.
2. Write a note on "Evaluation" in the ancient days and modern times.
3. Write about the introduction of Examination system in India initiated by the British Government.

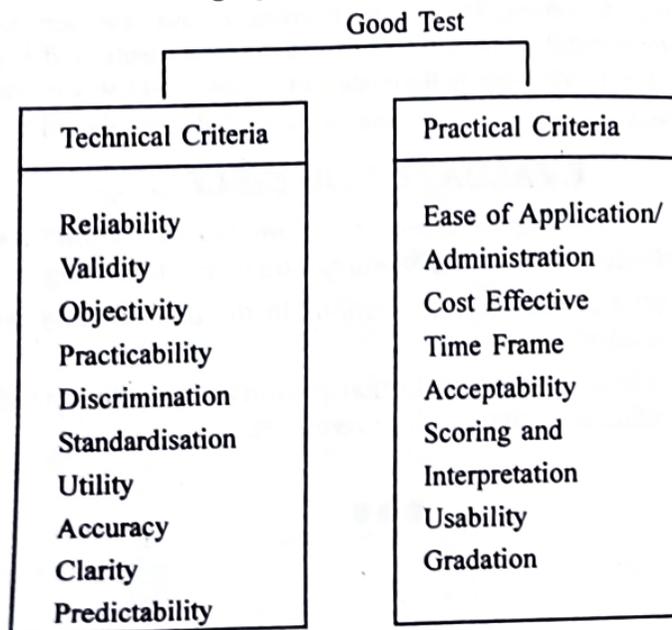


CHAPTER 4

Qualities of a Good Test, Principles and Steps in Construction and Use of an Achievement Test, Blue Print and Question Paper, Item Analysis, Construction of Multiple Choice Questions, Diagnostic Test, Remedial Teaching in Physical Sciences

Qualities of a Good Test

The following figure represents the criteria of a good test :



- **Validity** : A test is said to be valid when it measures what it claims to measure. For example,, a test of science should not measures linguistic ability. It must measure the acquisition of scientific knowledge for it to be valid.
- **Reliability** : A test is reliable to the extent that it measures consistently, from one time to another. It must functions similarly with similar groups. It should rate the same candidates with the same or different examiners at the same or different times. The difference in score should be negligible.
- **Objectivity** : A test should yield a clear score value for each performance the score being independent of the personal judgement of the scores i.e. an objective test should yield the same or the nearly the same score, irrespective of the person scoring it.
- **Practicability** : It should be easy to administer. It should be suitable for both bright and dull students. It should neither be too long nor too short. It should be useful and acceptable to both teachers and students.
- **Discrimination** : Test item must discriminate students a widely as possible. As discrimination can distinguish between a person with greater or less ability. So that they score more or less point or marks.
- **Standardisation** : A test should have all defined s'eps. If reliability and validity of an item is known, it is called its standardization.
- **Utility** : An item should be easy and simple which should involve less time. A test item should expense negligibility. The questions should neither be too difficult nor too easy.
- **Accuracy** : It deals with the ability of an item to measure least count or smallest measurement that can be made with the help of the test i called accuracy.
- **Clarity** : The language used in the questions should be simple. clear precise, specific, easy to comprehend and unambiguous.
- **Graded** : A test should be graded according to the age, intelligence, maturity level of students.
- **Predictability** : A test item can give a forecast of the possibilities oTTne students. Thus predictability is to say in advance what is expected to happen.

- **Economical** : A test should be economical both in terms of cost and time.
- **Scoreable** : The test should be such that during scoring subjectivity can be kept at a minimum and the scorer doesn't get bored due to monotony or laborious nature of paper.
- **Simplicity of Administration, Scoring and Interpretation** : It should be easy to administer, score and interpret clear-cut instructions for administration must be provided. A score key/guide must accompany the test.

Principals and Steps in Construction and use of an Achievement Test in Physical Science

An Achievement test is an important tool in the school evaluation programme. It is necessary for the teacher to know how for the pupils have attained in a particular subject area. Therefore, achievement test is employed for measuring the amount success or level of an individual in a specific field or an area of accomplishment. So, achievement test is post-oriented. Therefore, any test designed to measure the various achievements of a student in a school after a period of training of learning is called an Achievement Test.

Definitions of Achievement Test :

"The type of ability test that describes what a person has learned to do is called an Achievement Test." —Thorndike and Hagen

"Any test that measures the attainments or accomplishments of an individual after a period of training of learning is called as an Achievement Test." —N.M. Downie

"Any Achievement or proficiency test is used to ascertain what and how much has been learnt or how well a task can be performed, the focus is on evaluation of the past without reference to the future, except for the implicit assumption that acquired skills and knowledge will be useful in their own right in the future." —Super

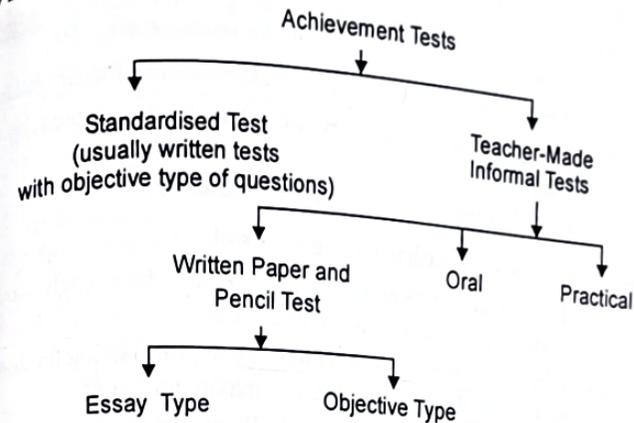
"Achievement Test is a test designed to measure knowledge, understanding and skills in a specified subject or a group of subjects."

—Freeman

Assessment involves collecting information about students knowledge, skill and abilities. An Achievement Test is a formal assessment. The test helps the teacher to understand the level of comprehension of the students in a particular subject and helps him to estimate the capabilities of the students.

