According to the Syllabus
Maharshi Dayanand University, Rohtak, Ch. Bansi Lal University Bhiwani, Ch. Ranbir Singh University, Jind, Indra Gandhi University, Meerpur, Guru Jambheshwar University, Hissar

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EXAM NOTES

PEDAGOGY OF BIOLOGICAL SCIENCE

[Paper–4 & 5 (Group–C, Opt.–i)]

For :
B.Ed.–1st year

By:
Payal Bhola Jain

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SYLLABUS

PEDAGOGY OF BIOLOGICAL SCIENCE
[Paper– 4 & 5 (Group–C, Opt.–i]

Time: 3 Hours ***Max. Marks: 100***
(Theory: 80 Internal: 20)

NOTE FOR PAPER SETTER

(i) Paper setter will set 9 questions in all, out of which students will be required to attempt 5 questions.

(ii) Q. No. 1 will be compulsory and will carry 16 marks. There will be 4 short-answer type questions of 4 marks each to be selected from the entire syllabus.

(iii) Two long answer type questions will be set from each of the four units, out of which the students will be required to attempt one question from each unit. Long-answer type questions will carry 16 marks each.

(iv) All questions will carry equal marks.

OBJECTIVES

After completion of the course, student teachers will be able to:
develop awareness about developments in the area of biological sciences
orient prospective teachers in specific educational aspects of science e.g. aims and objectives of biological science, pedagogical analysis of contents in biological sciences, methods of teaching, evaluation
enable prospective teachers to be effective teachers in order to perform the required role as a biological teacher under Indian School conditions

COURSE CONTENT

UNIT-I

- Nature, History, scope and Interdisciplinary linkage of Biological Sciences
- General Aims and Objectives of Biological Sciences
- Facts and principles of Biology & its applications consistent with the stages of cognitive development of learners, Origin of life and evolution, biodiversity, observation and experiments in Biological Science.
- Bloom's taxonomy of educational objectives
- Formulation of specific objective of Biological Science in behavioural terms

UNIT-II

1. **Pedagogical Analysis**
   - Meaning, importance and Steps of Pedagogical Analysis
   - Pedagogical Analysis on the following topics:
     - Photosynthesis,
     - Human digestive system,
     - Food Chain,
     - Ecological Balance
     - Respiratory System
     - Excretory
     - Circulatory
     - Hereditary and Environment

UNIT-III

- Development of Instructional Material: Unit planning, Lesson planning, Preparation of Teaching aids, Development of Demonstration Experiments.
- Development of Self-Instruction materials, Linear Programme
- Teaching Strategies: Problem Solving, Investigatory approach, collaborative learning, experimental learning
- Micro Teaching Skills: Skill of Introducing the Lesson, Skill of Questioning, Skill of Illustration, Skill of Explaining, Skill of Stimulus Variation

UNIT-IV

- Concept of measurement and evaluation
- Types of evaluation: Formative, Summative, Diagnostic
- Preparation of an objective type and achievement test, Attributes of a good Achievement Test
- Different types of Grading
- Continuous and Comprehensive Evaluation

TASK & ASSIGNMENTS: ANY ONE OF THE FOLLOWING (10 MARKS)

- Model of Food Chain
- Model of Respiratory System
- Model of Excretory System
- Any other project/assignment given by the institution

CONTENTS

UNIT-I

UNIT-IV

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[Paper–4 & 5 (Group–C, Opt.–i)]

UNIT–I

- *Nature, History, Scope and Interdisciplinary linkage of Biological Sciences*
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1

Inclusive Practices in Classroom

1.1 NATURE, HISTORY, SCOPE AND INTERDISCIPLINARY LINKAGE OF BIOLOGICAL SCIENCES

1. Describe the nature and history of Biological Science.

Ans. Biological science is a natural science concerned with the study of life and living organism including their structure, functions, growth, evolution, distribution and taxonomy. Modern biological science is a vast and eclestic field, composed of many branches and subdisciplines. Thus Biological science involves the studies of all kinds of micro-organisms, plants and animals.

Biological science is related to mankind ever since the origin of man, therefore, this branch of science stands first in order of other studies compared to other branches of science. Ever since the origin of life man is eager to know about various phenomenon of life processes such as health and disease, birth, growth and death. However man depends on plants and animals for food, shelter and clothing which are immediate needs of life, come from Biologial science, perhaps it was the elementary need of man to know about living being so that maximum benefits can be drawn out of them.

In general, Biological science recognizes the cell as the basic unit of life, genes as basic unit of heredity, evolution as the engine that propels the synthesis and creation of new species.

It is also understood today that all organisms survive by consuming and transforming energy and by regulating their internal environment to maintain a stable and vital condition.

Subdisciplines of biology are defined by the scale at which organism are studied, the kinds of organism studied, and the methods used to study them : biochemistry examines the rudimentary chemistry of life : Molecular biology studies the complex interactions among biological molecules : botany studies the biology of plants; cellular biology examines the basic building-block of all life, the

cell; physiology examines the physical and chemical functions of tissues, organs and organ systems of an organism; evolutionary biology examines the processes that produced the diversity of life; and Ecology examines how organisms interact in their environments.

In this way, the following characteristics show the nature of biological science:

1. Biological science is the branch of science that deals with the study of life. Hence, it is also called life science.
2. Biological science is such a vast field that it encompases the study of various aspects of living organism as well as their interactions with the non-living components. Hence the study of these different aspects form different branches of biology.
3. Biological science helps us to know more about ourselves.
4. Biological science helps us to know about the diversity in the living world and the ways by which it can be preserved.

History of Biological Science

The history of Biological science traces the study of living world from ancient to modern times. Although modern biology is a relatively recent development, sciences related to and included within it have been studied since ancient times. Natural philosophy was studied as early as the ancient civilizations of Mesopotamia, Egypt, the Indian subcontinent, and China. However, the origins of modern biology and its approach to the study of nature are most often traced back to ancient Greece. While the formal study of medicine dates to Hippocrates (ca. 460 B.C. –c.a. 370 BC), it was Aristotle (384 BC -322 BC)) who contributed most extensively to the development of biology. Especially important are his History of Animals and other works where he showed maturalist leanings, and later more empirical works that focused on biological causation and the diversity of life.

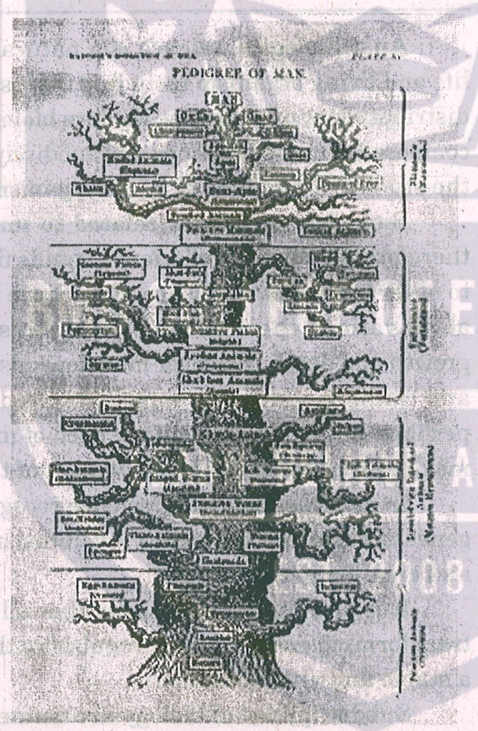

Fig. Ernst Haeckel's Tree of Life (1879)

Aristotle's successor at the Lyseum, Theophrastus, wrote a series of books of botany that survived as the most important contribution of antiquity to the plant sciences, even into the Middle Ages.

Scholars of the medieval Islamic world who wrote on biology included al-Jahiz (781-869), Al-Dinawari (828-925) who wrote on anatomy and physiology. Medicine was especially well studied by Islamic scholars working in Greek philosopher traditions, while natural history drew heavily on Aristotelian thought, especially in upholding a fixed hierarchy of life.

Biology began to quickly develop and grow with Anton Van Leeuwenhoek's dramatic improvement of the microscope. It was then that scholars discovered spermatozoa, bacteria, infusoria and the diversity of microscopic life. Investigations by Jan Swammerdam led to new interest in entomology and helped to develop the basic techniques of microscopic dissection and staining.

Advances in microscopy also had a profound impact on biological thinking. In the early 19th century, a number of biologists pointed to the central importance of the cell. Then, in 1838, Schleiden and Schwann began promoting the now universal ideas that (1) the basic unit of organisms is the cell and (2) that individual cells have all the characteristics of life, although they opposed the idea that (3) all cells come from the division of other cells. Thanks to the work of Robert Remak and Rudolf Virchow, however, by the 1860s most biologists accepted all three tenets of what came to be known as cell theory.

Meanwhile, taxonomy and classification became the focus of natural historians. Carl Linnaeus published a basic taxonomy for the natural world in 1735 (variations of which have been in use ever since), and in the 1750s introduced scientific names for all his species. Georges-Louis Leclerc, Comte de Buffon, treated species as artificial categories and living forms as malleable–even suggesting the possibility of common descent. Though he was opposed to evolution, Buffon is a key figure in the history of evolutionary thought; his work influenced the evolutionary theories of both Lamarck and Darwin.

Serious evolutionary thinking originated with the works of Jean-Baptiste Lamarck, who was the first to present a coherent theory of evolution. He posited that evolution was the result of environmental stress on properties of animals, meaning that the more frequently and rigorously an organ was used, the more complex and efficient it would become, thus adapting the animal to its environment. Lamarck believed that these acquired traits could then be passed on to the animal's offspring, who would further develop and perfect them. However, it was the British naturalist Charles Darwin, combining the biogeographical approach of Humboldt, the uniformation geology of Lycell, Malthus, writings on population growth, and his own morphological expertise and extensive natural observations, who forged more sucessful evolutionary theory based on natural selection; similar reasoning and evidence led Alfred Russel Wallace to independently reach the same conclusions. Although it was the subject of controversy (which continues to this day, Darwin's theory quickly spread through the scientific community and soon became a central axiom of the rapidly developing science of biology.

The discovery of the physical representation of heredity came along with evolutionary principles and population genetics. In the 1940s and early 1950s,

experiments pointed to DNA as the component of chromosomes that held the trait-carrying units that had become known as genes. A focus on new kinds of model organisms such as viruses and bacteria, along with the discovery of the double helical structure of DNA in 1953, marked the transition to the era of molecular genetics. From the 1950s to present times, biology has been vastly extended in the molecular domain. The genetic code was cracked by Har Govind Khorana, Robert W. Holley and Marshall Warren Nirenberg after DNA was understood to contain codons. Finally, the Human Genome Project was launched in 1990 with the goal of mapping the general human genome. This project was essentially completed in 2003, with further analysis still being published. The Human Genome Project was the first step in a globalized effort to incorporate accumulated knowledge of biology into a functional, molecular definition of the human body and the bodies of other organisms.

At the beginning of the 21st century, biological sciences converged with previously differentiated new classic disciplines like Physics into research fields like Biophysics. Advances were made in analytical chemistry and physics instrumentation including improved sensors, optics, tracers, instrumentation, signal processing, networks, robots, satellites, and compute power for data collection, storage, analysis, modelling, visualization and simulations. These technology advances allowed theoretical and experimental research including internet publication of molecular biochemistry, biological systems, and ecosystems science. This enabled worldwide access to better measurements, theoretical and experimental research including internet publication of molecular biochemistry, biological systems, and ecosystem science. This enabled worldwide access to better measurements, theoretical models, complex simulations, theory predictive model experimentation, analysis, worldwide internet observational data reporting, open peer-review, collaboration and internet publication. New fields of biological sciences research emerged including Bioinformatics, Neuroscience, Theoretical biology, Computational genomics, Astrobiology and Synthetic Biology.

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2. Describe the scope and interdisplinary linkage of Biological sciences.

Ans. Biological science is a branch of science which deals with study of life. It is concerned with the study of living organism which are immeasurably diverse and complex than the non-living matter. Hence biological science is also described as life science or natural science. Biological science reveals to us the secrets of life uncovered by biologist through centuries of researches. Biological science is of great importance to mankind in a practical sense.

Biological science is such a vast field that it encompasses the study of various aspects of living organisms as well as their interaction with the non-living components. Hence the study of different aspects form different branches of biological science.

These are the main branches of biological science.

1. **Aerobiology** :– The study of airborne organic particles.

2. **Agriculture** :– The study of producing crops and raising livestock, with an emphasis on practical applications.
3. **Anatomy** : The study of form and function, in plants, animals and other organisms or specifically in humans.
4. **Histology** : The study of cells and tissues, a microscopic branch of anatomy.
5. **Astrobiology** : The study of evaluation, distribution, and future of life in the univese.
6. **Biochemistry** : The study of chemical reaction required for life to exist and function, usually a focus on cellular level.
7. **Bioengineering** : The study of biology through the means of engineering with an emphasis on applied knowledge and especially related to biotechnology.
8. **Biogeography** : The study of distribution of species spatially and temporally.
9. **Bioinformatics** : The uses of information technology for the study, collection and storage of genomic and other biological data.
10. **Biomathematics** : The quantitative or mathematical study of biological processes, with an emphasis on modelling.
11. **Biomechanics** : Often considered a branch of medicine, the study of the mechanics of living beings, with an emphasis on applied use through prasthetics or orthotics.
12. **Biochemical research** : The study of health and disease.
13. **Pharmacology** : The study and practical application of preparation, use and effects of drugs and synthetic medicines.
14. **Biomusicology** : The study of music from a biological point of view.
15. **Biophysics** : The study of biological processes through physics, by applying the theories and methods traditionally used in the physical science.
16. **Biosemiotics** : The study of biological processes through semiotics by applying the models of meaning-making and communication.
17. **Biotechnology** : The study of the manipulation of living matter, including genetic modification and synthetic biology.
18. **Synthetic biology** : Research integrating and engineering, construction of biological functions not found in nature.
19. **Building biology** : The study of the indoor living environment.
20. **Botany** : The study of plants.
21. **Cell biology** : The study of the cell as a complete unit and the molecular and chemical interactions that occur within a living cell.
22. **Cognitive biology** : The study of cognition as a biological function.
23. **Conservation biology** : The study of the preservation, protection or restoration of the natural environment, natural ecosystem, vegetation and wildlife.
24. **Cryobiology** : The study of the effects of lower than normally preferred temperatures on living beings.
25. **Developmental biology** : The study of the processes through which an organism forms, from zygote to full structure.
26. **Embryology** : The study of the development of embryo.

27. **Ecology** : The study of the interactions of living organisms with one another and with the non living elements of their environment.
28. **Environmental biology** : The study of the natural world, as a whole or in a particular area, especially as affected by human activity.
29. **Epidemiology** : A major component of public health research studying factors affecting the health of populations.
30. **Evolutionary biology** : The study of the origin and descent of species over time.
31. **Genetics** : The study of genes and heredity.
32. **Epigenetics** : The study of heritable changes in gene expression or cellular phenotype caused by mechanisms other than changes in the underlying DNA sequence.
33. **Hematology (also known as Haematology)** : The study of blood forming organs.
34. **Integrative biology** : The study of whole organisms.
35. **Limnology** : The study of inland waters.
36. **Marine biology (or Biological oceanography)** : The study of ocean ecosystems, plants, animals and other living beings.
37. **Microbiology** : The study of microscopic organisms (micro-organisms and their interactions with other living things).
38. **Bacteriology** : The study of bacteria.
39. **Mycology** : The study of fungi.
40. **Parasitology** : The study of parasites and parasitism.
41. **Virology** : The study of viruses and some other virus like agents.
42. **Molecular biology** : The study of biology and biological at the molecular level, some cross over with biochemistry.
43. **Nanobiology** : The study of how nanotechnology can be used in biology, and the study of living organisms and parts on the nanoscale level of organisation.
44. **Neurobiology** : The study of the nervous system including anatomy, physiology and pathology.
45. **Population biology** : The study of how population dynanisms including.
46. **Population ecology** : The study of how population dynamics and extinctions.
47. **Population genetics** : The study of changes in gene frequencies in populations of organisms.
48. **Paleontology** : The study of sometimes geographic evidence of prehistoric life.
49. **Pathobiology or pathology** : The study of diseases, and the causes, processes, nature and development of disease.
50. **Physiology** : The study of the functioning of living organisms and the organs and parts of living organisms.
51. **Phytopathology** : The study of plant diseases (also called) plant pathology.
52. **Psychobiology** : The study of biological bases of psychology.

53. **Quantum biology** : The study of quantum mechanics to biological objects and problems.
54. **Sociobiology** : The study of biological bases of sociology.
55. **Structural biology** : A branch of molecular biology, biochemistry and biophysics concerned with the molecular structure of biological macromolecules.
56. **Zoology** : The study of animals, including classification. Physiology, development and behaviour, including.
57. **Ethology** : The study of animal behaviour.
58. **Entomology** : The study of insects.
59. **Herpetology** : The study of reptiles and amphibians.
60. **Ichthyology** : The study of fish.
61. **Mammalogy** : The study of mammals.
62. **Ornithology** : The study of birds.

Interdisciplinary linkage of Biological sciences : Inter-disciplinary branches indicate the relationship of biological science with other branches of science. Some common interdisciplinary branches are Bio-physics, Bio-chemistry, Biometry and bio informatics. Psychology and sociobiology are interdisciplinary branches involving biology and social sciences. Applied branches enable us to apply the knowledge gained from different areas to be used for welfare of man, animals and plants. There are many uses of interdisciplinary linkage of Biological sciences.

1. Biological sciences has been serving its best in the field of improvement of food resources. Crop plants can yield better through genetic manipulation and cross-breeding techniques. Growth rate and photosynthetic ability of plants can also be increasesd by the use of these techniques.
   Efficiecy of Dairy farming is enhancing through the use of a protein responsible for increasing milk production.
2. Field of Health and Medical have been developed a lot by using better technology of Biological sciences. Many diseases have been eradicated after getting the knowledge of disease producing germs and bacteria. Better and cheaper drugs are being introduced in markets. Control over communicable diseases has become possible by using the methods of Biological sciences. Area of personal and social health has gained a lot through the new inventions in the field of medical sciences.
3. Techniques of Biological sciences are contributing in the field of pollution control. Biodegradation techniques can be applied for eliminating the toxic and non-toxic industrial wastes. Agriculture wastes are used to generate biogas. Biproduct of this process can be used as manure in the fields. Both Aerobic and anaerobic micro-organisms are used in sewage treatment.
4. Through genetic engineering novel techniques in animal breeding are being introduced. To improve the health of animals safe and effective vaccines for infectious diseases have been introduced.

5. Knowledge of Biological sciences and technology has helped in discovering alternative sources of energy that are known as bio-fuels. Ethanol, a liquid biofuel and methane a gaseous bio-fuel are important alternative fuel to coal, wood, oil, petroleum etc. These fuels are generated by using waste materials which are decomposed by micro-organisms.
6. Effective family planning measures are being used for population control. The safest, long-lasting and cost effective vaccines for family planning have been invented.

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1.2. GENERAL AIMS AND OBJECTIVES OF BIOLOGICAL SCIENCES

3. Discuss aims and objectives of Biological Science education at the secondary level.

Or

Explain the general aims of teaching Biological Sciences. Also justify the inclusion of this subject in secondary school curriculum.

Or

Describe general aims and objectives of teaching biological science at secondary school level. (C.B.L.U. 2018, M.D.U. 2018)

Ans. There have been many attempts from time to time in our country as well as abroad by educationists to think about the aims of Biological science teaching at different stages of school education. Two such attempts which were made in our country are worth noting. One of these attempts was made in 1956 at Tara Devi Hills through an All India Seminar organised on the topic "Science Teaching in Secondary Schools", The other one relates to the recommendations made by Kothari Commission in 1966. In the light of such attempts, the following aims can be set at secondary stage of school education for the teaching of Biological sciences.

At the Lower Secondary Stage (For Classes VIII to Class X)

1. To provide the students deep insight with the facts and principles of Biological sciences.
2. To develop their ability to perform scientific experiments in a skilful manner and to enable them to get better insight into the application of Biological sciences.
3. To equip the students with all the basic scientific knowledge and skills helpful in everyday life.

4. To provide appropriate opportunities for the development of the inventive and creative faculties of the students.
5. To enable the students to adopt and learn some useful scientific activities in the form of hobbies and leisure hours purposeful activities.
6. To create in them appropriate faith concerned with the values and contribution of Biological sciences.

At the Secondary Stage (Class XI and XII)

1. To attain desirable proficiency in the specialized areas or branches of Biological sciences.
2. To provide opportunities and inspiration through relevant reference material and specialized magazines to students for the sake of understanding as well as creation of something new in the field of science.
3. To make them acquainted with latest concepts and advancement in their respective specialized branches or fields.
4. To get them ready for the work related to some specialized vocation like medicine, microbiology etc.
5. To encourage the students to get engaged in the independent deep study of their specialized areas or branches.

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1.3 FACTS AND PRINCIPLES OF BIOLOGY AND ITS APPLICATIONS CONSISTENT WITH THE STAGES OF COGNITIVE DEVELOPMENT OF LEARNERS, ORIGIN OF LIFE AND EVOLUTION, BIODIVERSITY, OBSERVATION AND EXPERIMENTS IN BIOLOGICAL SCIENCE

4. Describe the facts and principles of Biology and its applications consistent with the stages of cognitive development.

Ans. Jean Piaget (1896-1980) was a biologist who originally studied molluscs but moved into the study of the development of children's understanding, through observing them and talking and listening to them while they worked on exercises he set. His view of how children's minds work and develop has been enormously influential, particularly in educational theory. Piaget was very interested in knowledge and how children come to know their world. He developed his cognitive theory by actually observing children (some of whom were his own children). Using a standard question or set of questions as a starting point, he followed the child's train of thought and allowed the questioning to be flexible. Piaget believed that children's spontaneous comments provided valuable clues to understanding their thinking. He was not interested in a right or wrong answer, but rather what forms of logic and reasoning the child used. After many years

of observation, Piaget concluded that intellectual development is the result of the interaction of hereditary and environmental factors. As the child develops and constantly interacts with the world around him, knowledge is invented and reinvented. His theory of intellectual development is strongly grounded in the biological sciences. He saw cognitive growth as an extension of biological growth and as being governed by the same laws and principles. He argued that intellectual development controlled every other aspect of development - emotional, social, and moral.

He proposed that children's thinking does not develop entirely smoothly: instead, there are certain points at which it "takes off" and moves into completely new areas and capabilities. He saw these transitions as taking place at about 18 months, 7 years and 11 or 12 years. This has been taken to mean that before these ages children are not capable of understanding things in certain ways, and has been used as the basis for scheduling the school.

Stages of Intellectual Development

Piaget discovered that children think and reason differently at different periods in their lives. He believed that everyone passed through sequence of four qualitatively distinct stages. The four stages are:
1. **Sensorimotor - birth to 2 years**: Piaget's earliest stage of cognitive development is the sensorimotor stage (ages 0 to about 2 years). Until they are about two years old, children spend most of their intellectual efforts integrating their senses with their psychomotor abilities - hence the term *sensorimotor*. These children constantly assimilate new persons, objects, and ideas through their existing structures and modify these structures while they progress from a bundle of reflexes to the more sophisticated thinkers of the next stage. Because they are relatively predictable, interesting, and uncomplicated creatures, children in this stage offer ideal exhibits for the study of Piaget's ideas; and Piaget and others have developed very detailed descriptions of children during this stage. The next three stages all contain the word *operation*. By merely looking at the labels for the stages, we can guess that *pre*operational children do not yet do operations, the *concrete* operational children can perform operations on concrete objects or ideas, and that *formal* operational learners can perform operations on abstract concepts. Therefore, if we can understand what an operation is, we can understand what Piaget meant by these three labels.

Preoperational - 2 years to 7 years: An *operation* is the mental manipulation of an object or idea. **Preoperational** children (from about age 2 to about age 7) are not yet able to mentally manipulate objects or ideas. They are stuck with what they can directly perceive through their senses. When they are presented with some sort of information that confuses their senses, like the optical illusion they are unable to think it through and to realize that reality must be different from what they see. They have a short attention span, especially when they themselves do not initiate the activity. They consider actions more concrete than words. They have an egocentric perspective.

Concrete operational Stage: **Concrete operational** children (from about age 7 to about age 12), can mentally manipulate objects or ideas - as long as these are concretely present or at least directly recalled from memory. For example, when presented with a problem a concrete operational child would be able to solve the problem by reversing the process The child could also apply the principle of identity. This mental manipulation enables the concrete operational child to go beyond simple sensory input. In different language, the concrete operational child is engaging in a low level of abstraction. What this child cannot do is perform abstractions on abstractions. They can manipulate ideas mentally, but they need props as the ideas presented to them continue to become more abstract. Their attention span is longer than for preoperational children, but they often want to focus on something new.

Formal operational (abstract thinking) Stage: The **formal operational** learner (beginning around age 12 but not fully developed until age 18 or 20), however, could solve the problem by simply inventing the imaginary people and moving them around mentally. Even though they are capable of abstract thinking, concrete thinking is still easier. Most people don't get really good at formal operational thinking and use it habitually until they are 21-23 years old. Even then, most sensible people check their abstract reasoning with concrete diagrams, etc. Abstractions are essential for complex ideas, but these require that concrete ideas on which these are built be over learned. They need to generalize their abstract thinking abilities to numerous settings, many of which they will not encounter until they leave school. Even when they are incorrect, their attempt at hypothetical thinking may be a productive step in the right direction.

Stages of Cognitive Development

Stage	Characterised by
Sensori-motor (Birth-2 yrs)	Differentiates self from objects Recognises self as agent of action and begins to act intentionally: e.g. pulls a string to set mobile in motion or shakes a rattle to make a noise Achieves object permanence: realises that things continue to exist even when no longer present to the sense (pace Bishop Berkeley)
Pre-operational (2-7 years)	Learns to use language and to represent objects by images and words. Thinking is still egocentric: has difficulty taking the viewpoint of others Classifies objects by a single feature: e.g. groups together all the red blocks regardless of shape or all the square blocks regardless of colour.

Stage	Characterised by
Concrete operational (7-11 years)	Can think logically about objects and events. Achieves conservation of number (age 6), mass (age 7), and weight (age 9) Classifies objects according to several features and can order them in series along a single dimension such as size.
Formal operational (11 years and up)	Can think logically about abstract propositions and test hypotheses systematically Becomes concerned with the hypothetical, the future, and ideological problems

The accumulating evidence is that this scheme is too rigid: Many children manage concrete operations earlier than he thought, and some people never attain formal operations (or at least are not called upon to use them).

How children learn

A central component of Piaget's developmental theory of learning and thinking is that both involve the participation of the learner. Knowledge is not merely transmitted verbally but must be constructed and reconstructed by the learner. Piaget asserted that for a child to know and construct knowledge of the world the child must act on objects and it is this action which provides knowledge of those objects; the mind organizes reality and acts upon it. The learner must be active; he is not a vessel to be filled with facts. Piaget's approach to learning is a readiness approach. Readiness approach in developmental psychology emphasizes that children cannot learn something until maturation gives them certain prerequisites. The ability to learn any cognitive content is always related to their stage of intellectual development. Children who are at a certain stage cannot be taught the concepts of a higher stage.

Intellectual growth involves three fundamental processes: assimilation, accommodation, and equilibration. Assimilation involves the incorporation of new events into preexisting cognitive structures. Accommodation means existing structures change to accommodate to the new information. This dual process, assimilation-accommodation, enables the child to form schema. Equilibration involves the person striking a balance between himself and the environment, between assimilation and accommodation. When a child experiences a new event, disequilibrium sets in until he is able to assimilate and accommodate the new information and thus attain equilibrium. There are many types of equilibrium between assimilation and accommodation that vary with the levels of development and the problems to be solved. For Piaget, equilibration is the major factor in explaining why some children advance more quickly in the development of logical intelligence than do others

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ORIGIN OF LIFE AND EVOLUTION

5. What do you know about origin of life and evolution? Describe the facts and principles related to origin of life and evolution.

Ans. Origin of life on earth : Darwin's theory of evolution explains how life evolved from simple to more complex forms and Mendel's experiments provides the mechanism for the inheritance of traits from one generation to the next. But neither of them tells us anything about how life began on earth in the first place.

A British Scientist J.B.S. Haldane (who became a citizen of India later), suggested in 1929 that life must have developed from the simple inorganic molecules which were present on earth soon after its formation. He speculated that at that time the conditions on earth, which were far from the conditions we see today, which could have given rise to more complex organic molecules that were required for life. The first primitive organisms would arise from further chemical synthesis.

How did these organic molecules arise? An answer was suggested by the experiment conducted by Stanley L. Miller and Harold C. Urey in the year 1953. They assembled an atmosphere similar to that thought to exist on early earth (this had molecules like ammonia, methane and hydrogen sulphide, but no oxygen) over water. This was maintained at a temperature just below 100°C and sparks were passed through the mixture of gases to simulate lightning. At the end of a week, 15% of the carbon (from methane) had been converted to simple compounds of carbon including amino acids which make up protein molecules. So, can life arise on earth again from the beginning?

We have noticed that there is an inbuilt tendency to variation during reproduction, because of errors in DNA copying, as well as a result of sexual reproduction both. Now we shall consider some consequences of this tendency.

Speciation

Trial now we have seen micro-evolution, which means that the changes are small, even though they are significant. Also, they simply change the common characteristics of a particular species. But this does not explain properly how new species come into existence. That can be said to have happened only if this group of beetles we are thinking about, splits into two populations that cannot reproduce with each other. When this happens, they can be called two independent species. So, can we extend the reasoning we have used above to explain such speciation?

Consider what would happen if the bushes the beetles feed on are spread widely over a mountain range. As a result the beetle population becomes very large. But individual beetles feed mostly on a few nearby bushes throughout their lifetime. They do not travel far. So, in this huge population of beetles, there will be sub-populations in neighbourhoods. Since male and female beetles have to meet for reproduction to take place most of it will be within these sub-populations. Obviously, an occasional adventurous beetle might go from one site to another. Or a beetle is picked up by a crow from one site and dropped in

the other site without being eaten. In both the cases, the migrant beetle will reproduce with the local population. This will result in the genes of the migrant beetle entering a new population. This type of gene flow is bound to happen between populations that are partly, separated. If, however, between two such sub-populations a large river comes into existence, the two populations will be isolated further, decreasing the levels of gene flow between them.

Over generations, genetic drift will accumulate different changes in each sub-population. Natural selection may also operate differently in these different geographic locations. Thus, for example, in the territory of one sub-population, crows are eliminated by eagles. But this does not happen for the other sub-population, where crow numbers are very high. As a result, the green variation will not be selected at the first site, while it will be strongly selected at the second.

The processes of genetic drift and natural selection together will result in these two isolated sub-populations of beetles becoming more and more different from each other. Finally, members of these two groups will be incapable of reproducing with each other even if they happen to meet.

