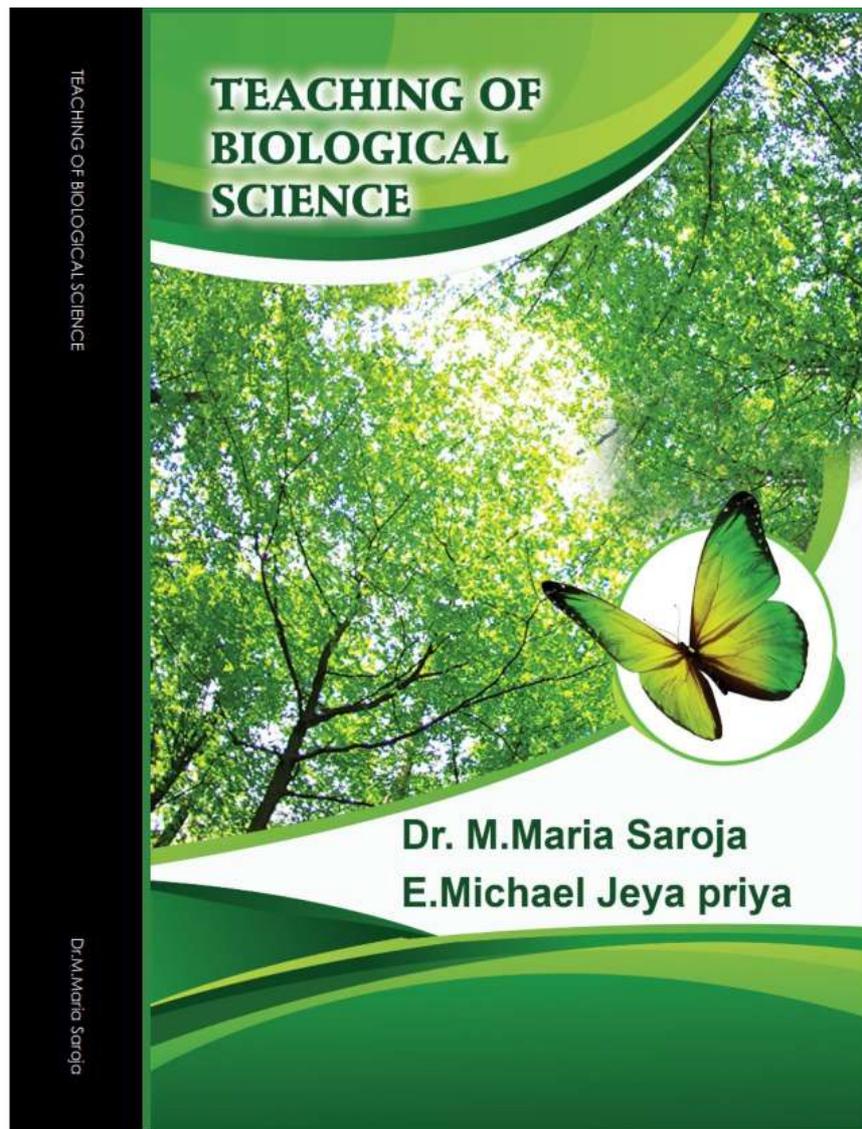


About the Book

This book Teaching of Biological Science primarily designed to fulfill the need of biological science students of B.Ed. Greater care has been taken to ensure that this book provides a complete reference to the examination needs of the students as well as a useful hand book on imparting sound teaching-instruction in biological science. Extensive use of flow charts has been made throughout the book to help the reader to understand the key concepts at a glance.

This book divided into ten parts; efforts have been made towards presenting the book in a simple and effective language. The contents of this book are arranged in a coherent manner. The book enables the student teachers to acquire knowledge of aims and objectives of teaching Biological Science, Science laboratories organization and register maintenance. Safety procedures in a Biology Laboratory, besides mastery over the lesson plan, unit plan. The student-teachers can also understand the curriculum development in science. All attempts have been made to include the latest trends and current educational practices, evaluation, technology in teaching biological science and provision for inclusion.



TEACHING OF BIOLOGICAL SCIENCE

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Rs.500/-

ISBN: 978-93-86785-32-9

First Edition: New Delhi, 2019

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Printed by **ISARA SOLUTIONS**

B-15, Vikas Puri, New Delhi 110018

CONTENTS

Unit-I		
AIMS AND OBJECTIVES		
1.1	Meaning of Biology	1
1.2	Branches of Biology	2
1.3	Importance of Biology	4
1.4	Scope of Biology	6
1.5	Objectives of Teaching Biological Science in School	7
1.6	Aims of Teaching Biological Science	14
1.7	Aim of Teaching Biology at Different Levels	26
1.8	Relationship of Biology with Other Branches of Science	32
1.8.1	Correlation between Biology and other school subjects	34
1.9	Values in Teaching Biological Science	38
1.10	Role of Biology in Human Welfare	44
1.11	The Taxonomy Group	50
1.11.1	Bloom's Taxonomy	51
1.11.2	Anderson & Krathwohl's Revised Blooms Taxonomy (2001)	60
Review Questions		65
Unit-II		
MICRO TEACHING AND MINITEACHING		
2.1	Micro-teaching	66
2.2	Definition of Micro-Teaching	67
2.3	Characteristics of Micro-Teaching	67
2.4	Concept of Micro-Teaching	68
2.5	Micro-Teaching Cycle	68
2.5.1	Definitions of the Steps Involved	70
2.6	Main Assumptions of Micro-Teaching	71

2.7	Underlying Principles of Micro-Teaching	72
2.8	Steps of Micro-Teaching	74
2.9	Rationale of Micro-Teaching Procedure	75
2.10	Phases of Micro-Teaching	76
2.10.1.	Analysis of Teaching	77
2.11	Teaching Skill	78
2.12	Steps of Micro-Teaching technique	79
2.13	Meaning of Various Teaching Skills	80
2.13.1	Micro-Teaching Skill	82
2.13.2	Comparison between Micro teaching and Traditional Teaching	85
2.13.3	Micro teaching skills and their components	86
2.13.4	Skill of Explaining	87
2.13.5	Black Board Writing Skill	88
2.13.6	Stimulus Variation Skill	90
2.13.7	Reinforcement Skill	93
2.13.8	Questioning Skill	95
2.13.9	Skill of Introducing a Lesson or Set of Induction	99
2.13.10	Demonstration Skill	102
2.13.11	Skill of Closure	103
2.14	Mini –Lesson	105
2.14.1	Mini-Teaching skills.	107
2.14.2	Understanding Major Steps in Teaching a Mini-Lesson	111
2.14.3	Practicing a Mini-Lesson with Five Teaching Steps	112
2.15	Link Practice (Integration of Teaching Skills)	117
Review Questions		118
Unit-III PLANNING FOR TEACHING		
3.1	Planning for Teaching	119
3.2	Year plan	120

3.2.1	Characteristics of the Year Plan	121
3.2.2	Principles for the Year Plan	122
3.2.3	Importance of the Year Plan	122
3.2.4	Steps in Making the Year Plan	123
3.2.5	Advantages of a Year Plan	124
3.3	Unit Plan	124
3.3.1	Criteria for a Good Unit	125
3.3.2	Types of Units	126
3.3.3	Content of a Unit Plan	127
3.3.4	Steps in Unit Planning	128
3.3.5	Advantages of Unit Plan	130
3.3.6	Disadvantages of Unit Plan	130
3.4	Lesson Plan	132
3.4.1	Need and Importance of Lesson Plan for Teacher-Education Programme	134
3.4.2	Principles of a Good Lesson Plan	136
3.4.3	Characteristic of an Effective Lesson Plan	136
3.4.4	Requirements for a Planning a Lesson	139
3.4.5	Advantages of Lesson Plan	139
3.4.6	Demerits of Lesson Planning	141
3.4.7	Difference between Unit Plan and Lesson Plan	141
3.5	Approaches to Lesson Planning	142
3.5.1	Herbartian Approach	142
3.5.2.	The Herbartian lesson plan	143
3.5.3	Merits of Herbartian Lesson Planning	146
3.5.4	Demerits of Herbartian Lesson Planning	146
3.6	Bloom's Taxonomy	147
3.6.1	Merits of Bloom's Lesson Planning	150
3.6.2	Demerits of Bloom's Lesson Planning	151
3.7	Steps Involved in a Model Lesson Plan	151
3.7.1	Sample Format of a Lesson Plan	157
	Review Questions	161
Unit-IV		
INSTRUCTIONAL STRATEGIES		
4.1	Instructional Strategies	163

4.1.1	Lecture Method	164
4.1.2	Demonstration or Lecture-Cum-Demonstration Method	169
4.1.3	Biographical Method	177
4.1.4	Historical Method	178
4.1.5	Team Teaching	179
4.2.1	Laboratory Method	187
4.2.2	Heuristic Method	191
4.2.3	Experimental Method	193
4.2.4	Project Method	195
4.2.5	Inductive and Deductive Methods	202
4.2.6	Scientific Method	204
4.2.7	Assignment Method	207
4.2.8	Discussion Method	208
4.2.9	Problem Solving Method	209
4.2.10	Review Method	210
4.2.11	Tutorial Teaching Method	212
4.2.12	Discovery Method	215
4.2.13	Question-Answer Teaching Method	217
4.3	Innovations in Biology Teaching	219
4.3.1	Investigation Technique	220
4.3.2	Enquiry Technique	221
4.3.3	Personalised Instruction	222
4.3.4	Programmed Instruction	224
4.3.5	Types of Programming	229
4.3.6	Computer Assisted Instructions (CAI)	238
4.3.7	Computer Managed Instructions (CMI)	248
4.3.8	Teaching Machine	249
4.3.9	Seminar Presentation	251
4.3.10	Symposium	258
4.3.11	Workshop	259
4.3.12	Panel Discussion	260
4.3.13	Supervised study method	261
4.4	Textbook	262
Review Questions		271
Unit-V		
SCHOOL CURRICULUM		
5.1	Curriculum	272
5.2.1	Meaning of Curriculum	272

5.2.2	Definition	273
5.2.3	Characteristics of Curriculum	274
5.2.4	Curriculum Styles	275
5.2.5	Objectives of the Curriculum	276
5.2.6	Concept of Curriculum	277
5.2.7	Principles of Curriculum Development	277
5.2.8	Achievement of wholesome behavior pattern	279
5.2.9	Types of Curriculum	282
5.2.10	Curriculum Organization	285
5.2.11	Process of Curriculum Development	287
5.2.12	Approaches Involved in Curriculum	289
5.3.1	Defects in the Existing School Science Curriculum	293
5.3.2	Functions of Science Curriculum	294
5.3.3	Defects in the Present Curriculum	295
5.3.3	Drawbacks of Biological Science Curriculum	298
5.3.4	Improvement of Bioscience Curriculum	299
5.3.5	Qualities of a Good Bioscience Curriculum	299
5.3.6	Reforms in the Present Curriculum	300
5.3.7	National Curriculum Framework	302
5.4.1.	Problems in Adapting Curriculum to Local Needs and Resources	305
5.5.1	Curriculum Development in India	312
5.5	National Institute of Education	315
5.5.3	Biological Sciences Curriculum Study (B.S.C.S.)	316
5.5.4	Nuffield Foundation Science Teaching Project	321
5.5.5	National Talent Search Scheme	323
5.6.1	Science Library	328
5.6.2	Importance of School Library	329
5.6.3	The Role of the Library in Schools	329
5.6.4	Objectives of a Science Library	330
5.6.5	Limitations	330

5.6.6	Science Libraries and their role in teaching of Science	331
5.6.7	Functions of a Science Library	332
5.6.8	Organization of a Science Library	333
5.7	Computers and the Library	336
5.8	Virtual Library	336
5.9	Digital Libraries	337
Review Questions		337
Unit-VI		
TECHNOLOGY IN TEACHING BIOLOGICAL SCIENCE		
6.1	Educational Technology	339
6.2	Hardware Approach	340
6.3	Software Approach	341
6.4	Educational Broadcast / Telecast	341
6.5	Edger Dale's Cone of Experience	343
6.6	Audio-Visual Aids	350
6.6.1	Classification of A.V. Aids	351
6.7	Projected aids	353
6.7.2	Video Cassette Recorder and Player	353
6.7.3	OHP and transparencies	354
6.7.4	Slide Projectors	358
6.7.5	Film Projector	359
6.7.6	Closed Circuit Television (CCTV)	360
6.8.1	Non-Projected Aids	362
6.8.2	Charts	362
6.8.2	Models (Static and Working)	364
6.8.3	Flash cards	365
6.8.4	Pictures	366
6.8.5	Chalk board	367
6.8.6	Flannel board	369
6.8.7	Magnetic Boards	370
6.8.8	Bulletin Boards	370
6.8.9	Exhibits	372
6.8.10	Study Exhibits	372
6.8.11	Audio Players	373
6.9	Use of Internet in Biology learning	375
6.10	E-learning	376