In the school evaluation programmes, various forms of achievement tests are used to measure the extent of learning of the pupils. So it is

Types of Achievement Test



Difference between Teacher-Made and Standardised Tests

Teacher-Made Test	Standardised Test
1. Quality of test item is unknown	1. Quality of Test items is known.
2. Used to evaluate the content and outcomes of the school curriculum	2. Used to evaluate common content and outcome of a number of schools
3. These are not reliable	3. These are reliable
4. These are flexible in Administration	4. The administration produced is standard based on given instruction.
5. Scores cannot be compared with another sample or content	5. Scores can be compared on norm groups.

Important Features of Achievement Test :

- (1) Its main purpose is to measure the modification of behaviour brought about by learning.
- (2) In achievement test weightage should be given to knowledge, understanding, application and skill according to behaviours to be measured.
- (3) A good achievement test is tried out and selected on the basis of its difficulty level and discriminating power.
- (4) It is accompanied by norms which are developed at various levels and on various age groups.
- (5) It should have description of measured behaviour.
- (6) It includes a test manual for its administering and scoring.

Purpose of Achievement Tests :

- (1) Its purpose is assessing the performance of the students.
- (2) It motivates the students.
- (3) Its purpose is to diagnose the strength and weaknesses of the students.
- (4) It report the parents about the achievement of their children.
- (5) It tells about the effectiveness of methods adopted by the teacher.
- (6) It predict the future progress of the child.

Functions/Uses of Achievement Test

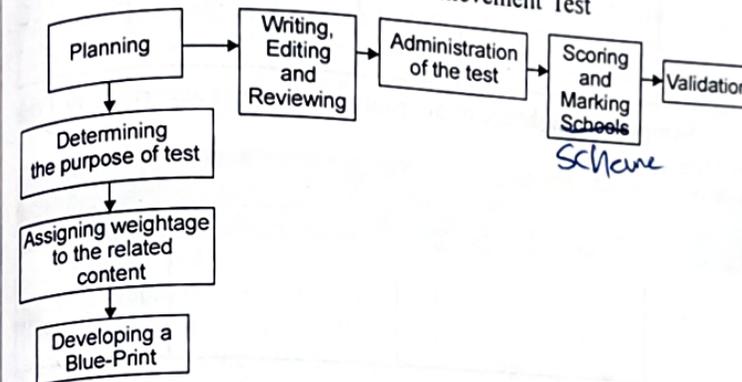
- (1) To find at the beginning of the year where each student stands in the various academic areas.
- (2) It helps the teacher in selecting the appropriate methodology so that all the students got the maximum benefits.
- (3) The teacher can classify the brilliant and slow-learners.
- (4) To provide basis for promotion to the next class.
- (5) The teacher is able to diagnose the strength and weakness of the students in various subjects.
- (6) To expose pupil's difficulties which the teacher can help them to solve.
- (7) Students are motivated to work hard for removing their shortcomings.
- (8) These tests help to select students for the awards and scholarships.
- (9) It helps the teacher to evaluate whether his teaching is proper or not.
- (10) It helps in placement of students in various fields.
- (11) Tests help to determine the efficiency of one school with the others.
- (12) To evaluate, revise and improve the curriculum in the light of these results.
- (13) Tests help to select talented or gifted students for special classes or courses.
- (14) Tests help to evaluate the extent to which the objectives of education are being achieved.
- (15) Tests help to classify school objectives.

Construction of an Achievement Test

Generally the Achievement Tests that are conducted in schools are prepared by teachers by considering certain principles and objectives in mind. A teacher prepares the test, and gives due weightage to instructional

QUALITIES OF A GOOD TEST, PRINCIPLES AND STEPS IN...

- objectives, content distribution and difficulty level. These tests help in :
- (a) Understanding the success of a teaching method.
 - (b) Identifying the strengths and weakness of the students.
 - (c) Developing the remedial measures.
 - (d) Application of knowledge gained.

Steps in the construction of an Achievement Test

(1) **Planning** : The test constructor, who plunges directly into item writing, is likely to produce an inconsistent test. Without any advance plan, some area of syllabus will be over emphasized while others may remain untouched. A test constructed without a blueprint is likely to be unbalanced and representative of teacher's interest. Much of the criticism has been done of the objective test system for over emphasis on rote memory and disproportioned in coverage of the syllabus. Test specification should draw up before the items are prepared.

1.1 Determining the purpose of Test : The test is developed by the teacher to assess the student's achievement. This step also includes determining the contents to be included and the related instructional objectives to be achieved.

1.2 Assigning Weightage to the Related Content : This includes assigning marks to the topics that are included in the contents according to their importance and relevance. This can be done according to instructional objectives, units and sub-units of types/forms of questions. A sample is shown below :

Sample of Weightage of Distribution of Marks According to Instructional Objectives

S.No.	Instructional Objectives	Marks	%age of marks
1.	Knowledge		
2.	Understanding		
3.	Application		
4.	Skill		

Sample of Weightage of Distribution of marks according to Content

S.No.	Units/Sub-Units	Marks	Units/Sub-Units	Marks

Sample of weightage of distribution of marks according to Type of Questions

S.No.	Type of Question	Marks for each question	No. of questions

Developing Blue Print : A blue-print is a sort of the design for the test paper in which a detailed question-wise distribution of marks over specific objectives, topics and forms of questions are presented. All the steps discussed above should be borne in mind before preparing a blue-print.

A Sample of Blue Print

Examination Paper Subject
 Class Time M.Marks

Objectives	Knowledge			Understanding			Application			Skill			Total	
	E	SA	VSA	E	SA	VSA	E	SA	VSA	E	SA	VSA		
Questions														
1														
2														
3														
4														
5														
Sub-Total														
Total														

E = Essay Type Questions, SA = Short Answer Type Questions
 VSA = Very Short Answer Type Questions

2. Writing, Editing and Reviewing : The second step in the construction of the achievement test is the writing the test items. Following the scheme in Blue-Print the investigator write the multiple choice items related to the different content areas.