There can be a number of ways by which this can happen. If the DNA changes are severe enough, such as a change in the number of chromosomes, eventually the germ cells of the two groups cannot fuse with each other. Or a new variation appears in which green females will not mate with red males, but only with green males. This allows very strong natural selection for greenness. Now, if such a green female beetle meets a red male from the other group, its behaviour will ensure that there is no reproduction between them. New species of beetles are being generated effectively.

Evolution and Classification

Based on these principles, evolutionary relationships of the species seen around us can be worked out. It is a kind of going backwards in time. This is by identifying hierarchies of characteristics between species.

Similarities among organisms will allow us to group them and then study the groups. For this, which characteristics decide more fundamental differences among organisms, and which ones decide less basic differences? What is meant by 'characteristics', anyway? Characteristics are details of appearance or behaviour; put differently a particular form or a particular function. That we have four limbs is thus a characteristic. That plants can carry out photosynthesis is also a characteristic.

Most organisms share some basic characteristics. Then in all the organisms cell is the basic unit of life. The characteristics in the next level of classification would be shared by most of the organisms of them but not all. A basic characteristic of cell design that varies among different organisms is whether the cell has a nucleus. Bacterial cells do not, while the cells of most other organisms do. Among organisms with nucleated cells, which ones are unicellular and which ones multi-cellular? That property marks a very basic difference in body design, due to specialisation of cell types and tissues. Among multi-cellular organisms, whether they can undertake photosynthesis or not will provide the next level of classification. Among the multi-cellular organisms that cannot carry out photosynthesis, whether the skeleton is inside the body or around the body will mark another fundamental design difference. It can be seen that, even in these few questions that have been asked, a hierarchy is developed that allows us to form classification groups.

The more closely two species are related, the more common characteristics they will have. And the more closely they are related, the more lately they will have had a common ancestor. An example will help. A brother and a sister are closely related. They have common ancestors in the first generation before them, namely, their parents. A girl and her first cousin are also related, but less than the girl and her brother. This is because cousins have common ancestors, their grandparents, in the second generation before them, not in the first one. We can now appreciate that classification of species is in fact a reflection of their evolutionary relationship.

Thus, we can build up small groups of species with recent common ancestors, then super-groups of these groups with more distant common ancestors, and so on. Theroritically, we can keep going backwards like this until we come to the opinion of a single species at the very beginning of evolutionary time. If that is the case, then at some point in the history of the earth, non-living material must have produced life. There are various theories about how this might have happened. It would be interesting to come up with theories of our own!

Evolution by Stages

Now one might ask – if complicated organs, such as the eye, are selected for the advantage they provide, how can they be generated by a single DNA change? Surely over generations such complex organs will be created gradually? But how can each intermediate change be selected for? There are a number of possible explanations for this. Even an intermediate stage, such as a rudimentary eye, can be useful to some extent. This might be enough to give a fitness advantage. As a matter of fact the eye – like the wing – seems to be a very popular adaptation. Insects have them, so does an octopus, and so do vertebrates. Each of these organisms has different eye structure–enough for them to have separate evolutionary origins.

Also, a change that is useful for one property to start with can become useful later for quite a different function. For example feathers, can start out as providing insulation in cold weather. But later, they might become useful for flight. As a matter of fact, some dinosaurs had feathers, although they were not able to fly using the feathers. Birds seem to have later adapted the feathers to flight. This, of course, means that birds are very closely related to reptiles, since dinosaurs were reptiles!

It can be said that very dissimilar-looking structures evolve from a common ancestral structure. It is true that analysis of the organ structure in fossils allows us to make estimates of how far back evolutionary relationships go. But those are guesses about what happened in history. Are there any current examples of such a process? Let us consider the example of wild cabbage which is a good example. Over more than two thousand years humans have cultivated wild cabbage as a food plant, and yielded different vegetables from it by selection. This is, naturally, artificial selection rather than natural selection. So some farmers have wanted to select for very short distances between leaves, and have bred the cabbage that we eat. Some have wanted to select for arrested flower development, and have bred broccoli, or for sterile flowers, and have made the cauliflower. Some have selected for swollen parts, and come up with a turnip shaped edible stem known as kohlrabi. Some have simply looked for slightly

larger leaves, and come up with a leafy vegetable known as kale. Would we have thought that all these structures have come down from the same ancestor if we had not done it ourselves?

Another way of tracing evolutionary relationships depends on the original idea that we started with. This idea was that changes in DNA during reproduction are the basic events in evolution. If that be the case, then comparing the DNA of various species should give us a direct estimate of how much the DNA has changed during the formation of these species. This method is now extensively used to define evolutionary relationships.

Human Evolution

The same tools for tracing evolutionary relationships – excavating, time-dating and studying fossils, as well as determining DNA sequences – have been used for studying human evolution. There is a great diversity of human forms and features all over the planet. So much so that, for a long time, people used to talk about human 'races'. Skin colour used to be the most common way of identifying these so called races. Some were called black, white or brown. A major question debated for a long time was, have these apparent groups evolved differently? Over recent years, the evidence has become very clear. The answer is that there is no biological basis to the opinion of human races. All humans are a single species.

Not only that, irrespective of where we have lived for the past few thousand years, we all come from Africa. The earliest members of the human species, Homo sapiens, can be traced there. We can trace our genetic footprints back to our African roots. A couple of hundred thousand years ago, some of our ancestors left Africa while others stayed there only. While the residents spread across Africa, the migrants slowly spread across the planet – from Africa to West Asia, then to Central Asia, Eurasia, South Asia, East Asia. They travelled down the islands of Indonesia and the Philippines to Australia, and they crossed the Bering land bridge to the Americas. They did not follow a single line, so obviously they were not travelling for the sake of travelling. They went forwards and backwards, with groups sometimes separating from each other, sometimes coming back to mix with each other, even moving in and out of Africa. Like all other species on the planet, they had come into being as an accident of evolution, and were trying to live their lives the best they could.

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BIODIVERSITY

6. What is biodiversity? What are biodiversity facts and principles. Describe the importance of biodiversity.

Ans. Biodiversity is the variety of different types of life found on the earth and the variations within species. It is a measure of the variety of organisms present in different ecosystems. This can refer to genetic variations, ecosystem

variation, or species. Variation (number of species) within an area, biome or planet. Terrestrial biodiversity tends to be greater near the equator, which seems to be the result of the warm climate and high primary productivity. Biodiversity is not distributed evenly on Earth. It is richest in the tropics. Marine biodiversity tends to be highest along coasts in the Western Pacific, where sea surface temperature is highest and in the midlatitudinal band in all oceans. There are latitudinal grandients in species diversity. Biodiversity generally tends to cluster in hotspots, and has been increasing through time but will be likely to show in the future. The number and variety of plants, animals and other organisms that exist is known as biodiversity. It is an essential component of nature and it insures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind. The richness of biodiversity depends on the climatic conditions and area of the region. All species of plants taken together are known as flora and about 70,000 species of animals are known as fauna which includes birds, mammals, fish, reptiles, insects, crustacans, molluscs, etc. The term biological diversity was used first by wildlife scientist and conservationist Raymond F. Dasmann in the year 1968 lay book A different kind of country advocating conservation. The term was widely adopted only after more than a decade, when in the 1980s it came in common usage in science and environmental policy. Thomas Love Joy, in the foreword to the book conservation Biology, introduced the term to the scientific community until then the term 'natural diversity' was common, introduced by the science division of the nature conservancy in an important 1975 study, "The preservation of natural Diversity". By the easily 1980s TNC's science program and its head, Robert E. Jen Kins, Love joy and other leading conservation scientists at the time in America advocated the use of the term "biological diversity". The terms contracted form biodiversity may have been coined by W.G. Rosen in 1985 while planning the 1986 National Forum on Biological Diversity organized by the National Council (NRC). It first appeared in a publication in 1988 when sociobiologist E.O. Wilson used it as the title of the proceedings of that forum. Since this period the term has achieved widespread use among biologists, environmentalists, political leaders and concerned citizens.

A similar terms in the united states is "natural heritage". It pre-dates the others and is more accepted by the wider audience interested in conservation. Broader than biodiversity, it includes geology and landforms.

Definitions

"Biodiversity" is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region." An advantage of this definition is that it seems to describe most circumstances and presents a unified view of the traditional types of biological variety previously identified :

- taxonomic diversity (usually measured at the species diversity level)
- ecological diversity often viewed from the perspective of ecosystem diversity.
- mor phological diversity which stems from genetic diversity.

In 2003 Professor Anthony Campbell at Cardiff University, UK and the Darwin Centre, Pembrokeshire, defined a fourth level : Molecular Diversity. This multilevel construct is consistent with Dasman and Love joy. An explicit definition consistent with this interpretation was first given in a paper by Bruce A. Wilcox commissioned by the International Union for the conservation of nature and Natural Resources (IUCN) for the 1982 world National Parks Conference. Wilcox's definition was "Biological diversity is the variety of life format at all levels of biological systems (i.e., molecular organismic, population, species and ecosystem). The 1992 United Nations Earth Summit defined biological diversity as "the variability among living organisms from all sources, including, interalia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part : this includes diversity within species, between species and of ecosystem." This definition is used in the United Nations Convention on Biological Diversity. One textbook's definition is "variation of life at all levels of biological organization."

Genetically biodiversity can be defined as the diversity of alleles, genes and organisms. They study processes such as mutation and gene transfer that drive evaluation.

Measuring diversity at one level in a Group of organisms may not precisely correspond to diversity at other levels. However, tetrapod (terrestrial vertebrates) taxonomic and ecological diversity shows a very close correlation.

Biodiversity is more than just species : A species diversity is only one part biodiversity. To properly catalogue all the life on Earth, we also have to recognize the genetic diversity that exists within species as well as diversity of entire habitats and ecosystems.

Genetic Biodiversity is the variation in genes that exists within a species. A helpful way to understand genetic diversity is to think about dogs. All dogs are part of the same species, but their genes can dictate whether they are chihuahua or a great dane. There can be a lot of variation in genes - just think about all the colours, sizes and shapes that make up the genetic diversity of dogs.

Ecological Biodiversity is the diversity of ecosystems, natural communities and habitats. In essence, it is the variety of ways that species interact with each other and their environment. The forest of Maine differ from the forests of Colorado by the types of species found in both ecosystems, as well as the temperature and rainfall. These two seemingly similar ecosystems have a lot of differences that make them both special.

Some Biodiversity Facts

Researchers have estimated that there are between 3-30 million species on Earth, with a few studies predicting that there may be over 100 million species on Earth! Currently, we have identified only 1.7 million species. So we have a long way to go before we can come close to figuring out how many species are on Earth!

- There is more biodiversity within tropical ecosystems than temperate or boreal ecosystems. Tropical rain forests have the most diversity.

- The most diverse group of animals are invertebrates Invertebrates are animals without backbones, including insects, crustaceans, sponges, scorpions and many other kinds of organisms. Over half of all the animals already identified are invertebrates. Beetles are some of the most numerous species.
- Science has no much more to learn about the biodiversity of microscopic organisms like bacteria and protozoa.

The Importance of Biodiversity

Biodiversity is extremely important to people and the health of ecosystems. A few of the reasons are :

- Biodiversity allows us to live healthy and happy lives. It provides us with an array of foods and materials and it contributes to the economy. Without a diversity of Pollinators, plants and soil, our super markets would have a lot less produce.
- Most medical discoveries to cure disease and lengthen life spans were made because of research into plant and animal biology and genetics. Every time a species goes extinct or genetic diversity is lost, we will never know whether research would have given us a new vaccine or drug.
- Biodiversity is an important part of ecological services that make life livable on Earth. They include everything from cleaning water and absorbing chemicals, which wetlands do, to providing oxygen for us to breathe – one of the many things that plants do for people.
- Biodiversity allows for ecosystems to adjust disturbances like extreme fires and floods. If a reptile species goes extinct, a forest with 20 other reptiles is likely to adapt better than another forests with only one reptile.
- Genetic diversity prevents diseases and helps species adjust to changes in their environment.

Simply for the wonder of it all there are few things as beautiful and inspiring as the diversity of life that exists of Earth.

Threats to Biodiversity

Extinction is a natural part of life on Earth. Over the history of the planet most of the species that ever existed, evolved and then gradually went extinct. Species go extinct because of natural shifts in the environment that take place over long period of time, such as ice ages.

Today, species are going extinct at an accelerated and dangerous rate because of non-natural environment changes caused by human activities. Some of the activities have direct effects on species and ecosystems such as :

- habitat loss/degradation
- over exploitation (such as over fishing)
- spread of non-native species/diseases

Some human activities have indirect but wide-reaching effects on biodiversity including :

- climate change
- pollution

All of these threats have put a serious strain on the diversity of species on Earth according to the International Union for Conservation of Nature (IUCN) globally about one third of all known species are threatened with extinction that includes 29% of all amphibians, 21% of all mammals and 12% of all birds. If we do not stop the threats to biodiversity, we could be facing another mass extinction with dire consequences to the environment and human health and livelihood.

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OBSERVATION AND EXPERIMENTS IN BIOLOGICAL SCIENCE

7. What do you know about observation and experiments in Biological sciences? What are the facts and principles of observations and experiments in Biological sciences?

Ans. It is the experiment that makes science so different from non-scientific subjects. It is seen as the heart of the scientific method. A hypothesis is tested by an experiment. So what is an observation? To put is very concisely you could say that an experiment is controlled observation of an event which occurs naturally. In other words, we can set up an experiment to make more careful observations. These observations can then be used to make a new hypothesis or to prove an existing one.

It is more difficult to set up an experiment in biological science or medical science than in physics and chemistry. This is because biological science deals with living things and this can lead to ethical problems. In biological science it is not easy to control the variable you examine. There are two types of experiments :

1. Laboratory experiment
2. Natural or observational experiment

1. Laboratory experiment : The laboratory experiment is carried out under fully controlled conditions in a laboratory. These experiments are similar to some you will carry out on your course.

Natural or observational experiments : The observational experiments use nature directly as its laboratory. The scientist observes what happens in nature without much control over what is happening. Observational experiments are often carried out when something unusual happens in the natural world or if there is an accident. For example, if, new island is formed by a volcanic eruption, scientist may use the opportunity to observe how rocks are made or how the plants and animals colonise it.

Mr. Morgan was famous in the 1930s for his laboratory experiments in the genetics with fruit flies. We kept crossing the fruit to make observations that would prove Gregor Mendel's law or segregation and independence.

One of the most famous nature experiments was carried out by Charles Darwin when he sailed the world in the 1930s. He made thousands of observations about the types and kinds of plants and animals around the globe and then developed his theory of evolution by natural selection. His theory has been accepted today because it can be used to explain so much about the natural world.

Facts : No variables change in a conrolled experiments

A control experiment is one in which the independent variable is removed. Remember the independent variables is the one you vary to that hypothesis. If it can not be directly removed from the control, then it is set to a standard value.

So, an experiment must have a control. Sometimes, this is not possible.For example, in the study of some features of a volcano you cannot set up another volcano as a control. Nor can you set up a control experiment to prove the theory of evolution. What you have to do in cases like this is to continue making thousands of observations to try and disapprove your hypothesis.

The control experiment verifies that the results you get are due to the one variale you are testing. In a controlled experiment, the experimental variables is also kept constant.

How to write out our experiment : You must write clearly and honestly. Don't confuse people by being vague or complex. Use the following headings :

1. Aims : State your hypothesis and what the experiment aims to show. Keep this selection very short.

2. Method : Write out clearly what you did so that another person can do the same thing. Use clearly labelled diagrams. Give all measurements you see. Leave nothing out. If you had a difficulty, say so.

Result : Write down what happened. Present any data you obtained in clear tables if possible.

Conclusion : Write down your conclusion and explain your results in the light of your hypothesis and say whether it supported or not.

Principles of observation and experiments : All good experiments follow these five principles.

1. Careful Planning and Design : It is often very difficult to design a really good experiment. It can take a scientist several months or year to design an experiment that shows a hypothesis is correct. It is not much good designing an experiment to show that the hypothesis is true. It must be designed to try and disapprove the hypothesis. If you cannot disapprove the hypothesis, other scientists are likely to accept it. If you only try to prove your hypothesis the chances are that another scientists will then design an experiment to show that you were wrong.

2. Safety : Safety in the laboratory must be considered at all stages of development. Your laboratory hand book describes in detail the safety procedures that must be taken.

3. Control experiment : A good experiment should have a control experiment running at the same time if possible.

4. Remove Bias as much as possible : A bias is a predjuce or an inclination to see a situation in one way only. It is difficult to make an observation without being biased. Think, for example, of the varied descriptions of a good score in a match or how much it rained last Wednesday. 'It was a brilliant goal' or 'it was a lucky shot'. To try and remove the bias from experiments scientists use the following methods.

(A) Measurement : Here are some common instruments :

1. Thermometers remove your bias about hot or cold objects.

2. A measuring tape removes your bias about length.
3. A protractor removes your bias about angles.

(B) Using a large sample size : If for example, if your experiments involves testing a vaccinations for TB on Badgers, there is a little point in testing it on just two badgers and then saying it is a success. A large sample is needed to ensure that the vaccination is working on the whole population.

(C) Random Selection : When it is not possible to carry out a test on every individual species or individual in test, you can take a random selection of individuals. The random selection must be made without bias. For example, if you want to select twenty flowers from a field, it is best to throw a quadrat backwards over your shoulders and take the flowers within the quadrat.

(D) Double Blind Test : The purpose of this test is to

(i) Prevent bias

(ii) Prevent self deception

(iii) reduce errors in experiments.

It works in a very simple way Imagine that you have discovered a natural remedy called EYEBRIGHT that improves people's eye sight. To carry out a double blind test on 20 people you must do the following :

1. Make up pills with EYE BRIGHT and pills without EYEBRIGHT. All the pills must look identical.
2. Divide the pills into their two groups and give them to another scientist who does not know which one contains the EYEBRIGHT and which ones donot. The ones that do not contain it are called the placebo pills.
3. Ask the scientist to give the placebos to 10 people and the EYEBRIGHT to the other 10 (remember the scientist does not know which ones are the placebo) and to monitor the effects they have.
4. Lastly, the scientists must return the results to you. After examining the data, look at who has taken the EYEBRIGHT.

It is important that the test is given by another scientist who monitors the results, even though he does not know who is getting the placebo. In this way, the test can give a true indication as to how good the EYEBRIGHT is.

5. Repeatability : All experiments must be repeatable by either the scientist or more specially by other scientists. If an experiment can not be recreated at least once more, then it is suspect and will probably not be accepted by other scientists as a valid experiment.

Types of Observations : Biologists can make two types of observations :

Qualitative and Quantiative : Quantitative observations are those that can be written down as quantities : so measuring the length of a bacterium is a quantitative observation. Counting the number of fish that move up a river is a quantitative observation.

Qualitative Observation are those that use the qualities of the things. For example, a botanist might say that the flowers are white; a zoologist might observe that the reptitles were the first to leave when it became colder. An Ecologists might record his observation by writing the rats are destroying the ecosystem."

Familiar instruments used for qualitative and quantitative observations are :

Cameras : Video cameras, digital cameras, small cameras on microscopes or hidden on animals.

ph meters : for measuring how acidic a liquid is.

Thermometers for measuring temperature. Computer software is used to collect data, analyse data and create models and how things work. pH meters can be attached to computers and automatically draw graphs of collected data.

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1.4 BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES

8. What do you understand by Bloom's taxonomy of educational objectives? Give an account of the objectives in knowledge sub-domain with examples.

Or

Describe Bloom's Taxonomy of Educational Objectives.

Or

What is Bloom's taxonomy of instructional objectives? Name some of the popular taxonomies.

Or

Describe the classification of Bloom's Taxonomy of Educational objectives with suitable examples.

Or

Discuss Bloom's Taxonomy of Educational objectives. **(C.B.L.U. 2018)**

Or

Explain Bloom's Taxonomy for Educational Objectives of cognitive doman in detail. **(M.D.U. 2018)**

Ans. Dr. Benjamin S. Bloom of University of Chicago was the editor of the book **Taxonomy of Educational Objectives**. It was known as the classification of Educational goals created by a committee of college and university examiners. Taxonomy means a system of classification. In this form, a taxonomy like Bloom's taxonomy presents a system of classification of the objectives. This taxonomy of educational objectives has classified the educational goals into three main domains :

I. Cognitive domain;
II. Affective domain;
III. Psychomotor domain.

I. Cognitive domain

The cognitive domain includes those objectives which are related to the recall or recognition of knowledge. It is also linked with the development of

intellectual abilities and skills. In cognitive domain the taxonomy of educational objectives is organised under six major categories :

1. Knowledge : Knowledge includes those behaviours and test situations which lays stress on the remembering, either by recognition or recall. The evaluation is made through a simple recall or multiple-choice questions. From content's point of view, there are three levels which fall in the knowledge category.

(i) Knowledge of specifics : It implies the recall of specific terminology, facts and informations. **The knowledge of terminology** is the knowledge of the verbal and non-verbal symbols. These have ordinary references. **Knowledge of specific facts and informations** contain the knowledge of events, dates, persons, places etc. This sort of knowledge has its relation with the general order of magnitude of a phenomenon.

(ii) Knowledge of ways and means of dealing with specifics : It includes the ways and means of organising, studying, judging and criticising. It also consists of the methods of inquiry, the chronological sequences and the standards of judgement within a field as well as patterns of organisation through which the areas of fields themselves are determined and internally organised. Bloom has divided the ways and means of dealing with specifics into five categories namely knowledge of (a) conventions, (b) trends and sequences, (c) criteria, (d) methodology (e) classification and categories.

(iii) Knowledge of universals and abstractions : It is related to laws, principles, generalisations, theories and structures. These are the highest levels of instructions and complexity. **Prof. Bloom** has given two forms of knowledge of universals — (a) Knowledge of principles and generalisations; (b) Knowledge of theories and structures.

2. Comprehension : Comprehension is based upon the knowledge. If there is no knowledge, there will be no comprehension. Comprehension means the basic understanding of the facts, ideas, methods, processes, principles or theories etc. Consequently what is communicated to learner, he may translate or summarise, interpret and extrapolate. Thus, the comprehension objective includes three types of activity :

(i) Translation : The student is expected to translate or summarise the communicated knowledge in his own words. Translation abilities consist of :

(a) Translation of one level of abstraction to some other level or ability to summarise.
(b) Translation of one symbolic form to another.
(c) Translation from one verbal form to the other.

(ii) Interpretation : Interpretation means to cite examples, explain, discriminate, classify, rearrange, verify or generalize.

(iii) Extrapolation : It implies to estimate or comprehend the use of knowledge and extend it to other subjects and fields. It includes the making use of trends, predictions, implications and estimation, the process of explaining differentiation in facts and to arrive at conclusions.

3. Application : The application of an idea, principle or theory may be made possible only when it is grasped and understood appropriately. Thus, the category of application automatically involves both the earlier categories i.e., knowledge and comprehension. This category includes the use of abstractions in particular and concrete situations. Application objective has three levels :

(i) Generalisation of facts, laws, principles and theories.
(ii) Diagnosis of pupils weaknesses
(iii) Application of contents or terms and laws by the pupils.

4. Analysis : Analysis refers to an understanding of a higher level. It is possible only when the knowledge, comprehension and application objectives have been acquired. The analysis objective consists of division of contents into its elements and these are mutually related. Analysis objective has three levels :

(i) Analysis of elements : It involves the identification of the elements included in a communication.

(ii) Analysis of relationships : It includes the connections and interactions between elements and parts of a communication.

(iii) Analysis of organised principles : It consists of the organisation, systematic arrangement and structure which holds the communication together. It consists of the explicit as well as implicit structures.

5. Synthesis : Synthesis is termed as the creative objective. This objective aims to help the learner to acquire necessary ability to combine the various elements or components of an idea, object, concept or principle in order to produce an integrated picture. It is without any doubt a higher level of learning. It involves knowledge, comprehension, application as well as analysis. Synthesis has three levels :

(i) Production of a unique communication : It involves the development of a communication in which the writer or speaker endeavours to convey ideas, feelings and experience to others.

(ii) Production of a plan or proposed set of operations : It comprises of the development of a plan of work or the proposal of a plan of operations. The plan should be able to satisfy requirements of the task which may be provided to the student or which he may develop for himself.

(iii) Derivation of a set of abstract relations : It includes the development of abstract relations either to classify or expound particular data or phenomena or the deduction of proposition and relation from a set of basic proposition or symbolic representations.

6. Evaluation : Evaluation is the highest level of objectives of cognitive domain. It aims to develop in the student the ability to make appropriate value judgement about what has been attained by him in the form of knowledge, understanding, application, analysis and synthesis. Consequently the student is expected to take appropriate decision about the quantitative and qualitative value of a particular idea, object, principle or theory. He may arrive at an appropriate decision about the matter and methods by applying all the cognitive abilities acquired through the earlier categories of cognitive objectives. Evaluation has two levels :

(i) Internal judgement of the material and methods
(ii) External judgement of the material and methods.

II. Affective Domain

Affective objectives are concerned with the interests, emotions, appreciation, attitudes, mental tendencies and values of the pupils. The teacher should endeavour to develop maximum affective domain of the pupils by affective objectives. Bloom, Krathwohl and Masia classified the objectives of affective domain as below :

1. Receiving : Receiving represents the initial category for the objectives which belong to the affective domain. Receiving means pupils will to receive. It is directly related to the sensitivity of the pupils which occurs in the presence of some activity or stimulus. It includes inculcation of certain interests, attitudes, values or the ideas. For the fulfilment of the affective domain objective, three sequential activities are as follows:

(i) Awareness of the phenomenon : There can be simple awareness without specific discrimination or recognition of the objective characteristic of the object, even though these characteristics must be seemed to have an effect.

(ii) Willingness to receive phenomena : Here we describe the behaviour of being willing to tolerate a given stimulus, not to neglect it.

(iii) Controlled or selected attention : There is an element of the learner's controlling the attention here, so that the favoured stimulus is chosen and attended to despite distracting stimuli.

2. Responding : Receiving is pre-requisite for responding. Once a learner 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 behaviour like obeying, answering, reading, discussion, recording, writing and reacting to a stimulus. The pupils are inspired to response. Responding has three levels :

(i) Obedience for responding : There is learner's obedience for responding. 'Compliance' is perhaps a better term in comparison to obedience.

(ii) Willingness to respond : Here the learner is very much willing to respond not because of fear of punishment, but "on his own" or voluntarily.

(iii) Satisfaction in response : At this level the learner finds satisfaction or pleasure in responding.

3. Valuing : Receiving and responding are pre-requisites for achieving this category. Valuing relies on receiving and responding. Valuing includes the worth of a thing, phenomenon or behaviour. This level has three kinds of activities :

(i) Acceptance of a value : There is emotional acceptance of value at this level.

(ii) Preference for a value : Behaviour at this level implies preference for a value.

(iii) Commitment to a value : At this level, the student is very much committed to the value. The student's commitment to the underlying value guides his behaviour.

4. Organisation : Receiving, responding and valuing are the pre-requisites for the organisation category. Here a student gives some order to each value. He encourages situations for which more than one value is required. As a result this category of objectives leads the student to form a set value structure or philosophy of life. Thus necessity arises for :

(a) The organisation of values into a system.

(b) The determination of the interrelations among them.

(c) The establishment of the dominant value.

Organisation objective has two levels :

(i) Conceptualisation of values : At this level, the quality of abstraction or conceptualisation is added. This allows the individual to establish how the value relates to those that he already holds or to new ones that he is coming to hold.

(ii) Organisation of a value system : When such a situation arises before the pupils in which more than one value is appropriate, then they organise these recorded values in an order or sequence.

5. Characterisation of value : It is the highest level category of the objectives belonging to the affective domain. Upto this stage, the learner has the ability to imbibe all the essential affective behaviour. Here the learner is destined to imbibe typical characteristics of his individual character i.e., life style of his own. The characterisation of a value system has two levels :

(i) Generalised set : The behaviour level is that which provides an internal consistency to the system of attitudes and values at any particular moment. It is selective responding at a very high level.

(ii) Characterisation : This is the peak of the internalisation process. It consists of the broadcast objectives with respect to both to the phenomena covered and to the range of behaviour which they comprise. The learner develops a consistent philosophy of life.

III. Psychomotor Domain

Psychomotor objectives are concerned with the training of the student's physical activities and the development of the skills. The main levels of psychomotor domain are :

1. Imitation : For the learning of a psychomotor activity i.e., drawing or surveying skill in Mathematics, the task begins with the imitation of observed acts. The child observes the demonstrated behaviour related to drawing of a line angle / circle etc. He feels an inner push or an impulse to imitate action. It is followed by the overt repetition of the demonstrated behaviour.

2. Manipulation : The second category of psychomotor objectives emphasizes manipulation on the part of the learner for the acquisition of skills by following directions, performing selected action and fixation of performance through essential practice.

3. Precision : In the third category of psychomotor objectives learner performs skilled acts or motor activities with a desired level of precision and as such may be said to reach a higher level of refinement in reproducing a given act or skilled task.

4. Articulation : In the fourth category of psychomotor objectives learner is able to coordinate a series of acts by setting appropriate sequence and achieving harmony or internal consistency among different acts.

5. Naturalisation : It is the highest stage reached in terms of the development or proficiency needed in the learning of a skill or psychomotor act. The learner is able to perform a single act or a series of articulated acts with a greater refinement, ease and convenience as automatic and naturally as possible.

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1.5 FORMATION OF SPECIFIC OBJECTIVE OF BIOLOGICAL SCIENCE IN BEHAVIOURAL TERMS

9. Explain the term "Writing Objectives in Behavioural Terms". What is its need? Name a few important methods or approaches of such writing.

Ans. Specification of objectives in a task of teaching and learning may prove more effective and purposeful if they get translated into behavioural language. The writing of an objective in behavioural terms is always done in relation to the following three things :

1. **Nature of the objectives** i.e., knowledge, application etc.
2. **Area or domain of the behaviour** i.e., cognitive, affective etc.
3. **Specific content areas** in which behavioural changes are planned to be brought about i.e. means of irrigation, parts of a flowering plant etc.

There are different / various methods or approaches of writing of objectives in behavioural terms. It is not a new concept/approach in the field of education but it is an old concept. It has five historical basis :

1. Drucker (1954) advocated that the activities of management should be explained in terms of objectives. He laid stress on the behavioural aspects of the objective.
2. Bloom (1956) shifted the emphasis from content to the objectives in examination system. He held that achievement tests should be objective-centred instead of content-centred. Each question should evaluate one specific objective. In this way he endeavoured to write these objectives in behavioural terms.
3. Robert Mager's Approach (1962) is most popular in the development of programmed instruction. According to Mager, the instructional objectives are best described in terms of terminal behaviour desired from the learners. He concentrates on cognitive and affective objectives. In this approach, he lays stress on action verbs instead of mental processes. The cognitive objectives can be best realised by programmed instruction strategy.
4. Robert Miller's Approach (1962) is used for writing psychomotor objectives in behavioural approach. The origin of this approach is from the military science. In this way, the training objectives can be best written by Miller's Approach.
5. NCERT (1972) (Regional College of Educational, Mysore RCEM) also developed an approach for writing objectives in behavioural terms. This approach is applicable for cognitive, affective and psychomotor objectives of teaching and training. It gives major emphasis on mental abilities for writing objectives in behavioural terms.