6.11	Radio Lesson	377
6.12	Educational Television	378
6.13	Multimedia Computers	379
6.14	Power Point and its uses	380
Review Questions		381
Unit-VII		
LABORATORY IN BIOLOGY		
7.1	Laboratory	382
7.2	Location and Types of Laboratories	383
7.3	Planning a Biology Laboratory	383
7.4	Care and Maintenance of Apparatus	384
7.5.1	Maintenance of Laboratory	385
7.5.2	Chemical Substances	387
7.5.3	Preparation of Practical Timetable	388
7.5.4	Administration of the Laboratory Work	388
7.6.1	Laboratory Registers	394
7.6.2	Accession Register	395
7.6.3	Non-consumable Register	395
7.6.4	Consumable Register	396
7.6.5	Breakage Register	398
7.6.6	Issue Register	399
7.6.7	Stock Registers	399
7.6.8	Requirement Register	400
7.7	Management of Safety	400
7.7.1	General Safety Rules for the Lab	400
7.7.2	Accidents and First Aid	401
7.8	Structure and Design of a Biology Laboratory	408
7.9	Preparation of Indent	415
7.10	Procedures for the Purchase of Equipments	416
7.11.1	Science Kits	419
7.11.2	Comparison of Science Kits and Science Laboratories	423
7.12.1	Co-Curricular Activities	424
7.12.2	Importance of Co-Curricular Activities	426

7.12.3	Organisation of Co-curricular Activities in Teaching	429
7.12.4	Excursion or Field Trips	430
7.12.5	Organisation of Excursions or Field Trips	433
7.12.6	Science Museums	438
7.13	Methods of preservation and safe Display	444
7.13.1	Aquarium	445
7.13.2	Terrarium	447
7.13.3	Vivarium	448
7.13.4	Science Museum	449
7.14	Science Clubs	450
7.14.1	Types of Science Clubs	453
7.14.2	Organisation of Science Club	455
7.15	Science Fairs	462
7.15.1	Organization of Science Fairs	466
7.16	Classification of Educational Materials	469
7.16.1	Characteristics of Improved Apparatus	469
7.16.2	Improved Apparatus	472
Review Questions		481
Unit-VIII EVALUATION		
8.1	Concept and Process of Evaluation	482
8.2	Meaning and Definition of Evaluation	483
8.3	Need for Evaluation	484
8.4	Importance of Evaluation	485
8.5	Relation between Assessment, Measurement and Evaluation	486
8.6	Characteristics of Evaluation	488
8.7	The Concept of Evaluation	490
8.8	The Process of Evaluation	491
8.9.1	Suggestions for Improvement and Remedial measures	492
8.9.3	Functions of Evaluation	493
8.10	Types of Evaluation	495
8.11	Tools of Evaluation	
8.12	Types of Observation	497

8.13	Rating scales	498
8.14	Checklists	499
8.15	Anecdotal record	500
8.16	Cumulative record	501
8.17	Types of Tests	502
8.17.1	Teacher-made tests	502
8.17.2	Oral tests	503
8.17.3	Written test	503
8.17.4	Essay type test	504
8.17.5	Short answer type test	504
8.17.6	Objective type tests	505
8.18	Standardized test	505
8.19	Difference between Teachers-made Achievement Test and Standardized Achievement Test	506
8.20	Diagnostic test	506
8.20.1	Intelligence tests	507
8.20.2	Aptitude tests	507
8.20.3	Self-reporting Techniques	508
8.21	Preparation of Scholastic Achievement Test (SAT)	510
8.21.1	Meaning and Definition of Achievement Test	510
8.21.2	Important Features of Achievement Test	511
8.21.3	Functions of Achievement Tests	511
8.22	Construction of Standard Objective based Test/Unit Test	512
8.23	Characteristics of a Good Test	513
8.24	Preparation for a Unit Test	514
8.25	Preparing the test	517
8.26.1	Meaning and Definition of Action Research	521
8.26.2	Characteristics of Action Research	521
8.26.3	Steps of Action Research	523
8.26.4	Fields of Action Research	525
8.26.5	A paradigm of Action Research Projects	528

8.26.6	Types of Action Research	532
8.27.1	Remedial Teaching	534
8.27.2	Purposes of Diagnostic Test in Biological Sciences	537
8.27.3	Preparation of a Diagnostic Test	237
Review Questions		541
UNIT-IX		
PROFESSIONAL DEVELOPMENT		
9.1	The Biology Teacher	542
9.2	Who as a Good Biology Teacher?	542
9.3	Traits of a Biology Teacher	544
9.4	Creed of Biology Teacher	544
9.5	Professional Ability of Biology Teacher	546
9.6	Questionnaire for Self Evaluation	547
9.7	Biology Teacher's Attitude	547
9.8	Requisite to Bio-Data of Biology Teacher	548
9.9	Academic Qualifications	550
9.10	Inspection of Biology Department	551
9.11	Qualification of a Science Teacher	553
9.12	Professional Growth of Science Teachers	555
9.12.1	Summer Institutes for Science Teachers	556
9.12.2	Summer Institutes	557
9.13	Science Teacher's Diary	560
9.14	Time Table	562
9.15	Home-Work	563
9.16	Supervision of Science Department	564
9.17	Professional Growth of Biology Teacher	566
9.18	Need of Training of Biology Teachers	567
9.18.1	Advantages of Training	567
9.19	Means of In-Service Training	568
Review Questions		571

UNIT-X		
PROVISION FOR INCLUSION		
10.1	Creativity	572
10.2	Definition	572
10.3	Characteristics of Creative Persons	573
10.4	Methods of Developing Creativity	573
10.5.1	Gifted Children	574
10.5.2	Main Characteristics of Gifted Child in Biology	576
10.5.3	Adjustment Problems of Gifted	579
10.5.4	Identification of the Gifted	580
10.5.5	Enrichment Programmes for the Gifted	581
10.6.1	Backward Child	584
10.6.2	Identification of Backward Child	584
10.6.3	Characteristics of Backward Child in Biology	584
10.6.4	Teacher's Duty towards Backward Child	585
Review Questions		588
Bibliography		589
Index		590

Chapter 1

AIMS AND OBJECTIVES

1.1 Meaning of Biology

Biology is a natural science concerned with the study of life and living organisms, including their structure, function, growth, evolution, distribution, identification, and taxonomy. Biology literally means “the study of life”. Biology is such a broad field, covering the minute workings of chemical machines inside our cells, to broad scale concepts of ecosystems and global climate change. Biologists study intimate details of the human brain, the composition of our genes, and even the functioning of our reproductive system. Human’s exploratory activities have resulted in the accumulation of vast source of knowledge called Biology. In Biology, we study about nature which means the entire universe. The knowledge is now organised in several disciplines for the convenience of the study. This knowledge is based on inquiry, observations, and logical extensions, and is testable by experiment or has logically convincing explanation. Science may rightly be said to be a domain of inquiry.

In order to define Biology, the meaning of Science will have to be understood. ‘Science is a systematic study of the facts and discovery of the reason of a happening’. Lamarck and Treviranus were two scientists of 1802 AD, who had given the name ‘Biology’ to the systematic study about the creatures or living things. The word ‘Biology’ is formed by the synthesis of the two Greek words ‘Bios’ and ‘Logos’. ‘Bios’ – means ‘Life’ and ‘Logos’ is ‘discourse’ or ‘Study’. Thus, Biology is also known as science of life, today.

The advent of Biology took place when man came in contact with the forests. He was dependent for his living on the plants and animals. For diseases and wounds, he depended on herbs and for food on animals and plants.

1.2 Branches of Biology

There are two main branches of Biology namely –

1. Pure Biology
2. Applied Biology

1. Pure Biology – The scientists try to understand the phenomenon of nature and satisfy their intellectual needs. They do not form a relationship with the practical aspect of life. For them, the acquisition of knowledge is the way to salvation.

2. Applied Biology – In the Applied Biology, the biologists work to find solutions for problems related to making life easier for them. They utilize acquired knowledge for practical use and try to draw precise conclusions.

On the basis of knowledge and technical knowledge of Biology, the study of Biology has been divided under 3 heads:

1. Zoology – Zoology is formed by the two Greek words ‘zoo’ and ‘logos’. Zoo means creatures, animals or fauna and ‘logos’ means study. Thus, ‘Zoology’ is that branch of Biology under which the study of animals or fauna is done.

2. Botany – The second branch of Biology is Botany which is a combination of the Greek words ‘Botane’ and ‘Logos’. ‘Botane’ means plants or flora and ‘Logos’ is study or science. Thus, ‘Botany’ is that branch of Biology under which the study of plants or flora is conducted.

3. Microbiology – Besides these two branches, the third branch ‘Microbiology’ has developed. It is that branch of Biology in which the study of micro-organisms and plants are conducted. The various branches of Biology are depicted in the following table:

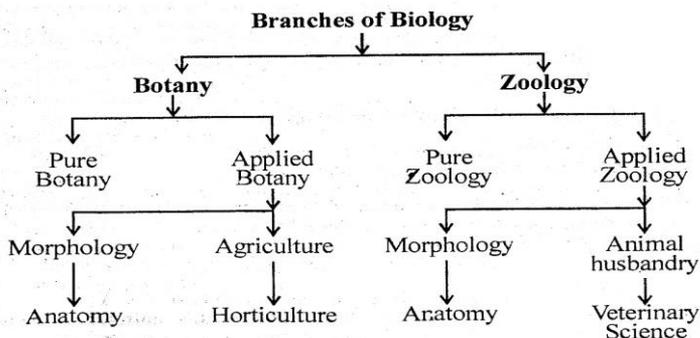
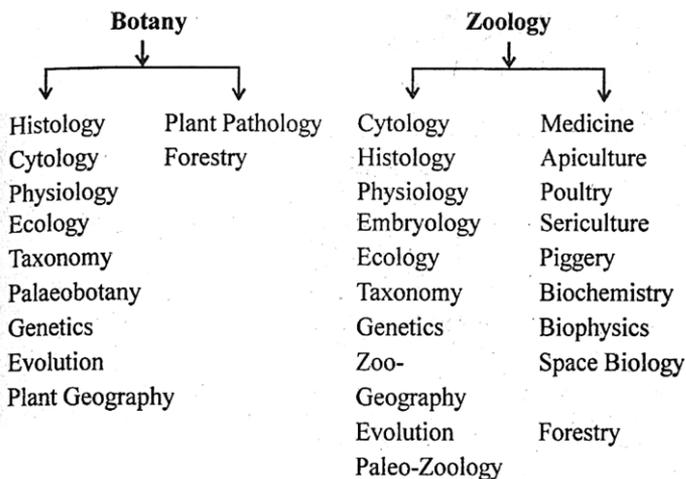


Figure: Branches of Biology



1.3 Importance of Biology

The following values are achieved by the study of biology –

1. Solution to the problem of food
2. Solution to the problem of clothing
3. Solution to the problem related to health
4. Solution to the problem of security or defence
5. Biology and Agriculture
6. Biology and Industry

7. Biology and Recreation

8. Biology and Development of Society

1. Solution to the problem of food – The study of Biology teaches us as regards to what type of food would be the best for a living being right from its birth, what would be the ingredients of that food and what its nutritional values would be and from where it can be procured. The study of Biology trains human beings as to which plants and animals can be used as food and which are poisonous. Our food, be it vegetarian or non-vegetarian, comes under Biological area. Thus, by the study of Biology, a human being can work towards propagation, improvement, and health of his race.

2. Solution to the problem of clothing – In the prehistoric times, bark of plants and skins of animals were used as clothes. Even today, man is dependent on their sources for his clothing; silk can be obtained from silk-worms and wool from sheep; Cotton, flax and fibers from plants and these solve the problem of clothing. But rearing of silk-worms and sheep is possible only where the life-cycle of these (silk-worms and sheep) is fully known. Study of Biology gives us a systematic knowledge of this.