Questions can be written in the following ways – writing all the questions at one time, writing questions according to their form or types of writing questions unit wise so that the whole syllabus to be covered in the test. Questions should not be ambiguous or out of syllabus. Various types of questions like sentence completion, True or False, Matching Type can be included according to the blueprint prepared.

Marking Scheme : The marking scheme ensures objectivity in judgement and eliminates differences in score which may be due to idiosyncrasies of the evaluator.

Editing and Reviewing : A preliminary draft of the achievement test thus prepared was firmly edited by the teacher herself and secondly it was given to some other subject expert to check the accuracy of the content and language. It was accordingly edited and reviewed. After required correction, final draft of the Achievement Test was prepared.

3 Administration : The achievement test would have served its purpose only after it is properly administered. Decision regarding time and place of administration have to be taken. The best of tests when badly administered can give faulty and unreliable results, hence utmost care has to be given to conduct of the test.

Instructions :

- (i) Do not discuss anything with your neighbours.
- (ii) Do not make unnecessary haste to finish the test.
- (iii) Please see that no item is left out, you have to answer all the items.
- (iv) Please go through the written instructions carefully before starting.
- (v) Please write your Roll No. and Name before Start.

Time-Limit : Instructions related to time are given.

4. Scoring Key and Marking Scheme : For the objective type questions a scoring key and for short answers and essay type questions a marking scheme is prepared. The marking scheme indicates :

- (I) No. of points expected for the answer.
- (II) The outline of each point or answer.
- (III) The weightage to each point.

5. Validation : Validation of the test items means examining the extent to which the test item reflects on the functional utility on each

item. Such a scrutiny determines whether an item is worth being included in the test or not.

For this Item analysis is being done :

(i) Difficulty Value

(ii) Discrimination Index

(i) **Difficulty Value** : An item's difficulty value is defined as the pass % i.e. % of pupils who got the item right.

$$D_v = \frac{R_u + R_L}{N} \times 100$$

D_v = Difficulty Value, R = Right Response, N = Total Pupils

(ii) **Discrimination Index or Power** : It refers to the degrees to which it can effectively discriminate between pupils with high score and those with low scores.

$$D.P. = \frac{R_u - R_L}{1/2 N}$$

where DP = Discrimination Power, N = No. of Pupil

R_u = Right Responses in Upper Group,

R_L = Right Responses in Lower Group

This tells about the overall effectiveness of distractors in the given item.

Preparation of an Objective Type Achievement Test in Physical Sciences

Class : IX

Time : 25 minutes

Topic : Kinetics, Dynamics

M. Marks : 25

Note : All the questions are compulsory. Questions to be answered in the space provided.

1. Fill in the blanks (5 marks)

(i) 1 Newton = _____ dynes

(ii) Unit of Velocity in M.K.S. System _____

(iii) A person standing in a bus falls backward when the bus suddenly starts because of _____

(iv) A vertically projected body travels with _____

(v) Vectors has both _____ and magnitude.

2. Choose the correct answer from the multiple choices and write it in the given space on the right hand side of the question : (5 marks)

- QUALITY PRINCIPLES AND STEPS IN... 365
- (I) A body of mass m starts from rest with a constant power. If velocity of the body at displacement S is V , then the correct alternative is
 (a) SaV (b) SaV^2 (c) SaV^3 (d) SaV^4
- (II) If a body of mass 10 kgs travels with velocity of 50 m/s, then the momentum of body is
 (a) 5 (b) 1/5 (c) 500 (d) None
- (III) Which of the following is a scalar quantity ?
 (a) Velocity (b) Force
 (c) Time (d) Displacement
- (IV) If linear momentum is increased by 50% then kinetic energy will be increased by
 (a) 50% (b) 100% (c) 125% (d) 25%
- (V) Work done by a spring force is
 (a) Always Negative (b) Always Positive
 (c) Always Zero (d) May be positive and negative

3. Match the following :

(6 marks)

Column A	Column B
A. Force of Friction	Change in kinetic energy
B. Normal Reaction on a block kept on horizontal ground	Change in mechanical energy
C. Work done by all forces	Can be less than mg
D. Work done by all forces other than conservative forces	Can be equal to mg

4. State True or False (T/F) :

(6 marks)

- (i) Velocity, Force are the examples of scalars.
 (ii) Work done by the net force acting on a particle is equal to the change in kinetic energy.
 (iii) Change in potential energy is always equal to the work done by external forces.
 (iv) Work and energy have the same SI units.
 (v) Newton's laws are valid only in frames at rest.
 (vi) If a spring is elongated it does positive work.

5. Answer the following in one word : (5 marks)
- What is Newton's third law of Motion ?
 - What is the relation between acceleration and force ?
 - $m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$. Write this equation in term of principle of conservation of momentum.
 - Define law of conservation ?
 - One difference between velocity and speed ?
 - Examples of scalars.
 - Why does a person run a very long distance before he takes a long jump ?

Scoring Key

1. (I) 10^5 (II) m/sec (III) Inertia of Rest
(IV) Retardation (V) direction
2. (I) 3 (II) 3 (III) 3 (IV) 3 (V) 4
3. (1) (a) 4 (b) 3 (c) 1 (d) 2
(2) (a) 4 (b) 3 (c) 2 (d) 1
4. (I) False (II) True (III) False (IV) True (V) False
(VI) False
5. (1) There is equal and opposite reaction for every action.
(2) Directly proportional
(3) Total momentum before collision is equal to total momentum after collision.
(4) The sum of the weights of the reactants is exactly equal to the sum of weights of the products.
(5) Velocity is a vector, speed is scalar
(6) Length, Time and Volume
(7) To gain Inertia of motion.