Here we shall describe the following three approaches or methods for writing objectives in behavioural terms;

1. Robert Mager's Approach
2. Robert Miller's Approach
3. RCEM Approach

1. Robert Mager's Approach

According to Robert Mager, the instructional objectives are best described in terms of terminal behaviour expected from the learners. He is of the view that the behavioural objectives should be written in the following manner :

(i) Identification of the terminal behaviour and its meaning.
(ii) Description of the significant conditions under which the behaviour is expected to occur.
(iii) Specification of criteria of acceptable performance by describing how good a learner's performance must be for being acceptable.

Mager's approach is based on Bloom's classification of objectives for writing the objectives in behavioural terms. Mager has used 'Action Verbs' for writing the objectives. Through this process a student's behaviour and learning process can be written in behavioural terms and can be evaluated and measured with ease.

A list of associated Action Verbs in the Cognitive Domain

S.No.	Objectives based on Bloom's Taxonomy	Associated Action Verbs
1.	Knowledge	Define, List, Label, Measure, Name, Recall, Recognise, Reproduce, State, Write, Outline.
2.	Comprehension	Change, Classify, Distinguish, Explain, Formulate, Identify, Illustrate, Indicate, Interpret, Justify, Judge, Name, Represent, Select, Summarise, Transform, Translate
3.	Application	Assess, Change, Conduct, Construct, , Compute, Demonstrate, Discover, Explain, Establish, Find, Generate, Illustrate, Modify, Predict, Perform, Select, Solve, Use
4.	Analysis	Analyse, Associate, Compare, Conclude, Contrast, Criticise, Differentiate, Identify, Justify, Point out, Resolve, Select, Separate

S.No.	Objectives based on Bloom's Taxonomy	Associated Action Verbs
5.	Synthesis	Argue, Conclude, Combine, Desire, Discuss, Generalise, Integrate, Organise, Prove, Relate, Re-state, Select, Summarise, Synthesize
6.	Evaluation	Associate, Choose, Compare, Criticize, Conclude, Defend, Determine, Evaluate, Judge, Identify, Recognise, Relate, Select, Summarise, Support, Verify.

A list of associated Action Verbs for the affective Domain :

S.No.	Objectives based on Bloom's Taxonomy	Associated Action Verbs
1.	Receiving	Ask, Accept, Attend, Beware, Catch, Discover, Experiment, Identify, Favour, Follow, Observe, Prefer, Perceive, Insist, Select, Name
2.	Responding	Answer, Assist, Complete, Derive, Discuss, Develop, Help, List, Label, Name, Obey, Present, Practise, Record, Select, State, Write
3.	Value	Accept, Attend, Complete, Choose, Determine, Demonstrate, Discriminate, Develop, Increase, Indicate, Participate, Prefer, Recognize
4.	Organisation	Add, Associate, Compare, Complete, Coordinate, Correlate, Determine, Find, Form, Generalise, Integrate, Judge, Plan, Prepare, Relate, Select, Synthesize, Organize
5.	Characterisation of Value	Accept, Change, Characterize, Decide, Discriminate, Develop, Experiment, Face, Identify, Confirm, Prove, Revive, Serve, Solve, Verify.

Inorder to write objectives of special domain in behavioural form, appropriate related subject activities are selected. Then by linking the subject-material with work activity, objectives can be written in behavioural form.

1. First state conditions under which the performance is to take place such as "Giving a slide of an animal cell and another of plant cell the student through microscopic observation are able to or will be able to....."

2. Then use an action verb for telling what students will be able to do like study / differentiate / identify etc.
3. In the end state a criterion for success like "Giving a slide of an animal cell and another of a plant cell the students through microsocpic observation will be able to recognize atleast two types of structural similarities and two types of dissimilarities in them."

By following such procedure an instructional objective related to the topic "parts of a flowering plant" may be written as under.

"Given a flowering plant i.e., rose the students are able to identify/locate its parts like corolla, calyx, pedicel, stamens, carpels with 100% accuracy.

Limitations of Robert Mager's Approach : Even though Robert Mager's programmed instructions are quite popular, they suffer from some limitations which are given as under :

1. Mager's Approach is a behavioural approach, but human learning cannot be explained only through stimulus - Response Learning.
2. Mager has concentrated on cognitive and affective objectives and neglected the psychomotor domain.
3. In this approach stress has been laid on behavioural approach and behavioural terms have been extensively used. Nothing has been mentioned about related mental processes or mental capabilities. Therefore, this approach does not justify the objectives of cognitive and affective approaches / domains of writing.
4. The overlapping of action verbs in different categories of the cognitive as well as affective objectives creates confusion in the use of appropriate action verbs for writing particular instructional objective.
5. Moreover the list of action verbs is very long. It is not objectively appropriate to teach all these activities in classroom teaching.

2. Robert Miller's Approach

Mager in his approach badly neglected the conative domain or psychomotor aspect of the behaviour. Robert Miller (1962) while using skill analysis has propagated psychomotor objectives for writing behavioural terms. The process of this approach is as under :

(i) To explain the indicator which indicates some relevant activity.
(ii) To control the person or thing which motivates towards the direction of work.
(iii) To explain the indicator to which reaction is motivated.
(iv) To explain that action which has been completed.
(v) Indication of reactions and feedback.

Miller has also prepared a list of action verbs for writing the actionable objectives. We can take the help of these action verbs to write the psychomotor objectives. Harrow's (1972) list of these action verbs is as under :

A list of associated Action Verbs for Psychomotor :

S.No.	Objectives based on Harrow's classification	Associated Action Verbs
1.	Reflex movements	Bite, Stretch, Loosen, Harden, Making Small, Jerk, Lengthen, Relax, Straighten
2.	Basic fundamental	Catch, Fall, Creep, Drink, Jump, Walk, Run, movement Reach, Kneel
3.	Physical abilities	Start, Begin, Bear, Bend, Conduct, Stop, Smash, Increase
4.	Perceptual abilities	Balance, Bend, Throw, Write, Feed, Identification by touching, Catch, Discover, Identification by smelling or healing, Eat etc.
5.	Skilled Movements	Dig, Dive, Dance, Drive, Play, Musical organs, Shoot, Swim
6.	Non-discussive	Mimic, Tease, Stand, Sketch, Smile, Pose communication Sit etc.

Miller has endeavoured to write the objectives of his approach in a behavioural form by giving an example from the field physical training and exercise.

S.No.	Instructional objectives of psychomotor domain	Write in behavioural form
1.	Reflex Movements	Students can move their arms with the sound of a drum.
2.	Basic Fundamental Movements	Students can jump from a minimum height.
3.	Physical Abilities	Students can stand on their toes for a minimum time.
4.	Perceptual Abilities	Students can balance their body on parallel bars.
5.	Skilled Movements	Students can take a dive for a minimum period of time or swim.

3. RCEM Approach

Reaction against the limitations of Mager's approach and Miller's approach : Both Mager's and Miller's approaches have fasted to write

instructional objectives in behavioural form in all the three domains of behaviour. If Mager is related with Cognitive and Affective domains of objectives, Miller's approach deals with psychomotor objectives. Both the approaches have failed to write about the human behavioural aspects and their objectives. Both the approaches have depended on Associated action verbs for writing the objectives of the behaviour and the approach process but both the approaches have neglected the mental activities totally. Because of these weaknesses both the approaches have been criticised. To remove these weaknesses, research work has been undertaken. In our country also, work has been done in this regard. As a result of which a new method has been developed which is called RCEM Approach. It has been called so because it has been developed at Regional College of Education, Mysore.

To write instructional objectives in behavioural terms, RCEM approach instead of action verbs, has depended on 'mental activities' or 'mental abilities'. This method, with minor changes, has been adopted from Bloom's classification of objectives. It is named as RCEM sted taxonomy.

In this approach 4 categories of classification have been adopted instead of Bloom's 6 categories of classification in cognitive domain. The final two classifications have been named as creativity. The other change is that Bloom's comprehension has been re-named as understanding.

Objectives and Mental processes in RCEM Approach :

S.No.	Objectives	Mental activities or Mental abilities	
1.	Knowledge	1. 2.	Recognise Recall
2.	Understanding	1. 2. 3. 4. 5. 6. 7.	See relationship Cite example Discriminate Classify Interpret Verify Generalise
3.	Application	1. 2. 3. 4. 5.	Reason out Formulate hypothesis Establish hypothesis Infer Predict
4.	Creativity	1. 2. 3.	Analyse Synthesise Evaluate

As is clear from the above that objectives of cognitive domain have been classified into 4 categories and 17 mental activities. These mental activites or abilities can be applied and objectives can be written in behavioural vocabulary. For this in RCEM Approach 17 statements have been mentioned which are as under :

1. **Knowledge Objectives :**
   - 1.1 Students.....have the ability to recognise.
   - 1.2 Students.....have the ability to recall.
2. **Understanding Objectives :**
   - 2.1 Students.....have the ability to see relationship.
   - 2.2 Students.....have the ability to cite example.
   - 2.3 Students.....have the ability to discriminate.
   - 2.4 Students.....have the ability to classify.
   - 2.5 Students.....have the ability to interpret.
   - 2.6 Students.....have the ability to verify.
   - 2.7 Students.....have the ability to generalise.
3. **Application Objectives :**
   - 3.1 Students.....have the ability to reason out.
   - 3.2 Students.....have the ability to formulate hypothesis.
   - 3.3 Students.....have the ability to establish hypothesis.
   - 3.4 Students.....have the ability to infer.
   - 3.5 Students.....have the ability to predict.
4. **Creativity Objectives :**
   - 4.1 Students.....have the ability to analyse.
   - 4.2 Students.....have the ability to synthesis.
   - 4.3 Students.....have the ability to evaluate.

How to write objectives in RCEM Approach : The procedure for writing objectives is as under :

1. First of all a student should take care of entry behaviour.
2. Student should, thereafter, concentrate on his learning experience, subject material etc.
3. Student should give thought to objectives of education and learning.
4. Student should select appropriate eventual activities. Keeping in view the entry behaviour, subject material and specific objective.
5. Try to make use of the 17 frames or statements of the RCEM Approach given earlier in this chapter and fill in the blanks in view of the entry behaviour of the learner and learning experiences given to him.

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EXAM NOTES

PEDAGOGY OF BIOLOGICAL SCIENCE

[Paper–4 & 5 (Group–C, Opt.–i)]

UNIT–II

2. *Pedagogical Analysis*
   - *Meaning, importance and Steps of Pedagogical Analysis*
   - *Pedagogical Analysis on the following topics:*
     - *Photosynthesis,*
     - *Human digestive system,*
     - *Food Chain,*
     - *Ecological Balance*
     - *Respiratory System*
     - *Excretory*
     - *Circulatory*
     - *Hereditary and Environment*

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2

Pedagogical Analysis

2.1 MEANING, IMPORTANCE AND STEPS OF PEDAGOGICAL ANALYSIS

1. Describe the meaning, importance and steps of Pedagogical analysis.

Or

What do you mean by pedagogical analysis of a content material in the subject Biolosical Science? Explain by laying emphasis on the need of such analysis.

Or

Explain the concept and procedure of Pedagogical analysis of a unit in detail by quoting examples.

Or

Explain clearly what do you mean by the term pedagogy or science of teaching?

Or

What different points should be bollowed for Pedagogical analysis. **(C.R.S.U. 2018)**

Or

Discuss the importance and steps of Pedagogical Analysis is detail. **(M.D.U. 2018)**

Ans. Pedagogical Analysis means an analysis based on Pedagogy i.e. an analysis by which the rules of science of teaching may be made on the basis for teaching of content of a subject. In order to clarify Pedagogical Analysis further, it becomes essential to understand both these words separately.

The meaning of Analysis is to separate the accumulated articles. In this process the problem is divided into smaller parts in order to solve it. For example–while sipping a cup of tea, a thought comes into mind as to how it has been prepared. Through analysis it is known that it has been prepared by mixing water, sugar, tea, milk etc. in definite quantities and by heating it for a fixed time. Similarly, the assistance of unit analysis is taken to divide teaching unit into its different components like. sub-units and topics. Thus, the process of

content analysis is exercised to divide the content of syllabus set for a particular content into its major and minor sections, major concepts, topics, and sub-topics as well as units and sub-units.

The literal meaning of Pedagogy is "Science of Teaching", means, it may be said that knowledge of all those things concerned with good teaching by which we are able to achieve the objective of teaching. For achieving this objective, required knowledge and skill are provided by the Pedagogy. For the teaching of Science pedagogical analysis may be shown as under—

The very analysis of any contents of Science based on the rules of the Pedagogy is called the Pedagogical analysis of the content of Science.

Then the content of Syllabus, units and topic of a subject is divided into its parts only in order to arrange and organize it sequentially, it would be called content analysis. But, when the content is analysed on the basis of parameters and principles of the Science of Teaching, it would be called Pedagogical analysis.

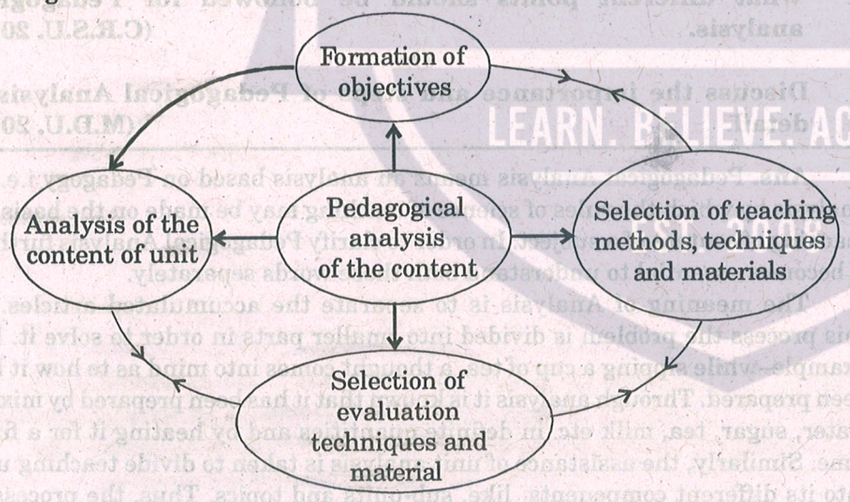
Process of Pedagogical Analysis

A teacher of Science must keep in mind the following steps while making pedagogical analysis of a content—

1. Content analysis of the topic or unit under study.
2. Writing the instructional objectives in behavioural term of teaching-learning concerned with that topic or unit.
3. Selection of methods, techniques, activities and audio-visual aids to achieve the instructional objectives.
4. Selection of evaluation, technique and devices in order to evaluate the teaching-learning process of that unit.

Though the above mentioned four steps of Pedagogical Analysis appear to be separate but these are strongly inter-related. One step, establishing relationship with the second, third and the fourth step gets included in the Pedagogical Analysis.

The mutual relation and link of these steps may be clearly shown by the figure given below :



Relation and link within Pedagogical Analysis

In order to make Pedagogical analysis of the content of a particular topic and content of the subject or Science, the formation of four points would be needed focussing the attention on the above figure.

1. Content analysis
2. Formation of objectives in Behavioural Terms
3. Selection of Teaching Methods, Techniques and Material
4. Selection of Techniques and devices of Evaluation

The Pedagogical Analysis of any content is dependent upon the above mentioned points.

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PEDAGOGICAL ANALYSIS OF TOPICS IN THE SUBJECT BIOLOGICAL SCIENCES : PHOTOSYNTHESIS

2. Perform pedagogical analysis of subject content on photosynthesis for class X.

Ans. Carry out a pedagogical analysis of a topic on Photosynthesis.

A. Content Analysis of the topic 'Photosynthesis' incorporating major and minor concept as below :

1. What is Photosynthesis?
   — Defining Photosynthesis
   — Expounding the meaning of photosynthesis.
2. Mechanisms of the process of photosynthesis :
   — What happens during photosynthesis?
   — How does it take place?
3. Factors responsible or essential for carrying out photosynthesis:
   (i) Presence of Sunlight
   (ii) Presence of Carbon dioxide.
   (iii) Presence of Chlorophyll
   (iv) Presence of Water
4. Use and significance of photosynthesis :
   (i) Assisting green plants in the preparation of their food on their own for their survival.
   (ii) Helping in the maintenance of the flow of food energy on the earth.
   (iii) Provide a helping hand in maintaining ecological balance in a particular eco-system.

B. Objective Formulation (Listing of Behavioural Outcomes). After going through the teaching of the contents related to the topic "photosynthesis", students are expected to demonstrate the following kinds of behavioural outcomes.

1. They define the term "Photosynthesis."
2. They state that green plants having cholorophyll prepare their food on their own as a result of photosynthesis.
3. They state that green plants only are capable of converting the light energy of the sun received by them into food evergy due to the process of photosynthesis.

4. They expound how green plants are beneficial in maintaining appropriate balance of carbon-dioxide and oxygen in the environment through the process of photosynthesis.
5. They identify that in green plants chlorophyll is present in the cells of green stems and leaves.
6. They explain and illustrate the use and significance of photosynthesis in the sustenance of life on the earth.
7. They expound the term ecological balance and enumerate the role of photosynthesis in its maintenance.

C. Listing teaching methods, devices, activities and aid materials etc.

1. Methods and Devices used :

Methods : Lecture Method, Demonstration Method

Devices : Explanation Device, Narration Device, Experimentation and Observation Device.

2. Activities and Aid materials employed.

(i) Whole making use of lecture method, narration, explanation and illustration devices, assistance of chalkboard writing and sketching charts and pictures will be employed.

(ii) Assistance of slides will be taken for highlighting the main points, explanation of facts and concepts related to photosynthesis.

(iii) Use and importance of photosynthesis in the sustenance of life on the earth will be expounded and illustrated with the help of audio and video films for this purpose.

D. Listing of evaluation procedure, devices etc. Oral, practical and written mode of testing and evaluation will be employed for the evaluation of the teaching outcomes of the concepts regarding "photosynthesis". As a teacher made evaluation devices the following items will be employed for evaluation purpose—

(a) Essay Type Questions.

1. What is photosynthesis? What really goes inside the process of photosynthesis? Explain in detail.
2. Explain the necessity of the presence of sunlight, chlorophyll, carbon-dioxide and water for carrying out photosynthesis by the green plants.
3. Discuss in detail the use and significance of photosynthesis in the sustenance of life in the world.

(b) Short Answer Type Questions.

1. Define the term photosynthesis.
2. Name the process of mechanism that assists the green plants for preparing their food on their own.
3. Write the chemical reaction involved in the process of photosynthesis.
4. Where does chlorophyll lie in the green plants?
5. What is meant by the flow of food energy on the earth?
6. What is implied by flow of total energy into the biosphere?
7. What is formed out of the process of photosynthesis carried out in green plants?
8. How does photosynthesis help in the maintenance of the required proportion of oxygen and carbon-dioxide in the atmosphere?

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HUMAN DIGESTIVE SYSTEM : RESPIRATORY, EXCRETORY, CIRCULATORY

3. Discuss in brief the role of various organs of our digestive system in digesting the foods and liquids.

Ans. The complete process of the digestion of food passes through five stages :

1. Ingestion; 2. Digestion; 3. Absorption; 4. Assimilation; 5. Defecation

1. **Ingestion :** Taking the food into the mouth is called Ingestion.
2. **Digestion :** Conversion of non absorbable food into absorbable form is called Digestion. The digestion of the food is started from the mouth.
3. **Absorption :** Reaching of digested foods into blood is called Absorption. The absorption of digested foods takes place through small intestinal villi.
4. **Assimilation :** Use of absorbed food in the body is called assimilation.
5. **Defecation :** Undigested food reaches into large intestine where bacteria turns it into faeces which is excreted through anus.

Summary of Digestion

	Gland juice		Enzyme	Edible substance	After reaction
1.	Saliva	(i) (ii)	Ptyalin Maltase	Starch Maltose	Maltose Glucose
2.	Gastric juice	(i) (ii)	Pepsin Rennin	Protein Casein	Peptones Calcium paracasein
3.	Pancreatic juice	(i) (ii) (iii)	Trypsin Amylase Lipase	Protein Starch Fat	Polypeptides Sugar Fatty acid and glycerol
4.	Intestinal juice	(i) (ii) (iii) (iv) (v)	Erepsin Maltase Lactase Sucrase Lipase	Protein Maltose Lactose Sucrose Fat	Amino acid Glucose Glucose and fructose Glucose and glactose Fatty acid and glycerol

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RESPIRATORY SYSTEM

4. Discuss in brief our respiratory system for carrying out the process of respiration.

Ans. The most important organ of the respiratory system of human is lungs where the exchange of gases takes place.

All those organs come under respiratory system which help in exchange of gases are : Nasal passage, Pharynx, Larynx or Voice box, Trachea, Bronchioles, Lungs etc.

Nasal passage : Its main function is related to sniffing. Its inner cavity is lined with mucous membrane. This secretes approximately 1/2 litre of mucous everyday. This prevents the particles of sand, bacteria or other small organisms from entering into the body. It makes the air wet entering into the body and equalises it with the temperature of the body.

Pharynx : It is situated behind the nasal cavity.

Larynx or Voice box : The part of the respiratory way which connects the pharynx with trachea is called larynx or voice box. Its main function is to produce sound. At the larynx entrance gate there is a thin blade like door, which is called epighettis. When any food particle is swallowed it closes the glottis, due to which food does not enter into respiration pipe.

Trachea : It enters into the thoracic cavity. The two main branches of trachea are called bronchi. Right bronchi enters into the right lungs after being divided into three branches. Left bronchi enters into the left lungs after being divided into only two branches.

Lungs : There is a pair of lungs in the thoracic cavity. Its colour is red and looks like sponge. Right lung is larger in comparison to left lung. Each lung is surrounded by a membrane which is known as pleural membrane. There is a network of blood capillaries. Here oxygen enters into the blood and CO_2 comes out.

The process of respiration can be divided into four parts :

1. External respiration
2. Transportation of gases
3. Internal respiration
4. Cellular respiration

1. External respiration : This is divided into two parts :

(a) Breathing; (b) Exchange of gases

(a) Breathing : In lungs air is taken and given out at a certain rate which is called breathing.

Mechanism of Breathing :

(i) Inspiration : At this stage, air from the environment enters into the lungs through the nasal passage, due to increase in dimension of thoracic cavity a low pressure is formed in the lungs and air enters into the lungs from environment. This air continues to enter until the pressure of air inside and outside the body became equal.

(ii) Expiration : In this process air comes out of the lungs.

Constitution of air in breathing :

	Nitrogen	Oxygen	Carbon dioxide
The air inhaled	79%	21%	0.03%
The air exhaled	79%	17%	4%

(b) Exchange of gases : The exchange of gases takes place inside the lungs. This gaseous exchange takes place on the basis of concentration gredient through normal diffusion.

The exchange of oxygen and carbon dioxide gases takes place because of their difference in partial pressures.

2. Transportation of gases : The process of reaching of gases (oxygen and carbon dioxide) from lungs to the cells of body and coming back again to the lungs is known as the transportation of gases. Transportation of oxygen takes place by haemoglobin present in blood. Transportation of carbon dioxide from cells to lungs takes place by haemoglobin only to the extent of 10 to 20%. Transportation of carbon dioxide takes place through circulation of blood :

(i) By mixing with plasma : Carbon dioxide forms carbonic acid after mixing in plasma. Transportation of 7% carbon dioxide takes place in this form.

(ii) In the form of bicarbonates : 70% part of carbon dioxide in the form of bicarbonates is transported. It mixes with potassium and sodium of blood. It forms potassium bicarbonate and sodium bicarbonate.

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5. Develop a content-cum-pedagogical analysis note on Digestive System.

Ans. A. Pedagogical Analysis of the topic "Human Body Systems—Digestive, Circulatory, Respiratory and Excretory" incorporating major and minor concepts as below :

(a) Digestive System

1. What is digestion?
2. What do you mean by Digestive System?
3. Organs of the digestive system and their functioning:
   - (i) Mouth
   - (ii) Gullet
   - (iii) Small Intestine
   - (iv) Large Intestine
   - (v) Stomach
   - (vi) Rectum
   - (vii) Duodenum

(b) Blood Circulatory System

1. What do you mean by the circulatory system?
2. Organs and constituents of the blood circulatory system.
   - (i) Heart
   - (ii) Arteries
   - (iii) Veins
   - (iv) Capillaries
   - (v) Blood
3. Mention the way blood is circulated or transported?

(c) Respiratory System

1. What do you mean by the Respiratory System?
2. Organs constituting our respiratory system.
   (i) Nose (ii) Pharynx
   (iii) Lungs (iv) Larynx
   (v) Trachea (vi) Bronchioles.
3. Mention the way the respiratory process is carried out.

(d) Excretory System

1. What do you mean by the excretory system?
2. Organs constituting our excretory system
   (i) Lungs (ii) Skin
   (iii) Kidneys
   (iv) Large intestine and its extension.

B. Objective Formulation (Listing of Behavioural Outcomes)

After going through the teaching of the contents related to the topic **"Our Body Systems – Digestive, Circulatory, Respiratory and Excretory"**, it is expected from the students to demonstrate the following types of behavioural outcomes—

1. They define the terms digestion, digestive system, blood circulatory system, respiratory system and excretory system.
2. They name the significant organs which comprises our digestive, circulatory, respiratory and excretory systems.
3. They expound the processes in relation to the digestion of food, transportation and circulation of the blood, respiration and excretion.
4. They expound the significance of teeth, stomach, small intestine and large intestine in the digestion of food and liquids.
5. They state the different functions of stomach as an organ of our digestive system.
6. They state the role of liver, pancreas and gall bladder in the digestion of our food.
7. They demonstrate the role of rectum and anus as organs of our digestive system.
8. They tell the meaning of the digestive tract and name its different constituents.
9. They state the role of duodenum in the digestion of food.
10. They state the role of arteries, veins and capillaries as organs of our blood circulatory system.
11. They state the role of nose, pharynx, larynx, tracheas, bronchioles and lungs as organs of our respiratory system.
12. They state the role of our lungs, skin, large intestine and kidneys as organs of our excretory system.

C. Listing teaching methods, devices, activities and aid materials employed.

1. Methods and Devices Applied.

Methods – Lecture Method, Demonstration Method.
Devices – Explanation Device, Narration Device, Illustration Device.

2. Activities and Aid materials employed.

(i) While making use of lecture method, narration, explanation and illustration devices, assistance of chalkboard writing and sketching, charts and pictures, models etc. will be employed.

(ii) Assistance of slides/transparencies will be taken in order to highlight the main points, expounding facts and concepts connected to the systems of the body and their working particularly in the situation as mentioned below.
   — providing definitions of the terms digestion, digestive system, blood circulatory system, respiratory system and excretion system
   — depicting diagrams for the instance of the location, composition and working of the various organs of the body systems.
   — naming and explaining the different organs

(iii) Displaying or exhibiting video films and film strips for the demonstration of the composition and functioning of the body systems combined with running commentary on the part of the teacher.

D. Listing of Evaluation Procedures, Devices etc.

Oral, practical and written mode of testing and evaluation will be employed for the evaluation of the teaching-learning outcomes of the concepts in relation to the body systems. As a teacher made evaluation device, the following items will be employed for evaluation purpose.

(a) Essay Type Questions

1. Discuss in brief the significance of our digestive system in digesting the foods and liquids.
2. Discuss the role of different organs of our blood circulatory system for carrying out the process of transportation of blood in our body.
3. What do you mean by excretion? How the process of excretion is carried out by the different organs of our excretory system?

(b) Short Answer Type Questions

1. Name the various constituents of digestive tract.
2. State the role of kidneys as organ of our excretory system.
3. Draw a labelled diagram of kidneys as an excretory system.
4. Draw a diagram of heart for explaining its internal structure and flow of blood.

(c) Objective Type Questions

1. Fill in the blanks.

(i) Human heart consists of _____ chambers.
(ii) Stomach empties its contents slowly into the _____.
(iii) Liver produces a digestive juice known as _____.
(iv) _____ of waste material is necessary for our health and well being.

2. Match the following :

Column I	Column II
(a) Digestion	Lungs
(b) Excretion	Capillaries
(c) Blood circulation	Excretion

(d) Trachea — An organ of the excretory system
(e) Urethra — An organ of the respiratory system
(f) Sweating in summer season — Kidney
(g) Respiration — Stomach.

3. Write True (T) or False (F) against the following statements.

(i) Process of digestion of food does not start from mouth.
(ii) Kidneys exist in pairs.
(iii) Pancreas produces powerful digestive juices known as enzymes.
(iv) No digestive activity is carried out by oesophegus or gullet.
(v) Our lungs are separated from each other with the help of diaphragm.

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FOOD CHAIN

6. What do you mean by pedagogical analysis? Carry out pedagogical analysis of a topic on Food Chain for Class X.

Or

What do you understand by pedagogical analysis of the content? Give a brief account of the activities and experiments for both class students on the following major concepts.

Ans. In its simple meaning the term pedagogical analysis (a competition of two words, pedagogy and analysis) stands for a sort of analysis which is based on pedagogy. Thus we should endeavour to get familiar with the term analysis and pedagogy.

Analysis as a term symbolises a process of breaking or separating a thing into its smaller parts, elements or constituents. Water can be analysed into its constituents or elements, hydrogen and oxygen, with the help of a process of analysis known as electroanalysis. We break a teaching unit into its constituents – sub-units, topics or single concepts etc., with the help of the process of unit analysis. Likewise we can break the contents of the prescribed course in a subject into the various constituents – major and minor section and sub-sections, units and sub-units, major concepts and minor concepts, topics and sub-topics etc., by adopting a process of content analysis.

With reference to the meaning of the term pedagogy, we find that in the available dictionaries it has been briefly defined as science of teaching.

Accordingly the analysis of a given content material in the subject life sciences carried out well in the spirit of the science of teaching (Pedagogy) is known by the term pedagogical analysis of the contents in life sciences.

Pedagogical Analysis of the Content Material—Food Chain.

A. Content analysis of the topic "Food Chain" incorporating major and minor concepts as below.

1. What is a food chain?

(i) Meaning and definition of the term food chain.
(ii) Examples of the food chains.

2. Network of food chains :
(i) Meaning of the term "Network of Food Chains".
(ii) Illustrations of the network of food chains.

3. Trophic levels in a food chain :
(i) Meaning of the term trophic levels in a food chain.
(ii) Illustrations of the concept of trophic levels with the help of a number of food chains.

4. Food chains and flow of energy in the biosphere :
(i) Flow of food energy in the biosphere.
(ii) How food chains help in the smooth flow of this food energy?