3. Solution to health related problem – By the study of Biology, human beings can study the human anatomy and functions of various body parts. They can also get the knowledge of things which are useful and helpful in growth and for good health; and accordingly they can take good care of the body. Thus, the study of Biology is the source of all health plans.

4. Solution of security – There was a time when different diseases were considered to be wrath of Gods and there was no treatment for those. But, today, as a result of the study of Biology, the term ‘Wrath of Gods’ has been replaced by ‘micro-organisms’ (virus, bacteria etc) Typhoid, chickenpox, small pox, etc., are caused by ‘micro-organism’. If these

microorganisms are destroyed, the diseases can be controlled. The study of Biology clearly states what diseases are caused by which 'organisms' and which living things act as carriers of the disease. Thus, measures can be taken to curtail the spread of the disease germs and prevent the diseases from becoming epidemics.

5. Biology and Agriculture – The study of Biology helps in identifying useful and harmful plants. Useful plants can be propagated. By the study of Zoology, it can be found out which plants are destroyed by which organisms, what its life-cycle is, where it resides, and how it can be controlled. Biology also helps in studying about the helpful microbes along with those that are harmful in agriculture.

6. Biology and Industry – Leather from the hides of animals, silk from worms, fur, fats, honey, pearls, shells, horns, and tusks are also obtained from animals and to develop these industries the study of Biology is essential. The study of Biology helps in the study of life-cycles of different plants and animals, their nature, rearing, etc.

7. Biology and Recreation – The recreational aspect of the study of Biology lies in the fact that man has made various aquarium, terrarium, and vivarium. Various coloured fish, birds, and butterflies are reared and kept in these zoos. Fruits and flowers are grown in free time. This is made possible by the study of Biology because it helps in the study of the nature of these plants and animals.

8. Biology and Human Development – The study of 'Heredity and Genetics' helps man in studying the breeds of plants and animals and how this can be improved and thus harmful characteristics can be removed gradually. Thus, the study of Biology helps in improving and cultivating good characteristics and helps in the development of human race. The help which Biology renders in space, research,

industrial pollution, atomic pollution, and population control cannot be negated.

1.4 Scope of Biology

The knowledge of Biology is useful to know about the morphology, cytology, physiology, and reproduction of living organisms. It helps us to know the ecological relationships and evolution of organisms on this earth. The knowledge of Biology also helps in understanding the biochemical processes and the metabolic reactions occurring in the living cells. It throws light on the genetic materials the DNA and the RNA and their role in heredity and reproduction. It provides knowledge about the nature and importance of microorganisms on this earth. It also gives an insight into applied and advanced scientific subjects like biotechnology, molecular biology, biophysics, astrobiology, etc.

Biologists study many different facets of life from the molecules that make up individual cells to the behaviour and ecology of animals and plants. Their studies encompass both basic and applied science because today's biologists play an increasingly important role in the progress of agriculture, human and animal health, and also in business and industry.

Whether in the laboratory, in the office, or in the field, biologists meet the daily challenges of preserving our environment, developing new defences against disease, increasing agricultural productivity, and expanding our understanding of the basic processes of life. There is an increasing need for biological scientists to meet these challenges.

1.5 Objectives of Teaching Biological Science in School

Major Instructional Objectives

If science programme in the schools is to be effective, we must know what we are trying to accomplish and then put in

all our efforts to achieve it.

Any subject in the school curriculum should try to achieve the general aims of education set to make the child a good citizen, who can adjust himself and participate in the democratic set up of society. Individual development in all the dimensions of a child's personality and the social efficiency are some other general aims of education. It is, however, out of the scope of this book to discuss all those aims. We shall limit our discussion to the main objectives of science teaching which are dealt under the following heads:

1. Knowledge
2. Skills
3. Abilities
4. Attitudes
5. Training in scientific methods
6. Interests and Habits
7. Appreciation
8. Providing work for leisure
9. Training for a better living
10. Forming basis for vocation and specialization

1. Knowledge

This is one of the major aims which has been over-emphasised so far at the cost of other aims of teaching science. However, the pupils studying science should acquire the knowledge of:

- Fundamental principles and concepts useful in daily life.
- A body of facts to understand the scientific literature.
- Inter-relationship and interdependence of different branches of science.
- Knowledge of plants and animals and their interdependence.
- Knowledge of natural phenomenon

- Knowledge of the origin and evolution of plants and animals, origin of earth, moon, and other planets and satellites.
- Knowledge of general rules of health and human body
- The student should be able to apply this knowledge in his/her daily life.

2. Skills

The student should acquire skills in experimentation, construction, observation, drawing, and problem-solving.

The skill in experimentation will include:

(a) Experimental Skill.

- Handling of apparatus and instruments
- Arranging the apparatus for an experiment
- Preserving chemicals, specimens, apparatus, etc.

(b) Constructional Skill

- Making hand-made apparatus
- Repairing of certain instruments

(c) Drawing Skill

- Drawing skill includes drawing the sketches of certain experiments, Biological specimens, instruments, etc.

(d) Problem-solving Skill

(e) Observational Skill

3. Abilities

The teaching of science should also aim at developing certain abilities in the students such as:

- Ability to sense a problem
- Ability to organise and interpret
- Ability to analyse
- Ability to generalise
- Ability to predict from a given data
- Ability to organise science exhibitions, fairs, etc.
- Ability to locate reliable and necessary information from appropriate source

- Ability to discuss, argue, and express using scientific terminology
- Ability to improvise and manipulate the instruments using the acquired knowledge

4. Attitudes

Scientific attitudes are the most important outcomes of science teaching. Though some people view the scientific attitudes as the by-products of teaching science, a majority of the people consider them as equally important as the knowledge aim. Science should be taught directly and systematically because developing scientific attitude has a number

of characteristic features which distinguish it from the other attitudes.

A man with scientific attitude

- Is critical in observation and thought
- Is open-minded
- Respects other's points of view and is ready to change his decision on presentation of new and convincing evidence
- Is curious to know more about the things around him, wants to know 'Why', 'what' and 'How' of the things he observes
- Is objective in his approach to problems
- Does not believe in superstitions and false beliefs
- Suspends judgments until suitable support is obtained
- Believes in cause and effect relationship
- Is truthful in his observations and draws conclusions based on accurate facts
- Is unbiased and impartial in his judgments
- Adopts a planned procedure in solving a problem
- Believes that truth never changes, but his ideas of what is true may change as he gains better

understanding of that truth

- Accepts no conclusion as final or ultimate
- Seeks to adopt various techniques and procedures to solve the problem
- Selects the most recent, authoritative, and accurate evidence related to the problem.
- Seeks the facts and avoids exaggeration

5.Training in scientific method or reflective thinking

The method by which the scientists approach a problem may be termed as **Scientific Method**. S/He will attack the problem in the same way even in an area in which s/he is quite ignorant *i.e.*, the training in method of attacking a problem, which s/he gets in the pursuit of science, is transferable to other situations in life. S/He will adopt a definite procedure, characteristic of a scientist in arriving at desired conclusions. First of all, s/he will sense a problem, define it, collect suitable evidences, organize and interpret the data, formulate the hypothesis, test its validity and accuracy and finally draws conclusions. All these steps involve *scientific attitude* of mind, habits and skills which are characteristic of reflective thinking. The training in scientific method should be one of the important aims of the teaching of science.

6. Interests and Habits

The teaching of science should also aim at developing some interests in reading scientific literature, in scientific hobbies, in activities of science clubs, in vocational fields, in nature, etc. The teacher should stimulate interest in the students by providing such activities and situation which may foster the above mentioned interest. E.g. Organisation of science fairs, excursions, library reading, etc. The motivational techniques, like rewards and punishments, praise and blame and rivalry may be made use of at times. The psychological principles of learning *viz.* Readiness, Exercise and Effect, should invariably be utilised by the

teacher. The students must be prepared to accept the problem in hand. When the problem becomes real to the students, their interest in the solution will always follow. Once the interest in the pupils is aroused, the learning becomes easier.

Certain socially desirable habits like honesty, truth, tolerance, self- confidence, self-reliance etc., should be inculcated through the teaching of science.

7. Appreciation

The student of science should be able to appreciate the contribution of science in the progress of civilization, the adventures of scientists, natural phenomena, contribution of scientific method, etc. The appreciation must come as an outcome of science teaching and the teacher must make the students conscious of the benefits bestowed by science for the comforts of the mankind. The adventures of scientists in exploring the truth should be told by the teacher.

The students should occasionally be taken for outings so as to appreciate the beauty of nature.

8. Providing work for leisure

The problem of leisure can be easily solved by teaching the students different types of hobbies and other scientific activities. For example, students should be taught to prepare articles of their daily use such as inks, soaps, cream, boot-polish, etc. They should also be given knowledge and training in some useful activities like gardening, maintenance of aquarium, and other livestock, preservation and collection of animals and plants, etc. The students, after having learnt the technique and procedures involved in different hobbies and scientific activities, can engage themselves in a useful and productive work in their leisure hours. They can also improvise certain instruments.

9. Training for better living

The students of science should know the laws of health and hygiene and should be given training in healthy living.

They should be taught to take special care of the body and so improve their surroundings, and thereby improving the standard of living. S/He should know the ways and means of prevention with his own domestic, social, and national environment and the economic and cultural conditions.

10. Forming basis for career and later specialisation

In addition to being an integral part of general education, whole science programme at Secondary stage should also prepare the students for some vocation and specialisation in the individual subjects. So, different types of knowledge and training should be given to those students who intend to go for higher studies or those who want to enter some profession. This should form a basis for further pursuit in the field of science.

1.6 Aims of teaching Biological science

One of the important aims of education is to help students to become responsible democratic citizens of the country. The responsibility of science teachers is not only to teach facts, principles, and processes of science, but also to facilitate students to discharge their social responsibilities and preserve democracy as well. They should appreciate how science and technology have developed and are affected by many diverse individuals, cultures, and societies. They need to be encouraged to appreciate and participate in the responsible use of science and technology for the benefit of society, to visualize future of our nation and to become sensitive and responsible citizens. It is important to develop critical thinking in them about the interconnectivity of science, technology, and society in order to maintain a healthy and sustainable society. Students should be encouraged to develop a scientific vision about different issues, about acquiring and processing information, about scientific and technological developments and their relevance to everyday life and long-term implications to society.

Science education aims at making the students develop their scientific attitude, so that in later life, they can help the society in making rational choices when confronted with various possibilities and challenges.

Humans' inquisitiveness and usefulness of the knowledge of science are the two main factors which have led them to continuously strive to understand the behaviour of nature and use the science based on at least four fundamental values:

- Curiosity is good and should be encouraged.
- Knowledge itself is good. It is good to acquire knowledge.
- It is wrong to falsify or fabricate the data on which knowledge is based.
- It is good to keep an open mind (to be willing to examine and consider new evidence and arguments) tempered by a vigilant level of scepticism.

Curiosity is surely the most essential trait a scientist can possess. Curiosity leads to the search for knowledge for its own sake, which is the driving force behind the great majority of scientific discoveries ever made. Acquiring knowledge for curiosity's sake leads naturally to the second value that knowledge is good-not because it may be useful in some pragmatic way, but simply because it increases our store of knowledge about the universe in which we live. Staying open-minded and skeptical is certainly a value and goal for all scientists, provided that one's open-mindedness is reserved for objective evidence, as opposed to subjective opinion.

Curiosity can be a hard sell because, sadly, many of today's students seem to lack curiosity about the world

and universe outside their personal spheres of relevance. Even at the college level, many students appear to have no interest in learning about anything as remote as stellar evolution, photosynthesis, Krebs cycle, the Burgess Shale fossils, hydrothermal vent communities, lateral gene transfer, the bacterial origin of mitochondria, and so on. Yet these topics would not seem remote if they were approached in a creative and spirited manner.

Most investigations in science involve some form of scientific method. It shows creativity of humankind in seeking solution to its problems. The approach used by the scientists in the study of astronomy and ecology is observation and prediction. In microbiology, they rely on laboratory experiment focused on cause and effect relationship. This is a glimpse of the process by which science works. The essential elements of this process have been collected in what is known as scientific method.

In science, experimentation and theory building complement each other. Sometimes a new experiment throws up observation which forces modification in an existing theory or demands the development of an altogether new theory. At other times, theoretical development in a theory predicts a new phenomenon which needs to be verified by experiment. This interplay between theory and experiment is a fascinating facet of the scientific process.