ITEM ANALYSIS

Meaning of Item Analysis

- The analysis of students' responses to each item on the test is called item analysis.

Importance of Item Analysis: Item analysis data are useful in:

- Improving the test,
- Serving as a basis for class discussion,
- In diagnosing the students' strengths and weaknesses, and

Item Analysis Deals With:

- Item Difficulty
- Item Discrimination
- Effectiveness of distracters

Item Analysis Questions:

- Does the item discriminate between the good and the poor student?
- How difficult is the item?
- How effective is each distractor in the item?

Steps / Procedure of Item Analysis:

- Step 1:
After scoring the test, arrange the test papers in order, from the highest score to the lowest score.
- Step 2:
Select the 25% percent of the papers with the highest score and call at the High Scoring Group (HSG).
Select the same number of papers with the lowest score and the call at Low Scoring Group (LSG).
The middle group of papers is not needed in item analysis.
- Step-3
Prepare Tabulation Sheet
Item analysis working Sheet
Item Difficulty

Item Difficulty Definition: The difficulty of an item is defined as "the percentage of student who got the item right."

Item Difficulty Formula:

$$P = \frac{H + L}{N} (100)$$

In which

P = index of item difficulty

H = Number of students in the High Scoring Group who got the item right

L = Number of students in the Low Scoring Group who got the item right

N = Total number of students (HSG+LSG)

- **Item Difficulty Interpretation:**
- Range = 0 - 100
- Easy Item = Above 70%
- Moderate (Average) = 30-70%
- Difficult = Below 30 %

2. Discrimination Power:

- **Definition:** The ability of the test to differentiate between good (Height Scoring) and poor (Low Scoring) students.

Formula of Discrimination Index:

$$D = \frac{H - L}{N/2}$$

In which

D = index of discrimination

H = Number of student in the high scoring Group who got the item right

L = Number of student in the low scoring group who got the item right.

N = Total number of students in both (HSG+LSG)

Example:

- What is the Index of discrimination of Item 3 in Above Table?

$$D = \frac{H - L}{N/2}$$

$$D = \frac{7 - 2}{20/2}$$

$$D = 0.5 \text{ Answer}$$

Interpretation:

- **Range =** (+1) — 0 — (-1)
- Maximum size Zero Minimum Size

Construction of Multiple Choice Questions

The student has to choose from a list of possible answers that which is most correct.

"A multiple choice item has two parts: the stem consisting of a direct question or an incomplete statement and two or more options consisting of answers to questions or completion of the statement."

—R.L. Ebel and D.A. Frisbie (1986)

A multiple item consists of two parts :

1. The 'stem' which contains the problem.
2. Options or Response i.e. list of suggested answers.

Different Forms of MCQ's :

- (a) **The correct answer form :** It contains three or more choices but only one of them is correct.
- (b) **The best answer form :** One or more or all choices may be correct but one of them is the best answer. The examinee is required to select the best one.
- (c) **The multiple response form :** The correct answer may consist of more than one choices and the examinee is asked to identify all those which are correct.
- (d) **The incomplete statement form :** The stem is incomplete and can be completed by the correct choice. The examinee is asked to select the correct one.
- (e) **The substitution form :** The word outlined in the stem is to be substituted by the correct response. Responses are given and the examinee is asked to select the one which can substitute the desired word.
- (f) **The combined response form :** The choices are different phrases or sentences of a paragraph. The examinee is required to correct the order of the phrases or sentences.

E.g. : (1) Which of the following is the normal temperature of a human body :

- | | |
|------------|------------|
| (a) 98.4°C | (b) 98.4°C |
| (c) 98.4°C | (d) 100°C |
| (e) 97.4°F | |

Advantages :

- (1) If properly constructed they are valid and reliable.
- (2) Wide range of subject matter can be covered.
- (3) They are easy to score
- (4) These items can be objectively scored and intended outcomes are evaluated.

Disadvantages :

- It makes the job of teacher difficult
- It becomes cumbersome and laborious.
- The choice of distractors is difficult.
- Setting of timeframe is difficult.

CONSTRUCTION & USE OF DIAGNOSTIC TEST IN PHYSICAL SCIENCE

WHAT IS A DIAGNOSTIC TEST? A Diagnostic Test is a test with items in a multiple-choice or short-answer format that has been designed with common misconceptions in mind.

STEPS FOR CONSTRUCTION OF DIAGNOSTIC TEST IN SCIENCE: The following steps are used for diagnostic test in Science:

- i. Preparation of the final draft of the test.
- ii. To prepare properly graded objective type of test items suiting to the concept and expected level of performance and the anticipated weakness deficiencies and difficulties of the students.
- iii. To be definite about the minimum expected level of performances with regard to the behavioural changes in the acquisition of knowledge and understanding, skills, application, interests, appreciations etc.
- iv. Analysis of the concepts in terms of the specific learning outcomes and behavioural changes.
- v. Identification of the major concepts to be developed through the instruction of a particular unit, lesson or content material.

WHY USE DIAGNOSTIC TESTS? Diagnostic Tests are used to assess how well students understand key concepts in a Physical Science topic -prior to, during, and after instruction. All students bring prior knowledge, skills, and experiences with them to school and they are dependent on this prior learning to make sense of new learning. To be effective, teachers need to find out just what it is that their students already know and can do. This is particularly important for students who do not share the same cultural background as their teacher. They will come to school with rather different packages of knowledge, skills, and experiences with which to make sense of new learning.

SOME SUGGESTIONS FOR DIAGNOSTIC TESTS :

- Strengths and gaps in content knowledge can be identified from assessments and units of work.