B. Objective Formulation (Listing of Behavioural Outcomes).

Students after going through the teaching of the contents connected with the topic "Food Chains" are believed to demonstrate the following kinds of behavioural outcomes.

1. They are able to give the meaning of food chains.
2. They demonstrate the flow of food energy in a chain on land.
3. They define the term network of food chains.
4. They tell the meaning of the term trophic levels in a food chain.
5. They recall the meaning of the term producers, consumers etc. in the trophic levels of food chains.
6. They are able to explain the meaning of the term flow of food energy in the biosphere.
7. They cite the examples of "who eats whom" for expounding the concepts of food chain and trophic levels in a particular food chain.
8. They state the importance of food chains in the maintenance of the flow of energy in the biosphere.
9. They classify different living beings beionging to a particular food chain at the various trophic levels.
10. They state reason why vegetation food habits assist us in getting more energy.

C. Listing teaching methods, devices, activities and aid materials etc.

1. Methods and Devices Used :

Methods : Lecture Method, Problem Solving Method, Nature Observation Method, Demonstration Method.

Devices : Narration Device, Explanation Device, Observation Device, Illustration Device.

2. Activities and Aid Materials Used :

(i) While making use of lecture method, explanation, narration and illustration devices, assistance of chalkboard writing and sketching, charts and pictures, flow diagrams and models will be taken.

(ii) Students will be told to observe around their physical environment and note their observations for further discussion

and drawing essential conclusions about the concept of food chain, flow of food energy, network of food chains etc.

(iii) Making use of transparencies and slides in order to highlight the main points/concepts/facts in connection with the contents of the topic 'food chain'.

(iv) Video films alongwith audio recording, computer graphics, moving films particularly linked with the themes and concept of food chain, networking of food chains, flow of food energy in the biosphere etc., will be employed.

(v) Verbal examples and illustrations from daily life happenings and natural observations of environmental surroundings will be provided as and when so required in illustrating the major and minor concepts in relation to the content material of the topic "food chain."

D. Listing of Evaluation Procedures, Devices etc. Oral, practical and written mode of testing and evaluation will be employed for the evaluation of the teaching outcomes of the topic "Food Chain."

In oral mode, it is expected from the students to respond orally to the oral questions asked to them either in the shape of personal interview or as a member of the classroom group discussions.

In practical mode, they will be asked

(a) to record the observational findings in order to enquire and investigate several things in relation to the concept of food chain while assigning them the responsibility of a keen observer of both natural and experimental surroundings.

(b) to draw valid inferences and conclusions from the recordings of their observation.

(c) to convey their findings in terms of the explanation of the facts and principles which are related to the concept of food chain.

In written mode as a teacher made evaluation device, the following items will be employed for the sake of evaluation.

(a) Essay Type Questions

1. What do you mean by food chain. Explain its meaning and concept through appropriate illustrations and examples.
2. Illustrate the term "Network of food chains" through verbal examples as well as flow diagrams.
3. Mention trophic levels in a food chain? Give illustration with the help of various food chains prevalent in nature.
4. Explain in detail how the phenomenon of food chain assists in maintaining appropriate flow of energy in the biosphere.

(b) Short Answer Type Questions

1. Give the definition of the term "Food Chain".
2. Give the definition of the term network of food chains.
3. Present a flow diagram to illustrate the concepts of flow of food energy in the biosphere.
4. Why vegetation food habits help us in getting more energy?

(c) Objective Type Questions.

1. Fill in the blanks :

(i) Green plants have the capability to convert solar energy into _____ energy.

(ii) Steps in a particular food chain for the transfer of energy are technically named as _____ in a food chain.

(iii) Transfer of energy from one trophic level to another. Trophic level is known by the term _____ in a particular food chain.

2. Choose the correct alternative of the following :

(i) Producers represent _____ trophic level in a food chain consisting of the four trophical levels :

(a) First (b) Second
(c) Third (d) Fourth

(ii) As we move higher and higher in the food chain, the amount of energy available to the consumers :

(a) becomes more and more
(b) becomes less and less
(c) neither increases nor decreases
(d) becomes limitless.

(iii) Wolves and lions are said to occupy the same trophic level as they both

(a) eat herbivorous animals
(b) utilise their food with about 10% efficiency.
(c) reside on land
(d) possess a wide range of dietary items.

3. Write True (T) or False (F) against the following statements :

(i) Food chain implies the unidirectional flow of energy in a chain like relationship.

(ii) Carnivores are the animals which feed up on plants.

(iii) Network of food chains is named as food web in nature.

(iv) A particular organism can have food relationship with only one organism in a food web.

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7. Develop a content-cum-pedagogical analysis note on Ecological balance.

Ans. Pedagogical Analysis of the Content Material—Ecological Balance

A. Content analysis of the topic "Ecological Balance" incorporating major and minor concepts as below.

1. What do you mean by ecological balance?
   (i) Meaning of the terms ecosystem and biosphere.
   (ii) Defining the term ecological balance.

2. Maintenance or disturbance of ecological balance
   (i) Giving the meaning of the term maintenance or disturbance of ecological balance.
   (ii) The contribution of food chains in maintaining ecological balance.
   (iii) Population control is helpful in maintaining ecological balance.
   (iv) Human beings playing a role in maintaining/disturbing the ecological balance.

B. Objective Formulation (Listing of Behavioural Outcomes).

Students after going through the teaching of the contents related to the topic "Ecological Balance" are expected to demonstrate the following types of behavioural outcomes.

1. They explain the meaning of the terms ecosystem and biosphere.
2. They distinguish/differentiate between the terms ecosystem and biosphere.
3. They are able to define the term ecological balance.
4. They give examples of the terms maintenance of ecological balance and disturbance in ecological balance.
5. They illustrate how population control helps in maintaining ecological balance.
6. They mention about our undesirable habits and ways of living responsible for bringing ecological crisis in our biosphere.
7. They tell about what should be done by us in order to avoid ecological crisis or maintenance of ecological balance in our biosphere.
8. They state how the protection of green plants may be helpful in maintaining ecological balance in our biosphere.

C. Listing Teaching Methods, Devices, Activities and Aid Materials etc.

1. Methods and devices applied.

Methods : Lecture Method, Demonstration Method, Enquiry Method, Problem Solving Method, Nature Observation Method.

Device : Narration Device, Illustration Device, Explanation device, Observation device.

2. Activities and Aid Materials employed.

(i) While making use of lecture method, explanation, narration and illustration devices, appropriate help of chalkboard writing and sketching charts and pictures, flow diagrams, models etc. will be used.

(ii) Making use of transparencies and slides will be made to highlight the main points/concepts/facts connected with the contents of the topic "ecological balance" particularly in the situations that follow.

— Distinguishing biotic and abiotic environment by giving examples

— Giving definition of the term ecological balance.

— Maintaining ecological balance among producers and consumers of food energy.

— Highlighting the activities helpful in maintaining ecological balance or responsible for bringing ecological crisis.

(iii) Students will be asked to observe around their day to day physical environment or will be given specially arranged opportunities for attaining direct experiences in relation to the concepts of ecological balance and ecological crisis in a specialized food chain, ecosystem and biosphere.

(iv) Verbal examples and illustrations from routine life happenings and naturalistic observations of environmental surroundings will be given as and when required for the appropriate explanation, illustration, analysis, synthesis and evaluation of the major and minor concepts in relation to the content material of the topic "Ecological Balance."

D. Listing of Evaluation Procedures, Devices etc. Oral, Practical and Written (essay type, short answer type and objective type questions) mode of testing and evaluation will be employed for the evaluation of the teaching outcomes of the topic "Ecological Balance."

In oral mode it will be expected from the students to respond orally to the questions asked either in the shape of personal interview or as a member of the classroom group discussions :

In practical mode they will be required :

(a) To record the observational findings for inquiring and investigating many things in relation to the concept and mechanism of "ecological balance" around their physical and natural surroundings as well as the time of experimental activities performed or facts demonstrated in the class or opportunities provided at the time of visits and excursions.

(b) To draw valid inferences and conclusions from the recordings of their observations.

(c) To convey their findings in terms of the explanation, understanding and application of the facts and principles and in connection with the concept of ecological balance.

In written mode as a teacher-mode evaluation device the following items will be employed for evaluation purpose.

(a) Essay Type Questions

1. What do you mean by ecological balance? Explain its meaning through proper illustrations and examples.
2. Discuss in detail how food chains assist in the proper maintenance of ecological balance.
3. Discuss in detail the role of population control in the proper maintenance of ecological balance.

4. What do you mean by ecological crisis? How does it occur?
5. Discuss in detail the measures or activities undertaken by the human beings for the proper maintenance of ecological balance.

(b) Short Answer Type Questions

1. Define the term 'ecological balance.'
2. How is ecological crisis caused by our resorting to destroy forests?
3. Provide four examples each of the things included in one's biotic and abiotic environment.
4. How does pollution in water bring ecological crisis in the water kingdom as well as in the total biosphere?
5. Give an example where unusual increase or decrease in the population of the members of a food chain disturb the ecological balance.
6. Draw a diagram showing maintenance of ecological balance among producers and consumers of food energy in a particular food chain.

(c) Objective Type Questions

1. Fill in the blanks :

(i) There remains a perfect balance among the members of producers and _____ of food energy in a particular food chain.

(ii) Excessive increase or decrease in the population of a member of the food chain may bring ecological _____ .

(iii) Nature is always in the habit of maintaining proper ecological balance among the different _____ of the biosphere.

2. Write True (T) or False (F) against the following statement.

(i) Mountains, rivers and minerals are the examples of the objects comprising our biotic environment.

(ii) Nature demands from us to meet our food requirements from the vegetable world for the maintenance of proper ecological balance.

(iii) Urbanisation results in serious imbalances in both biotic and abiotic environments.

(iv) Cutting of the forest trees is essential for the maintenance of appropriate ecological balance.

3. Tell which one of the following statements is not true.

(i) Food chain helps in maintaining ecological balance.

(ii) Nature by itself does not cause ecological crisis.

(iii) Proper ecological balance can be maintained by protecting the population of green plants by the mankind.

(iv) Control of population assists in maintaining ecological balance.

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8. What is the meaning of heredity and environment? Discuss in detail.

Or

"Development is the matter of both heredity and environment." Explain this statement and illustrate the relative importance of heredity and environment in growth and development

Or

Discuss the importance of heredity and environment in the development of personality.

Or

Heredity and environment are complementary to each other. Justify.

Ans. Heredity and environment contribute significantly to the development of an individual. These are the two sides of the same coin. The meaning of heredity and environment is explained below:

What is Heredity—Heredity is a process by which mental and physical characteristics are passed by parents to their children of the time of their conception. The child inherits from its parents the ancestral characteristics, and this is called heredity. According to **H.A. Peterson :** "Heredity may be defined as what one gets from his ancestral stock through his parents." Heredity is a **constant element** that is present from the time of conception and the influence of heredity continues throughout life. Hereditary characteristics are relatively unchangeable and determine a man's development and his elemental nature. The child inherits these characteristics such as the structure of his body, colour, physiognomy, hands, feet, the form of legs, mental abilities, intelligence, memory, thinking and their capabilities from his ancestors naturally. According to **Douglas and Holland :** "One's heredity consists of all the structures, physical characteristics, functions or capacities derived from parents, other ancestors or species."

The Process of Heredity—The child grows from germ cells. The reproductive organs of a male and a female produce germ cells. The female germ cell is produced by the ovary of the woman and is called ovum. The other germ cell produced by the male is called sperm (spermatozoa). The union of a sperm with the female egg (ovum) results in the egg being fertilized, the fertilized ovum, called zygote, is the beginning of the infants conception and life in the mother's womb. The infant is born after approximately 280 days of conception (about nine months).

In the nucleus of each cell are found very small parts like threads which are known as chromosomes. Chromosomes always exist in pairs. Each human cell contains 23 pairs of chromosomes or 46 chromosomes. Each chromosome has a large number of genes. The genes are minutest physical substances and are the real carriers and determiners of hereditary traits. **A chromosome is a thread like structure that has strings of tiny particles called genes.** The genes are the real **genetic units.** These are the physical substances passed on from parents to the children. Each sex cell carries from about 80,000 genes to 1, 20,000 genes and each gene has certain physical and mental characteristics. Some genes have natural physical characteristics like height, colour of the hair

and of the eyes, nose etc. Some others have natural mental characteristics that determine intelligence, aesthetic capabilities and nature of a person. Some genes are **dominant** and some others are **recessive.** (A dominant Gene causes a person to have a particular physical characteristic, for example brow eyes, even if only one of their parents has passed on this Gene. In this way an infant gets 23 pairs of chromosomes from his parents (23 from the father and 23 from the mother) These 46 chromosomes together determine the child's hereditary characteristics. The father and the mother contribute equally to the genetic characteristics of the infant.

At the time of conception both the reproductive cells are mature. The male reproductive cell, the spermatozoa, fertilizes the female reproductive cell, ovum, and zygote is conceived. The process of fertilization is very important for the child. Three characteristics of the infant get conceived with the zygote coming into being.

1. Hereditary Endowment— Immediately after the ovum gets fertilized by the sperm the infant in the zygote inherits the hereditary traits of its parents and ancestors. The infant gets 23 pairs of chromosomes each from its parents. These 46 chromosomes carry number of genes. The genes of either parent may be more dominant or recessive.

The parent whose dominant genetic traits get transmitted to the infant in a greater measure make hereditary traits in it more dominant. This depends completely on co-incidental genetic permutation and on how many dominant genes it has received from its father and from its mother. In the fertilized ovum (zygote) there are 23 chromosomes from mother and the same number of chromosomes (23) is transmitted by the sperm. After conception, genes cannot be changed. Neither anything can be added to them nor subtracted from them. But after the conception has taken place the health of the mother depends on the good food and good environment which consequently makes a positive effect on the physical and the mental development of the infant. Thus once the infant is conceived, its hereditary traits and characteristics cannot be changed or either its sex, nor colour nor its physiognomy can be changed.

2. Sex of the Baby— After conception has taken place the mother is curious to know the sex of the infant. How can it be known whether the infant is male or female? The biologists have found out how the sex of the infant is formed but have no control over its formation. The sex of the infant like other hereditary traits depends on co-incidence or chance. What will be the sex of the infant? This is determined at once after the ovum is fertilized by the sperm and the zygote is conceived. It is the chromosomes that transmit the traits of the parents to the child. The chromosomes are thread like material structures that are found in the nucleus of each sex cell. They always exist in pairs and each living being has definite number of chromosomes. Each sex cell of a human being carries 23 pairs of chromosomes (46 in all). Among the 23 pairs of chromosomes, 22 pairs are alike both in men and women. But one pair of chromosomes which is called **sex chromosome** is completely different in men and women. It is this pair of chromosomes that determines the sex of the infant; whether it will be male or female. The 23rd pair of chromosomes in a woman is alike and is known as xx chromosomes. But the 23rd pair of chromosomes in a man consists of an x chromosome and a y chromosome, meaning the pair has two different chromosomes. Among the 23 pairs of chromosomes **y-chromosome exists by itself and only in male cells.**

In the process of maturation of sex cells among a woman and a man a matured ovum is produced in a woman and matured sperms are produced in a man. In this process of maturation of germ cells the pairs of chromosomes split into two equal halves and only 23 chromosomes remain in the matured ovum and the matured sperm. The ovum always contains an 'x' chromosome while sperm may contain either 'x' or 'y' chromosome. If an 'x' chromosome of a man fuses with an 'x' chromosome of a woman, the zygote conceived in the process will receive the 'x' chromosomes from both the parents and the foetus will develop into a girl child. But if the 'y' chromosome unites with the ovum of the woman / the foetus will develop into a male child. The fusion of sperm and ovum leads to formation of zygote. During fusion the chromosomes of the man and the woman pair and zygote receives 23 pairs of chromosomes, half from father and the rest half from mother. So, it is clear that if x-chromosome of the sperm pairs with the ovum, a girl child is conceived and if y-chromosome fertilizes the ovum, the new cell, zygote, will develop into a male child.

3. Number of Babies—The number of babies conceived is determinable within a few hours of conception. Normally a young woman gives birth only to one child (singleton). Sometimes a mother gives birth to more than one off spring with a time difference in delivery of a few hours. This is known as **multiple births.** Multiple births may include giving birth to twins (two babies), to triplets (three babies), quadruplets (four babies) and quintuplets (five babies). The multiple births these days are more than they used to be earlier and the death rate is proportionally higher. Multiple birth, are mainly of two types: (a) Identical twins and (b) Fraternal twins, the identical twins are conceived when the fertilized ovum (zygote) splits into two. As a result two individual identical babies develop and are born with identical traits because each carries the same genes. Mostly both the foetuses develop in the same foetal sac. Both are of the same sex, either male or female. Sometimes two matured ova are produced in the ovary during the menstrual cycle of the mother, and both the ova are fertilized by two different sperms of the father simultaneously. As a result two zygotes are formed carrying a combination of different chromosomes and genes. They are born as fraternal twins or non-identical twins. Their physical and mental traits, their colour, their physiognomy etc. are not identical. The similarities in the traits of the identical twins are much greater since they carry the same genes transmittal to them by one sperm. The research studies conducted with regard to the effect of heredity have revealed that the physiological traits like colour, height, the colour of the eyes and of the hair and other traits and characteristics are affected by the heredity factor. In the same way the intelligence and the mental abilities are also influenced by heredity. Besides, the mental abnormalities and ailments and other behaviour defects like schizophrenia etc. are to a great extent also due to heredity. The chromosomes that determine sex of the child also organise the development of heredity-linked disorders like abnormal growth of fingers (shorter in length or being more than five), boldness etc. Diabetes is also hereditary. All these disorders are sex-linked and are called sex-linked characteristics because these are determined by the same chromosomes that determine the sex of the child.

The Laws of Heredity

The following are the three laws of heredity.

1. Law of similarity–According to this law: **Like begets like.** A cat begets a kitten, a cow a calf, a mouse a mouse ling and a human being a human child.. The children take after their parents. The children of the intelligent parents are intelligent those of the feeble minded are dullards. In the same way the children of the white people are white and those of black parents are black. But there are exceptions to this law of heredity too. It has been seen that the white parents have begotten black children and white children have been born to the black.

2. Law of Variation—According to the law of variation all the children do not necessarily take after their parents. They are somewhat different from their parents in height, body structure, colour, physiognomy etc. This difference owes itself to the genes present in the germ cells of their parents.

In this context Sorenson–1948 says—"The reason for such variations lies in the characteristics of the germ cells of the parents. Germ cells contain many determiners (which constitute chromosomes and genes) which are in fact responsible for the transmission of hereditary characteristics to the off-springs". The counsel of variation lies in the type of combination of chromosomes and genes a child gets from its parents at the time of conception. Although, according to this law there is physical and mental variation between the children and the parents, yet in spite of this variation the siblings are identical to a greater degree than other children.

3. Law of Regression—According to the law of regression the child tends to regress (return) towards the average physically, intellectually and emotionally, rather than farther below or above it. Therefore, the children of very talented parents may have average intelligence. In this context, **Crow and Crow–1979** have said. "Children of tall parents tend to be taller than the average but not so tall as their parents. The offspring of especially talented parents can be expected to be less gifted than their parents and similarly the children of less able parents probably will exceed parental ability." The law of regression is a natural tendency. But it is not necessary that regression will always take place in all living beings. But this tendency does exist.

The following are the reasons of Regression—

(i) The talented parents have some ordinary (average) germ cells that may combine to produce less talented children.

(ii) If a talented parent, father or mother, cohabits with a person who lacks in the talents producing genetic characteristics, the genetic fusion of excellent talent-producing germ-cells cannot take place as happens between two talented parents. As a result the child born will not be so talented as the parents are. In the same way the feeble minded parents have some ordinary and also some extra-ordinary germ cells. If they fuse the progeny will be possibly more talented than the parents because they regress towards the average.

These three laws of heredity are very important for understanding the genetic traits and characteristics of a person.

Laws of heredity are very important for understanding the genetic traits and characteristic of a person.

What is Environment?

The environment means the natural world in which people, animals, plants live. We are surrounded by it from all sides. The word **environment** is widely used. The Oxford Advanced Learner's Dictionary defines it as (i) the conditions, that affect the behaviour and development of somebody/something;"(ii) "the physical conditions that somebody/something exists in (iii) "the natural world in which people, animals and plants live". The Environment is an external force that affects us directly. The environment includes all those situations that affect human beings throughout their life. This includes material, intellectual, social, moral, economical, political and cultural forces. These forces affect an individual's activities, behaviour and personality. The impact of the environment begins with the conception of the child. In the words of **Douglas and Holland**: "The term environment is used to describe, in aggregate, all of the external forces, influences and conditions which affect the life, nature, behaviour, growth, development and maturation of living organisms".

The contribution of the environment to the development of the individual is significant growth. The life of an individual begins with his conception by his mother. The influence of the mother's health, her style of living and thought begins to show when the mother's ovum is fertilized and the zygote begins to develop into a foetus. After the birth of the child the life style of the people surrounding it, their food habits and their thoughts start influencing hjm. The formation of thoughts, the skills and the habits of the individual depend on his environment. The environmentalists contend that an individual becomes great, not on account of his heredity but on account of the excellent environment he lives in. The environmentalists give greater importance to the environment than to heredity. **John Locke**, an eminent European scholar is of the view that a child is like a clean state on which anything could be written. The children will become what they are taught. Locke has considered the environment as the main cause of individualistic differences. According to him the individual differences develop on account of the divergent environment. If the environment is good the development of the individual too will be good. Like John Locke, Robert Owen too has laid emphasis on the importance of the environment. According to him every person's life is completely influenced by the environment. Watson, the famous behavioural psychologist has gone to the length of saying. Give me an infant; I will make him a doctor, a lawyer, a thief, a dacoit or whatever I like. In this way the environmentalists have given greater importance to the environment than the heredity.

Relative Importance of Heredity and Environment

The relative importance of Heredity and environment has been highlighted as below:

1. Inseparability of Heredity and Environment—Both heredity and environment are equally important for the development of a person. Heredity and environment cannot be separated from each other; they are inseparable. Heredity endows a person with abilities and capabilities that develop. Environment provides an opportunity for those abilities and capabilities for their development. Just as good soil and fine seed are necessary, so are heredity and congenial environment which are necessary for the development of an

individual. If a person lacks in the inner potential inherited some respect, his desirable development will not take place despite the conducive environment. In this way heredity and environment make equal impact and contribution to his development. Heredity is the foundation stone and the environment is the building. **Mac Ivor and Page** has said that every activity of life is organized by the heredity and the environment. Both are necessary to produce result. Both are inseparable.

2. Heredity and Environment are Complementary to each other— Heredity and Environment are complementary to each other; they help each other and co-operate with each other. Just as Engine and Petrol are essential for a car to operate, in the same way heredity and environment are equally important for the child's development. The tendencies inherent in a child develop with the help of the environment. If a child is lacking in intellectual capabilities, even the excellent environment provided to him will not be able to develop them. In the same way a child born with excellent intellectual potentials will fail to develop them if the environment is contrary and uncongenial. **Woodworth** has said that it is meaningless to ask which of the two- environment or heredity is more important. Both are equally essential.

3. Child is the product of Heredity and Environment— The child is the product of heredity and environment. Both play equally important role in his development. If either one is lacking, the development of the child is impossible. **Woodworth and Marquis** have said that both heredity and the environment are collectively responsible for the differences in the individuals. According to them an individual is not= heredity + environment but the individual = heredity × environment. If the child is considered to be a foundation and environment as a body, the child will be the product of these. In this way, the child is the product of heredity and the environment.

Importance of Heredity and Environment in Learner's Development—There are three processes that contribute to human development:

Growth consists of increases in physical size. These increases are quantitative, rather than qualitative. Educators typically do relatively little to influence the growth of learners. However, educators need to be aware of these changes, because they influence other aspects of development.

Maturation consists of changes that occur relatively independently of the environment. Maturation is usually considered to be genetically programmed - the result of heredity. Educators typically do relatively little to influence the maturation of learners. However, educators need to be aware of these changes, because they influence other aspects of development.

Learning is a process that enables learners to modify their behaviour fairly rapidly in a more or less permanent way in response to experience, so that the same modification does not have to occur again and again in each new situation. It is a response to the environment. Although learning occurs in many settings, not just in school, it is learning that is the primary focus of teachers and other educators.

Growth, maturation, and learning interact to promote the development of individuals; and the role that each plays will vary, depending on the person's age, the aspect of development, and the background of the individual. Since

development is a result of the interaction between heredity and environment, and since heredity and environment are different for different people, it seems obvious that individuals will encounter factors that make them different from other individuals. As a result, we can expect individual differences in developmental characteristics and variation in the ages when people will experience events that will influence their development.

Importance of Heredity—Teacher plays a pivotal role in development of a learner. It is necessary for a teacher to acquire the knowledge of heredity and the environment for desired development of learner. It has been explained below :

(i) There are physical differences in the children on account of heredity. With the help of this knowledge, the teacher can contribute to the physical development of the children.

(ii) The inborn capacities differ on account of heredity. Keeping this in mind the teacher can help the slow learners to make progress in their learning proficiency.

(iii) There is a sex difference among children on account of heredity. On account of this the degree of ability in learning different subject varies among them; in some it is greater in some other it is less. With his knowledge of heredity and environment, he can arrange appropriate subject for their study.

(iv) A lot of differences exist among the children on account of heredity. These differences become more comprehensible with their development. The teacher can observe these differences among the children and can arrange study material for them accordingly.

(v) The learning capacity among the children varies due to heredity factors. The teacher can help the students to learn with the help of his knowledge of heredity and environment.

(vi) The children inherit some tendencies from heredity. The teacher can observe these tendencies of the children and can bring about reforms, by helping develop desirable tendencies and repressing the undesirable ones.

(vii) **Woodworth**—According to **Woodworth** the level of mental abilities in the urban children is partially higher than those of the rural students on account of heredity. The teacher can adapt his teaching according to this disparity with the help of the knowledge of heredity and environment.

(viii) It is the law of heredity that the children begotten by the talented parents may be less talented and those of the untalented parents may be talented. The teacher who knows this well can show the right kind of behaviour to the students.

Importance of Environment— The importance of the teacher in the context of the environment has been highlighted in following points:

(i) The child spends most of its time in the family, in the neighbourhood and on the playground and is influenced by the environment prevailing in these places. The teacher can, keeping in mind the environment of these places, guide the children properly.

(ii) A good educational environment contributes significantly to the intellectual development of the children, to their intelligence and knowledge. On the basis of this knowledge the teacher can provide an excellent educational atmosphere to his students.

(iii) The child remains into contact with a specific cultural environment and cultivate an attitude according to its ideals. The teacher can make a significant contribution to the cultural development of the children on the basis of his knowledge to the cultural background of his students.

(iv) Life develops in a conducive environment and an individual reaches out for excellence. The teacher, who understands this, provides a conducive environment to the students keeping in mind their interests, tendencies, capacities and capabilities of their proper development.

(v) UNESCO'S experts and specialists are of the view that environment makes an all compassing influence on the emotional development of the children and helps in the building of their character. Therefore, the teacher should build an environment for the students that will ensure that balanced development.

(vi) The environment determines the child's progress to development. It is the environment that determines whether the child will grow up to a gentleman or a bad man, whether he will be morally sound or amoral, whether he will be sober or sexually perverted, whether he will became a businessman or a literature; whether he will be a patriot or unpatriot. The teacher on the basis of this knowledge can build a congenial environment for the proper development of his students.

(vii) Every social set up has a specific environment and the child has to adjust to the given environment. The teacher acquainted with this knowledge can turn the school into a mini-society and can help the children teach to adjust to their specific environment.

(viii) The teacher is capable of creating an environment in the school in which the children can cultivate the ability to express themselves, learn good and refined social manners, know their rights and duties and gain the capability of controlling their natural tendencies.

Therefore, it is very necessary for the teacher to understand the importance of both the environment and the heredity. With the help of this knowledge, he can help the students in their balanced development.

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LAXMI®

EXAM NOTES

PEDAGOGY OF BIOLOGICAL SCIENCE

[Paper–4 & 5 (Group–C, Opt.–i)]

UNIT–III

- *Development of Instructional Material: Unit planning, Lesson planning, Preparation of Teaching aids, Development of Demonstration Experiments.*
- *Development of Self-Instruction materials, Linear Programme*
- *Teaching Strategies: Problem Solving, Investigatory approach, collaborative learning, experimental learning*
- *Micro Teaching Skills: Skill of Introducing the Lesson, Skill of Questioning, Skill of Illustration, Skill of Explaining, Skill of Stimulus Variation*

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3

Development of Instructional Material

3.1 DEVELOPMENT OF INSTRUCTIONAL MATERIAL

Unit Planning

1. Comment upon Unit Planning.

Or

What is unit planning? Discuss how can it be properly carried out in the subject life sciences.

Or

Discuss with an example the procedure of unit planning in the subject life sciences.

Or

Differentiate between lesson planning and unit planning.

(C.R.S.U. 2018)

Ans. According to **Preston,** "A unit is as large a block of related subject matter as can be over-viewed by the learner."

Bossing says, "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."

Heidgerken is of the view that the most significant aspect of the unit concept is the implication that what is learnt is larger and more involved than a few scattered facts.

Carter V. Good remarks, "Unit may be described as an organisation of various activities, experiences and types of learning around a central problem or purpose, developed cooperatively by a group of pupils under teacher-leadership."

H.C. Morrison says, "A unit consists of a comprehensive series of related and meaningful activities so developed as to achieve pupil purposes, provide significant educational experiences and result in appropriate behavioural changes."

Thus by the term unit we may comprehend one of the complete and meaningful subdivisions of prescribed course of a subject, centered around a single problem or purpose capable of assisting in the realization of the desired teaching learning of the subject.

After understanding the meaning of the term unit now we can attempt for knowing about the nature and meaning of the term unit planning. As indicated the syllabus for its proper coverage in a session is divided into some complete and meaningful sub-divisions called units. Now to think about an appropriate way for the teaching-learning of the subject matter or learning experiences contained in these units by keeping an eye over the proper realization of the teaching. Learning objectives of the subject Life Sciences is known by the term unit planning in life sciences. Thus the term unit planning may be defined as a scheme or plan chalked out for the teaching-learning of a particular unit mentioning the ways and means of imparting learning experiences related to that unit in view of the just realization of its teaching-learning objectives.

Unit Formation in the subject Life Sciences : The task of unit planing in Life Sciences may begin with the formation of proper units out of the subject matter and learning experiences to be imparted to the students during the entire session. For unit formation in the subject Life Sciences, a teacher may proceed as under :

1. He may accept the different topics mentioned in the prescribed syllabus as various units for the task of his unit planning.
2. He may combine the various similar topics of the syllabus for unit formation.
3. He may formulate such units on the basis of divisions like life centered units, environment centered units, animals and plants centered units etc.