Broadly speaking, science is a particular way of looking at nature, which may also be called scientific attitude. One of the most important characteristics of science is that even the most established theories can be modified, or even abandoned, if the new experimental results do not fit into the existing theories. This promotes

skepticism among scientists. They look at every new observation or theoretical calculation with a healthy dose of skepticism and do not accept it till the result has been reproduced by many scientists at various places. Reproducibility is one of the important criteria for a scientific result to be acceptable. It is believed that scientists, in their exploration, employ inquiry and scientific method. The use of scientific method and inquiry in daily life promotes scientific temper and rationality. That is why it has been emphasized that all of us should imbibe the spirit of scientific inquiry in our personal lives. So, science can never belong to a country or region. It belongs to the whole mankind.

Science enhances the quality of our life and it is visible in all walks of life. Since science has been developed by people who are part of a group, society or a country, it is expected that their social, psychological, political, and economic perceptions could change the course of development of science.

The science education is aimed for the learner to

- Know the facts and principles of science and its applications, consistent with the stage of cognitive development.
- Acquire the skills and understand the methods of process that lead to generation and validation of scientific knowledge.
- Develop a historical and developmental perspective of science and to enable the learner to view science as a continuing social enterprise.
- Relate science education to environment (natural environment, artefacts and people) local as well as global

and appreciate the issues at the interface of science, technology, and society.

- Acquire the requisite theoretical knowledge and practical technological skills to enter the world of work.
- Nature and natural curiosity, aesthetic sense, and creativity in science and technology.
- Imbibe the values of honesty, integrity, cooperation, concern for life, and preservation of environment.
- Cultivate scientific temper-objectivity, skepticism, critical thinking and freedom from fear and prejudices.

Acquisition of knowledge and understanding:

An important trait of humans is to wonder, observe, and interact with the surroundings and look for the meaningful patterns and relations by making and using new tools and building conceptual models to understand this universe. This human's endeavour has led to modern science which took thousands of years to get crystallised. So, one can say that, science leads to generation of ideas helping to make sense of observed facts that get accepted if they find observations, but may be refused until tested through evidence. These represent a broad view and are generalised as the scientific principles that are true universally.

It is important for children to acquire the knowledge of science content, i.e., concepts and underlying principles as they provide a sound base to explore the unknown and to build further knowledge, yet these cannot be passed to children directly. In addition, their understanding cannot be developed by rote learning. It can be done by providing children relevant and age appropriate learning opportunities that allow them to undergo experimental learning through exploration and interaction with their environment and construct their knowledge. Creation of knowledge is crucial to children's

learning. Their previous experiences are very important for it, as the experiences lead them to develop new ideas. Teachers need to collect such experiences of children to build further knowledge on their previous knowledge. For this, they may engage the children in meaningful discussions through questioning and listening. Even children's drawings and concept maps also serve as good tools to acquire such information.

Development skills:

Science is about asking and finding answers to them through scientific method and inquiry. The processes that scientists use in it are science process skills. Science is important to all young people, not only to acquire the knowledge associated with it, but also to imbibe its inquiry and process skills. These skills enable them to develop into adults who are able to take informed and responsible action while engaging and reflecting upon different ideas, opinions, beliefs, or values. These are long lasting thus; tend to be useful throughout each area of our lives. These skills involve the use of all the sense organs providing hands-on experiences for enjoyable and effective learning.

Doing experiments require certain skills, which are called laboratory skills. In order to do experiments, students have to handle the apparatus carefully, set up the apparatus to perform the experiment and make correct observations. These are the skills which come under laboratory skills. Some simple apparatus can be prepared by the students which also require some skills. When they experiment in laboratory, they have to move with the other students cooperatively sharing the responsibilities. This develops positive feeling in the students. This is called general skill. They also need to develop drawing skill. These skills are necessary for the students to develop

when they study Biology. All these basic skills are important individually as well as when they are integrated.

Development of scientific attitude:

Scientific attitude is a composite of a number of mental processes or tendencies to react consistently in certain ways to a novel or problematic situation. These include accuracy, intellectual honesty, open-mindedness, respect for evidence, skepticism, suspended judgment, critical thinking, perseverance, and looking at true cause and effect relationship. Scientists, because of their thirst for knowledge become perpetual learners. They are constantly curious and continually seeking knowledge by inquiring. This, in turn, nurtures the trait of scientific attitude.

Students who study science are curious. So, the students of Biology are also curious. They are also open-minded to hear anything from anybody. They receive information and come to a conclusion or judgment only based on facts. At the same time, they are ready to test and verify their judgments. This makes them believe that nothing is final in Biology. They are truthful in doing experiments, making observations, recording and reporting. They also have faith in cause and effect relationship. The students of Biology possess all these qualities and also develop these qualities while studying Biology. These qualities are called as scientific attitude.

Science attitude can be nurtured over a period of time through process relevant learning situations that require creating an open classroom environment encouraging the children to perform activities and experiments and reading scientific literature, freely interacting with their surroundings and asking questions. A science teacher needs to provide the children experiences of a number of scientific activities as a

base for a thorough understanding of science and developing scientific attitude and temper.

Development of thinking abilities:

In science, critical thinking increases science learning potentials. It requires deliberate review of the way in which activities are carried out, the ideas emerges and the way these can be improved. It is the ability to analyse information and experiences in an objective manner. Reflecting on the processes of thinking does not come readily to young children as it involves abstract thinking as well. Teachers can facilitate this by engaging the children in discussions through activities.

The process of linkage of the past experiences in terms of cause and effect relationship on a model of set rules, i.e. thinking with reasoning is known as logical thinking. Children should be helped to reason out consistently before arriving at conclusion. Scientific temper is the refined logical thinking.

Nurturing curiosity:

Curiosity leads to questions in his/her mind like why, what and how. When students ask such questions, the teacher should not discourage them. S/He should facilitate them to find answer using scientific principles. Science is nothing but all that happens around us. Students come across many questions out of curiosity. Curiosity leads to inculcation of learning to learn aspect of education. Curiosity can be generated in the learners by taking them to science centers, providing opportunities to work on science project and to read scientific literature, facilitating interaction with persons having scientific attitude, encouraging to participate in science exhibitions and science quizzes, etc. Science activities can be designed to encompass several factors making up curiosity. Curiosity gets aroused as a result of doubt,

perplexity, contradiction, cognitive conflict, ambiguity, lack of clarity, etc. A teacher needs to create suitable learning situations for this.

Nurturing creativity:

Creative thinking is a novel or innovative way of seeing or doing things. Creative thinking enables a learner to explore available alternative and consequences of actions or non-actions and contributes to decision-making and problem solving.

Creativity has been defined in different ways. It is the production of relevant and novel product and process. Also, it involves classification and assessment of different components of the problem or delineation, manipulation and linkage of ideas in a novel manner to solve a problem, or to deal with an idea or to confirm a conclusion. Creativity is doing or seeing the things differently. It cannot be taught, but developed in children by using planned strategies and techniques.

The teacher plays an important role for nurturing creativity in learners. From pedagogical perspective of physical science, inquiry and activity oriented, process based teaching-learning can facilitate in nurturing creativity. Therefore, the role of the teacher should be to

- Assist students in developing models of inquiry and discovery
- Guide students in the use of multidisciplinary approach
- Recognise and appreciate creative ideas and products of students
- Provide rich variety of learning experiences to students

- Encourage students to frame questions and browse variety of reading materials and
- Express to the students that their ideas have value.

A creative child thinks differently, expresses unending curiosity, and possesses divergent thinking ability. She wonders what makes things work. S/he is always a keen observer who ponders over the outcome of an event of phenomena and seeks information. S/he had original, divergent, independent, fearless, and intuitive thinking and welcomes new ideas. S/he likes to ask thought-provoking questions rather than fact seeking or memory type questions. Teachers should identify these traits and provide a variety of learning experiences of inquiry and discovery of science to nature creativity.

Nurturing aesthetic sense:

Aesthetics deals with the creation and appreciation of beauty that gives us happiness. Harmony, order, and pattern are some of the criteria which define beauty. A learner of science is also concerned with them. S/he gets motivated to see some patterns in the properties of substances and other things in his/her surroundings. S/he appreciates his/her creation and derives joy when finds that a particular toy or a gadget works on same scientific principle that s/he has already learnt.

For nurturing aesthetic sense through science teaching learning, the teacher may encourage students to consider the following steps:

- Observe keenly while doing any work. For example, observing the flowers while walking in the garden one can appreciate their colour and wonder why the flower

is of that particular colour. Observe, analyse and reject what is not scientific.

- One should be conscious of one's inner being.
- Learn to be generous. One should develop the sense of sacrifice and self-righteousness.

Development of problem solving skill

Problem solving means that an individual has learned the skills and acquired relevant information necessary to solve problems that are not only curricular, but also related to everyday life.

Various skills required for problem solving can be enhanced by providing opportunities to students to ask questions, think aloud, look for alternative explanations and procedures, isolate and control variables, keep records, apply reasoning and analogy, make models, and apply process skills in teaching-learning of science. Students can explore potentiality while working on the problem. They feel a sense of achievement on getting success and develop self-confidence.

In order to provide opportunities for problem solving, we need to inculcate the following abilities among the learners:

- Flexible and divergent thinking
- Decision-making and generating self-confidence
- Accepting or rejecting hypothesis
- Correlating between various quantise or phenomena
- Checking the validity of results
- Expressing the task in term of goals
- Searching for innovative practices
- Creating new challenges for life and
- Developing positive and cooperative attitude

To solve the problems in science, students must acquire what cognitive psychologists call declarative knowledge which consists of the body of knowledge and facts needed to work in science. Simply acquiring knowledge of science is not sufficient. One must organise this knowledge in such way that it can be retrieved easily to solve problems. Simultaneously, while acquiring and organising declarative knowledge, one must also acquire procedural knowledge (knowledge of processes) which are procedures and heuristics that can be applied for solving problems.

1.7 Aim of Teaching Biology at Different Levels General Aims of Teaching Biological Science

The general aim of science education is to develop well-defined abilities in cognitive and affective domains, besides enhancing psychomotor skills. It helps to foster an uninhibited spirit of inquiry characterized by creative, innovative, and objective approaches. Educational programmes are designed to help in unravelling the mysteries of the interrelationship between science and the day-to-day life, health, agriculture, industry, and indeed, the individual and the universe. Scientific wisdom, knowledge and skills are ammunitions that instill confidence and inspire the individuals to challenge the existing beliefs, prejudices, and practices. They work as a liberating force and serve as a reliable tool in one's search for truth, harmony, and order in different aspects of life.

Curriculum aims of Teaching Biology

The aim of Biology curriculum is to provide biology-related learning experiences for students that develop scientific literacy, so that they can participate actively in our rapidly changing knowledge-based society, prepare for further studies of careers in the fields related to life science, and

become lifelong learners in science and technology. The broad aims of the curriculum are to enable the students to:

- Develop and maintain an interest in Biology, a sense of wonder and curiosity about the living world, and respect for all living things and the environment.
- Construct and apply knowledge of Biology, understand the nature of science in Biology-related contexts, and appreciate the relationships between biological science and other disciplines.
- Develop the ability to make scientific inquiries; think scientifically, critically, and creatively and solve biology-related problems individually and collaborately.
- Understand the language of science and communicate ideas and views on biology-related issues.

Lower primary stage

In classes I and II, Environmental Studies is wholly devoted to the fundamentals of science. In Classes III to V, Environmental Studies branches into two sections: one dealing with science and the other with history and geography that are taught together under the title Social Studies. The objectives of teaching science in the primary stages are to:

- Learn about flora and fauna, natural resources, the sources of energy and so on, by interacting with the immediate environment.
- Sharpen observation, inculcate the spirit of exploration, and
- Develop concern, sensitivity, and the ability necessary for the preservation and protection of physical and natural resources.

Contents (Lower primary stage)

At the primary stage, science is taught under the umbrella of Environmental Studies. The contents are

thematically organised into chapters titled: Things around plants, Animals and Us, Our Body and Food, and Health and Weather. The syllabus concludes with a chapter titled: Man, Science and Environment.

Upper primary stage

At the upper primary stage, namely from Classes VI to VIII, students are expected to consolidate and strengthen the abilities acquired during the primary stage. The objective is to develop an understanding of the nature of scientific knowledge; certain physical, chemical and biological facts and their relationship to their manifestation in nature and in daily life. The student should be enabled to develop the capacity to use science to help in solving problems and arriving at the right decisions. Pupils are also expected to develop the skills required to operate ordinary laboratory or science equipment, and to design simple experiments to seek and find explanations for natural phenomena. At this stage, science education should help the pupil to develop an understanding and appreciation of the joint enterprise of science and technology and the interrelationship of these with other aspects of the society.