- Literacy and numeracy testing can identify whether lack of reading skills or number understanding are barriers to learning.
- The achievement criteria from the standards (for example, demonstrate understanding, explain, analyze, evaluate) can be a guide for what to look for when students are engaged in discussion or oral explanation.
- Use "know, want to know, and learned" (KWL) charts as the basis for a class or individual activity.
- Use trigger activities (for example, movie clips, YouTube clips, newspaper articles, guest speakers, charts) to stimulate curiosity and elicit prior knowledge.
- Set up structured learning conversations or interviews: teacher-student or student-student.
- Set up practical activities that allow students to demonstrate what they know, for example, creating a chart of definitions by matching cards.
- Observe students in practical activities for leadership, interpersonal skills, risk management, practical performance.
- Assign a rich task as a diagnostic tool. Observe how students approach it and what they make of it.
- Set an activity to be done in co-operative learning groups.
- Direct questioning has a place: teacher to student, student to student, student to teacher.

PREPARATION OF DIAGNOSTIC CHART

There are many stages of planning but diagnosis or stocktaking is the most important one. It has got twin objectives of identifying educationally backward areas and focuses and target groups, which need attention of planners and require immediate intervention. The diagnosis exercise may also result into identification of a variety of problems that a particular system is facing.

A variety of information is required for the preparation of the diagnosis chart. The information required can be classified as primary and secondary data, time-series and cross-sectional data, quantitative and qualitative data, information at micro and macro levels and also under the formal and non-formal system of education. In other words, all the possible sources that give information on upper primary education should be explored as this will help to correctly analyze the educational development in a district and its blocks.

Generally, information available through secondary sources is used in the diagnosis but variables on which information is not readily available can be collected from the field, which is termed as primary data. This set of data is then converted into the form of indicators so as to take stock of the situation. Both the cross-sectional and time-series data are used in the diagnosis exercise that depends upon the nature of the variable, which is under study. Generally, cross-sectional data are used to take stock of the situation but there are a few variables, such as enrolment, age-specific population etc., which need time-series data.

IDENTIFICATION OF DIFFICULTIES & REMEDIAL TEACHING

Remedial Teaching is identifying slow learners and giving them the necessary guidance to help them overcome their problems, after identifying their areas of difficulty. Contrary to what is said, remedial teaching is done perfunctorily without identifying their areas of difficulty and underlying cause for lagging behind. Some students are unsympathetically branded as 'block heads' without an earnest attempt to know the real cause of their slow learning.

Who is a slow learner? In the present system of education, students are identified as slow learners purely on the basis of their poor performance in the examination, which, in most cases deviates from what is taught. Consequently even talented students are sometimes misconstrued as dullards. So, a slow learner is one whose performance is very dismal in the examination. He is neither mentally retarded nor is on the lower rungs of intelligence scale.

The reasons for some students learning slowly are innumerable. One of the main reasons is the 'no detention system' at the primary and upper primary level. Students are promoted to higher classes on the basis of attendance, even if they score low marks. The heterogeneous composition (mental age & physical age) of overcrowded classes in all government run schools and private schools also produces slow learners. So the incapacity of the teacher to pay individual attention to a student over a long period makes a student a slow learner. A slow learner is thus a product of negligence of school at different stages of learning, in spite of his innate capacity to learn.

There are some problems very specific to the individual. Ill health, lack of concentration, less exposure to the subject taught and parental background are some causative factors for slow learning. Talents differ. A child's capacity to learn different subjects varies from student to student. For instance, learning mathematics is a knack. All students do not do well in mathematics just as they do in other subjects. While other subjects can be learnt at any stage, it is very difficult for students to

QUALITATIVE PRINCIPLES AND STEPS IN...
 learn mathematics without the basics. Students show interest in the subjects they like and neglect other subjects if not taken care of. An urban child learns languages like English well while a rural child cannot, however well the teacher tries to explain.

REMEDIAL MEASURES:

Learning takes place from simple to complex. If for some reason the student has not learnt the basics, it is futile to teach him the advanced topics. Remedial teaching is not revising the topics taught repeatedly. Careful analysis of the students' performance in the examination and diagnosing the areas of difficulty are key aspects in remedial teaching. Once the difficult areas are identified, the next task is to plan the learning experiences to teach the basics to understand the given topic.

Teachers often feel that what has not been learnt at the primary level, cannot be taught simultaneously with the prescribed topics at the secondary level as they are busy completing the syllabus. Experience shows that once the basics are taught, the learning process is accelerated and the slow learners comprehend and grasp the given topics of the class, since they have already attained the mental age.

In government run residential schools in Andhra Pradesh and Jawahar Navodaya Vidyalayas nationwide, the students are admitted in class VI based on a selection test consisting of a variety of questions to test intelligence and aptitude of the students.

It has been observed that many students thus selected do not possess the basics which they are supposed to learn at the primary level. But these schools have produced excellent results over the years by introducing bridge courses in their academic planning.

Subjects like physics pose difficulty for students when compared to biology. In biological sciences, students can see and find meaning in what they study whereas physics is somewhat intricate and difficult for students without good knowledge of mathematics. Poor performance in physics can be remedied by first teaching the required basic mathematical operations. Sometimes language becomes a barrier for students to understand the vast areas in subjects like geography. The innumerable new words used to describe various phenomena baffle the students. The teacher has to explain all the words and their usage related to his subject before he teaches the concept.

The new words used in questions could confuse students and elicit wrong answers from them. Students should be exposed to a variety of questions with antonyms and synonyms - all the words used to frame a question to test the topic taught. Merely tagging the slow learners with

bright students or segregating them into separate sections will not help the slow learners.

Students learn a lot from the peer group. Unconscious learning does not take place if students are segregated. Keeping the slow learners in the peer group of bright students and paying individual attention to them by the teacher will enable them to overcome their difficulties.

Student is central in the learning process. When group discussions are held in the classroom, the slow learners are benefited much. Suitably tailored lesson plan by the teacher and careful monitoring by the school administration will help slow learners have a better grasp of all lessons in schools.