Due to the above mentioned procedures, some of the units in teaching of life sciences may be termed as below :

— Birds surrounding us
— Plants surrounding us
— Insects surrounding us
— Our body and its functioning
— Our body system
— Micro-organisms and their significance in our life
— Forest wealth and its significance in our life
— Animal world and its value in our life
— Health and diseases
— Life on earth
— Reproduction
— Food we eat
— Food production and management

For the purpose of dividing the contents of the syllabus into various units, a teacher of life sciences should endeavour to take notice of the following items or things :

(i) The total no. of days and working hours available for the teaching of Life Sciences in a particular grade or class.
(ii) The totality and meaningfulness of the units formulated in terms of some special purpose or objectives attained.

(iii) Appropriateness in terms of the age, interests, needs and abilities of the learners.
(iv) Suitability in terms of the resources and teaching-learning conditions available for the teaching-learning of the units.
(v) The appropriate division of the whole syllabus in view of the total time and resources available.
(vi) Being in perfect tune with the realization of the teaching-learning objectives in the subject life sciences.
(vii) The appropriate integration and correlation of the content and learning experiences available within the units themselves.
(viii) The appropriate correlation, coordination and integration among the various units formulated out of the prescribed syllabus for the required continuity and suitability.

How to Proceed Further in Unit Planning?

1. Preparation : It is apt to motivate the student for learning. This spirit should be maintained throughout and not only at the outset.

2. Previous knowledge test : A unit should start from the ladder where the students are standing at present. The background of students should be questioned. The teacher should begin with the pupils where they are.

3. Presentation : Subject matter is provided to the students with the help of aids or direct or indirect experience so that new experiences to the knowledge of students are added. Presentation leads to organisation of subject matter where old experiences are intermingled with new ones and students assimilate these.

4. Summarization : At the end of the unit the whole content is summarised. Sectional summaries can also be provided.

5. Drill or Recapitulation : This is done so that the factor discussed are revised. Then the students will be able to review the whole unit.

6. Evaluation : This is very essential part of unit. It only informs the teacher how much students have gained and what discrepancies are left in a unit and how to improve them. Evaluation can be done by questionnaires, tests etc. It is essential to assume that attention is given to all the variables which influence the curriculum of the school.

An Example of Unit Planning

Name of the unit : Our Body systems

Name of the sub-units

(i) Concept and meaning of our body systems
(ii) Digestive system
(iii) Blood circulatory system
(iv) Respiratory system
(v) Excretory system
(vi) Nervous system

After dividing the subject matter and learning experiences into the above mentioned smaller but complete and meaningful sub-units efforts will be made to proceed further in the task of unit planning by formulating the teaching-learning objectives; teaching decision regarding the methods, strategies and aid material for the teaching-learning of all the sub-units, evaluation of the teaching-learning outcomes and essential follow up work in terms of recapitulation, practice or drill work.

Importance and Advantages of Unit Planning : Unit planning in Life Sciences proves helpful and advantageous on the following grounds :

1. The syllabus in terms of contents and learning experiences to be covered in the entire session is appropriately divided into units in view of the time available for the teaching of life sciences. It is helpful in the appropriate coverage of the syllabus within the available time and duration of the session.
2. Unit represents the unified and integrated wholes of the meaningful and purposeful content material and learning experiences. The organisation of the subject matter and learning experiences into such meaningful wholes proves very much advantageous both from the educational and psychological angles to the students.
3. The unit plan makes the process of learning more interesting and vital. Irrespective of individual difference students work with co-operation in a group, independently. In the process of learning and teaching, the participation of the teacher and taught takes place.
4. Unit planning has an appropriate provision for the review, recapitulation, practice and drill work related to the contents and learning experiences which are related to the sub-units.
5. Unit planning develops certain skills among the students and sharpens their insight. It saves time and develops students interest in learning. They actually know the value of contents learnt by them.
6. Unit planning clears the aims-general as well as specific of teaching. It works and develops in democratic atmosphere i.e., the students as well as the teacher work in a co-operative way.
7. Unit planning has an appropriate provision for the diagnosis of the learning difficulties of the students and subsequent remedial instruction.
8. With the help of unit planning, the students can apply the knowledge gained in other situation also. They become confident, resourceful and reliant.
9. Unit planning helps in the proper organisation and systematization of the teaching-learning process. It helps the teacher to make adequate preparation for the utilization of proper methods and resource material for providing instructions.
10. Unit planning paves the way for a proper daily lesson planning. A teacher feels at home in the task of his daily lesson planning in view of the blueprint provided by unit planning.

Demerits and Limitations of the Unit Planning : Unit planning has following shortcomings and limitations.

1. The division of the contents of the syllabus into meaningful and complete units and sub-units is not an easy task. Sometimes units are not systematically arranged and thus they create confusion among the students.
2. Unit planning requires efficient, hard working and trained teachers who are not always available. The task of unit planning needs expertization as well as labour and time spent on the part of a teacher. The teacher is overlooked with teaching and other functionary duties. Therefore he takes too little interest in the proper planning of the units.
3. Proper evaluation cannot be carried out in the lower classes. Unit planning may make the teacher extra conscious for the implementation of planned scheme as the planning becomes an end rather than the remaining means for the realizatien of the teaching-learning objectives.
4. Unit planning puts restrictions on the freedom of teachers. There is little scope for the originality and creativity of the teacher due to the predetermine objectives, learning experiences, methods and resources etc.
5. The teaching-learning process becomes too much time bound through the adoption of unit planning. It makes the teacher too much conscious about the time. Limitations and restrictions of time provided by the teacher may prove a big hurdle for the teaching and learning of this subject.

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LESSON PLANNING

2. What is lesson planning? How will you proceed to plan lesson for teaching life sciences? Answer in the light of the famous Herbertian steps for the lesson planning?

Or

What is lesson planning? How can this task be carried out by a teacher of life sciences?

Ans. Lesson plan is a teacher's own guide to control the teaching learning process under the conditions he finds himself in. Lesson plans differ from teacher to teacher. But the teachers should have the ability to frame lesson plans which provoke productive thought and action among the students.

In simple words, lesson planning means the planning of a daily lesson related to a particular unit of a subject to be covered by the teacher in a specific school period for the realization of some stipulated instructional objectives. It is a kind of theoretical chalking out of the details of the journey which a teacher has to go to perform practically in the classroom alongwith the students.

Importance of planning in teaching

1. The subject matter can be presented in a logical, systematic and organized way by keeping in view the intellectual development of the students.
2. The adequate subject matter can be obtained for teaching so that the aims and objectives of teaching the subject are achieved.
3. The number, type and the time to use teaching aids, is decided in advance and confusion about their use during teaching is avoided.
4. A written lesson plan provides a feeling of security, particularly for the unexperienced teachers.

5. Lesson planning also assists the teacher in recapitulation, evaluation of his teaching and knowing about the effectiveness of presentation of the subject matter to the class.

Criteria for selecting a lesson : The lessons that are planned for teaching in the class should

(a) fulfil the objectives of teaching that lesson
(b) suit the age, intelligence, aptitude, social development
(c) induce activity and critical thinking among the students
(d) be of the nature that it can be taught by utilizing local or school resources
(e) be presented in ascending order of difficulty and involve learning from concrete to abstract as far as possible.

Planning the lesson : When writing a lesson, it is better for the teacher to divide it into certain parts and each part appropriately emphasized. Generally we divide the lessons into the following parts :

1. Preliminary Information : This part includes information about the lesson such as subject, unit, lesson, class, date, number of students, duration, average age of the students and the name of the school etc.

2. Aims and Objectives : Here the teacher furnishes statements related to the aims and objectives of teaching that lesson to the class. These can be divided into two parts such as

(i) General aims and objectives
(ii) Specific aims and objectives

3. Teaching aid : The teacher, in this part, writes the aids he will be using during the presentation of the lesson to the class. Teaching aids can also be divided into two categories such as

(i) General aids and (ii) Specific aids.

The general teaching aids include the things like chalk, black board and pointer etc. that are commonly used during teaching, but the specific aids include charts, models, specimens or glasswares and instruments that are needed while teaching that particular lesson only.

4. Previous knowledge testing : When the teacher goes to the class to teach something, he always has a mind, or expects, that the students possess knowledge in that discipline upto a particular extent. In this part of the lesson he furnishes statements about what he expects the students to know (Assumed Previous Knowledge) and for satisfying himself about the level of knowledge on the part of students, he puts certain question to the class (Previous Knowledge Testing). At the very outset the teacher should ask general questions and then he should direct his questions towards the particular topic that is to be discussed in the class.

5. Introduction : After testing the level of knowledge possessed by the students, the teacher asks certain questions connected to the daily life activities of the students and afterwards some questions related to the topic that he wishes to teach. Some questions may be even from the content of the topic. After that the students are not able to answer some questions from the content of the topic

or related to that, or the answers are not clear, or only a few students reply to the questions, the teacher announces the topic to be taught that way. Therefore this part of the plan includes the questions that the teacher puts to the class and a statement for the announcement of the topic.

6. Presentation : In this part of the lesson the teacher writes the actual subject matter that he wishes to teach. The subject matter is written in organized, systematic and logically coherent manner. Generally presentation of the topic is divided into three parts :

(a) Method of Teaching : It includes questions the teacher puts to the class from time to time during the presentation of the subject matter and the activities that the teacher undertakes before the class.

(b) Matter to be taught : It includes the total subject matter that the teacher gives in answer to the questions he puts and that is inferred from the activities, the teacher undertakes.

(c) Black Board work : It includes the work, to be done by the teacher, on the blackboard and this may include writing of difficult terms, definitions, generalizations and drawing of certain diagrams. The order of presentation of questions and activities come under the heading **Method of Teaching,** therefore this part requires special consideration. It is not always essential that presentation should be divided into three parts sometimes. Only two parts Methods and Activities and Black Board work can serve the purpose.

7. Generalizations : After the lesson is finished, the teacher generalizes his topic. He makes one or two statements that summarize the entire topic that the teacher taught that day. Suppose the teacher gave demonstration to depict that water, light, chlorophyll and carbon dioxide take part in the process of photosynthesis and starch and oxygen are the end products. At the end he may generalize, "In the process of photosynthesis chlorophyll, utilizing water, carbon dioxide and light, synthesizes food and oxygen is released."

8. Applications : This part of the lesson includes some statements about the applications of the generalizations or principles that the teacher had taught. Application of the biological knowledge can be in further learning, in explaining other biological phenomena or in solving the problems which the students happen to come across in their daily life.

9. Recapitulation : After the lesson is completed the teacher asks some questions so that he could know how far the students are able to recollect the things or whether they have comprehended the subject matter or not. In this part of the lesson the teacher writes those questions that he will be putting to the class after he completes his lesson. The questions should be representative of the whole subject matter taught and these should be well structured and organized.

10. Self evaluation : After the lesson or the unit is completed, the teacher can give a class test so that he could evaluate the way he organized and presents the subject matter to the class but this does not essentially make a part of the lesson plan.

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3. Prepare a Lesson Plan on the topic of Biology for Class IX.
(C.B.L.U. 2018)

Ans.

Lesson Plan

Subject : Life Science **Date :** _____

Topic : Structure of Cell **Class :** IX

Duration : 40 minutes

Aims :

(a) General Aims :

1. To add new information to the existing stock of knowledge of the students.
2. To develop certain skills and interests of the students in Life Sciences.
3. To develop scientific method in the students.

(b) Specific aims : To develop the knowledge of students related to the structure of typical cell.

Teaching Aids :

(a) General Aids : Black-board, chalk, duster and pointer.

(b) Specific Aids : 3 charts showing structure of typical cell, plant and animal cells and various types of cells. Microscope, slides, petridishes, needles, onion, scale leaves etc.

Assumed Previous Knowledge :

1. Students are able to realise the difference between living and non-living things.
2. Students know that plants and animals are made up of cells.
3. Students also have an elementary idea of structure of typical cell.

Previous Knowledge Testing and Introduction of the topic :

1. What is the structural unit of the wall of the room?
2. Name the structural unit of organisms.
3. How do you categorize organisms based on the number of cells they are made of?
4. What is cell theory?
5. Name some cell organelles.
6. What is the difference between a plant and animal cell?

(Students will not be able to answer some questions or probably the last question).

Announcement of the topic : "Well students, today we will be discussing about the structure of a typical cell."

Presentation

S.No.	Method	Material	Black Board Work
1.	How was the knowledge of cell structure discovered?	History of scientific events tell us that Robert Hooke (1665) saw a thin slice of cork under his self-made, microscope and noticed numerous compartments in that and assigned them the name 'cells'. Anton Leeuwonbock (1632-1723) saw different living structures like bacteria through his crude microscope. In 1833 English biologist Robert Brown described the cell nucleus. In 1938 M.J. Scheiden and T. Schwann told that every organism is made up of cells and they formulated cell theory. After that details of cell structure were known by their minute details.	Cells Robert Hooke (1665) Leeuwonbock (1632-1723) Robert Brown (1833) Nucleus Scheiden and Schwann (1338)
2.	What is cell theory?	In 1838 Scheiden and Schwann formulated cell theory, which is as follows : (a) Cell is the structural unit of all organisms. (b) Cell is the functional unit of all organisms. (c) The new cells come from pre-existing cells.	Cell theory (a) Cell is the structural unit of all organisms. (b) Cell is the functional unit of all organisms. (c) The new cells come from pre-existing cells.
3.	What do you know about the shapes and sizes of different cells?	Cells have various shapes such as square, rectangular round, fibrous and thread like. The size of cells is measured in microns and one micron is one thousandth of a millimeter. Some bacterial cells are only 0.5 microns while some plants fibres are 20 to 550 mm (utricaceoe) in length. Ostrich egg cell is 5 cm in diameter.	(Display chart with different cells or draw diagrams.) Rectangular, Round Fibrous, Thread like Micron (u) = 1/1000 mm Bacterial cells 0.5 microns Fibres - 20 to 550 mm

S.No.	Method	Material	Black Board Work
4.	What do you know about the structure of a cell? (Displaying some onion scale peel cells under microscope)	If we see plant cell under microscope we find cell wall as the outermost part. Next to this, see cell membrane which encloses the cytoplasm. In the centre there is nucleus. Cytoplasm other than nuc-leus is called protoplasm. Protoplasm is jelly like substance and we see vacuoles and certain cell organelles like chloroplast, mitochondria and other plastids.	(Display chart showing structure of a cell.) Cell wall, cell membrane, Cytoplasm, Protoplasm, Nucleus, Vacuoles, Chloroplast, Mitochondria Ribosomes, Endoplasmic Reticulum, Golgi bodies.
		In animal cells we also see centriole with centrosomes above the nucleus. In electron -microscopic structure of the cell we can also see ribosomes, endoplasmic reticulum and golgi bodies.	
5.	What is the difference between a plant and an animal cell? (Mount a plant cell and an animal cell under different microscopes and depict them to the students.)	We find the following differences in plant and animal cells. (a) There is a cell wall in plant cells but it is not found in animal cells. (b) In plant cells we find larger and more in number, the vacuoles as compared to animal cells. (c) In plant cells we see centrioles with centro-somes which we do not see in animal cells.	(Displaying a chart depicting differences in plant and animal cell structures.) Plant cells : (a) Cell wall (b) Chloroplasts (c) Vacuoles Animal cells : Centriole with centro-somes.

S.No.	Method	Material	Black Board Work
	What are the functions of different cell organelles?	We can state the functions of various cell organelles as : In plant cells, cell wall gives definite shape to the cells and protects these. Cell membrane in both plant and animals is of semipermeable nature and it regulates the entrance and exist of different substances in the cell. Chloroplasts of plant cells participate in the process of photosynthesis. Centriole and centrosomes in animal cells help in cell division.	Cell wall : Shape, protection, cell membrane regulation of entrance and exist of substances. Chloroplasts : Photosyn- thesis centriole- centrosomes cell division mitochondria respiration
		Mitochondria, both in plant and animal cells, participate in respiratory reactions and release of energy. Nucleus contains hereditary material and regulates the activities of the cell. Golgi bodies give out certain secretions, ribosomes assist in protein synthesis and endoplasmic reticulum assists in transport within the cell. Vacuoles act as sinks and maintain turgidity.	Nucleus : Heredity material and cellular control Golgi bodies : Secretion Ribosomes : Protein, synthesis. Endoplasmic reticulum : Transport within the cell Vacuoles : Excretion turgidity.

Generalization :

1. There has been contribution of several biologists in exploring the cell structure.
2. There are various shapes and sizes of cells and plant and animal cells differ in their structure to some extent.
3. Different cell organelles, cell wall, cell membrane, nucleus, mitochondria, chloroplasts, vacuoles, centriole, golgi bodies, ribosomes and endoplasmic reticulum perform various functions in the cell and the cell acts as structural and functional unit in the organisms.

Applications :

1. How did the knowledge about cell structure grow up?
2. What is cell theory?

3. What do you know about shape and sizes of various cells?
4. What do you know about the structure of typical cell?
5. What are the differences in the structure of plant and animal cells?
6. What are the functions of different cell organelles?

Homework : Draw a labelled diagram of typical cell and point out differences in structures of plant and animal cells.

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PREPARATION OF TEACHING AIDS

4. What is meant by the term teaching aids? What types of different teaching aids may be used in teaching of life sciences? Discuss the preparation of any type of teaching aid used by you in your training programme.

Or

Discuss the importance of using teaching aids in teaching life sciences.

Ans. We sense the world around us by our sense organs such as by touching, seeing, smelling, hearing and tasting. When these sensations have some meaning for us, these can be defined as perceptions. These perceptions stand for facts. Then the facts are organized into concepts and generalizations. Therefore for better learning we are supposed to perceive the things clearly and in as many ways as possible. We employ some aids while teaching in the class for better perception and learning. These aids are generally known as teaching aids or audio-visual aids in the field of teaching learning process.

Classification of Teaching Aids :

Teaching aids may be classified as audio aids, visual aids, audio-visual aids and activity aids.

1. Audio aids like radio, tape recorder, gramophone etc. represent that aid material which helps the learner to acquire the knowledge through his auditory senses.
2. Visual aids like charts, picture, chalk board, models, sketches, diagrams, graphs, bulletin board, epidiascope, micro-projector, filmstrips etc. represent that aid material which assist the learner in acquiring the learning experiences through his visual senses.
3. Audio-visual aids like films, television, video-films etc. represent all those equipments and aid material in which the learner attains opportunity to utilize both his auditory and visual senses for gaining the desired learning experiences.
4. Activity aids are those aids in which the students learn by engaging in some useful activities. These aids facilitate learning through sight and sound as well as through doing. Museum, acquarium, vivarium, botanical garden, excursions, field trips, fairs, zoological place, science clubs etc. where activities like collection and preservation of organism are undertaken.

Importance of Teaching Aids

The place of teaching aids in teaching of life sciences can be stated as follows :

1. **Interest creators :** Teaching aids play the role of inspirators and interest creators. As these provide interest to the pupils and inspire them to further study than the actual classroom instruction and text book assignment. These aids contact directly with the instincts of the students. They motivate them towards the learning process effectively.
2. **Vividness :** These aids provide vividness to the learning situation and make teaching effective. Lecturing and passive hearing is minimized. Participation of the students in teaching learning process is more.
3. **Appealing to the senses :** These aids make an appeal to the senses. They make things concrete. Due to these aids, the content matter of studies remains fresh in the minds of the students.
4. **Good substitute for direct experiences :** Effective teaching requires direct experiences for the learners. It is not always easy or possible to take the children out for direct experiences.
5. **Helpful in developing various skills :** The use of teaching aids helps in the development of various skills among the students. They come to know how to draw a diagram of the topic. They also learn how to use the apparatus. If they face any problem in conducting an experiment, they apply their mind to solve the problem.
6. **Provide variety :** These aids provide variety in the classroom and meet the requirement of individual differences of the students.
7. **Conceptualization :** Learning becomes concrete to abstract and students can conceptualizate real things. False imagination and guessing is avoided.
8. **Develop scientific attitude :** Use of teaching aids involves students in the teaching learning process. This helps develop scientific attitude and scientific method of working.
9. **Save the time and energy of the students and teachers :** Teaching aids help in the smooth sailing of the process of teaching and learning. A fact, principle or phenomenon that cannot be understood properly with a verbal explanation or experience can be understood well in time with the help of some relevant aid material. Thus the time and energy of both the students and teachers is greatly saved by the use of teaching aids.
10. **Provide solutions to a number of educational and administrative problems :** The use of teaching aids may prove a big helping hand to both the teachers and students in their efforts for making the task of teaching and learning effective and purposeful as possible. It may also prove a ready made solution for a number of education and administrative problems such as — indiscipline, over crowded classes, inadequacy of present available facilities, short of classroom and good teachers etc.

Selection and Use of Teaching Aids

Teaching aid should be selected as per the topic in hand and considering the age, intelligence and social development of the students. In case of audio-aids language should be well structured, voice should be clear. As far as possible, it should be substitute for reality, visual aids should be clearly visible and the illustrations should be effective. So far as use of the aids is related, the teacher should very well know operating the aid. Students should actively participate in the use of aids. Aids should not be over used. The effectiveness of the aids should be evaluated from time to time.

There can be a long discussion about the types, their significance, working and preparation of teaching aids for teaching life sciences but here it will be limited to the description of some generally used aids.

1. Chalk board : Generally a black board is used in the classroom but there can be coloured boards and chalks as well. Boards are usually fixed but there can be roller and hinged boards also. The classroom boards are generally brought in use for writing down certain statements, drawing, diagrams and sketches, making calculations etc. It is considered to be an economical and effective teaching aid. It is of great help in systematic teaching and sequential presentation of the subject matter. Working on the board catches attention of the students and its use establishes a connection between lecturing and illustrations. While working on the chalk board the teacher should also pay attention to the class and the board work should not be long drawn.

2. Charts, Diagrams and Pictures : These aids can be applied where the drawings are complicated and difficult to draw. Some phenomena can also be taught in a systematic way by presenting the diagrams and pictures in sequence. These aids secure better attention and things can be presented in their ratio-proportions. During presentation the teacher should observe that the aids are clearly visible to the students and are serving the purpose for which these are integrated in the instruction. Some systems of organisms, anatomical details, some natural phenomena and various organisms can be very well shown by using these aids.

3. Flannel graph and Bulletin board : Flannel graph is a wooden frame on which a place of flannel is tightly stretched, that gives the background on which some coloured cuttings of diagrams, apparatus and pictures of organisms etc. can be displayed with the help of puns. Bulletin board is a kind of notice board in the form of a frame or box which is covered with glass or thin wire gauze. Newspaper cuttings, articles for wall magazine, cuttings of science magazine etc. can be displayed on the bulletin board. The flannel graph can very well be used in the classroom teaching and the time consumed in making drawings and pictures on the boards or charts can be saved. The bulletin board material gives upto date knowledge to the students in concerned discipline if the material is regularly changed and students are encouraged to read that. Different activities such as those of clubs, excursions, seminars, projects etc. can be reported on the bulletin board.

4. Specimens and Models : Preserved specimens of living things and their models are good visual aids that can be employed in teaching life sciences. By viewing the actual things; students develop adequate concepts about their regarding shape, structure and colour etc. The teacher is able to undertake comparative studies of the organisms while making use of their representations. Therefore museum material as well as prepared and purchased models should be used, as far as possible, while teaching in theory classes.

The teacher can deliver the topic alongwith 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.

5. Epidiascope : When some figures, diagrams and sketches which are on opaque surfaces, are to be projected, epidiascope is used. This device possesses a source of light by which the object is brightly illuminated. There is a mirror, fixed at some angle to direct the light rays to the lens system. The lens system magnifies the figure or diagram on the screen.

6. Slides and Filmstrips : Slides and filmstrips are wonderful visual aids. They can be usefully incorporated in classroom teaching. By arranging the slides and film strips in required sequence we can depict the topic systematically. Certain phenomena such as growth in plants and animals, embryonic development, cell division, seed germination, the process of fertilization etc. can be illustrated nicely by arranging the slides or film strips in order.

7. Radio and Tape-recorder : Both of these are audio-aids. They are made use of in teaching. Radio brings us news and programmes of far distance. The difficulty with using radio is that the programmes are generally not broadcasted during school time and also it is somewhat costly aid. Tape-recorder is a convenient but costly device. Here the recorded programme, talks or discussions can be reproduced at any time and in appropriate sequence in lieu of the teaching. One can record and reproduce the recorded material in the classroom such as singing of birds, speeches and discussions etc.

8. Films and Television : Films and Television involve our senses of hearing and viewing simultaneously. The films can be shown wherever their use is thought effective as the teacher can explain some phenomena in relation to its broad aspects and after that it is shown in the film or the film is first projected. Then the teacher provides some short explanation after that. When the film is shown, the teacher should encourage questions and discussions in the class.

Use of television in teaching is quite recent. During television lessons a few minutes are allotted for introduction of the topic. Phenomena shown by television gives an impression of being 'live' and learning and retention is very much satisfactory.

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DEVELOPMENT OF DEMONSTRATIVE EXPERIMENTS

5. Describe the development of demonstration experiments.

Ans. Through the development and demonstration of the relevant experiments in the classroom or laboratory, a life sciences teacher then may possess the ability to lead his students to learn essential laboratory and experimental skill for conducting independent or group laboratory work in

the life sciences laboratory in addition to helping them to comprehend and grasp appropriately the related contents of the subject matter by following the principles "Learning by experiment" and "Learning through observation" etc.

Needs and purposes of demonstration experiments :

1. It helps in appropriate understanding and grasping of the facts, principles, processes and applications in relation to the subject matter taught in the class.
2. It assists in soothing the curiosity of the students in relation to the truth or verification of scientific facts, principles, processes and applications.
3. It helps in inculating derived interests, attitudes and aptitudes among the students for having the knowledge about scientific truths and their scientific verification.
4. It assists in learning essential skills for performing independent or group practical work in the laboratory though careful observation and active participation in the demonstration work done by the teacher.
5. It helps in developing scientific attitude among the students by making them truthful and honest. They learn how to arrive at decisions by actual experiments.

Development of demonstration experiments in Life Science : Demonstration experiments in life sciences for their successful outcomes need careful planning and expert execution upon the part of the teacher of life sciences. Consequently, the development work of demonstration experiments in life sciences need to be carried out in the following three successive steps :

A. Preparation for Demonstration Experiments
B. Presentation of Demonstration Experiments
C. Follow up of Demonstration Experiments

A. Preparation for Demonstration Experiments : Demonstration experiment is, infact, an acid test of the teacher's ability. Thus the teacher must be fully prepared for it. He should take the following points while preparing demonstration experiments.

(a) Subject matter;
(b) Lesson notes including the type of questions to be asked;
(c) Rehearsal of Experiments;
(d) Collection and arrangement of apparatus needed.

The desired demonstrative activities for the teaching-learning of the above concept concerned with the topic photosynthesis (included in the syllabus of class VII) will cover the following :

(i) Taking a plant like croton or colens (planted in a pot) possessing leaves of partly green and partly non-green and placed it in sunlight for three or four days in the botanical garden or open space in the school campus.

(ii) Plucking of any one leaf of this plant and dipping it in boiling water for a few minutes and later boiling it in alcohol for getting rid of all chlorophyll from the leaf in order to make it colourless or white.

(iii) After that add a few drops of iodine solution on the leaf in order to have the taste of the presence of starch on account of the presence of photosynthesis.

(iv) After that ask students to observe the result and derive conclusion from their observation.

It is obvious here students will observe that only that part of the leaf turns black which was green i.e., supposed to have chlorophyll. It will help them to conclude that presence of chlorophyll is very much essential for photosynthesis.

(v) The experiment discussed above represents one of the many other activities or demonstration experiments planned by a life science teacher for teaching the contents concerned with the topic photosynthesis which belongs to the curriculum/syllabus of class VII. He may plan the demonstration of many other facts and concepts in connection with photosynthesis as below:

— Sunlight is essential for photosynthesis.
— Presence of carbon dioxide is essential for photosynthesis.
— Presence of water is essential for photosynthesis.

(vi) The lighting and seating arrangements of the classroom at the time of demonstration, use of essential teaching aids etc. for making the demonstration work more effective should also be carried out appropriately by the teacher.

B. Presentation of demonstration experiments : For the proper presentation of the planned demonstration experiments in the class , a teacher should take care of the following points :

1. He should make sure that demonstration is visible to the whole of the class. If the experiment involves use of small material, the teacher should use micro-projector, otherwise use large containers as petri dishes, test tubes etc.
2. Voice of the teacher should be loud enough to be heard by every student.
3. The teacher should pace his presentation. He should be in no hurry. But at the same time he should not stretch the demonstrations for longer time as it mars the interest of the students. If the demonstration does not work, he should not feel irritated. He should leave the problem to the class and present the demonstration on the next day.
4. The teacher should make use of the blackboard and develop a summary of the procedure. He should draw equipments and write the results etc.
5. While performing demonstrations, the teacher should seek students participation as far as possible.

C. Follow up of the demonstration experiments : After performing demonstration experiments in the class, teacher must have the essential follow up work for the appropriate realization of the purposes of demonstration by taking care of the following things.

1. The teacher can do oral questioning.
2. The teacher can ask some questions to the class, after the demonstration is over.
3. The teacher can also induce discussion in the class about the procedure, realizations and application of generalization, involved in the demonstration.
4. He should also try to assess the outcomes of his demonstration work in the light of the objectives set for such demonstration and try to fill up the gaps by getting repeated the act of demonstration or clarifying the doubts expressed by the students in drawing out the appropriate conclusion from the demonstration.

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3.2 DEVELOPMENT OF SELF-INSTRUCTION MATERIAL LINEAR PROGRAMME

6. What is linear programming? Throw light on its characteristics.

Or

What is linear programming? Why is it termed as linear or extrinsic? Discuss its procedure.

Or

Explain linear programming in detail.

Ans. In programmed instruction the presentation of the instructional material or subject matter to the learner in a suitable form is defined as programming. Different types of programming have emerged due to researches and experimental studies in the field of programmed instruction. Some of the styles of programming are listed below :

1. Linear or Extrinsic Programming
2. Mathetics Programming
3. Branching or Intrinsic Programming
4. Computer Assisted Instruction Programming
5. Ruleg system of Programming
6. Learner Controlled Instruction Programming

But here we would be discussing in brief the most popular basic format or style of programming. This is called Linear or Extrinsic Programming.

Linear or Extrinsic Programming

The credit for propagating the linear programming style goes to H.F. Skinner (1955). Linear programming is directly related with his theory of 'operant conditioning'. It is based on the belief that human behaviour can be shaped or conditioned slowly, step by step with suitable reinforcement for each desired response. As a result, the instructional material is sequenced into a number of meaningful steps known as frames in linear programming. These frames are given to the learners in the arranged sequences one at a time. It is

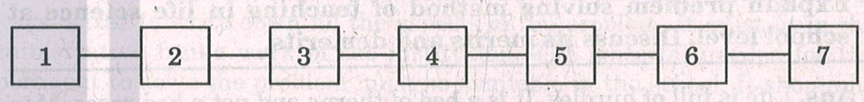
essential for the learner to give response to each step in an active manner. When the learner has responded, he is given information about the correctness of his response. It helps in reinforcing his behaviour. He may be given motivation to learn the next frame in the arranged sequence. By proceeding from one step to another, the learner may then be able to acquire the desired learning experiences.