Contents (Upper primary stage)

Science education imparted to the students of the upper primary stage ought to form part of a smooth and seamless transition from the ‘environmental studies approach’ to a more formal study of science. With this as the guiding principle, efforts have been made to formulate content and approach. Accordingly, the organisation of concepts in Class VI is somewhat similar to those of the lower primary. In Class VII and VIII, subject matter is dealt with a greater length. Themes like Science in Everyday Life; Things around Us changes around Us; Measurement; Separation of Substances; The Living World; The Living Body; Air, Water and Energy; Balance of Nature and The Universe make up the course

material that engage the students at Class VI. This is followed in Class III and VII by more subject-oriented themes such as Mechanics; Heat; Electricity; Magnetism; Carbon and its Compounds; Metals and Non-metals; Life Processes; Evolution, etc. Interdisciplinary topics like Health, Nutrition, and Agriculture also constitute integral part of the subjects taught at this stage.

Secondary stage

School education comes to a close with the secondary stage comprising classes IX and X. The aim of teaching science at this stage is primarily directed towards the learning of key concepts that span all the disciplines of science. At the secondary stage, the pupil should be enabled to develop a more profound understanding of the basic nature, structure, principles, processes, and methodology of science, with special reference to its relationship with agriculture, industry, and contemporary technology. The teaching of science at this stage should help the pupils to develop insights in health and environment. Greater emphasis needs to be placed on precision and accuracy while handling laboratory equipment and while being engaged in procedures such as quantitative measurement, collection, presentation, analysis of data, and drawing inferences.

Contents (Secondary stage)

Science at the secondary stage, is introduced around ten themes, such as: Matter, Nature and Behaviour, Motion; Force and Energy; Ways of Living; Human Beings; World of Work; Energy; Food and Health; Environment; Natural Resources and the Universe.

The time allotted for teaching science at primary, upper primary and secondary stages are 15% and 13% respectively of the total instructional time.

Higher Secondary stage

The most important and crucial stage of school education is the higher secondary level. This is the transition level from the generalized curriculum to a discipline-based curriculum. In order to pursue their careers in basic sciences and professional courses, students take up Biology as one of the subjects. The aim and objective is to provide them sufficient background to meet the challenges of academic and professional streams. Here, each chapter starts with an introduction followed by subject matter and importance has been given to develop skills in experimentation and observation.

Content (Higher secondary stage-Biology)

Science, at the higher secondary stage, is introduced around seven themes, such as Taxonomy of Angiosperms, Plant Anatomy, Cell Biology and Genetics, Biotechnology, Plant Physiology, Biology in Human Welfare and the same is given to the practical session also in addition to Economic Importance of Botany. In Zoology, the students are exposed to fascinating fields such as Human Physiology, Medicine, Microbiology, Immunology, Bio-informatics, Environmental Biology, Genomics, Aquaculture, Medical Laboratory Techniques, and Livestock Management. Almost all these themes are given for practical sessions too. These themes or topics are revised and updated time-to-time to cope with changes in the society.

1.8 Relationship of Biology with Other Branches of Science

It is not possible to teach any subject without the help of other subjects. One subject depends on the other. The relationship among the other branches of science is more than the relationship with the other subjects. Because the ideas in the branches of science are interlinked with one another and are also common to every science. But they are deep and

extensive in the modern atmosphere that they are considered as different subjects such Physics, Chemistry, Biology, Geology, Geophysics and Genetics. So, the Biology teachers should know the other branches of science also well. Only then, ideas of branches of science could be correlated.

Biology and Physics:

Good living place, environment, and climate conditions of a place are very necessary for the living beings to live well. The below mentioned Biology teaching depends on physical science.

While teaching the functions of the eye, we have to explain the process of lens arrangement in the camera and the travelling of the light rays through the lenses and the occurrence of images. When it is not possible to explain the falling of images, it can only be explained. Through screen and candle, falling of images can be correlated with the falling of images in the eye screen.

The osmosis is taught in biology as how the plants take water through the roots. The same osmosis is taught in physical to explain the process of osmosis through specific gravity. It is not possible to show the transition or water through plants from the root, so this process can be explained with the help of physical science osmosis experiment. The internal root structure and osmosis could be correlated in teaching.

Similarly, sensory organs like the eye, the ear, nose, tongue, and skin; and nervous system, tissue system, blood pressure, expansion and contraction of heart, the digested food taken through the veins and absorption by glands, walking, running, jumping could be correlated and explained with the help of physical science. In these activities, both Biology and

physical science are found mixed together. Hence, this branch of science is called Bio-physics.

Biology and Chemistry

Biological concepts and the concepts of Chemistry are closely related. They are as follows.

- The cell division, cell formation, and its components are based on the theory of molecule formation.
- In order to explain the strength elements found in our food, we have to explain them only with the help of chemical components like carbohydrate, protein, Amino acids, fat, and vitamins. We have to use the correlation between Biology and Chemistry here.
- To understand some biological concepts like the quality of gas in respiration, nitrogen cycle, carbon cycle, and oxidation, we need to have the basic knowledge of Chemistry. The Bio-chemistry is very much helpful to us to understand this.
- The obstacles in the body, sugar, urinary infection problems, other physical disturbances along with the diagnostic gadgets used to detect diseases are the basis of the ideas of chemistry.

1.8.1. Correlation between Biology and other school subjects

Biology and Mathematics

The knowledge of Mathematics helps in the teaching of Biology to a great extent. The formation of the body in definite propositions is an example to this.

- Equations are used in many places in Biology teaching. In the starch preparations of the plants

Carbon, Hydrogen, and Oxygen are mixed in a definite proportion.

- The measurements in the microscope used in Biology experiments are marked as
 - 1 Micron = $1/1000$ M.Meters (or) 0.0001mm
 - 1 Milli Micron= 10A (or) $1/1000$ micron
- The number of small cells in the lungs ranges from 200 to 500.
- The total length of the blood vessels in a human body is more than 1,00,000k.meters.
- The measurement of the heart is 9cm at its broadest side, 13cm in length, and it weighs 285-340grams for men and 247-285 grams for women.
- Graphs play a prominent role in learning Biology. Particularly in heredity calculation, Mathematics knowledge is more employed.

Biology and History

In history, the past events are arranged in order. As the life of a king or a nation is arranged in order in History, the life of a living being is arranged in Biology. The inventions in Biology, the effects, or researches are taught in the methods of history teaching. Similarly, while teaching history, the availability of food materials production, occupations, and establishments of roads are correlated.

Biology and Geography:

Biology plays a role in the forests, mountain, plains, rivers, and tanks that come in geography. The climatic conditions of a particular place help in the life of living beings. It also plays a role in the dimensional development. Hence, along with the composition of the body of the animals, the nature of the land of their inhabitation should also be

explained. Likewise, how the creatures of the sea and the creatures of the forests get their body compositions differently should be explained. And also how their food habits change and the difference in their body features should be taught through correlation between Biology and Geography.

Biology and Languages:

We employ the language only to express our ideas to others. No concept can be expressed or dreamt of without a language. Similarly for understanding the concept of Biology, theories and thoughts and to express them to others language is a must. So, language and Biology go hand in hand and are correlated with each other.

Biology and Drawing:

In Biology, drawing is an important act. Line drawings, diagrams drawn in the record note books, drawings drawn on the black board, cartoons, concept maps, and drawing of real objects are possible only by practicing drawing skills. If the fundamentals of drawings are learnt clearly, it can be of great use in the Biology classes.

Biology and other Arts:

The craft teachers teach the students as to how things can be made by making use of the wood, metals, papers, and clay. Students can make use of the knowledge to make teaching aids by themselves and this can create in students an experience of doing things and learning biological concepts.

Biology and Environment:

The surrounding in which the living organisms live is called the Environment. There are two important factors in the natural atmosphere. They are animate and inanimate things. That is things with life, and objects without life. Only when

the knowledge of the power of sunlight, the gases of the space, climatic conditions is present adequately, the knowledge of the creature of these places and their activities could be understood clearly.

Man depends on plants and animals for his food and protection. Likewise, animals depend on other animals and plants. The connection between the living and the non-living could be correlated to the atmosphere and taught to students.

In the above mentioned ways, Biology teaching could be correlated with other subjects and natural setups in order to make Biology teaching very effective. Students can get the full knowledge and learning experiences and ultimately more skills could be developed in students.

The benefits of correlation:

1. Correlation brings integration to lesson plan.
2. It helps in bringing a complete development in the students.
3. It connects the society and the school.
4. It brings the ideas and concepts to a close connection.
5. It bifurcates ideas as against single thought.
6. It creates interest in learning.
7. It brings broadmindedness in teachers.
8. It motivates the teachers to learn more subjects and concepts.
9. It encourages learning by doing.
10. It helps natural learning.

Limitations:

It is not possible to correlate all the subjects. All teachers can not follow correlate teaching. It can be practiced in higher classes because the higher class students have got more to learn.

In order to use correlative teaching, the subjects should be flexible. The teachers should have more interest and full freedom to act while using this. The students should be encouraged to learn by this method.

Even if it is one subject, if it is correlated with the students' life, students will have more involvement in learning.

1.9 Values of Teaching Biological Science

Science has been given due place in our school education programmed by being made as a compulsory subject. More emphasis is now being paid over the scientific and technical education. By doing so, in fact, a right step has been taken to push our country forward and to enable us to compete with other progressive nations. It has necessitated to lay due emphases on the teaching of science right from the primary stage. Realizing such need, Kothari Commission has very rightly remarked in their recommendations as follows:

“Science and Mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling”.

Utilitarian value of day-to-day use

The Modern age is the age of science. We see a network of scientific gadgets based on latest scientific inventions all around us. Science has revolutionized our way of living. Now, our lives depend on scientifically invented gadgets so much that we cannot do anything without them. It is now imperative for everyone not only to understand science but also to master it from all angles. According to Herbart Spencer, “The knowledge gained through science is much more useful in guiding our life style than gained through other source”.

Intellectual value:

The study of science provides us the opportunity of developing our mental facilities of reasoning, imagination, memory, observation, concentration, analysis, originality and of systematic thinking. Science gives us the insight which enables us to search the truth and the reality of nature around us. Science does not permit us to accept anything which we cannot prove by actual observation, reasoning, and experimentation. The queries of all problems and phenomena can be satisfactorily answered only by the wisdom of science.

Disciplinary value:

Science develops our personality as a whole. It inculcates spirit of enquiry, seriousness, and systematic thinking. It brings about total transformation in one's view point and makes the thought process more organised. Science makes us think seriously and helps to observe the real nature of the problem. It helps us to judge all the good and bad points, together with the gain and loss likely to be incurred in the plan of action contemplated. Science is the only subject which promotes interest in study, concentration, and habit of hard and systematic work. It also inculcates the habit of viewing a problem impartially with an alert mind. This helps to lead one's daily life successfully in a well organised and systematic way.

Cultural value:

From time immemorial, man has been trying to maintain and preserve their way of life and standard through the use of science. But somehow our way of life has been changing with the passage of time and progress of science. This change in our life-style is due to the inventions of science. The development of culture is the history of science. We can judge the progress of civilisation and culture of a

nation by its progress in science. Science not only develops our culture but also helps in preserving it.

Moral value:

Some people believe that science is responsible for the lack of faith in God, but in reality, the situation is reverse. Science does not permit blind faith; it also does not admit faith in idol worship which follows many useless customs and rituals. The search for truth or reality of nature and search of God are identical aims. Thus, the pursuit of knowledge of nature or study of science cannot be called contrary to religion and faithlessness. Science and its pursuit not only include all the traits of morality but also in developing them. The qualities of honesty of purpose, truth, justice, punctuality, determination, patience, self-control, self-respect, self-confidence, and tolerance are automatically developed in man if he follows scientific method in his pursuit of knowledge. In science, every conclusion depends upon tests and actual observations and not by cheat and deceit.

Aesthetic value

Science is a beauty art, a source of entertainment, and a successful means of attaining physical comforts. Even the study of science is a source of great pleasure, when one gets answers to one's questions about the mysteries of nature. Science helps us to utilize our leisure purposefully.