EVALUATE YOURSELF

1. What are the qualities of a Good Test based both on Technical Criteria and Practical Criteria?
2. What are the principles and steps in Construction and Use of an Achievement Test in Physical Science education?
3. Draw a blue print of a Good Test in Physical Science? What things should be taken into consideration while drawing a blue print for a test in Physical Science?
4. Prepare an Objective Type Achievement Test in Physical Sciences.
5. What is Item Analysis in the field of teaching? What is its importance? Also give the formula for its calculation.
6. What do you know about Multiple Choice Questions? What are their advantages and disadvantages?
7. What is a Diagnostic Test in Physical Science? What are its uses? What are the steps involved for construction of diagnostic test in science?
8. Write some suggestions for making the Diagnostic Test more useful? How to prepare the Diagnostic Chart?
9. Write a note on identification of difficulties and remedial teaching in Physical Sciences.



CHAPTER 5

Continuous and Comprehensive Evaluation (CCE) in Physical Science

CONTINUOUS AND COMPREHENSIVE EVALUATION

Excellence in diverse area should be recognized and rewarded. And it is children's responsiveness to what is taught rather than just their capacity to retain it that should be the focus of evaluation.

NCF-2005 –NCERT

Examinations are an indispensable part of the educational process or some form of assessment is necessary to determine the effectiveness of teaching learning process and their internalization by learners. Various commissions and committees have felt the need for examination reforms. The Hunter commission (1882), Calcutta University Commission or Sadler commission (1917-1919), Hartog committee report (1929), secondary education commission (1952-53) have all made recommendations regarding reducing emphasis on external examination and encouraging internal assessment through continuous and comprehensive evaluation.

National Policy of Education (NPE-1986); states that "Continuous and Comprehensive Evaluation" that incorporates both scholastic and non-scholastic aspects of evaluation, spread over the total span of instructional time".

Report on the committee for review of NPE (1986) recommendation brought out by government of India in 1991 lays down norms for "Continuous comprehensive internal evaluation and suggests. Safeguards against abuse of this evaluation system.

Need of continuous and comprehensive evaluation

Success in education is determined by the extent to which the learning objectives are realized. The progress towards attainment of objectives has to be assessed and evaluated for otherwise; we will not know where we are going.

One of the main purpose of evaluation at school stage is to help the learner's improve their achievement in scholastic areas and to develop life skills and attitudes with reference to the larger context and canvas of life. Hence it is only CCE which intended to provide a holistic profile of the learner through assessment of both scholastic and non-scholastic aspects of education which helps in identifying the positive attributes of the learner which are usually not assessed during the examination.

Meaning of Continuous and Comprehensive Evaluation

Continuous and comprehensive evaluation (CCE) refers to a system of school-based evaluation of student that covers all aspects of students development.

It is a development process of assessment which emphasizes on two fold objectives. These objectives are continuity in evaluation and assessment of broad based learning and behavioral outcomes on the other.

The first term 'Continuous' is meant to emphasize that evaluation of identified aspects of students 'growth and development' is a continuous process rather than an event, built into the total teaching-learning process and spread over the entire span of academic session. It means regularity of assessment, frequency of unit testing, diagnosis of learning gaps, use of corrective measures, retesting and feedback of evidence to teachers and students for their self-evaluation.

The second term 'Comprehensive' means that the scheme attempts to cover both the scholastic and the co-scholastic aspects of students' growth and development. Since abilities, attitudes and aptitudes can manifest themselves in forms other than the written word, the term refers to application of variety of tools and techniques (both testing and non-testing) an aims at assessing a learner's development in areas of learning like:

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> Knowledge | <input type="checkbox"/> Understanding (comprehension) |
| <input type="checkbox"/> Applying | <input type="checkbox"/> Analyzing |
| <input type="checkbox"/> Evaluating | <input type="checkbox"/> Creativity |

So CCE is a curricular initiative, attempting to shift emphasis from *testing* to holistic learning. It aims at creating good citizens possessing *sound health*, appropriate skills and desirable qualities besides academic

CON...VE EVALUATION..... 377
excellence. It is hoped that this will equip the learners to meet the challenges of life with confidence and success.

The objectives of CCE

- To help develop cognitive, psychomotor and affective skills.
- To lay emphasis on thought process and de-emphasise memorization.
 - To make evaluation an integral part of teaching- learning process.
 - To use evaluation for improvement of student achievement and teaching-learning strategies on the basis of regular diagnosis followed by remedial instruction.
 - To use evaluation as a quality control devise to maintain desired standard of performance.
 - To determine social utility, desirability or effectiveness of a programme and take appropriate decision about the learner, the process of learning and the learning environment.
 - To make the process of teaching and learning a learner- centered activity.

WHAT SHOULD BE ASSESSED?

Since education is concerned with the total all-round development of the child, (physical, socio-emotional, intellectual etc) all aspects of the child's development need to be assessed. At the moment we do not assess the whole child, but only his or her academic achievement in specific areas. We assess learner's basically on examination results, we do not assess effort, performance, attitudes to learning, ability to practically apply what is learned in everyday situations, nor do we assess them on how creatively they use techniques or critically evaluate different theories.

To make the process more comprehensive in nature, It is important that assessment of the child's learning be done in a whole range of situations and environments both in and out of the classroom. The assessment process also needs to be part of the way of providing information and feedback on the extent to which the school and teachers have been successful in realizing the expected outcomes of education.

In view of getting a complete picture of the child's learning, assessment should focus on the learner's ability to-

- Learn and acquire desired skills related to different subject areas.
- Acquire level of achievement in different subject areas in the requisite measure.

- ❑ Develop child's individual skills, interests, attitudes and motivation.
- ❑ Understand and lead a healthy and a productive life.
- ❑ Monitor the changes takes place in child's learning, behavior and progress over time.
- ❑ Respond to different situations and opportunities both in and out of school.