The following format for a linear programming makes the concepts clear :

Format for a Linear Programme

1. _____
Response 1. _____
Correct 2. _____
Answer 1 Response 1. _____
Correct 3. _____
Answer 2 Response 1. _____
Correct 4. _____
Answer 3 Response 1. _____
Correct 5. _____
Answer 4 Response 1. _____

The following is the diagrammatic representation of a linear programme :



Skip Linear : Basically, the skip linear type of programming resembles Linear Programming. But, the former differs from the latter in this manner. When the learner is going through the programme, at certain points he is provided with a test question or questions. If his response to the test question is correct, he is asked to skip over a few frames and is advanced to a part ahead in the programme.

But if his response is incorrect, he is made to go through the normal sequence in order to obtain further practice. In other words, he proceeds in the sequential order.

Characteristics of Linear Programming

In brief we may summarize the characteristics of linear programming as given below :

1. Linear programming represents a linear arrangement which is composed of a single track programme.
2. Here the learning material is presented into series of small steps or frames.
3. By presenting the material in the properly sequenced small steps, the opportunities of an error in responding are minimized.
4. The programmer controls the instruction process. All the learners will have to follow the same path. Care should be taken that the steps are not changed.

5. The learner receives reinforcement for each of his responses by attaining information about the result.
6. The learner has to compose his own answer to each question.
7. The learner is supposed to respond actively to each step or frame.
8. The responses of the learner get immediate reinforcement.
9. Linear programming permits self-pacing. Learning can be done as per one's own speed.
10. The steps are small and the learner is not permitted to move to the next frame in hand. As a result, linear programming moves slowly but steadily. It leads a learner from initial to terminal behaviour.

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3.3 TEACHING STRATEGIES

Problem-Solving Method

7. Explain problem solving method of teaching in life science at school level. Discuss its merits and demerits.

Ans. Life is full of hurdles. It is a bed of thorns and not a bed roses. Man has to face problems in his day to life. He spends all his life. He spends all his life in finding solutions to them. So if a problem is presented for a solution at the school level, then it is very useful for the children. If we wish our students to be effective citizens of tomorrow, then the school has to be related to real life situation. We must create similar situation in the school where children can use their ability and capability to find their solution.

According to **Prof. Bossing**, "Facing problems is the nature of life itself. Even the most elementary existence is filled with problems of finding the physical satisfaction of food, shelter and safety."

According to **John Dewey**, "Whatever, no matter how slight and common place in character perplexes and challenges the mind, so that it makes belief itself uncertain, there is then a genuine problem." In short we can say that to find a satisfactory solution to the problem is called problem-solving method.

Main characteristics of Problem-Solving

1. Sense of belonging towards the problem : The best thing about this method is that the students consider the problem as their own. The problem should be according to the interest and aptitude of the students. If some problem is solved immediately, then students take personal pride in it.

2. A problem must stimulate the thinking power of the students : Sometimes the teacher presents such problems that are beyond the age-level and understanding of the children. Then they take least interest in solving them. So it should be according to the mental level and physical capabilities of the students.

3. The problem must be intelligible to the students : If the problem is not easily understood by the students, then they will lack genuine interest in finding a solution to it. The problem should not be a burden for the children. They should enjoy each and every step of problem solving.

4. Selection of appropriate subject-matter-selection : Appropriate subject-matter is of utmost importance. It is the duty of the teacher to guide the students to select the material according to their age, capability and interest. Subject-matter should be relevant. It should be according to the needs of the students.

5. Practical and useful knowledge : The problem should be such that will give children creative satisfaction and get adequate use of it. It should be related to the previous knowledge of the students. Then it will definitely facilitate solution finding.

6. Educative value : Problem-solving method should have educative value also. As far as possible, it should be selected from real life situations. It may be a part of environment. For e.g. 'Study of Rainbow' in the sky.

7. Problem must be stated in clear and definite terms : The teacher should explain the problem in detail so that the students won't have to wander here and there. It should be worthwhile. It should have practical utility for students.

8. The solution of the problem must be put in writing : It is always better to write down all the aspects of the problem. It must fit in the administrative frame work of the institution. The material needed for the experiment to solve the problem must be available in the school. It should be seen that it is not costly. The problem must be new. If the problem is novel, then it will help in the development of innovative faculties of the students.

Merits of Problem Solving Method

1. Problems related to real life : Problem solving method provides chance or opportunity to analyse or solve the new problems. This method gives such kind of experience to students that will help them in solving their real life problem. This makes the students capable and confident in handling similar situations in life.

2. Development of critical thinking power : Problem-solving method sharpens the logical and critical analysis of the students. They become independent in their decisions. This method gives training in scientific method. It enables the students to develop scientific attitude among them. The students become truthful and honest. They collect their own datas and learn to arrive at their own decision. This method is based on an important principle of psychology. It is learning by doing.

3. Cordial and friendly relations between the teacher and the taught : Problem solving method leads to healthy relationship between the teacher and the taught. If a student is confronted with any problem, the teacher can give him proper guidance. Thus the problems get automatically solved. Students develop great regard for their teacher. So this method helps in the development of harmonious relationship between the teacher and the students.

4. Development of the spirit of tolerance : Problem solving method develops a feeling of working together. It is a motivating method. This method develops the power of observation and argumentation of the students. It develops

many skills of identifying a problem. Students formulate hypothesis. They also conduct an experiment. After that they arrive at conclusions which are extremely beneficial for future life. In this procedure students present their solutions to the problem one by one. They also listen to each other patiently. This habit develops their spirit of tolerance. They develop their view-point and thus their mental horizon is widened.

5. Knowledge gained is easily assimilated : In this method students gain knowledge through real life experience. This helps in making the knowledge permanent. This method is helpful in making the study of Science more interesting, useful and practicable in the daily life. It provides precious and valuable opportunity for the correct development of the cognitive abilities of the students.

6. Motivates student for extensive studies : The students have to consult a large number of books, subject-matter etc. for finding solutions. This motivates them for higher studies. Through this method, students form habit of diligence. This method makes the students self-dependent, self-reliant and also self-confident. Confrontation with the help of one's own mental faculties helps in understanding scientific facts and figures in a correct order. Students also become familiar with new references.

Demerits of Problem Solving Method

1. Long and slow progress : Problem solving method is very much time consuming. It is a wastage of time and energy. Both the teacher and the students have to work very hard in collecting material for finding solutions. Sometimes it takes months before a solution is found out. Due to the long and slow progress the completion of prescribed syllabus becomes difficult within a specific period of time.

2. Too much mechanical : The students have to follow various steps like— "Identifying the problem", "arriving at conclusion". All these methods make the students mechanical. This stops them from being creative. Too much stress is laid on experimentation and the other important aspects of Science teaching go into hiding.

3. Too much demanding : Problem solving method needs independent efforts on the part of students to get the solution of the problems. This method is not suitable for junior class students. This method demands scientific procedure and scientific thinking. Therefore there is always a doubt of drawing wrong conclusions. There is a requirement of capable teachers for this method to be put into practise.

4. Lack of reference material : Some problems which are complex in nature need collection of lots of books and reference material. Most of the children don't have any access to such material. Due to lack of availability of text books for this method, it puts extra pressure on the teacher who is already over-burdened.

5. Monotony : If one problem is discussed for weeks together then no novelty remains in the subject and the students get bored. They lose complete interest in the problem. It is wrong to think that all the students are problem-solvers. Problem solving method suits only to those who are blessed with creative mind. The task of thinking about the hypothesis is quite a challenging prospect. It is not possible in over-crowded classes. This method needs adequate library

and laboratory facilities which are missing in our schools. It becomes very difficult to select a particular problem for being used to teach a particular topic. For teaching science we need a number of problems to give essential knowledge and skills related to these subjects.

6. Dissatisfaction in case of failure : If a student is incapable of finding an appropriate solution, he feels disheartened. He develops an inferiority complex in himself. In every case we are supposed to be left with a lot a topics and content material. These cannot be dealt with the help of problem solving method. This method pre-supposes a gifted teacher to come forward to guide the students and gifted teachers are very rare in the school.

Conclusion : Problem solving is a wonderful idea theoretically. But it is very difficult to be put into practise because of the demerits of this method which are discussed above. The main reason is that our education system is examination oriented. The fear of examination hangs upon the heads of everybody. Marks are more important than anything else. But even then the problem solving method cannot be side-lined. It has its merits also. It has to be used within its own limits. It shall be great dis-service to science, if we are to ignore this method completely. It will be good if this method is combined with other methods.

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INVESTIGATORY APPROACH

8. What do you mean by Investigatory approach? Describe the merits and demerits of Investigatory approach.

Ans. The investigatory approach to science is modelled on the scientific method. It should skills and critical thinking. In addition to these, an investigatory approach to science offers excellent opportunities for developing important life skills in such areas as team work, organization, presentation and communication. Any knowledge acquired in this way is likely to result in a deeper understanding of the issue.

Pivotal Role of the Teacher : No matter how open ended an investigation. Is, the teacher plays a pivotal role in how the investigation is carried out and how useful the experience is for the student. Without guidance, the open – ended investigation can result in students feeling confused or frustrated.

It is important therefore to strike a balance between providing an environment in which discovery learning can occur and setting out enough guidance to ensure that students donot lose sight of the objective.

Certain strategies can be used to guide students through an investigation. The planning stage is crucial.

Encourage students to brainstorm initial ideas, outlining how the investigation will be undertaken. This can be beneficial for individuals or small groups. The teacher can play a pivotal role by having carefully thought – out a set of questions probing all aspects of the investigation and holding them in reserve in case the brain storming session falters.

Advice on carrying out an investigation problem statement : Turn the topic into a problem statement. The problem statement is a sentecne or question that identities the dependent and independent variable.

If we consider the following example : "Investigate how watering plants affects the way they grow."

Possible problem statement (these are just some of the possibilities) :

- How does the amount of water (independent variable) affect the height (dependent variable) of the plant?
- How does the amount of water affect the number of leaves a plant prodcuces.
- How does the number of leaves affect the amount of water taken by the plants.
- How does the time of the day that plants are watered at affect the up take of water.

It is important that each of the variable.

Hypothesis : Once the problem statement has been identified, it should be possible to :

- Make an educated guess about how the experiment will turn out. This is called the hypothesis. The hypothesis should connect the dependent and independent variable.
- Identify all the other things that might affect the outcome of the investigation.

Experimentation : The students need to conduct experimental work with due regard to :

- Proper and safe use of equipment.
- Accuracy and reliability of measurements.

Analysis : It is important to compile tables of measurements and results and to present findings graphically where possible. This allows the students to identify trends and patterns so that conclusions may be drawn.

Evaluation : Evaluating the results and estimating their accuracy and significance are important parts of the investigatory approach to science.

Merits of Investigatory Approach

(i) It also develops group feeling in the students. They get opportunities of working in groups.

(ii) This approach is psychological sound. It proceeds from concrete to abstract and from known to the unknown. It is based on the principles of learning by doing.

(iii) It gives the students self-confidence. It teaches them the dignity of Labour and makes them self-reliant.

(iv) This approach according to child nature. The children are active by nature.

(v) There is close relationship between the teacher and the taught. Practical work demands individual attention. The teacher has to supervise the work of pupils.

(vi) The child becomes clear about certain scientific ideas, concepts and statements. The learning becomes easy, interesting and lasting.

(vii) The things learnt experimentally are meaningful to the children. They can use the same in various situations.

(viii) This approach follows the important maxims to teaching like 'learning by doing', proceeding from 'concrete to abstract' and from 'known to unknown' etc.

(ix) This approach helps in getting practical and useful information rather than bookish one.

(x) In this approach the child gets the opportunity of receiving knowledge through his so many senses–eyes, ears and hands.

(xi) This approach provides enough freedom to work according to one's capacity and abilities.

(xii) This approach solves the problem of indiscipline.

(xiii) This approach is so much systematized and organised that it may be termed as scientific approach.

Demerits of Investigatory Approach

(i) It tends to become an end in itself, rather than a means to an end. The students may remain at the concrete stage only and never proceed to the abstract stage which is the ultimate goal of science.

(ii) This approach is suitable only for some topics. Thus it has a partial applicability.

(iii) This approach is not suitable in higher classes because the students have to understand abstract ideas and concepts. They have to work at the abstract level. Therefore, it is not possible to learn or to teach everything in a concrete way.

(iv) Our text-books also do not indicate the practical work which can be done by the students.

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COLLABORATIVE LEARNING

9. What is Collaborative Learning? Discuss the basic assumptions and features of collaborative learning.

Or

What is collaborative learning? Discuss the merits and advantages of collaborative learning.

Or

Write a note on collaborative learning.

Ans. Collaborative learning is learning strategy in which students are provided opportunities to learn by themselves in a group in a collaborative way. They share their ideas and information among themselves and help one another for having required knowledge, understanding and application of course units included in their syllabus. The collaborative learning advocates the learning in group by cooperating with one another in place of the competitive and individualistic approach. In collaborative learning, the students of a class or section work in small groups to help one another learn in a collaborative and non-competitive environment.

Basic Assumptions and Features of Collaborative Learning—

The basic assumptions and features of collaborative learning are given below :

1. Collaborative learning makes the teaching learning process as learner centered rather than teacher centered.
2. It advocates constructivist approach for the better teaching-learning outcomes. It encourages the students to formulate their own methods of understanding the content material.
3. It advocates interactive teaching-learning environment instead of more lecturing and demonstration on the part of the teacher. Thus the responsibility for learning is shifted to the students.
4. It advocates a non-competitive anxiety free collaborative environment.
5. It advocates social learning by assuming that learning takes place better in a social situation and group environment rather than individually.
6. It believes in group efforts than cooperation among the students rather than individual efforts and competition.
7. It advocates that the achievements and performance of the students may be evaluated in terms of group achievements.
8. It advocates that the students learns better in a collaborative way from one another on account of their proximity, equality, interdependent and rapport existing among them.
9. It believes that the students learn in best way when they are completely involved in the learning process by co-operating one another.
10. It advocates that group goals and individual accountability should be used together for the evaluation of group achievements and performance in collaborative learning.
11. In collaborative learning, the students must get opportunity to learn and work in group collaboratively in order to develop them into a collaborative and responsible social being. The students who collaborative one another in learning also learn to help one another in real life.

Merits and Advantages of Collaborative Learning—

There are many merits and advantages of the collaborative learning as given below :

(1) Advantages of collaborative learning in the field of Education—

1. Collaborative learning involves the students actively in the process of teaching and learning.
2. It makes the students responsible for their learning.
3. It makes the process of teaching and learning as learner centred rather than content and teacher centered.
4. It helps the students in developing different skills such as thinking skills, critical thinking and communication skills.
5. It is helpful for the weaker students in improving their performance when grouped with higher achieving students.

6. It helps the students to get opportunity for deeper understanding and insight of the subject matter.
7. It is helpful in providing interactive model for the classroom teaching in place of lecture and demonstration method.
8. It is helpful in improving classroom results by making the students more involved and motivated.
9. It is helpful in providing an anxiety free non-competitive simulating environment.
10. In collaborative learning, the teacher becomes more free and supervising the learning activities of his students.

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EXPERIMENTAL LEARNING

10. What do you know about experimental learning. Describe the merits and demerits of experimental learning.

Or

Write a note on experimental learning. **(M.D.U. 2018)**

Ans. Experimental learning is the method of learning where the students are required to do some experiments and practical work and varify certain scientific truth.

"To learn science is to do science" is the view of the veteran man of Science and famous Indian educationist Dr. D.S. Kothari. He further goes on to say, "There is no other way of learning science". The concept is not new. The person who initiated this move was Prof. H.E. Armstrong of City and Guilds Institute, London. He was the chief advocate of a special type of laboratory training–heuristic training and gave the view that real purpose of science was original investigation and discovery. Thus, it is essential to put the pupil in the position of a discoverer or investigator to discover the principles of science for himself.

In this method the pupil is expected to approach his scientific studies from the position and in the spirit of a research worker, for science is not a subject to be discussed. It is a practical subject and the appropriate way of learning is by doing. Prof. Armstrong believed in doing and not in observing what was being done. Thus, in this respect, this method is opposed to the Demonstration Method.

Form of the Method : The teacher poses a problem before the students and they are provoked to solve it independently by providing all necessary facilities and instructions for its solution. The students work as per instructions, performs experiments and maintain a record in their note books. They also jot down the conclusions arrived at as well as the bearing which these conclusions have on the problem in hand. The students are provided with the necessary guidance and help by the teacher in a reasonable amount when and where they need so.

Naturally when there is so much stress upon the fact that the pupil should dig out the problem himself and lay a hand at the problem himself and arrive at

the truth himself, this develops good training for his future life. Comparatively the quantity of knowledge attained will be far less, since this becomes a long and slow process when we put a small chap in position of a discoverer.

Role of the teacher : The problem-solving aspect to Science is now receiving special attention. It is not sufficienct on the part of a teacher to put forward a problem or question, and ask the class to solve it. Thus, the role of the teacher becomes more significant to inculcate experimental learning among the students, viz.

1. Encouragement of students : His aim should be to encourage his pupils :

(i) to **decide** upon problems that can be solved by scientific technique.
(ii) to **define** their true nature before moving ahead.
(iii) to **devise** experiments.
(iv) to **interpret** the data achieved and lastly.
(v) to **infer** laws and generalizations.

All the steps to decide, to define, to devise, to interpret, to infer have received adequate stress in this method.

2. Development of Logical Thinking : Teacher should remain very cautious in providing situations to all the learners so that they themselves become real investigators with their own logical thinking and reasoning to arrive at appropriate solution to the problem in hand.

3. Imparting new knowledge : The teacher must have wider knowledge and greater experience to deal with the subject-matter. He should possess the ability to open new vistas of knowledge in front of the pupils. This will help them in searching at will to discover new knowledge or facts.

4. Putting critical questions : The teacher should develop the habit of self-investigation in the minds of the students. For this, he should put stimulating and critical questions to make the pupil think.

5. Providing freedom : The teacher is a guide and a friend of the pupils. Therefore, he should prevail an atmosphere of freedom in the class-room so that self-expression, self-development and spontaneity among the students can be visible.

6. Individual attention : Individual attention of the teacher is the essential aspect of this method. It is because all the students may not be performing the same experiment at one time. Besides this, it establishes the bond between the teacher and the pupils.

Experimental Learning :

1. Psychological method : This method is based on a significant principle of psychology, i.e., 'learning by doing'. Therefore, the students, get a chance of having direct first hand experience by performing the experiments themselves. This method provides full weightage to the child instead of the subject-matter. Here child takes initiative in discovering the facts. His mental faculties get appropriate opportunities for their functioning and development.

2. Development of scientific attitude : This method assists in the development of scientific outlook and attitude among the students. It also assists them to imbibe relationship in dealing with the events and happenings around them. They learn to arrive at decisions by actual experimentation.

3. Active participation and involvement : By adopting this method, students pick up the habit of remaining active in the teaching-learning process. They must analyse, gather facts and engage in problem solving or discovery of scientific facts with the help of their own independent efforts. Thus, through this method, the students become self-dependent, self-reliant and self-confident.

4. Cultivation of good habits : The adoption of heuristic method helps the pupils to imbibe with certain good characteristics of personality such as self-confidence, self-reliance, habit of self-study, habit of diligency, independent thinking etc.

5. Providing individualized instructions : The adaptation of this method comprising self-investigation and discovery on the part of child requires adequate help and guidance from the teacher. The child is not avoided but remains in constant vigil and supervision of the teacher during the pursuit of his goal in this method. Teacher provides individual attention as well as individualized instructions since all the students may not be performing the same practical at one time.

6. Clarity and permanency of knowledge : The knowledge gained by this method is retained for a much longer time since the students learn by self-activity. Whatever the child acquires through this method, is with the help of his own efforts. Here the results of learning are very much encouraging in relation to the subject-matter and permanency of the material learnt.

7. Teacher-taught relations : Since the pupils have to approach the teacher time and again to get guidance and explain their difficulties, the relation between the teacher and the taught becomes more intimate and healthy.

8. Reduction in the load of home-work : In case the students are adopting heuristic method, there is very little requirement of doing extra home-work by the students. This reduces the burden of the students and makes science education a pleasant pursuit.

9. Solving discipline problem : Since students remain preoccupied with the task of discovering and finding out the facts and they are entrusted with the individual or joint responsibility of sharing the job of discovery, the chances of being indisciplined are lessened. Thus, this very method paves the way of a self imposed discipline for the pursuit of the joy of discovery and independent efforts.

Demerits of Experimental Learning

1. Not suitable for elementary classes : The students of the elementary classes are quite immature and do not possess the initiative of carrying out self-discovery. At this juncture, one needs sufficient information from his teacher in the shape of foundation work. It is not expected from him to conduct independent research or discovery for the acquisition of scientific facts. Thus, this very method is not suitable for the students of the elementary classes.

2. Too high expectation from the students : This very method expects too much from the students in the shape of self investigation and discovery. It is too much to expect that small children will discover everything themselves.

3. Too much expectation from the teacher : This very method expects too much on the part of teacher by way of providing each child appropriate guidance and help at the desired time. There is non-availability of gifted teachers. It pre-supposes a gifted teacher and small class, which are generally not available in our schools.

4. Obstacle in the path of the progress : Instead of proving an asset to the progress of the individual and the society, this method may prove a stumbling block as it demands to discover and rediscover the already discovered facts by the students. Thus, the attempts and energy can be brought in use for some new invention or discovery. In the blind pursuit of discovering the facts by themselves, un-experienced students may achieve nothing except the disappointment due to their own independent efforts.

5. Difficulty in finishing the syllabus : If the teacher leaves the children totally for self-investigation and independent efforts as needed in this method. Then there arises great difficulty in finishing the syllabus within the stipulated period.

6. Chances of faculty outcomes and conclusions : Since the students are not so mature and capable as to draw appropriate inferences from their independent observation and experimentation etc. There are chances of faculty outcomes and conclusions. This method may lead the students to acquire wrong information, learn faculty concepts and generalize incorrect principles, the rectification of which may pose a grave problem at some other stage.

7. Not appropriate in the existing scenario : This method may not prove appropriate in the present circumstances due to the following reasons :

(a) The number of students in a class is generally too large in our schools.

(b) The text books on science are not usually written on the lines as desired by this method.

(c) Requirement of material and equipments in sufficiency quantity cannot be fulfilled.

(d) The grading of problems is not an easy job as it requires skill and training.

(e) It is a costly affair since it requires well-equipped laboratories, well-stocked libraries and highly qualified and trained personnel.

Conclusion : The close analysis of the above merits and demerits of the heuristic method may lead us to conclude that it has both its strengths and weaknesses. This method may not be applicable to primary classes, however, it can be endeavoured successfully to some extent in secondary classes, particularly Senior Secondary Classes. But a number of limitations, as absence of gifted teachers and well-equipped laboratories and libraries stand in the way. Even if these drawbacks are removed, we cannot recommend the use of this method in its fullest form under the prevailing rules and regulations. It is, however, advisable that at least experimental learning should be given due importance for teaching science in our schools. The child should be led from known to

unknown by providing him full total opportunity to discover the facts by his own independent efforts. He should never be told about the scientific facts but guided through heuristic question to discover them and then reap the fruits of his discovery. Science taught in this way may then prove quite beneficial, effective and ever lasting in the minds of the students.

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3.4 MICRO TEACHING SKILLS

MICRO-TEACHING

11. Discuss the general process involved in micro-teaching by mentioning different steps and activities.

Or

What is micro-teaching cycle and what are the differences between micro-teaching and traditional teaching?

Or

What do you understand by micro-teaching skill.

(C.B .L.U. 2018)

Ans. Micro-Teaching—This is a totally new technique according to the Indian situation. In foreign countries the entire process of Micro-teaching is video-taped. After teaching, the pupil-teachers see their video-tape, and make self-analysis and get proper feedback. But these facilities are not available in India.

In India to get feedback of Micro-Teaching, the teachers are used. This is known as 'Supervisor Feedback'. Sometimes the friends of the pupil-teacher, who are also pupil-teachers, give the feedback. This is known as 'Peer Feedback'. Many times the entire micro-lesson is taped and after teaching, the pupil-teacher, sees it and gets feedback. This is known as 'Auto Feedback'.

Before Feedback, the various steps and conditions of Micro-teaching are as follows :

Steps involved in Micro-Teaching

STEP-1

Orientation—In the first step, the pupil-teachers should be given necessary theoretical knowledge of Micro-Teaching like : meaning of micro-teaching, its importance, uses and methods of teaching.

STEP-2

Discussion of Teaching Skills—In this step, the pupil-teachers should be familiarized with various skills like : components of teaching-skills, use of various skills in teaching, their significance etc.

STEP-3

Selection of a particular Teaching Skill—In micro-teaching, it is to be noted that only one-skill at a time can be practised. So one skill, out of various skills is chosen. All information/knowledge of that particular skill should be given to the pupil-teachers.

STEP-4

Presentation of a Model Demonstration Lesson—After giving full details of the chosen skill, a Model Micro Lesson should be presented before the pupil-teachers. There are various methods—

(i) The Lecturer or the teacher can read out the model lesson himself as demonstration.
(ii) For the Model Lesson, hardware like T.V. or Video-tapes can be used.
(iii) A model-lesson can be heard on the tape-recorder, after having been taped.
(iv) Model Lessons can also be given to the students, in the written form.

STEP-5

Observation and Criticism of the Model Lesson—The pupil-teachers should be told the proper method of observation and criticism of the Model Lesson. Observation schedule of all skills is different. The pupil-teachers should be told in detail regarding the use of observation and criticism.

STEP-6

Preparation of Micro-Lesson—The pupil-teacher prepares the model micro-lesson for practice and teaching of the chosen skill. For this, he can consult other pupil-teachers.

STEP-7

Teaching Session—In this step, Micro-teaching begins. For this purpose, the pupil-teacher selects a group of 5-10 students and teaches them, for 5-6 minutes, making use of one particular skill. The supervision of this micro-lesson can be done by his colleagues, teacher or through a tape-recorder or a video-tape.

STEP-8

Feedback—In this step, the pupil-teacher should immediately get feedback of his micro-lesson and he should be informed of his shortcomings, so that he can improve them. 6 minutes are set aside for feedback. This feedback is also called Criticism Session.

STEP-9

Replanning of the Lesson Plan—On the basis of the feedback, re-planning of the lesson is done. A pupil-teacher plans it himself and he is given 12 minutes for this replanning. This step is known as Replan Session.

STEP-10

Re-teaching—Replanned micro-lesson is taught to the same group for 6 minutes and the same observation-medium is used. This step is also known as Re-teaching Session. Like the earlier teaching, this is also under observation.

STEP-11

Re-Feedback—After teaching the re-planned lesson, the pupil-teacher is again given the feedback. This work also continues for 6 minutes.

STEP-12

Repetition of the Micro-teaching Session—In this way, the cycle of Micro-Teaching keeps going on till the pupil-teacher feels confident that he has gained expertise in the chosen skill. In this step, the pupil-teacher again makes a lesson plan and then teaches it and gets its feedback. So this way, he gains expertise in one particular skill.

Comparison between Traditional and Micro-Teaching :

1. In Traditional method of Teaching, objectives are not clearly specified in behavioural vocabulary. But in Micro-teaching it is done so.
2. In the Traditional method of Teaching, the duration of Teaching time is more, but in micro-teaching it is only 5-20 minutes.
3. In the Traditional teaching there are 50-100 students in the class, whereas in Micro-teaching, there are only 5-10 students.
4. In the Traditional method of Teaching, there is no system of giving immediate feedback, but in micro-teaching feedback is immediate.
5. The role of the teacher is not very clearly defined in the traditional system of teaching, whereas in micro-teaching, it is very specific.
6. In the Traditional method of education, the interaction cannot be studied objectively, but in micro-teaching it is possible.
7. The Traditional method of Teaching is very complex but micro-teaching is considered very simple.

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SIGNIFICANCE OF MICRO-TEACHING

12. What is the importance of Micro-Teaching? Prepare an Indian Model of Micro-Teaching.

Ans. Significance of Micro-Teaching—There are so many defects in the Student Training Programmes, conducted in the universities. No attention is being paid to complex problems like—teaching 35-40 students in one class, full chapter to be taught in 35-40 minutes, different issues to be taught in the same chapter, focus on different skills altogether etc. The pupil-teachers are sent to the class-rooms, from the beginning, without any preparation. Not only this, lack of systematic review, supervision or feedback, the reforms planned for Teacher Training Programmes receive a setback. In such situations, the students cannot achieve teaching competence of a required level. As a result, the students lose confidence in this training and give way to frustration.

Research Scholars have tried to strengthen, the Teacher Training Programmes in the Field of Student Training, by developing new methods and techniques. New innovations have been made like—analysing behavioural changes, interaction, micro-teaching etc. They have tried to strengthen the Training Programmes. Different conclusions of various researches have proved that micro-teaching is an effective technique.

Micro-teaching is such a technique in which difficulties of normal teaching have been reduced in the following ways :

(i) Only one skill at a time is practised.
(ii) Subject-matter is restricted to only one topic.
(iii) There are only 5-10 students in the class.
(iv) The duration of the lesson is from 5 to 10 minutes.

In Micro-teaching, the pupil-teachers are given opportunity to improve their lesson in a systematic feedback. The cycle of Teaching; Re-teaching, continues till the pupil-teachers achieve mastery over a specific skill upto the required standard. After Skill Acquisition Phase, the pupil-teacher goes to the next phase where he uses the skills learnt in an actual class-room. So he learns this smooth transition effectively. So micro-teaching programmes are used to train teachers in simplified and safe situations, to gain expertise over specific skills. These skills are then used by the pupil-teacher in actual teaching.