Social value:

Science is of great value to the society. Science makes a man a useful citizen. Science gives impetus to the progress of society by its new thoughts and inventions. From the very beginning of our civilization, science has played an important role in its development. In fact, the world has become a small social group. Today's society stands on the pillars of scientific

techniques and knowledge. All our social activities depend upon science. Science is essential for the progress of our society and nation. By studying science we can make our social life happy and comfortable by leading a healthy life and by gaining from public welfare activities based on science.

Vocational value:

Science has opened vast vistas of vocations, because scientific principles and inventions have become so universal and pervasive in our daily life. Scientific inventions have now helped widely in all the traditional vocations nowadays like-agriculture, poultry farming, and dairy farming. Science has also revolutionized modern vocations like-telephone, radio, and television broadcasting etc.

Psychological value:

Study of science fulfils the psychological needs of man and helps in evolution of natural curiosity and other instincts like instinct of collection, ego, and self-expression. The instincts of curiosity are responsible for the urge of investigation, experimentation, and research. In this way, the study of science develops all the latent faculties of a child.

Whether we consider from personal or from social point of view, the study of science has its special importance. The joy and bliss are obtained from successful investigation of scientific problems but in addition to it, it also gives children self-confidence and insight for solving any life-problem faced by them. In brief, the study of science gives us self-confidence and teaches us to lead a successful and meaningful life.

Develops problem-solving skills:

With the knowledge of science, we learn to think logically and solve a problem. It is this problem-solving skill, which is learnt in the early years that has enabled a person to solve problems. Communications, medicine, transportation, and almost everything we see around us are mainly present because individuals have used their knowledge of science to create real life applications. Knowledge in this subject also enables us to understand many other subjects better.

Awareness about technology:

Learning the basics of how certain devices work can help you in developing ideas of your own and invent new technology. Even the knowledge of how to use telescope, microscopes, and other devices in a laboratory can help you in examining objects and determining differences between them. Fixing minor problems in electronic objects in your own home is possible when you have the basic knowledge about technology.

How to conserve natural resources:

All aspects of the environment have a deep impact on our lives. As a student, science helps you to learn about how the earth functions and how to make use of natural resources. It also teaches you how the lack of these resources affects living things and how you can conserve these resources.

When you learn wildlife in science, you will learn about the many species that are already extinct, because of storage or absence of certain resources and environmental changes. Awareness about such aspects can help you contribute towards preserving wildlife. Science also teaches you to recycle and reuse products and promote a greener

environment. This knowledge is very essential to help in saving our planet for the future.

Instills survival skills:

Science helps to learn about the various weather conditions, and helps to distinguish between normal weather and dangerous weather. With this knowledge, learners can stay alert about the natural disasters or how to survive the disaster. As the learners learn about the characteristics of different objects that they use in day-to-day life, they will be able to distinguish between things that are safe to eat and those that they should not. Almost everything that a person does requires a basic knowledge of science, and logical reasoning that is based on this subject. So, it is undoubtedly necessary to learn science from the early years of school.

1.10 Role of Biology in Human Welfare

The development of science and technology is directly related to the development of human race. The developing civilizations utilized the knowledge of science and technology for their growth. We can say that the better conditions of human living are all based on the scientific inventions. The knowledge of biological science has really benefited the mankind. Some of its effects are:

Food

Food is a major requirement for all human beings. Our country is a thickly populated country and growing and supplying adequate food for all citizens is a major problem faced by our governments. The knowledge of Biology has helped the farmers as well as scientists to develop better quality seeds, healthy agricultural practices, resistant varieties, hybrids, pest control techniques, and obtain a better yield of foodgrains. Advanced techniques like tissue culture, production of synthetic seeds, and bio-control techniques can

also be explained to the farmers to obtain better yields. The growth of poultry and aquaculture is the result of biological science. The knowledge of Biology has helped in the Green Revolution and White Revolution in our country.

Health

The knowledge of biological science has revolutionized the field of medicine. It has improved the value of human life and increased the human lifespan. The research in this field has resulted in developing vaccines and medicines for eradicating the dreadful diseases. Here, we can quote the eradication of diseases like small pox and control of plague. We have recognized the importance of balanced diet and have developed methods to control malnutrition and mineral deficiencies by taking appropriate food. New inventions in pharmaceutical field led to the production of new drugs in the areas of cancer, heart ailments, AIDS, etc., bringing a ray of hope to the ailing. Developments of microsurgery, laser surgery, and non-invasive surgical techniques have made surgeries simple. Development in advanced diagnostic techniques has helped in the identification and cure of diseases. Advancement in life sciences has really helped in improving the standard of health in the human beings.

Population

Increase in population is the root cause of all problems in the world. The uncontrolled explosion of population results in scarcity of food, which causes a number of problems for the human beings. The knowledge of science helps in educating the people about the problems of over population and importance of population control. The need for family planning and advantages of small family norms, maintaining the health of the family, importance of health of the mother and child etc., are all understood by the knowledge of biological science.

Improvement of Domestic/Wild Animals

The growth and development related practices like poultry, dairy farming, aquaculture and pisciculture (fish farming) are all required for developing self-sufficiency by the people. The knowledge of Biology gives an insight into these practices and helps in the development of cross-breeds for giving more yields of meat and milk, disease resistance and vaccines for diseases and developing artificial breeding methods for improvement of population.

Production of Bio-products

Today is the age of biotechnology. Every individual has focused his/her attention on producing something from biological organisms. The development of alternative sources of food - the algal proteins from single cell cultures of chlorella, and spirulina have already taken place. Biological control of pests and diseases, production of bio-fertilizers in the place of conventional chemical fertilizers are the result of advancement in science and technology.

Conservation of Natural Resources

Conservation of environment is a major task of all the people today. Protection of our environment helps in protecting our human race. Forests are the natural sources which help in maintaining and balancing our environment. But degradation of this wealth and misuse of it has created a lot of imbalance, which has a negative effect on all aspects of our environment. The increase in temperatures, reduction of rainfall, depletion of our forest resources, loss of the snow cover, extinction of a number of plants and animal species is directly or indirectly related to the environmental degradation. To protect our mother nature, it has become mandatory for every person to help in the conservation of our natural resources, mainly forests and our environment. The social forestry programmes and afforestation programmes and

animal protection programmes have become the need of the day.

New Innovations for Improvement of Living Beings

Great advancements have occurred in the field of genetics resulting in the development of many scientific techniques, which could open new vistas of knowledge relating to the basic chromosome structures and DNA and RNA. This resulted in the vast exploration of biological principles pertaining to plants, animals, and man. The advanced concepts of DNA Fingerprinting, Eugenics, Preservation of the Gene Pool, Chromosome Mapping, etc., are the result of this explosion of knowledge. These have resulted in identifying genetic disorders, improving plant and animal gene pool, and the mapping of human gene. The Human Genome Project is the culmination of the efforts of all scientists which when completed will bring an all round development of human life.

Biology and Environment

Biology and environment are very closely related to each other. The study of Biology develops knowledge and understanding of the environment. Most of the aspects of Biology can be applied to the environment. It helps the individual to realize the importance of nature and appreciate nature. It creates awareness about the interrelationships among the organisms and the problems like environmental pollution, population explosion, and maintaining the health and sanitation of people, the deforestation and depletion of natural resources, and importance of maintaining ecological balance. Today, it has become important to relate the teaching of science to environment. It is called as Environmental Education. Environmental education can be defined as “an individual’s awareness of environment”.

With the growing trend of destruction of forest areas

due to increased population pressure and dependency on forest resources, there is an urgent need for creating an appropriate level of people's participation in environmental protection and conservation. The first step towards achieving this goal is to instill certain amount of environmental awareness through education in the students.

The chief goal of environmental education is to "prepare citizens capable of acting on behalf of the environment" by integrating information from different disciplines like social sciences and natural sciences. Integration of Mathematics, and physical science and biological science with the environment can be productively used in the educational system. The goal of environmental education can be achieved by using concepts of environment as a tool to teach Mathematics and Science, thereby infusing in the students the capability to tackle the environmental problems successfully in their everyday life.

The National Policy on Education (1986) has recommended that it is essential to develop an awareness of the environment by combining the classroom teaching with the application of environmental principles.

The UNESCO, Tbilisi Declaration, 1978 has said that "Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions".

The Objectives of Environmental Education are:

1. To develop an awareness of environment, and the physical, social, and aesthetic aspects of environment. To maintain adynamic equilibrium between all the six elements that support living system i.e., air, water, land,

flora, fauna, and light.

2. To develop the knowledge and understanding of the environment and its related problems.
3. To develop an attitude of responsibility towards environment and its conservation.
4. To acquire critical thinking skill, to identify and solve environmental problems.
5. To actively participate in environmental projects.
6. To plan the utilization of resources not only by present generation but also future generations without any exploitation.

Environmental education can be taught as part of topics in biological science or as a separate subject. The activities that form a part of the learning experiences of the students to develop environmental awareness are:

- Conducting discussions and debates on topics related to environment.
- Organizing field trips to impart an understanding of the nature and its problems.
- Developing simulated situations for environmental studies.
- Organizing project work on environmental problems.
- Creating an interest in environment by developing reading habits.

1.11 The Taxonomy Group

The idea for the classification of educational objectives first of all came up in an informal meeting of the college examiners attending the 1948 American Psychological Association convention in Boston U.S.A. The examiners at this meeting felt the same theoretical framework which could be utilized to exchange ideas and material among test workers shall facilitate communication among examiners.

The work done by the Taxonomy group started in 1949.

The examiners agreed that educational objectives should be classified under the following three domains:

- Cognitive
- Affective
- Psychomotor.

The taxonomy group consisting of **Benjamin E. Bloom, Max Englehardt, Edward First, Walker Hill** and **David R. Krathwohl** made a comprehensive attack on the problems of educational objectives. The group was of the view that the objective should be stated in behaviour form which can be observed and described. The group discussed the principles by which the taxonomy was developed. The group agreed that taxonomy should have educational, logical, and psychological basis.

1.11.1 Bloom's Taxonomy

Objectives

- To facilitate communication among teachers, examiners, and others educational workers.
- To set up a comprehensive, systematic list of the types of behavior at which educational procedures may aim.
- To provide a source of hypotheses and questions for methods of developing curricula, teaching methods, and testing techniques.
- To arrange educational behaviours or objectives, from simple or complex.
- In general, to lay bare many of the hitherto concealed assumptions underlying the statements of objectives that educators have developed in the past.

Domains

The educational objectives were divided into three major parts- the cognitive, the affective, and the psycho-

motor domains. They are described ahead in detail.

Cognitive Domain

It has been till now very well investigated and may include those objectives which deal with the recall and recognition of knowledge and development of intellectual abilities and skills.

1. **Knowledge Objective**—The cognitive objectives are concerned with the development of recall and recognition activities of the pupils with the help of terms, facts, information and theories. These create essential conditions for recalling and recognising the conventions, laws, theories, criteria, and categories by the pupils. From content's viewpoint, the following are the three levels in the knowledge category:

2. **Knowledge of Specifics**—Knowledge of specific means recalling of specific terminology, facts and informations. The knowledge of specific is also divided into two—(a) Knowledge of terminology and (b) Knowledge of specific facts. The knowledge of terminology is the knowledge of verbal and non-verbal references. These have normal signs and these include defining specific terms, description of their qualities, relationships and their parts so that the general meaning of the various terms may be acquired. Contrary to this, the specific facts mean the knowledge of events, dates, places and the persons. The knowledge of specific facts is concerned with the general knowledge of specific facts and their recalling.

3. **Knowledge of Ways and Means of Dealing with Specifics**—In this, appropriate decisions are taken and the criticism is carried out by studying systematically the various ways and means of the knowledge. Bloom has divided the ways and means dealing with specifics into the following five categories:

1. Knowledge of Conventions
2. Knowledge of Trends and Sequences
3. Knowledge of Criteria
4. Knowledge of Methodology
5. Knowledge of Classification and Categories

Knowledge of Universals and Abstractions is concerned with laws and principles. Prof. Bloom has given two forms of knowledge of universals—(a) Knowledge of principles and generalization and (b) Knowledge of theories and structures.

Comprehension - It means understanding of new knowledge to the pupils. It includes knowledge. The pupils who have comprehension of the contents, i.e. the recalling and recognition abilities regarding certain contents have been developed; they can carry on the activities of translation, interpretation, and extrapolation on the basis of comprehension objective. Thus, comprehension activities have three levels—(i) Translation, (ii) Interpretation and (iii) Extrapolation.