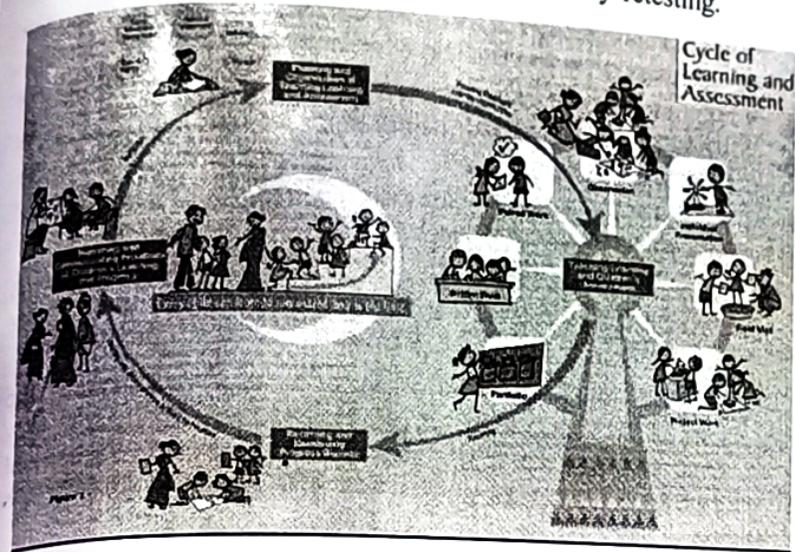
Apply what is learned in a variety of environments, circumstances and situations:

- ❑ Work independently, collaboratively and harmoniously.
- ❑ Analyze and evaluate
- ❑ Be aware of social and environmental issues.
- ❑ Participate in social and environmental projects and courses.
- ❑ Retain what is learned over a period of time.

Features of continuous and comprehensive Evaluations:-

1. The 'continuous' aspect of CCE takes care of 'continual' and 'periodicity' aspect of evaluation.
2. Continual means assessment of student in the beginning of instructions (placement evaluation) and assessment during the instructional process (formative evaluation) done informally using multiple techniques of evaluation.
3. Periodicity means assessment of performance done frequently at the end of unit/term (summative).
4. The 'comprehensive' component of CCE takes care of assessment of all round development of the child's personality. It includes assessment of scholastic as well as co-scholastic aspects of the pupil's growth.
 - ✓ **Scholastic:** The desirable behavior related to the Learner's knowledge, understanding, application, evaluation, analysis and creating in subject of scholastic domain.
 - ✓ **Co-scholastic:** The desirable behavior related to learner's life skills, attitudes, Interests, value, co-curricular activities and physical health are acquired in Co-scholastic domain.
5. Assessment in scholastic areas is done informally and formally using multiple techniques of evaluation continually and periodically. The diagnostic evaluation takes place at the end of unit/term test. The causes of for performance in some units

with appropriate interventions followed by retesting.



6. Assessment in co-scholastic area is done using multiple techniques on the basis of unidentified criteria, while assessment in life skills is done on the basis of indicators of assessment and checklists.

Functions of comprehensive and continuous evaluation

- ❑ In the teaching-learning process, the evaluation is expected to take care of scholastic and co-scholastic aspects. If a child is weak in some area, diagnostic evaluation and remedial measure should be adopted.

Important functions of continuous and comprehensive evaluations are as follows:

- ❑ It helps the teacher to organize effective teachings strategies.
- ❑ Continuous evaluation helps in regular assessment to the extent and degree of Learner's progress (ability and achievement with reference to specific scholastic and co-scholastic area}
- ❑ Continuous evaluation serves to diagnose weaknesses and permits the teacher to ascertain the individual learner's strengths and weaknesses and her needs. It provides immediate feedback to the teacher, who can then decide whether a particular unit or concept needs re-teaching in the whole class or whether a few individuals are need of remedial instruction.
- ❑ By continuous evaluation, children can know their strengths and weakness. It provides the child a realistic self assessment

of how she studies. It can motivate children to develop good study habits, to correct, and to direct their activities towards the achievement of desired goals. It helps a learner to determine the areas of instruction in which more emphasis is required.

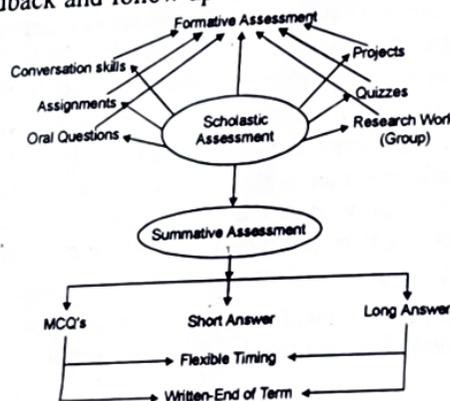
- Continuous and comprehensive evaluation identifies areas of aptitude and interest. It helps in identifying changes in attitudes, and value systems.
- It helps in making decisions for the future, regarding choice of subjects, courses and careers.
- It provides information/reports on the progress of students in scholastic and co-scholastic areas and thus helps in predicting the future success of the learner.

Continuous evaluation helps in bringing awareness of the achievement of the child, teacher and parents from time to time. They can look into probable cause of the fail in achievement if any, and may take remedial measure of instruction in which more emphasis is required.

Many times, because of some personal reasons, family problems or adjustment problem, the children start neglecting their studies, resulting in sudden fall in their achievement.

If the teacher, child and parents do not come to know about this sudden fall in the achievement and the neglect in studies by the child continues for a longer period then it will result in poor achievement and a permanent deficiency in learning for the child.