Indian Model of Micro-Teaching—The Principles of Micro-Teaching were developed in foreign countries, and rather than accepting them as they were, some necessary changes were made, to make them adaptable in the Indian context. The credit of developing the Principles of Micro-Teaching in India goes mainly to Prof. R. C. Dass and Dr. Balkrishna Passi : In 1975, NCERT, Education Department of Delhi, CASE (Centre for Advanced Studies in Education) Baroda and Education Department of Indore University, jointly worked on this project. For this project, help was taken from different Educational Institutions. Along with this, organisational problems of various Training Institutes were also analysed and discussed. Many Research and Training Programmes were conducted jointly by Teacher Educators and Teachers of Indore University. Instructional material prepared by Dr. Passi (1976), Singh (1976, 1979), Jangira, was used for the training of pupil-teachers. This research formed the basis of this development and an Indian Model of Micro-Teaching was developed. Its important details are as follows :

1. In countries like America, England, Australia etc., expensive electronic media like—films, video, tape-recorders and closed circuit T.Vs. are used to record different steps of micro-teaching.
   But in Indian context, these expensive electronic items are not used. For demonstration of Skills of Teaching which is known as Written material, Modelling, Explanations, Demonstrations, Discussion methods etc. are used.
2. In developed countries, for the analysis of Micro-teaching, audio-tape, video-tape, closed circuit T.V. etc. are used.
   But in India, for analysis and evaluation, the colleagues of the pupil-teacher do it. Based on this, immediate feedback is given to the pupil-teacher.
3. In the Indian context, instead of real school children, friends, pupil-teachers perform this role. In foreign countries, the school children are given money for the help they give for educational purposes.
4. The shape of Indian Micro-teaching is extremely flexible and practical. Micro-Teaching Programme can also be carried on in the absence or lack of laboratories, equipment or materials. If no special place is available, then also micro-teaching programme can be conducted.
5. The following time duration has been decided for the cycle of micro-teaching :

Teaching	6 minutes
Feedback	6 minutes
Re-planning	12 minutes
Re-teaching	6 minutes
Second Feedback	6 minutes
Total	36 minutes

It means that 36 minutes are allotted to the practice of one teaching skill.

This model is being used in many Departments of the Universities and Training Institutes.

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(A) SKILL OF INTRODUCING THE LESSON

13. What do you mean by Skill of Introducing the Lesson? Describe the component behaviours and observation schedule of this skill.

Ans. Meaning of the Skill : The Skill of Introducing the Lesson may be termed as proficiency in the use of verbal and non-verbal behaviour, teaching aids and relevant devices for making the pupils realize the need of studying the lesson by establishing cognition and affective rapport with them. The following are the component behaviours of this skill.

1. Maximum utilisation of previous knowledge of pupils : Introduction of a new lesson has to be based on previous knowledge and experience of pupils. Therefore, a teacher has to acquire the art of utilising such knowledge and experiences. Hence the teacher should keep in mind the following :

(i) Previous knowledge of the subject of the pupils.
(ii) General awareness of the pupils with the physical and social environment.
(iii) Devices and techniques of finding out the previous knowledge.
(iv) Techniques of establishing connection between previous and new knowledge.
(v) Ability of creating situations in the class for the utilization of previous experiences.

2. Using appropriate devices / techniques : A teacher should essentially acquire the ability of using appropriate devices or techniques for introducing a lesson. Such devices are listed as below :

(i) Use of examples, analogies, similarities.
(ii) Questioning
(iii) Lecturing, describing, narrating, illustrating
(iv) Story telling
(v) Dramatization or role-playing
(vi) Experimentation or Demonstration
(vii) Using audio-visual aids
(viii) Visits or excursions.

The appropriateness of the use of each of such device relies upon the unit to be taught and also on its suitability to the maturity level, age level, aptitude, culture and experience of the pupils.

3. Maintenance of Continuity : Continuity refers to the sequence of ideas or information being presented. Proper introduction demands the continuity in the sequence of ideas or information. There should be a logical sequence between the main parts of the introduction. What is done at a particular moment should be appropriately related to pupil's previous response. It should also be properly linked with the preceding activity or statements of the teacher himself.

4. Relevancy of verbal or non-verbal behaviour : A teacher should endeavour to observe appropriateness in his verbal or non-verbal behaviour. What is to be stated, asked, demonstrated, dramatized or illustrated should contribute a lot towards the introduction of lesson in the various ways such as :

(i) Testing of the previous knowledge
(ii) Utilising these past experiences.
(iii) Establishing both cognitive and affective rapport with the pupils.
(iv) Pin-pointing the aims of lesson
(v) Making the pupils understand the need and importance of studying the lesson.

For providing feedback on the teaching performance the micro lesson given by a trainee is supervised by the fellow trainees or teacher educator. In order to obtain objectivity and reliability in the observation process, it is good to lay down an observation schedule and get the supervisors trained in its use.

The observation schedule-cum-rating scale for the skill of introducing a lesson may comprise three columns. The first column points out the tallies against the occurrence of the different component behaviours of the skill. The second column specifies the components of the skill. The third one consists of seven point rating scale for each of the components of the skill. This very skill is being introduced in the following proforma.

Proforma for observation schedule-cum-rating scale of the skill-introducing the lesson.

Name of the student teacher : _____ **Date :** _____
Class : _____ **Session :** _____
Concept or Topic : _____ **Supervisor :** _____
Time duration : _____

Tallies	Components Desirable Behaviour	Ratings from extremely poor to excellent
	1. Using previous experience of the pupils	0 1 2 3 4 5 6
	2. Proper use of device/technique	0 1 2 3 4 5 6
	3. Overall impression about introducing a lesson	0 1 2 3 4 5 6
Tallies	Components (Undesirable Behaviour)	Ratings rom not at extremely to very often
	1. Lack in continuity	0 1 2 3 4 5 6
	2. Irrelevant verbal or non-verbal behaviour	

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(B) SKILL OF QUESTIONING

14. What do you mean by skill of questioning? Describe the component behaviours and observation schedule of this skill.

Ans. Meaning of the skill : Questioning is the major device used in any teaching-learning situation. If it is able to evoke desired response from the pupils, it can be called successful. Pupils respond in plenty of ways and styles such as no response, wrong response. Correct response etc. All this depends upon their own development level, nature of questions and teacher's behaviour. For the realization of the teaching objectives, a teacher is supposed to learn the art of managing the responses of the pupils for eliciting desired response. This can be done with the help of probing questions and some other desirable behaviours.

The term probing refers to going deep in the matter in hand. As a result, the skill of probing questions may be defined as the art or response management which comprises a set of behaviours or techniques for going deep into pupils responses with a view to elicit the desired responses.

Due to its emphasis on the ways and means of response management, this skill of probing questions has been termed as the skill of Response Management (Jangira and his associates 1979)

The skill of probing questions comprises the following component behaviours or techniques :

(i) Prompting (ii) Seeking further information
(iii) Refocussing (iv) Redirection
(v) Increasing critical awareness.

Prompting

In dramatics or role playing the prompting as a technique is used by someone behind the curtain. The purpose is to help the characters to speak the correct dialogue and demonstrate the desired behaviour before the audience. In the teaching-learning situation it refers to the hints provided by the teacher through well framed questions to a pupil in order to help him arrive at the desired response from the undesired situations like no response, incorrect or partially correct incomplete responses. It should be noted that the teacher himself does not provide the answer to the question put up in the classroom by him or any pupil but endeavours to deal with the situation by giving prompts.

The selection of specific prompts (hints, cues, restructuring or rephrasing of the question, step-by-step questioning) in a special situation relies upon the following factors :

(a) level of maturity and previous experience of the pupils
(b) ability of the pupils to manipulate the appropriate facts
(c) concept of principles
(d) logical consistency of the response
(e) desired responses etc.

If there is partially correct or incomplete responses, the technique of seeking further information is applied. In this way, the technique of seeking further information may be termed as a technique of getting additional information from the responding pupil to bring his initial incomplete or partially correct response to the desired response level. The following questions may be used for seeking further information from pupils :

(a) What else can you say?
(b) How can you make it more vivid?
(c) Will you please elaborate your answer?
(d) Give some illustrations/evidences/arguments.

Refocussing : The technique is applied in a correct response situation so as to strengthen the response given by pupil. While refocussing, the teacher manages to persuade the responding pupil either to relate his response with something already studied by him or to consider implications of his response in more complex situations. The questions such as, how does it differ from..... or similar to.....can you provide an example to support your answer, how is it applicable to the real life situations etc. are often involved in refocussing.

Redirection : This very technique is usually applied in a no response or incomplete response situation and needs putting or redirecting the same question to many pupils for eliciting desired response. This sort of redirection assists the teacher in the task of probing by prompting or seeking further information with the assistance of several pupils.

Increasing critical awareness

This technique is applied in a correct response situation to increase critical awareness in the pupil. It is expected from the teacher to ask 'how' and 'why' of a fully correct or desired response from the responding pupil. The following questions are helpful in asking the responding pupil to justify his response for the purpose of increasing critical awareness in him :

(a) How can you justify it? (b) Why do you assume so?
(c) How does it occur? (d) What may be the reason behind it?

Proforma for Observation Schedule-cum-Rating scale

Name of the student teacher : _____ **Date :** _____
Class : _____ **Session :** _____
Concept or Topic : _____ **Supervisor :** _____
Time duration : _____

Tallies (showing occurence of component behaviour)	Components	Ratings ranged from extremely weak to excellent mastery over the component
	Prompting	0 1 2 3 4 5 6
	Seeking further information	0 1 2 3 4 5 6
	Refocusing	0 1 2 3 4 5 6
	Redirecting	0 1 2 3 4 5 6
	Increasing critical awareness	0 1 2 3 4 5 6

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(C) SKILL OF ILLUSTRATION

15. What do you mean by Skill of illustration? Describe the component behaviours and observation schedule of this skill.

Ans. The word 'Illustrate' means 'to explain', give example and make the point clear or use pictures, graphs etc to make the subject clear to the students. The noun form of "Illustrate" is "Illustration", which means such material, that makes the subject-matter clear. When it becomes difficult for the teacher to explain an abstract idea, concept or principle despite the best efforts on his part, skill of illustration helps him a lot. When certain points, arguments and statements have to be elucidated, illustrations are used. The atmosphere of the class is changed through this skill. The traditional dullness gets disappeared when verbal and non verbal illustrations are used.

This skill includes :
(i) Verbal illustrations
(ii) Non verbal illustrations

(i) Verbal illustrations : Examples, which are given by word of mouth are called verbal illustrations e.g., explanation, illustration, word pictures, description etc. These are used to make the subject-matter clear, to widen the range of experiences and strengthen the imagination. Generally the teacher resorts to the use of explanation, description or elaboration, in the class, for the help of the students. With oral illustrations, explanation becomes more effective.

(ii) Non-verbal illustrations : It means 'objects' as illustration. For example - pictures, maps, sketches, charts, diagrams, graphs, black board, specimens, models etc. In examples we move from 'abstract to concrete', from 'simple to complex'. These illustrations make teaching and understanding easy. Psychology states that during classroom teaching, the more sense and action organs are activated the more effective becomes the learning; all are reinforced and the knowledge becomes permanent. Slow learners, who did not understand oral illustrations, benefit very much by non-verbal illustrations.

It should be realised that if the lesson deals with a particular branch of science, a widely-read teacher will draw illustrations from each and every branch of science.

Components of the skill

The main components of the skill of illustrating with examples are as follows :

1. Formulating relevant examples : The examples which the teacher uses should have relevance with the topic. An example which is connected with the idea, concept, principle, statement, rule etc can be said to be an appropriate example.

For eg. in lesson on the **Principles of Archimedes,** the narrow academician will realise about the content after demonstrating two or three experiments. The effects or results of these will prove the law. While a good teacher will think that his lesson is not over unless he has discussed with his students a lot of varied illustrations and applications of the principle. He would

also feel it incomplete unless he has met within different aspects or phases of life. For e.g. ships, floating bodies, diving and rising of submarines, the use of balloons as well as air-ships.

2. Formulating simple examples : Where simple things come first and complex later on is called a good teaching. That's why it is good for a teacher to begin with easy or simple illustrations. It is because these are based on the previous experiences and knowledge of the students. It would be better if the term "simple" is judged from the student's perspective. The reason is that what appears simple to the teacher may be difficult for the students.

3. Formulating interesting example : It is good for a teacher to formulate interesting examples inorder to make the topic interesting. A child can be forced to sit in the classroom but he can not be forced to learn. The same is with the horse. It can be taken to a pond of water but is extremely difficult to make it drink. With the help of examples, pupils attention and their curiosity is aroused. Then they understand the idea, concept, principle, rule or statement properly.

4. Using appropriate (suitable) media for examples : Mainly verbal and non-verbal media are used to convey the examples or illustrations to the students

(a) Verbal media of presentation of examples include :

(i) Story telling
(ii) Analogies and Comparisons
(iii) Similes

For example :

1. For a lesson on magnetism, the tale of the shepherd boy and his crook is very appropriate.
2. The anecdote of Guerike's experiments with hemispheres of 18 inches radius being pulled by a team of sixteen horses can be related so as to create interest in the lesson on air pressure.

(b) Non-Verbal media of presentation of examples includes:

(i) Improvised science apparatus : This is of great educative value. It is believed that understanding travels from hands to the head. If somebody has the ability to make things with his own hands, he will thoroughly understand the underlying principle. Then they will have an insight into the background, theory and practice. This will prove of great worth in educational gain.

(ii) Charts : Charts are used to visualise some idea or concept which may be more complex to understand on being treated only in words. They are a mixture of graphic and pictorial media which are designed for the orderly and logical visualisation of important facts and figures.

(iii) Pictures and portraits : Pictures of scientific interest and the portraits of legendary personalities are of utmost importance in providing a correct atmosphere to the science teaching, their application in demonstration work makes the teaching somewhat real, thrilling and exciting. Pictures are supposed to be bold, direct and large so that everyone in the class can see properly. If a picture is over-loaded with details, its purpose gets defeated. 'One picture one idea' means a successful pictorial illustration.

(iv) Chalk board: Words are artificial. They do not develop images in the minds of the students so easily. It is easier to grasp the image of a thing or a process than a description in words. Figures are thought to be easier to

perception in comparison to words. Therefore, the teacher can draw figures, sketches etc. on the chalk board so that the lesson can be illustrated for the easy comprehension of the pupils.

(v) Model : Model is chiefly representation or image of any real object. It is a miniature reproduction of the object. It corresponds in detail with the actual object and differs from it only in size. It is so designed to represent objectives, systems, ideas, concepts etc. With the help of mode, the science teacher can show the interiors of an object which is usually covered or invisible.

(vi) Experimental demonstrations : Almost all the modern inventions and applications of science in daily life are the result of constant experimentation on the part of great scientists and technicians. The face of the earth would not have been what we see at present but for the experimental work. Experimental evidence is the certain test of any theory, predicted and developed on purely theoretical basis. Any theory, however sound it may appear, cannot stand on a sound footing unless experimental results in its favour.

5. Making use of inductive-deductive approach :

(i) Inductive approach : Inductive approach is a procedure to prove a universal law by depicting that it is true in a specialized case, it is also true in the cases of similar types. Here, we proceed from concrete to abstract, from a specific example to the universal law or from particular to general. It is an appropriate component for the teaching of science since all the conclusions are the result of inductions.

(ii) Deductive approach : Deductive approach is the reverse of induction. Hence the facts are deduced or analysed by the applications of established formulaes or experimentation. Here the approach is said to be confirmatory. It is not explanatory. In this approach, the students proceed from general to particular, from unknown to known, from abstract to concrete, or from established principles to their applications.

The observation schedule-cum rating scale may consist of five components as illustrated below :

Observation schedule-cum-rating scale for the skill of illustrating with examples

Tallies (Frequency occurrence of component behaviour	Components	Ratings (Performed with regard to the use of component
	Relevancy of examples	0 1 2 3 4 5 6
	Simplicity of examples	0 1 2 3 4 5 6
	Interesting aspect of the examples	0 1 2 3 4 5 6
	Appropriateness of the media	0 1 2 3 4 5 6
	Appropriateness of the approach	0 1 2 3 4 5 6

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(D) SKILL OF EXPLAINING

16. What do you understand by skill of explaining? Illustrate the process of developing various components of the skill through a micro-lesson.

Or

Explain the skills of explaining in detial. **(M.D.U. 2018)**

Or

List the components of skills of explaining and prepare lesson plan. **(C.B.L.U. 2018)**

Ans. Meaning of the skill A teacher has to learn the skill of explaining so that he could make the pupils understand many ideas, concepts or principles which require explanation. Explanation is nothing but few interrelated appropriate statements. In this way the skill of explaining may be termed as the art of learning the use of interrelated appropriate statements by the teacher for making the pupils comprehend the desired concept, phenomenon or principle.

It is by all means a verbal skill and has two main aspects, as given below :

(i) The selection of appropriate statements relevant to the age, maturity, previous knowledge and content of the concept or phenomenon.

(ii) The skill of interrelating and applying the selected statements for the proper understanding of the concept or phenomenon.

The statements are generally believed to be of three types-the descriptive, the interpretive and the reason providing (generally meant for answering the questions how, what and why of a concept or phenomen or principle).

Components of the skill

The skill of explaining a concept or phenomenon consists of two types of behaviour-desirable and undesirable. While practising the skill, the occurrence of the desirable behaviours is to be increased. In the other hand the undesirable behaviours are to be decreased and extinguished.

These behaviours are to be summarized as below :

Components of the skill of the explaining.

S.No.	Desirable Behaviours	Undesirable Behaviours
1.	Using suitable beginning and concluding statements	Using irrelevant statements.
2.	Using explaining links	Lacking continuity in atements.
3.	Covering essential points	Lacking solvency
4.	Testing pupils' understanding	Using inappropriate ocabulary, vogue words and phrases

Meaning of the above component behaviours.

Desirable behaviours

1. Using appropriate beginning and concluding statements: Beginning statements is an opening statements announcing what is going to be explained by the teacher. It prepares the pupils mentally to receive the explanation. Besides this, concluding statements are formed after the end of the explanation in order to summarize or conclude the entire explanation.

2. Using explaining links : Explaining links in the form of words and phrases are meant for establishing links or continuously in the statements used for explaining a concept, phenomenon or principle. Some of these linking words and phrases generally used for explaining are listed below :

Therefore, thus, hence, because, so that, inorder to, in order that, consequently, since, inspite of, why, while, that is why, this is how, due to , owing to, the purpose of, the cause of, the function of, as a result of etc.

3. Covering essential points : The explanation given for the understanding of a given concept or principle should be as complete as possible.This sort of completeness is determined by the scope of the concept as specified in the instructional objectives. It should aim for covering all the essential points which will lead to clear understanding of the desired concept.

4. Testing pupils understanding : This components behaviour involves appropriate questions to the pupils to ascertain whether the purpose of explaining the concept has been achieved or not.

Undesirable behaviours

1. Using irrelevant statements : This behaviour carries the statements which are not related to the concept or principle being explained. These statements, instead of assisting the pupils to comprehend the concept, create confusion and distract the attention of the pupils.

2. Lacking continuity in statements. This behaviour consists of a missing link or break in the logical sequence of the interrelated statements by the teacher for explaining a concept.

3. Lacking fluency : Fluency relates to the flow of uninterrupted statements for explaining a concept. If a teacher lacks fluency, he may be seen to show the following types of behaviours :

(i) does not speak clearly,

(ii) utters incomplete or half sentences.

(iii) tries to reformulate or correct his statements in the midway of a sentence or a statement

(iv) uses fumbling ideas or inappropriate words or statements.

4. Using 'appropriate vocabulary, vague words and phrases. This behaviour consists of the following undesirable aspects.

(i) Use of vocabulary not known to pupils or inappropriate to their age, grade and maturity level,

(ii) Use of certain vague words and phrases (such as, infact, somewhat, you see, you know, I mean, actually, probably, perhaps, a little, almost etc.) obstructing the understanding of an explanation.

Observation schedule-cum-rating scale for the skill of explaining or narration.

Name of the student teacher : _____

Subject : _____ Concept : _____

Class : _____ Session : _____

Date : _____ Supervisor : _____

Tallies or Specific	Components	Ratings scale xtended to observation
	Desirable Behaviours	extremely weak to excellent performance.
Yes/No	1. Using appropriate beginning statements	0 1 2 3 4 5 6
Yes/No	2. Using appropriate concluding statements	0 1 2 3 4 5 6
Tallies	3. Using explaining links	0 1 2 3 4 5 6
Yes/No	4. Covering essential points	0 1 2 3 4 5 6
Yes/No	5. Testing pupils understanding	0 1 2 3 4 5 6
	Undesirable behaviours	Rating scale Not at all very much.
Tallies	1. Using irrelevant statements	0 1 2 3 4 5 6
Tallies	2. Lacking continuity in statements	0 1 2 3 4 5 6
Yes/No	3. Lacking fluency	0 1 2 3 4 5 6
Tallies	4. Using inappropriate vocabulary	0 1 2 3 4 5 6
Tallies	5. Using vague words and phrases	0 1 2 3 4 5 6

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(E) SKILL OF STIMULUS VARIATION

17. What do you understand by the Skill of Stimulus Variation? Illustrate the process of developing various components of this skill through a micro lesson.

Or

What do you mean by Skill of Stimulus Variation? Describe the component behaviours and observation schedule of this skill.

Or

Explain the meaning of Skill of Stimulus Variation. What are the component of this skill? Explain them with help of examples.

(C.R.S.U. 2018)

Ans. Meaning of the skill : The Skill of Stimulus Variation is based on the principle that change in the stimulus in one's perception captures his attention. Attention tends to shift from one stimulus to other stimulus at a great speed. It is extremely difficult for us to attend to the same stimulus for more than few minutes and in some cases few seconds. **In this way Skill of Stimulus Variation may be defined as a set of behaviours for bringing desirable change in the stimuli applied to secure and sustain pupils' attention towards classroom activities.**

According to **Sneha Joshi**, "What to change, when to change, and how to change requires a skill on the part of the teacher for securing and sustaining attention at a high level. Such a skill is named as Stimulus Variation,"

Components of the skill

The skill of introducing change or variation in the attention capturing stimuli in a classroom consists of the following component behaviour:

1. Movements : To secure and sustain attention in pupils, teacher has to move about in the class. The movement of the teacher attracts the attention of the pupils. He moves towards chalk-board to write certain important points. He moves towards pupils to ask questions, to check their note books, to solve their problems etc. however, all types of movements do not bring positive results. Therefore, when a teacher practises the skill of stimulus variation, he should make well-planned meaningful movements.

2. Gestures : Gestures are the movements of the parts of the body to direct attention, to express emotion, to emphasize importance or to indicate shape, sizes and movements etc. Gestures are usually made with the help of the movements of eye hand, head, body, facial expression, like extending the hands in a typical shape to point out his big or small an object is .

3. Change in speech pattern : To express emotions or feelings or to put stress on a particular point, the teacher can make sudden or radical change in tone, pitch or speed of the verbal presentation. The teacher should speak with correct pronunciation. Bombastic and ambiguous words should be able to change his speech pattern at proper points and in appropriate situations. Through this change in the voice, the lesson becomes interesting and the students remain attentive.

4. Focussing : Focussing refers to teacher's behaviour that focus or direct pupils' attention on a particular object, word, idea, rule or generalisation. The focussing can be obtained through verbal statements (verbal focussing), or gestures or movements (gestures focussing), and both verbal statements and gestures (verbal and gestural focussing).

5. Change in interaction styles : The communication process going inside the classroom is termed as interaction. A good teacher of science should change the interaction style after short intervals. In the class-room situation three styles of interaction are possible:

(i) Teacher class interaction : In this type of interaction, the teacher communicates to the whole class and whole or part of the class responds. The teacher may ask a question to the whole class and elicit responses to the same question from many pupils.

(ii) Teacher-pupil interaction : This type of interaction takes place when the teacher directs a statement or question to individual pupil. The teacher may ask an individual pupil a question, receive an answer, and follow it up with a series of questions, to the same pupil, when he wishes to probe into the issue more deeply.

(iii) Pupil-pupil : When the teacher puts a question and a discussion for answer takes place among pupils, then pupil-pupil interaction goes on in the class. The teacher can involve many pupils in a dialogue by putting up a question and without commenting to redirect the question to another pupil.

6. Pausing : Pausing refers to the behaviour related with introducing silence during task. It is used to divert the attention of the pupils. It is also used

to provide time to the pupils for assimilation of ideas and concepts. A pause of approximately three seconds is considered as quite effective in securing and sustaining pupil' attention,

7. Aural-visual switching : This behaviour refers to the introduction of the change or variation in the use of medium. The following three types of devices are applied to maintain the level of attention and motivation.

(i) Oral-visual switching : When the joins of attention is changed from verbal stimulus to visual stimulus, for example, when the teacher shows a model or a chart while speaking, the switching of sensory focus is from oral to visual. If the teacher shifts again to lecturing, then the switching is believed to be be from visual to oral.

(ii) Oral to oral-visual switching : When the shift is from verbal stimulus to verbal and visual stimulus and vice-versa. If the teacher while lecturing displays a model or a chart and expounds its various parts, this sort of switching is an example of oral to oral-visual switching.

(iii) Visual to oral-visual switching : Here the shift is from visual stimulus to verbal and visual stimulus and vice versa. When a teacher demonstrates an experiment silently and then expounds the phenomena with the assistance of a diagram or the chalk-board, this sort of change is from visual to oral-visual.

8. Physical involvement of the students : It refers to the change or variation in the types, forms and styles of the physical involvement in the types, forms and styles of the physical involvement of the pupils, sometimes they may be engaged in handling apparatus or aid material and other times in writing on the chalk-board, participating in the demonstration etc.

Observation schedule - cum-rating scale for the Skill of Stimulus Variation.

Name of the student teacher : _____
Subject : _____ **Concept :** _____
Class : _____ **Session :** _____
Date : _____ **Supervisor :** _____

Tallies (Frequenecy of occurrence of the component behaviour)	Components	Ratings (Perfor-mance in terms of respective extremely weak excellent)
	1. Movements	0 1 2 3 4 5 6
	2. Gestures	0 1 2 3 4 5 6
	3. Change in speech pattern	0 1 2 3 4 5 6
	4. Focusing	0 1 2 3 4 5 6
	5. Change in interaction styles	0 1 2 3 4 5 6
	6. Aural-visual switching	0 1 2 3 4 5 6
	7. Pausing	0 1 2 3 4 5 6
	8. Physical involvement of the pupils	0 1 2 3 4 5 6

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EXAM NOTES

PEDAGOGY OF BIOLOGICAL SCIENCE

[Paper–4 & 5 (Group–C, Opt.–i)]

UNIT–IV

- *Concept of measurement and evaluation*
- *Types of evaluation: Formative, Summative, Diagnostic*
- *Preparation of an objective type and achievement test, Attributes of a good Achievement Test*
- *Different types of Grading*
- *Continuous and Comprehensive Evaluation*

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4

Concept of Measurement and Evaluation

4.1 CONCEPT OF MEASUREMENT AND EVALUATION

1. Explain the concept of Measurement. How is it different from Evaluation? Explain it with examples.

Ans. Evaluation is the overall assessment of educational outcomes brought about as a result of teaching learning process. Therefore evaluation in life sciences will mean that it is the assessment of social learning outcomes brought about as a result of teaching this subject.

Evaluation is a relatively new term in the field of education that has been introduced to replace their terms like testing, measurement or examination. The old concept of testing and examination is very much confined or restricted in terms of objectives, scope and methodology etc. A glimpse of the following definitions will reveal the meaning and nature of the term evaluation.

1. Carter V. Good, "Evaluation is the process of ascertaining or judging the value or account of something by use of a standard of appraisal."

2. Wrightstone, "Evaluation is relatively new technical terms introduced to designate a more comprehensive concept of measurement that is applied in conventional tests and examination ..... the emphasis is upon broad personality changes and major objectives of educational programme. These include not only subject matter achievements but also attitudes, interests, ideas, way of thinking, work habits and personal and social adaptability."

3. Torgerson and Adams, "To evaluate is to ascertain the value of a process or a thing. Thus educational evaluation is the passing of judgement on the degree of worthwhileness of a teaching process or learning experience."

Measurement : Measurement is a one step ahead to the process of testing. When the work of testing ends, measurement comes to the scene for assigning numerical values to the test results. Although, the process of measurement does not necessarily rest on tests and testing. It is quite a broader concept. Let us make the meaning of the term measurement more clear with the help of following definitions.

1. **Carter V Good**, "Measurement may be understood and the comparison of a quantity with an appropriate scale for the purpose of determining the numerical value on the scale that corresponds to the quantity to be measured. "

2. **Remmers, Caze** and **Rummel**, "Measurement refers to observations that can be expressed quantitatively and answers the question "have much".

3. **Mahesh Bhargava**, "Measurement is the process of assigning symbols or numerals to observations, objective or events in some meaningful or consistent manner as per the rule."

The analysis of above definitions may clearly show that measurement is nothing but a process of quantification. We endeavour to assign numeral values or express the results of our observations or testing in a quantitative term through the process of measurement as precisely and objectively as possible.

Difference between Evaluation and Measurement

S.No.	Evaluation	Measurement
1.	It is the process of making value judgement about the quality of performance.	It is the process of assigning numbers as per specified rules.
2.	It is based on records, rating scale, observation, check tests etc.	It is a technique to do tests, observation and written tests.
3.	Statements regarding future of an individual can be made.	Statements regarding future scopes cannot be made.
4.	Its aim is to bring desirable change in the behaviour of an individual.	Its aim is to major only.
5.	It is a wider term and a continued process.	It is used to test a particular ability of the student.
6.	It is a comprehensive measurement.	It concentrates on one aspect at a time.
7.	Many evaluation devices like written tests, oral tests, practical exam, questionnaire etc are used.	Generally written tests, oral tests, achievement tests etc. are brought in use.
8.	It is a relatively new and latest concept of testing the students.	It is an old concept of testing the students.
9.	Here emphasis is on broad personality changes and major objectives of an educational programme.	Here emphasis is on subject matter achievement or specific skills and abilities.
10.	It evaluates in terms of interests, abilities and capabilities.	It measures in terms of number.

Rightstone has rightly said, "*Evaluation is a new technical term used to design a more comprehensive concept to measurement*".

Clara M. Brown opined, "*Evaluation is essential in the never ending cycle of formulating goals, measuring progress towards them and determining the new goals which emerge as a result of new warning. Evaluation involves measurement which means objective, quantitative evidence. But 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.*"

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4.2 TYPES OF EVALUATION : FORMATIVE SUMMATIVE, DIAGNOSTIC

Formative Evaluation

2. Give an account of Formative Evaluation.

Or

Explain the Formative Evaluation in detail.

Or

Discuss in brief Formative Evaluation.

Or

What is Formative Evaluation ? State the characteristics, principles and uses of Formative Evaluation.

Or

Write a note on Formative Evaluation. **(C.R.S.U. 2018)**

Ans. Formative Evaluation is defined as a technique of evaluation which is conducted to monitor the instructional process and to determine whether learning is occurring as desired. Formative Evaluation takes place during the formative years of the students. It implies evaluation of pupils during instruction. It takes into account smaller and independent units of the curriculum. The formative evaluation may be carried out both in formal (like checklists, quizzes, question-answers, assignments and tests) as well as informal (such as observations, listening to students comments and conversations) way. The essential characteristics of such evaluation may be briefly summarized as below :

1. In formative evaluation a particular unit of learning is selected.
2. Learning outcomes or behaviours of the pupils are determined in relation to each new element of the content.
3. It is administered during the lesson taught or instruction imparted.
4. It is beneficial to the extent it remains informative, closely related to the things being taught, timely and frequently.
5. Feedback to students provides reinforcement of successful learning and identifies the specific learning errors that need correction.