Application-Application objective also has three levels—(i) Generalisation of laws and principles, (ii) Diagnosis of pupils' weaknesses and (iii) Use of contents or terms and laws by the pupils in their own statements.

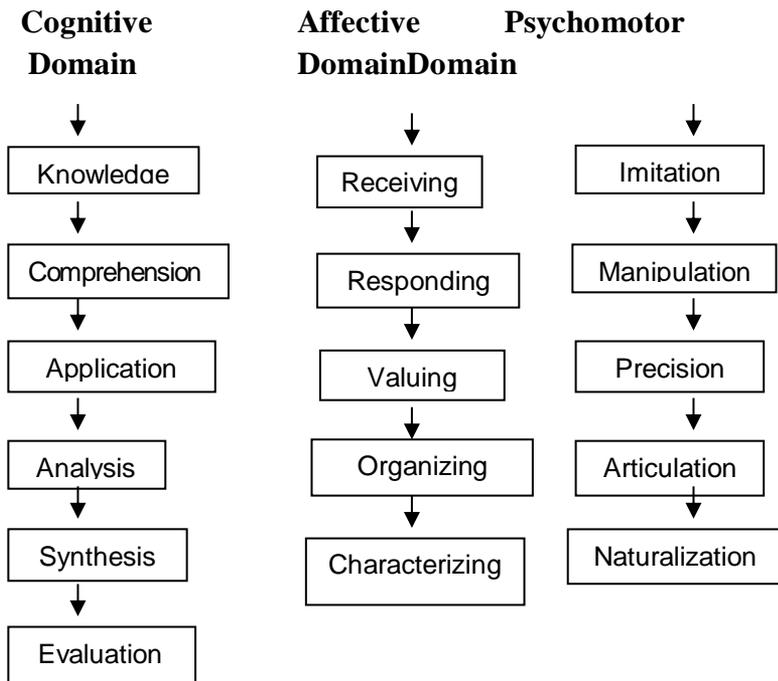
Analysis - Analysis is possible only when the knowledge, comprehension, and application objectives have been acquired. The analysis objective includes division of the contents into its elements and these are mutually related. Analysis objective has also three levels—(i) analysis of elements, (ii) analysis of relationships, and (iii) analysis of organised principles.

Synthesis - Synthesis is termed as the creative objective. The elements analysed in this step are assembled to give a complete picture and a new format is prepared. It develops the creative abilities of the pupils. Synthesis also has three

levels—(i) Production of unique communication,(ii) Production of a plan or proposed set of operations after synthesizing the elements, (iii) Derivations of a set of abstract relations.

Evaluation—Evaluation, the highest level of the cognitive domain, is a continuous process. After making critical decisions regarding the laws of contents, principles, and facts it is explored by tests or other types of norms that

- (i) Whether the determined teaching objectives have been achieved or not? If yes, to what extent?
- (ii) Whether the learning experiences created in the class-room proved effective or not amongst pupils? and
- (iii) How fairly the teaching objectives have been achieved?



Affective Domain

Affective objective is concerned with the interests,

emotions, mental tendencies, and values of the pupils. The development of affective domain is not easy because interests, emotions, mental tendencies, and sentiments are individual conditions, first concerned with a particular person and then with other persons. It is not easy to understand their nature and determine elements. Since our interests, sentiments, and mental tendencies are taken as the criteria for our personality, these occupy important place in education. It is the duty of the teacher to develop the affective domain of the pupils by affective objectives i.e. their interest, emotions, mental tendencies, and sentiments. Bloom has divided affective objectives into the following categories in order to develop the affective domain of the pupils:

1. Receiving
2. Responding
3. Valuing
4. Conceptualization
5. Organization
6. Characterization of a value System

1. Receiving - Receiving means pupil's will to receive. It is directly concerned with the sensitivity of the pupils which occurs in the presence of some activity or stimulus. Receiving has the following three levels:

- Awareness of the phenomena
- Willingness to receive phenomena
- Controlled or selected scheme

2. Responding - In this, pupils actively receive new knowledge under the influence of motivation. Responding has three levels:

- Acquiescence in responding
- Willingness to respond
- Satisfaction in response

3. Valuing - Valuing means those values in which the pupils have their belief and they give special importance to those in their life. It enables the pupils in showing the sentiments or stable feelings in their behaviour with the change in the circumstances. It has three levels:

- Acceptance of a value
- Preference for a value
- Commitment

4. Conceptualization - As the conviction regarding those values starts forming in the pupils, situations can also arise where more than one value is appropriate. In such situations, pupils think which value they should retain.

5. Organization - When such a situation changes before the pupils in which there is more than one value is appropriate, then they **organise** these received values in an order or sequence.

6. Characterization of a Value System - It is that level in which the consistency in the hierarchy of values of the pupil occurs. At this level, the teacher can characterise the knowledge of the value system of the pupils very easily. The characterisation of a value system has two levels:

- Generalized set
- Characterization

Psychomotor Domain.

1. Perception: Skill of keen observation, skill of sensing a problem and skill of developing self motivation are the specific objectives under this category.

2. Imitation: Skill of repeating the actions and skill of reflective thinking are the specific objectives under this category.

3. Manipulation: Skill to operate upon with intelligence and manage cleverly are the specific activities that fall in this category.

4. Precision: Skill of experimentation, skill of precise movements and neat execution of skills are the activities which fall under this objectives.

5. Articulation: Skill of logical thinking, reflective thinking, skill of mind and body and development of mathematical skill are specific objectives to attain this step.

6. Naturalization: As we practise a skill, in due course it becomes our natural habit. Skill of attaining success and skill of multiple actions are the specific activities under this objective.

Since science is a study usually involving direct experimentation, the psycho-motor domain has got great relevance.

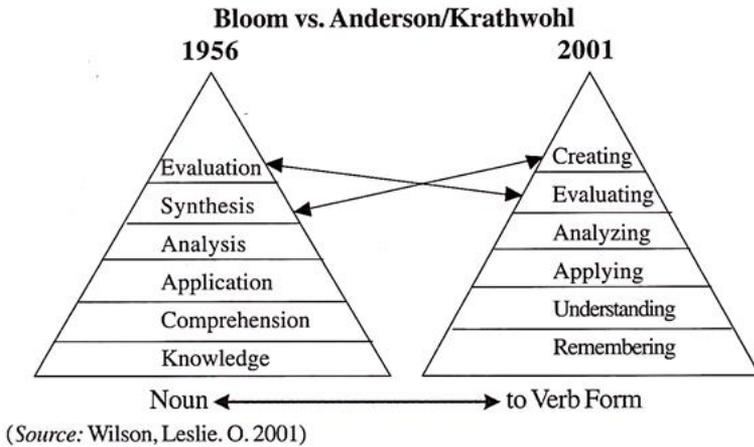
Blooms Taxonomy of Educational Objectives

Objectives	Ability	Associated Verbs
1. Knowledge	Recall, Recognize	Define, state, list, name, write, recall, recognize, label, underline, , reproduce, measure
2. Comprehension	Sees relationship, cites examples, Discriminate, Verify, Generalize	Identify, justify, select, illustrate, formulate, explain, classify, judge, justify
3. Application	Give reason, Formulate Hypothesis, Establish relation, Give inference	Predict assess, choose, demonstrate, construct, show, compute
4. Analysis	Analyse	Identify, conclude, differentiate, separate, compare,

		contrast, break down, resolve, criticise
5. Synthesis	Synthesise	Combine, summarise, organize, derive, relate, conclude, generalise
6. Evaluation	Evaluate	Determine define, criticise, evaluate

1.11.2 Anderson&Krathwohl’s Revised Blooms Taxonomy (2001)

In 1956, Benjamin S. Bloom classified domains of human learning into three parts – cognitive (knowing or head), affective (feeling or heart) and psychomotor (doing or kinesthetic, tactile or hand/body) as the educational objectives. Bloom’s taxonomy dealt with the varied aspects of human learning and was arranged hierarchically, preceding from the simplest functions to those that are more complex. However, over a period of time, new ideas and insight emerged about teaching-learning processes. In order to reflect their changed insight, and yield of researches and to meet the needs of the teaching-learning scenario of the twenty-first century learners, Lorin. W. Anderson, a former student of Bloom and David. R. Krathwohl, one of the co-authors of Bloom’s book, led a team of experts in revising Bloom’s taxonomy. The result was published in 2001 in the form of a book- *A Taxonomy of Learning, Teaching and Assessing- A Revision of Bloom’s Taxonomy of educational objectives* (New york- Allyn and Bacon). The revised taxonomy appears similar, yet with significant changes.



Anderson Krathwohl Blooms taxonomy:

Remembering: Learner’s ability to recall information

Understanding: Learner’s ability to understand information

Applying: Learner’s ability to use information in a new way

Analyzing: Learner’s ability to break down information into its essential parts

Evaluating: Learner’s ability to judge or criticize information

Creating: Learner’s ability to create something new from different elements of information

The Revised Taxonomy is Different in Three Ways-

(i) Terminology:

- It is a shift from the noun to verb.
- The word knowledge was considered as a category of thinking and is replaced by remembering. Thinking is an active process and knowledge is the product of thinking. Knowledge is not viewed as a form of thinking.
 - Comprehension is revised as understanding.
 - Evaluating has replaced evaluation. The word synthesis was not very communicative about the learning actions. Therefore, it is replaced by creating and putting the learnt things together in a novel way.

- The sub categories of the six categories are all in the form of verbs.

(ii) Structure:

In Bloom’s taxonomy, one has to find some ways to cut across different subject areas as the nature and contents of each subject area are different. Based on the theory of cognitive psychology, Anderson and Krathwohl came up with four dimensions of knowledge.

The intersection of the knowledge dimension and cognitive process dimensions gives 24 cells making the taxonomy table two-dimensional crossing of rows and columns shows knowledge and cognitive process being equally important. Let us see the meaning of different dimensions of knowledge in the context of biological science.

Two-dimensional taxonomy given by Anderson and Krathwohl

<i>Knowledge Dimension</i>	<i>Cognitive Process Dimension</i>					
	<i>Remembering</i>	<i>Understanding</i>	<i>Applying</i>	<i>Analysing</i>	<i>Evaluating</i>	<i>Creating</i>
Facutal knowledge						
Conceptual knowledge						
Procedural knowledge						
Metacognitive knowledge						

Factual Knowledge is the knowledge that is basic to specific disciplines. This dimension refers to essential facts, terminology, details or elements students must know or be familiar with in order to understand a discipline or solve a problem in it.a) Knowledge of terminology (b) knowledge of specific details and elements.

Conceptual Knowledge is the knowledge of classifications, principles, generalizations, theories, models, or structures pertinent to a particular disciplinary area.(a) knowledge of

classification (b) knowledge of principles and generalization
(c) knowledge of theories, models and structures

Procedural Knowledge refers to information or knowledge that helps the students to do something specific to a discipline, subject, or area of study. It also refers to the methods of inquiry, very specific or finite skills, algorithms, techniques, and particular methodologies.

- (a) Knowledge of subject specific skills and algorithms
- (b) Knowledge of techniques and methods
- (c) Knowledge of criteria for determining when to use appropriate procedures

Metacognitive Knowledge is the awareness of one's own cognition and particular cognitive processes. It is the strategic or reflective knowledge about how to go about solving problems, cognitive tasks, to include contextual and conditional knowledge and knowledge of self.

- (a) Strategic knowledge
- (b) cognitive tasks, including appropriate contextual and conditional knowledge,
- (c) self-knowledge

Thus, the structure is different in the following ways:

- (a) One dimensional taxonomy is revised in two dimensional forms.
- (b) The order of synthesis and evaluation is interchanged as the taxonomy is considered to reflect thinking levels in increasing order of complexities. Creative thinking (synthesis) is more complex form of thinking than critical thinking (evaluation). One can have critical thinking (judging and justifying ideas or things) without being creative (accepting or rejecting ideas to create new ideas or things).
- (c) In Bloom's taxonomy, evaluation was the upper most level of thinking. In the revised taxonomy, creating is at the top in the hierarchy.

(iii) Emphasis:

(a) The revised taxonomy is more authentic tool for curriculum planning, developing materials for teaching, and assessment process.

(b) Bloom's taxonomy was viewed as the tools best applied in the earlier years of schooling. Anderson and Krathwohl taxonomy can easily be used for higher level also. In this sense, it is broader in use.

(c) Emphasis is more on the description of the subcategories of learning.

For example-

(i) Recognizing- Locating knowledge in memory that is consistent with the presented material.