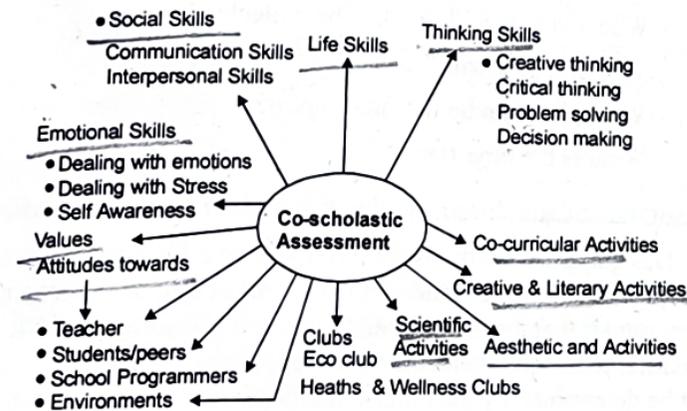
The major emphasis of CCE is on the continuous growth of students ensuring their intellectual, emotional, physical, cultural and, social development and therefore will not be merely limited to assessment of learner's scholastic attainments. It uses assessment as a means of motivating learners in further programmers to provide information for arranging feedback and follow up work to improve upon the learning in



the classroom and to present a comprehensive pictures of a learner's profile.

Limitations of Continuous and Comprehensive Evaluation

- The CCE may not be successful in a crowded class-room.
- It is not possible for a teacher to do CCE without knowing his students and their background.
- Some teachers and examinees threaten their students and make them insecure.
- It is more laborious and time-consuming.
- The CCE may work only when there is happy and healthy teacher – taught relationship.
- This can be developed by a true and devoted teacher having the thorough knowledge of the techniques of evaluation.
- The observations and judgment of teacher may not be free from favorites, prejudices and partiality i.e teacher may fail to maintain objectives in their role.
- In absence of sense of impartiality and resistance to pressures, CCE may become a mockery.



EVALUATE YOURSELF

1. What do you know about Continuous and Comprehensive Evaluation (CCE) in Physical Sciences? What is the need of CCE? What are the objectives of CCE?
2. Explain the features and functions of CCE. What are its limitations?

CHAPTER 6

Selection of Appropriate Evaluation Technique

Introduction :

It is often tempting to go in for an Evaluation Technique without taking the time to plan first. Planning is a crucial part of the Evaluation process. The key questions to ask are:

- What are we trying to achieve?
- Is the role of the group to advise or steer the project?
- Who and how will the data be collected?
- Who and how will the data be analyzed?
- Who will write up the final report?
- What is the time frame?

Selection of an Appropriate Evaluation Technique :

Designing the methods that you will use for your evaluation can seem quite daunting, but it need not be complicated or challenging. What is important is that the methods and tools you use are appropriate for your evaluation technique. Selection of an appropriate Evaluation Technique must be determined by the aims and objectives of your evaluation.

Quantitative and qualitative methods represent different ways data can be collected and used to evaluate:

- Quantitative approaches give numerical results. For example, the percentage of participants still exercising six months after completing a cardiac rehabilitation programme. Quantitative methods are most often used to assess a project's outcome.

SELECTION OF APPROPRIATE EVALUATION TECHNIQUE

Qualitative approaches use narrative or descriptive data rather than numbers. For example, a description of the views and attitudes of those completing a cardiac rehabilitation programme, and their thoughts on how it could be improved. Qualitative methods are most often used in a formative evaluation to aid a project's planning stage and when assessing participants' needs.

Both qualitative and quantitative methods can be appropriately used alone or in combination in evaluation. For example if you wish to evaluate diverse or complex aspects of the service it will probably be best to consider using multiple methods within your evaluation. Remember, what is crucial is that the method chosen does actually measure what it is intended to and answers the question you are asking.

It is also important to make a distinction between evaluation and monitoring. Monitoring is different and is essentially a check of the extent to which a project or service is proceeding according to plan. It is really a subset of evaluation and should not be used as a substitute for a full evaluation.

Types of Evaluation :

There are many different types of evaluations depending on the object being evaluated and the purpose of the evaluation. Perhaps the most important basic distinction in evaluation types is that between *formative* and *summative* evaluation. Formative evaluations strengthen or improve the object being evaluated — they help form it by examining the delivery of the program or technology, the quality of its implementation, and the assessment of the organizational context, personnel, procedures, inputs, and so on. Summative evaluations, in contrast, examine the effects or outcomes of some object — they summarize it by describing what happens subsequent to delivery of the program or technology; assessing whether the object can be said to have caused the outcome; determining the overall impact of the causal factor beyond only the immediate target outcomes; and, estimating the relative costs associated with the object.

Formative evaluation includes several evaluation types:

- *needs assessment* determines who needs the program, how great the need is, and what might work to meet the need
- *evaluability assessment* determines whether an evaluation is feasible and how stake-holders can help shape its usefulness
- *structured conceptualization* helps stakeholders define the program or technology, the target population, and the possible outcomes

- *implementation evaluation* monitors the fidelity of the program or technology delivery
- *process evaluation* investigates the process of delivering the program or technology, including alternative delivery procedures

Summative evaluation can also be subdivided:

- *outcome evaluations* investigate whether the program or technology caused demonstrable effects on specifically defined target outcomes
- *impact evaluation* is broader and assesses the overall or net effects — intended or unintended — of the program or technology as a whole
- *cost-effectiveness and cost-benefit analysis* address questions of efficiency by standardizing outcomes in terms of their dollar costs and values
- *Secondary analysis* reexamines existing data to address new questions or use methods not previously employed.
- *Meta-analysis* integrates the outcome estimates from multiple studies to arrive at an overall or summary judgment on an evaluation question.

Conclusion :

The scale of an evaluation can vary greatly from small scale in-house evaluations to large scale complex or risky evaluations commissioned externally. For example your evaluation may require a small in house evaluation, a medium scale evaluation with external support, or if a major piece of work it may need a large scale, externally commissioned and funded evaluation. And scale of an evaluation can lead the class teacher to select an appropriate Evaluation Technique.

EVALUATE YOURSELF

1. How to select an appropriate Evaluation Technique for your Science Class?
2. What is Formative Evaluation and what is Summative Evaluation?
3. Does the selection of an appropriate evaluation technique depend upon qualitative approach or quantitative approach?