6. Feedback to the teacher provides information for prescribing individual and group remedial work.

General Principles of Formative Evaluation :

1. It should include all the significant elements in a unit.
2. It should include items at each of the behavioural levels specified.
3. Test items may proceed from lower level to higher level.
4. Each item should hint at student's mastery of the unit element.
5. The test should reveal to the students the errors they have committed.
6. Remedial instructions should be imparted in the form of text-books, work-books, programmed instruction and films.

Uses of Formative Evaluation : Formative evaluation is of great value for both students and teachers.

(a) Uses of Formative Evaluation for Students :

(i) Learning the Subject-Matter : Formative evaluation can prove helpful to the student in his learning of the subject-matter and behaviours for each unit of learning. According to **Bloom**, "It is largely possible to have the large majority of students attain mastery of the subject, if instruction is appropriately individualised."

(ii) Mastery of Learning : Formative Evaluation can be of utmost help in effective pacing or mastery of student learning. If the subject-matter is arranged in a sequence, it may become essential for the student to master the units.

(iii) Goal for Learning : Formative evaluation can set goals for student learning. Even the time for schedule for each unit can be decided.

(iv) Sequence of Learning : Formative evaluation can be helpful to the students by dividing the entire learning sequence into smaller units. When a particular unit is being learnt, a thorough preparation should be done.

(v) Effective Reinforcement : The results of the formative evaluation can be an effective reinforcement or reward for students who have gained mastery or a near mastery over a unit of learning. The repeated evidence of mastery is a powerful reinforcement.

(vi) Diagnostic Value : Formative evaluation has diagnostic value. By locating the problems of the students appropriate remedial measures can be suggested for removing the difficulties.

(b) Uses of Formative Evaluation for Teachers :

(i) Locating Errors : Formative evaluation is helpful for the teachers in locating errors of the students. The teacher can use a different approach to explain difficult items.

(ii) Quality Control : Formative evaluation may also be used for quality control purposes. If the course is similar in content and objectives, the teacher may compare the performance of the present class with that of the previous class.

Bloom and his associates emphasize emphasis the fact that formative tests can be of great importance in helping the teacher as well as the students to determine the quality of learning that is bound to take place.

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SUMMATIVE EVALUATION

3. Give an account of Summative Evaluation.

Or

Discuss in brief Summative Evaluation.

Or

What is Summative Evaluation ? State the characteristics. Mention the steps for test construction in Summative Evaluation. What are the uses of Summative Evaluation?

Or

Write a note on Summative Evaluation. **(C.R.S.U. 2018)**

Ans. Summative Evaluation is defined as a technique of evaluation which is conducted at the end of an instructional segment to determine if learning is complete enough to move the learner to the next segment of instructions. From summative evaluation, the general level of student is judged and on the basis of student's performance, the effectiveness of teaching and instruction is evaluated. In this way, it provides reinforcement to teacher and helps in planning and organising of further teaching.

Characteristics of Summative Evaluation :

1. It summarizes the ultimate progress of the students as a result of a course of learning unit or lesson.
2. It is terminal and judgemental in character.
3. It is usually carried out at the end of a unit or course of instruction.
4. It is designed to determine the extent to which the instructional objectives have been achieved by the pupils.
5. The level of generalisation sought by the items in the examination used to collect data for the evaluation is an important characteristic of summative evaluation.

In the words of **Bloom and others**, "Perhaps the essential characteristic of summative evaluation is that a judgement is made about the student, teacher or curriculum with regard to the effectiveness of learning or instruction, after the learning or instruction has taken place."

Types of Summative Evaluation

1. Intermediate summative evaluation : It is linked with more direct, less generalised and less tranferable outcomes.

2. Long-term summative evaluation : It infers the extent to which a pupil has realised the entire range of outcomes contained in the model to which this evaluation is related.

Both the types of Summative Evaluation have their own significance. In the words of Prof. **Bloom and his associates**, "Both intermediate and long-term range summative evaluation are significant and should not be minimised.

However, if evaluation is to aid both the teaching and learning process, it must take place only at the termination of these processes but while they are still fluid and susceptible to modification."

Summative Evaluation Test Construction

The following are the steps for test construction in summative evaluation :

1. Develop or adopt table of specifications : The teacher should develop or adopt a table of specifications for the subject area.

2. Develop test items : The teacher should endeavour to develop or adopt the relevant test items.

3. Choose test items : Test items should be chosen for the different cells by sampling in rational manner.

4. Assemble test items : Test items should be assembled as per some systematic plan for easy to difficult. Various types of items such as matching, multiple choice and true-false should be grouped by types.

5. Scoring scheme : Appropriate scoring scheme should be adopted.

Uses of Summative Evaluation

The following are the uses of summative evaluation :

1. Basis of assigning grades : Summative evaluation serves as basis for assigning grades either by numbers or by letters. Grading assists in classifying pupils in terms of level of learning.

2. Basis of certification : Summative evaluation is helpful in certification of abilities and skills of pupils especially in technical training in secondary schools.

3. Predicting success : Summative evaluation assists in predicting success in a subsequent related course. It serves as the basis of providing education as well as vocational guidance to the pupils.

4. Beginning of instruction : Summative evaluation assists in knowing the level of achievement at a particular point of test. It assists in deciding the initiation point of instruction in the subsequent course.

5. Knowledge of progress : Summative evaluation helps the pupils in knowing their progress. It assists them in knowing and making up their deficiencies. In this way, it provides useful feedback to the pupils.

6. Comparison of groups : Summative evaluation helps in making comparisons of outcomes of various groups of pupils taught by various teachers.

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4. Differentiate between Formative and Summative evaluation. Is there need to study such type of content to students in Physical Sciences.

Or

Differentiate between 'Formative' and 'Summative' Evaluation.

Ans.

	Formative Evaluation	Summative Evaluation
1.	Formative evaluation takes place during the formative years of the students.	Summative evaluation takes place at the end of the term, course or programme.
2.	It implies evaluation of pupils during instruction.	It judges the general level of students.
3.	It provides information to the teacher for improving instruction and for prescribing individual and group remedial work.	It provides reinforcement to teacher and helps in planning and organising of further teaching.
4.	It is useful for the improvement of curriculum, teaching and learning.	It is designed to determine the extent to which the instructional objectives have been achieved by the pupils.
5.	In formative evaluation a particular unit of learning is selected.	It is terminal and judg-emental in character.
6.	Here the difficulties of student's learning are important.	Here the effectiveness of teaching is measured.
7.	It helps in the modification of instructional strategies.	It helps in certification of abilities and skills of pupils.
8.	Here more emphasis is on the achievement of objectives.	It depends on formative evaluation for its betterment.

Need to study Formative Evaluation and Summative Evaluation

There is a great need to study Formative Evaluation and Summative Evaluaion for the students of Physical Sciences. Both formative and summative evaluation are complementary to each other. In formative evaluation the difficulties of students learning are significant while in summative evaluation, the effectiveness of teaching is measured. Formative evaluation helps in improving the summative evaluation. Summative evaluation depends on formative evaluation for its betterment.

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DIAGNOSTIC EVALUATION

5. Discuss in brief Diagnostic Evaluation.

Or

Write a note on Diagnostic Evaluation.

Or

What is diagnostic test? How diagnostic evaluation can be done? Explain.

Ans. Diagnosis means a careful study of the conditions of learning to determine its nature and find out about the causation of problem, with the main purpose of correcting and remedying the difficulty involved in active remembering. Diagnostic tests are used to find out the difficulties of the pupils with a view to provide specific remedial measures to them.

A diagnostic test is one kind of educational tests. The educational tests have two functions or purposes.

1. Prognostic purpose — Attainment tests
2. Diagnostic purpose — Diagnostic tests

Prognosis means to measure the extent and level of learning outcomes or attainment of the students in a specific subject which has been taught to them. Diagnostic means to identify the causes of weakness and the poor attainment of the students. The prognostic and diagnostic functions are complementary to each other and both are essential in educational measurement and evaluation.

Meaning of Educational Diagnosis : The term diagnosis has been borrowed from the medical profession where it implies "identification of diseases by means of patient's symptoms". The word diagnosis is used in more or less in the same sense in education. Here the word 'diagnosis' implies to analyse the various difficulties faced by a student in a particular field of study or work. It not only tells and gives details about what children lack but it goes for remedial measures.

Anastasi is of the view that diagnostic tests are generally designed to analyse the individual's particular strengths and weaknesses within a subject-matter and to suggest causes for his or her difficulties. In a diagnostic test the main interest is in the performance on individual items or on small groups of highly similar items. In a diagnostic test, score or mark is not assigned for the correct answer but wrong answer provides the basis for the causes of his failure.

Diagnostic tests are also known as analytical tests. The correct answer gives the strength and wrong answer points out the weakness in the content of the subject. The term diagnostic as applied to tests is one fraught with danger and ambiguity. The educationists consider certain test as diagnostic while others are achievement tests which have no diagnostic characteristics. A diagnostic test does not yield the total scores of an individual in a subject which he has studied and taken the test.

Experts view :

Anne Anastasi — Diagnostic tests measure the individual's capacity or potentiality for learning a subject. But such a term deserves to be used with caution with regard to psychological tests.

Thorndike and Hagen : Diagnostic testing is not ordinarily based on immediate past instructions. It grows from readiness tests — ideally, the

diagnostic test contain a cross-section of test items that reflect the various aspects of achievement which the student should possess. His inability to answer a test item or a small group of selected test items, reveals his deficiency and allows diagnosis to be made.

Steps in Diagnosis : There are four steps in the diagnostic process :

1. The overall screening process : This is the level of survey diagnosis and consists chiefly of classroom screening.

2. Diagnostic testing : This is the level of specific diagnosis of the problem. It is identified with individual diagnosis.

3. Detailed investigation of the causes : The third step is the level of intensive diagnosis. It is associated with identifying the underlying causes of the disability — making analysis of the disability.

4. Remediation : Finally, the teacher draws up a programme of remediation Diagnosis is complete only when remediation takes place.

Uses of Diagnostic Tests :

1. Diagnostic tests are used as an inventory to find out how much the student knows about a particular phase of the subject-matter.
2. These tests are used to discover and analyse the difficulties of the students to provide specific remedial measures in order to remove their difficulties.
3. These tests are useful for providing appropriate remedial instructions to the individual students according to their need.
4. These tests provide us reliable data about the abilities, interests as well as the difficulties experienced by the students.
5. These tests are chiefly used for discovering faults, difficulties, handicaps and weaknesses of the students.

Types of Diagnostic Tests :

There are two categories or types of diagnostic tests :

1. Educational diagnostic tests : There are various types of educational diagnostic tests concerned with different subjects for specific class, grade or level.

2. Classical diagnostic tests : There are various types of clinical diagnostic tests concerned with vision, hearing and other aspects.

Blair and Jones rightly remarked, "Diagnostic evaluation (testing) is a good method of teaching which allows the student to progress according to his mental standard. It uses the internal methods of stimulation to take him to the higher level of capacity. It is based on the careful remedy of difficulties and according to the interests and needs of students."

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4.3 PREPARATION OF AN OBJECTIVE TYPE AND ACHIEVEMENT TEST, ATTRIBUTES OF A GOOD ACHIEVEMENT TEST

6. What are achievement tests? What steps are to be followed for the construction of a teacher made achievement test in life sciences? Discuss.

Or

Explain the procedure of construction of an objective type achievement test.

Ans. Achievement tests are employed for measuring the amount of success or achievement of individual in a specific field or area of accomplishment. In schools an achievement test is employed as a tool for measuring the nature and extent of students' learning in a particular subject or may be in a group of subjects. What amount a particular student has been able to learn and acquire or has been benefited from the learning experiences provided to him is ascertained with the help of these tests. Thus, achievement tests are essentially past-oriented. Achievement tests present evidences of what has been learnt or acquired by an individual by testing his present ability. An achievement test can be defined in the following words.

An achievement test is essentially a tool or device of measurement that helps in ascertaining quantity and quality of learning attained in a subject of study or group of subjects after a period of instruction by measuring the present capacity of the individual concerned.

Construction of an achievement test

Construction of an achievement test is not an easy job for a teacher. There is a need of adequate planning to be done before hand. The following steps will help in accomplishing this work properly.

1. Setting objectives. The first and the most significant step is to make clear one self about the objectives for which one wishes to frame the test. In all condition the objectives of the test should be appropriately decided and defined in terms of specific behaviour changes desired in the pupils.

2. Coverage of the contents . The contents which have to be covered in the test are directly reliant upon what has been taught by the teacher. It is expected from the teacher to keep an outline of the learning experiences provided by him, care should be taken that no major unit or sub-topic of what has been taught should be testout. It is not desired or necessary at all to ask from each and everything discussed by the teacher in the classroom.

3. Decision about the types of questions : Decision about the types of questions to be set in the test paper is also a major aspect of its construction. As indicated previously, all the three forms. Essay type, short answer type and objective type should get due place in a good achievement test.

4. Decision about the time : The total time allotted to the students for giving responses to the test items should also be realised

5. Preparation of the blue-print : This is the most important step in the planning of the test. Blue print is a kind of the design for the test paper in which we depict a detailed question wise distribution of marks over specific objectives, topics and forms of questions. Thus, all the factors mentioned in the above four steps should be remembered or taken into account while the blue print of the test is prepared.

6. Organising and arranging the items or questions. The questions to be included in the test need proper organisation and arrangement. The following points may be of great assistance in the regard.

(i) Each section should have separate instructions common to both the section.

(ii) Items should be arranged in order of difficulty from easy to more difficult.

7. Writing items and finding their difficulty value. After planning everything, the teacher may start writing items or questions. As a rule the test paper as a whole should neither be too stiff nor too easy. The analysis of the test results depicting the percentage of students. Passing each item can enable him to obtain a numerical index of the difficulty of the items. The higher the percentage passing, the easier the item will be.

8. Preparation of a scoring key. To ensure objectivity in scoring it is to have a pre-determined way of scoring. In essay and short answer type questions the answer and procedure for scoring should be pre-determined.

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7. Explain the attributes of a good test.

Or

Describe various attributes of good achievement test. **(C.B.L.U. 2018)**

Ans. A classroom witnesses teaching-learning process whereby the students learn and the teacher teaches. But the parents are interested only in the end result. Thus the measurement of the products of education is called the achievement test. It is a type of test of learning ability.

The achievement test brings into light the following aspects :

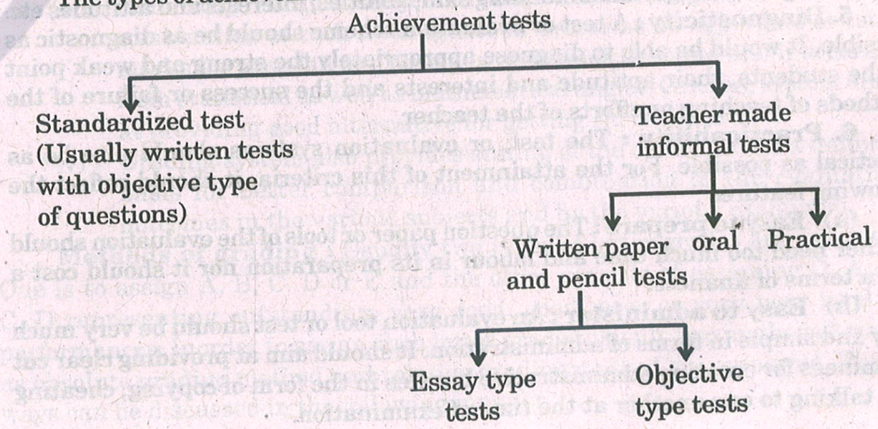
1. Efficiency of the teacher and the student.
2. Speed and capacity of learning by the students.
3. Grasping and retention ability of the students.
4. Success or failure of the teaching methods used by the teacher.
5. Area where teacher can improvise.

An achievement test can be defined in the following words:

An achievement test is essentially a tool or device of measurement that assists in ascertaining quantity and quality of learning attained in a subject of study or group of subjects after a period of instruction by measuring the present ability of the individual concerned.

Types of achievement tests

The types of achievement tests can be represented in the following manner.



Attributes of a good achievement test

The question may arise what sort of achievement test may be thought good or ideal for serving its desired purposes of testing or evaluation. In this regard the essential criteria or attributes for taking decision about the goodness of an achievement test may be laid down as below.

1. Validity : A good test always reflects its validity. A test is thought to be valid when it measures what it requires to measure. Validity in this regard stands for the accuracy of the working or behaviour of a device. The extent to which a testing device is believed to be accurate or perfect judging or testing a thing is generally referred to its validity. In this regard a test meant for assessing or evaluation the extent of the realization of the objectives of science teaching must be confined to this purpose only. If it tries to assess or measure the linguistic ability or general knowledge of the learners, it can't be treated valid or true in connection with its aims and purposes.

2. Reliability : A good test is always known for its reliability. A test is considered reliable when it tends to put the same results even after its repetition at number of times. A test is thought to be reliable to the extent to which it can remain consistent in terms of its functioning or performance for the assessment or measurement of the learning outcomes of the examinees.

3. Objectivity : A test or evaluation system must be very much objective. It is considered to be objective when it is not affected at all through the personal opinion, improvisions, biases, interests and attitudes of both the examinee and the examiners. In a test if the questions are given in such a way that the examiners give various answers or may pick up various methods to provide the solution which suits their own interests, opinions and attitudes, the test is thought to be objective. Besides this, in such a test the scoring is done by the examiners. It may also reflect quite subjectivity. All this depends upon their own opinions, interests, prejudices and attitudes. Contrary to this, is the responses to the test items by the examinees or scoring by the examiners do not get affected through their subjectivity, the test or evaluation system may be safely termed as objective.

4. Comprehensiveness : A test or evaluation system must be as comprehensive as possible. Comprehensiveness of the test reasons or relates to its length and extensiveness for covering the entire course or learning experiences to be tested. It should be competent enough to test all the stipulated objectives considering knowledge, understanding skill, abilities, interests and attitudes etc.

5. Diagnosticity : A test or evaluation scheme should be as diagnostic as possible. It would be able to diagnose appropriately the strong and weak point of the students, their aptitude and interests and the success or failure of the methods of teaching or efforts of the teacher.

6. Practicability : The test, or evaluation systems should also be as practical as possible. For the attainment of this criteria, it should reflect the following features :

(a) Easy to prepare : The question paper or tools of the evaluation should neither need too much time and labour in its preparation nor it should cost a lot in terms of finances.

(b) Easy to administer : An evaluation tool or test should be very much easy and simple in terms of administration. It should aim at providing clear cut examinees for creating administrative hurdles in the form of copying, cheating and talking to one another at the time of examination.

(c) Easy in Scoring : The evaluation tool or question paper should be set in such a manner that the responses of the examinees are easy in scoring as well as objective. It should demand less time and less energy on the part of the examiners.

7. Proper Gradation : The items of the evaluation tool or questions of the paper are appropriately graded in order of increasing difficulty which is suitable to the age, experience, ability and intelligence of the students.

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4.4 DIFFERENT TYPES OF GRADING

8. Grading is important part to assess the personality of children. How is it needful in different ways? Explain the nature and scope.

Or

Explain how grading is done in educational evaluation.

Or

Explain the different types of grading.

Ans. Grading system calls for providing letter grades to the students for their educational achievements rather than declaring them passed or failed or assigning numerical marks on a 100 point scale. It is preferred to the old system of percentage marking due to the following reasons.

(i) It is simple to assign grading instead of the exact numerical marking involving no biases and subjectivity.

(ii) Examiners do differ in their marking due to the subjectivity and standard of their marking. Grading Lessens the subjectivity and unreliability on the part of the examiners.

(iii) In the old system, one can see a provision of pass-fail or assigning divisions for a certain percentage of marks obtained by the students. Grading makes it more broad or wider by providing more graded categories. Grading system removes the old system of bunching the marks at the end for declaring pass or assigning particular divisions.

(iv) Generally various subjects have various ranging marks, and combination of such heterogeneous scores as an aggregate or total marks for pass-fail or division is very much unsound and inaccurate from statistical as well as mathematical angles. Grading system aims at providing good alternative for getting rid of this defect.

(v) Grading system also provides scaling of the evaluated on a uniform basis for better comparison and combination of the evaluation outcomes in the various subjects and by the various examiners.

Methods of grading : Usually two types of letter grades are assigned. One is to assign A, B, C, D or E and the other consists of assigning O, A, B, C, D representing outstanding, very good, good, poor or very poor level of performances. Inorder to assign such letter grades usually two methods known as absolute grading method and relative grading method are employed. These ways can be discussed in the following manner.

Absolute grading Method : In such grading method a pre-determined level or standard is fixed for assigning letter grades. It can be done in the following tow ways.

(i) A pre-established percentage scores required for a given grade is fixed. It can also be said that we fix different ranges of percentage marks for assigning them grade letters such as mentioned below :

Grade	Scores percentage
O	80% and above
A	70 - 79%
B	60 - 69%
C	50 - 59%
D	less than 50%

(ii) Another type of the absolute grading is known as criterion-referenced grading. In this case the criterion performance standard is fixed by the teacher or authorities in advance in the light of the difficulty level of the test and the standard or quality of learning performance required from the learners. The performance level and letter grades can be represented as below :

Grade Performance Level. (In relation to the achievement of pre-determined objectives).

Grade	Scores percentage
O	Outstanding (Excellent)
A	Above average (very good)
B	Average (Good)
C	Below average (poor)
D	Inadequate (very poor)

Relative grading method : In this method grades are provided on the basis of the comparative or relative positions (ranks) of the students in their class/ grade. In general practice, relative grading follow the 'normal curve' distribution for the allocation of grades. The assumption is that usually, the distribution of marks over a population of students follows the distribution pattern of a normal curve. The area under the normal curve may be statistically divided into equal segments. This helps us to mark the percentage of cases failing in each segment. Further may help us to take the decision like below.

Grade	Percentage of cases for being assigned the given grade
O	Top 7% of a class or group.
A	Top middle 24% of a class or group
B	Middle 38% of a class or group
C	Bottom middle 24% of a class or group
D	Bottom 7% of a class or group.

The decision about the top 7%, the next 24%, middle 38% and so on may be taken on the basis of numeral scores earned or performance level depicted by the students on any evaluation measure. Afterworks the students real numbers may then be arranged in descending order on the basis of their numerical scores or performances ratings. Top 7% are assigned grade O, coming 24% grade A, another next 38% grade B and so on.

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4.5 CONTINUOUS AND COMPREHENSIVE EVALUATION

9. "Evaluation is comprehensive and continuous". Discuss the statement in view of the inter-relationship between objective, learning experience and evaluation.

Ans. Evaluation as a comprehensive and continuous process.

Comprehensive Evaluation : Comprehensiveness of evaluation can be explained through the following task :

(i) Comprehensiveness in the form of objective and purposes : Evaluation is more comprehensive than examination, measurement and testing on the basis of achievements of objectives and motives. The parents of student, teachers, administrative category, student, syllabus and paper setters etc. all need the results of the evaluation. Thus, the result of evaluation guides all those who are associated with teaching-learning. Similarly the result of evaluation not only determines the objective, their organisation and management appropritely. Thus, evaluation provides the process of educational arrangement and appropriate endorsement to the exchangeable aspects, as a result of which evaluation plays a comprehensive role in providing them the desired shape.

(ii) Comprehensiveness in terms of tools and techniques : The means and techniques adopted for evaluation of testing, measurement and examination are very detailed and comprehensive. In the checking process of evaluation, qualitative explanation such as interview, personal, rating scale etc. are used in addition to maintain explanation of same thing. Thus, on the basis of techniques and means of evaluation it may be said more comprehensive in comparison to examination, measurement and testing.

(iii) Comprehensiveness in the term of output : The result achieved in evaluation process are more comprehensive and detailed than that of examination, measurement and testing. This fact can be proved through the following points :

(a) The result of evaluation provides us the details and decision about achievement, the appropriateness and meaninglessness of the result besides their quantitative distribution.

(b) Each aspect of personality of the students and behavioural changes in all respects and their development can be evaluated through its results, which is not possible by measurement, testing and examinations.

(c) Comprehensiveness of evaluation can be found out as it not only search the weaknesses of the student but suggests remedies as well. Besides it tells about the appropriateness of teaching-learning denotes about the experiences, syllabus, methods, techniques, material etc.

(d) In teaching-learning the teacher keeps in mind the participation of the students and makes them aware of the extent to which the process became successful.

Continuous evaluation : Evaluation is a continuous process besides being comprehensive and detailed.

The following points prove the continuity of this process :

(i) There is no time limit for evaluation. There is no definite time when after which how long the evaluation should be done such as examination and tests are conducted daily, weekly, fortnightly, monthly, half-yearly or yearly. But there is no time bond for evaluation process. Thus, it is continuous process.

(ii) Behavioural changes take place in the student due to teaching-learning process. It can't be said exactly when they will take place or what means of learning experiences will be required for this purpose.

Thus, the checks and the behaviour of student and their value determination should be continued uninterruptedly. Student should be encouraged to the same direction where their behavioural changes take place. This target can only be achieved as if they are told time to time that they are going in the right direction and on the path of learning. Such self-approval is considered necessary for the success of teaching-learning. Thus, it is necessary for evaluation process to go on continuously.

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10. What is the need and importance of comprehensive and continuous evaluation? Name various objective type tests by giving one example of each.

Or

Discuss in detail evaluation as a continuous and comprehen-sive process.

Or

Write the merits and demerits of comprehensive and continuous evaluation.

Ans. Evaluation is continuous and comprehensive. When we have it fully internal without the help of the external agencies, it is known as internal evaluation. Continuous and comprehensive internal evaluation is different from internal assessment. Internal assessment is just a part of external examination. Continuous comprehensive internal evaluation seems to be the panacea of all the ills which are being faced through the process of tradtional examinations. It is high time that we endeavour to make evaluation an integral part of the total teaching-learning process. The main objective of continuous and comprehensive evaluation is to test the over all personality of the child in all fields of life. All kinds of achievements of the students are evaluated continuously for the entire session.

Since the beginning of formal education, examinations and evaluations have been its inseparable parts. Some intellectuals do not favour it because during the days of examinations, students become weak. They tend to prepare only the selected questions, memorize the subject till midnight, and even then do not succeed. They try to resort to copying, tend to influence the invigilators. But this cannot be said the fault of examination or evaluation but the system.

According to **W.H. Ryburn, "It goes without saying that the examinations are the enemies of creative work at least as they are usually conducted."**

According to **Clara Brown, "Evaluation is essential in the never ending cycle of formulating goals, measuring progress towards them and determining new goals which emerge as a result of new challenges. Evaluation involves measurement which means objective qualitative evidence."**

Importance and Advantages of Comprehensive and Continuous evaluation :

1. Ascertains the progress of the students : Evaluation is an index of student's achievement. It makes us aware how much progress has been made by a student during a specific period of time and of what quality. It makes the teacher realise whether he is progressing in the right direction or not, whether the desired changes are taking place among the students or not.

2. Diagnosis of the weaknesses of the students : It is the duty of the teacher to guide the students. But unless he does not know the weaknesses of the students he is not able to guide them. The students must be fully aware of their weaknesses in day-to-day work. Those who are aware of their weaknesses feel shy of telling them to their teachers. Evaluation makes the students well-aware of their weaknesses.

3. Inspires and motivatives students : Tests motivate the students. Normally students do not wish to study. But soon as the test approaches, they start studying. If there are no tests, students won't be taking interest in studies. The subjects in which the tests are not held or the subjects in which it is not obligatory to pass, students do not take those subjects seriously.

4. Gradation of the students : Evaluation helps in grading the students into different levels or categories which student is apt for what level, is decided through evaluation. There are tests at the end of each academic session and student's achievements are evaluated.

5. Gives indication about the interests of the students : Evaluation indicates the interests of students in particular subjects. It is only on this basis that a decision can be made about the future vocation of a student. At present emphasis is being given on educational and vocational guidance. For this puirpose, various intelligence, aptitude, interest and achievement tests are provided. All these are different methods of testing.

6. Helps in providing individual attention : There are individual differences among the students. This reveals that all the students do not learn in the similar manner. It is because some students are bright, some average and some are slow learners. They should be provided a chance to learn at their own speed. The level of the students is decided through evaluation.

7. Helps in attaining the aims : Education is never aimless. The main aim of education is to develop the all round personality of the students. In addition to this, every subject has certain objectives. Through evaluation the teacher realises, how far his teaching has been successful in attaining these objectives.

8. Helps in improving instruction : The teacher makes use of several teaching methods and aids in his teaching. Evaluation brings out the weaknesses of curriculum and syllabus on the basis of which these can be reformed and improved.

Conclusion : Evaluation is an integral part of education because it judges and diagnoses the entire education system, its strength and weaknesses, the achievements of the students and also the performance of teachers.

Aims of Continuous and Comprehensive evaluation : The following are the aims of continuous and comprehensive evaluation :

1. To ensure the all round development of personality of the child.
2. To bring about an improvement in the teaching-learning process.
3. To give feedback to the teacher so that he knows his shortcomings in teaching.
4. To assess the child in the fields in which he cannot be assessed through written mode of examination.
5. To bring about an improvement in the existing examination system. This will help in reducing the fear of the examination.
6. To take care of the students with special requirements in the process of evaluation.
7. To enable the parents in comprehending the needs of their children.

Merits of Continuous and Comprehensive Evaluation :

1. Every teacher is well aware about his students. Whatever may be the subject or area of study, only the teacher teaching in the class-room everyday is able to judge the performance of his students completely and wholly. Assessment made by the teacher will certainly be more soothing and correct.
2. All the students studying for various courses will become regular and punctual. They will endeavour their home assignments and class-work to the entire satisfaction and of all concerned.
3. The problem of indiscipline will be remain subsided.
4. Obedience and proper regard for the teacher will revive. It will result into a very healthy academic and homely environment. Here teachers will have the ability to imbibe good qualities in the students.
5. The non-academic sort of problems will be reduced considerably.
6. It will help the teachers to reinstate all the good things of the past.
7. The job of administrator in educational institutions which is now treated as a big challenge, will become respectable and alluring.
8. Students will give equal importance to games, cultural activities and other curricular activities. Thus, students in the newly created environment will start caring for the total personality.
9. Problems like mass copying in the examination will be automatically solved.

Demerits of Continuous and Comprehensive Evaluation :

1. Shirkers of work in the teaching profession who are out there due to some compulsions of life may not work and the standard in their hands may deteriorate.
2. Evil things like bribery may increase in number and intensity.

Conclusion : Merits and demerits of everything are always there. Putting things correctly in their true spirit depends a lot upon the Head of the institution. If the staff members in the institution work as a team and perform everything in true spirit with honesty, sincerity and hard work, internal evaluation will improve everything from almost every angle.

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