(ii) Recalling- Retrieving relevant knowledge from long term memory.

Thus, we see that the revised Bloom's taxonomy has a number of subcategories of the cognitive processes. It is more explicit and provides a powerful tool to help in structuring the teaching-learning strategies and processes.

REVIEW QUESTIONS

1. What are instructional objectives? Discuss their relationship with general aims and objectives in relationship to the biological science teaching.
2. What is blooms taxonomy of instructional objectives? Provide the taxonomies of objectives in cognitive affective and psychomotor domain behaviour.
3. Classify and discuss the importance of science
4. Biology is a science. Critically evaluate how the knowledge of science helps in daily life.
5. Explain how you can relate biology with other subjects.

Chapter 2

MICRO-TEACHING AND MINI-TEACHING

2.1 Micro-Teaching

Micro-teaching technique was first adopted by Dwight W. Allen and his coworkers in 1961 at Stanford University, USA. Micro-teaching is one of the most important developments in the field of teaching practice. Micro-teaching is a constitute teacher training technique. It is a versatile tool that simplifies the teaching skills. Micro-teaching is a stimulated skill teaching to provide feedback to teacher trainees for the modifications of teacher behaviour. It is more an analytical method and completely new approach to provide feedback to modify teachers' behaviour according to the specified objectives. Micro-teaching is a controlled practice in which the normal complexities of classroom are reduced and that makes it possible to concentrate on teaching behaviour in the student teacher training programme.

- Micro-teaching is a training procedure for teacher preparation, aimed at simplifying the complexities of the regular teaching process.
- It is a scaled down sample of teaching in which a teacher and a small group of 5 to 10 pupils participate for a small period of 5 to 10 minutes. Such a situation offers a helpful setting for a teacher to acquire new teaching skills and to refine the old ones.
- Micro-teaching is a new design for teacher training with feedback about their performances immediately after the completion of lessons.

2.2 Definition of Micro-Teaching

- **Dwight** Allen, “Micro-teaching is the scaled down teaching encounter.”
- **M.B. Buch**(1968), “Micro-teaching is a teacher education technique which allows teachers to apply clearly defined teaching skills to carefully prepared lessons is planned series of five to ten minutes encounters with a small group of real students, often with an opportunity to observe the results on video-tape.”
- **Allen** and **Eve** (1968), “A system of controlled practice that makes it possible to concentrate on specific teaching behaviour and to practice teaching controlled conditions.”

2.3 Characteristics of Micro-Teaching

- It is a real teaching. It focuses on developing teaching skills and competencies.
- It is an analytical approach to training.
- It is a relatively new innovation in the field of teacher effective education.
- It is a highly individualized training device to prepare effective teachers.
- It produces adequate feedback for the trainees’ performances.
- It is a scaled down teaching.
- It reduces the class size up to 5 to 10 pupils.
- It reduces the duration of the period up to 5 to 10 minutes.
- It reduces the size of the topic.
- It reduces the number of teaching skills. A single skill is practiced.
- The usage of video – tape and closed circuit television makes the observations very objective.

- The teacher trainees are enabled to gain confidence in teaching and to master a number of skills by dealing with a small group of pupils.
- They are also enabled to learn and assimilate new teaching skills under controlled.

2.4 Concept of Micro-Teaching

Micro-teaching is a teacher training technique which helps the teacher trainee to master the teaching skills. It requires the teacher trainee

- to teach a single concept of content
- to use a specified teaching skill for a short time to a very small member of pupils

In this way, the teacher trainee practices the particular teaching skill in terms of definable, observable, measurable, and controllable form with repeated cycles till s/he attains mastery in using the skill.

2.5 Micro-Teaching Cycle

The six steps generally involved in micro-teaching cycle are Planning, Teaching, Feedback, Re-planning, Re-feedback, and Re-teaching.



There can be variations as per the requirements of the objective of practice session. These steps are diagrammatically represented in the following figure:

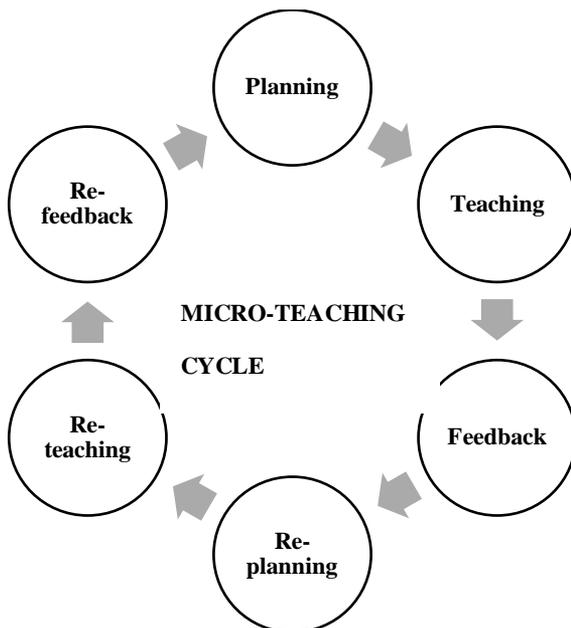


Figure: Micro-Teaching Cycle

Duration of microteaching cycle is given below:

Plan	–	6 minutes
Teach	–	6 minutes
Feedback	–	6 minutes
Re-plan	–	6 minutes
Re-teach	–	6 minutes
Re-feedback	–	6 minutes
Total	–	36 minutes

2.5.1 Definitions of the Steps Involved

- ❖ **Planning:** This involves the selection of the topic and related content in such a nature that the components used for the skill under practice may be made easily and conveniently. The topic is analyzed through different activities by the teacher and the pupils. The activities are planned in such a logical sequence where maximum application of the components of a skill is possible.

- ❖ **Teaching:** This involves the attempts of the teacher trainee to use the components of the skill in suitable situations, coming up in the process of teaching-learning, as per his/her planning of the activities. If the situation is different and not as visualized in the planning of the activities, the teacher should modify his/her behavior as per the demand of the situation in the class. S/He should have the courage and confidence to handle the situation arising in the class effectively.
- ❖ **Feedback:** This term refers to giving information to the teacher trainee about his/her performance. The information includes the points of strength as well as weakness relating to his/her performance. This helps the teacher trainee to improve upon his/her performance in the desired direction.
- ❖ **Re-planning:** The teacher trainee re-plans his/her lesson by incorporating the points of strength and removing the unskillfully handled points during the teaching in the previous attempt, either on the same topic or on another topic suiting to the teacher trainee for improvement.
- ❖ **Re-teaching:** This involves teaching to the same group of pupils if the topic is changed, or to a different group of pupils if the topic is the same. This is done to remove boredom or monotony of the pupil. The teacher trainee teaches the class with renewed courage and confidence to perform better than the previous attempt.
- ❖ **Re-feedback:** This is the most important component of Micro-teaching for behaviormodification of teacher trainee in the desired direction in each and every skill practice.

2.6 Main Assumptions of Micro-Teaching

In the words of Allen and Ryan, micro-teaching is an idea at the core of which lies five essential assumptions:

- ❖ **Real teaching:** Micro-teaching is a real teaching. Although the teaching situation is a constructed one in the sense that teacher and students work together in a practice situation, nevertheless, bonafide teaching does take place.
- ❖ **Reducing complexities:** Micro-teaching lessens the complexities of a normal class-room teaching. The size of the class, scope of content, and time are all reduced.
- ❖ **Focus on training:** Micro-teaching focuses on training for the accomplishment of specific tasks. These tasks may be the practice of techniques of teaching, the mastery of certain curricular materials, or the demonstration of teaching methods.
- ❖ **Increased control of practice:** Micro-teaching allows increased control of practice. In the practice setting of micro-teaching, the rituals of time, students, methods of feedback and supervision, and many other factors can be manipulated. As a result, a high degree of control can be built into the training programme.
- ❖ **Expanding knowledge of results:** Micro-teaching greatly expands the normal knowledge of results or feedback dimensions in teaching. Immediately after teaching a brief micro-lesson, the trainee engages in a critique of his performance. To give him/her the maximum insight into his/her performance, several sources of feedback are laid at his/her disposal.

2.7 Underlying Principles of Micro-Teaching

Micro-teaching revolves around certain principles to improve its reach in all round development of the teachers.

1. **One skill at one time:** The skills in micro-teaching are targeted one at a time. Training in particular skills is given until it is mastered. Once mastered, another skill is targeted next. Thus, micro-teaching aims at one skill at a time.
2. **Small scale content:** Limiting the content gives more freedom and ease to the trainees. Thus, micro-teaching is

based upon the principle of limited content. Teachers are to prepare their lessons within the given content therefore it becomes easier for them to conduct their lessons.

3. **Practice makes a man perfect:** Mastering skills require practice. While focusing on one skill at a time, micro teaching program also gives an opportunity to practice those skills. Lots of practice can boost the self-confidence and promote in the development of teaching skills.
4. **Experiments:** Experiments are the key factors in any concept. In micro-teaching, many experiments are conducted in order to test the skills of the teachers. For example, the supervisors conduct experiments where the length of the lessons, time duration, strength of the students in the class, etc., are changed. These skills are tested under controlled condition.
5. **Instantaneous feedbacks:** Micro-teaching consists of teacher-pupil and supervisor as students. Once a session ends, the teacher-pupil and supervisors come up with their feedback. This feedback is given instantly after the lesson plan ends. Thus, it helps in rectifying the drawbacks.
6. **Self-evaluating opportunities:** Evaluation plays an important role in any task. In micro-teaching, supervisors conduct various test and thus there are several chances to analyze the mistakes. Evaluation gives an opportunity to understand the mistake and overcome it. This program includes a session where drawbacks are pointed out along with their solutions. Thus, overall improvement becomes an easier target.
7. **Continuous efforts:** Acquiring and mastering skills is a slow and ongoing process. Even after mastering a previous skill, one should continually strive for betterment. Continuous efforts make it easier to attain overall development.

2.8 Steps of Micro-Teaching

The Micro-teaching programmes involve the following steps:

Step I- Particular skill to be practiced is explained to the teacher trainees, in terms of the purpose and components of the skill, with suitable examples.

Step II-The teacher trainer gives demonstration of the skill in Micro-teaching in simulated conditions to the teacher trainees.

Step III-The teacher trainee plans a short lesson plan on the basis of the demonstrated skill for his/her practice.

Step IV-The teacher trainee teaches the lesson to a small group of pupils. His/her lesson is supervised by the supervisor and the peers.

Step V-On the basis of the observation of a lesson, the supervisor gives feedback to the teacher trainee. S/He also reinforces the instances of effective use of the skill and draws the attention of the teacher trainee to the points where s/he could not do well.

Step VI - In the light of the feedback given by the supervisor, the teacher trainee re-plans the lesson plan, in order to use the skill more effectively in the second trial.

Step VII -The revised lesson is taught to another comparable group of pupils.

Step VIII - The supervisor observes the re-taught lesson and gives re-feedback to the teacher trainee with convincing arguments and reasons.

Step IX - The ‘teach – re-teach’ cycle may be repeated several times till adequate mastery level is achieved.

2.9 Rationale of Micro-Teaching Procedure

The steps of the Micro-teaching procedure are based on the sequence involved in behaviour modification formulated by McDonald. The steps are:

Step I: This involves stating the behaviour in operational terms.

Step II: This refers to the fixing of the criteria for measuring behaviours.

Step III: In this step, the entry behaviour of the individual is measured to know the point of the initial start.

Step IV: This involves the actual treatment of the behaviour modification.

Step V: The post-treatment measures of the changed behavior are obtained. The difference between the measures of the pre and the post treatments indicates the extent of behavior modification. The cycle is repeated till the desired level of behaviour is obtained.

In the Micro-teaching cycle, the same steps are involved.

- ❖ **Firstly**, the teacher trainee knows the behaviours (components of skill) to be practiced.
- ❖ **Secondly**, s/he practices the behaviour during the teaching session.
- ❖ **Thirdly**, s/he gets the feedback on the basis of the observation of his/her performance made by the supervisor.
- ❖ **Finally**, the teacher trainee improves upon his/her behaviour (performance) as desired.

2.10. Phases of Micro-Teaching

There are three phases of the Micro-teaching procedure which you have studied in the previous section of this Unit. They are:

1. Knowledge Acquisition Phase
2. Skill Acquisition Phase
3. Transfer Phase of Micro-teaching

Let us discuss these phases one by one.

1. Knowledge Acquisition Phase: In this phase the teacher trainee learns about the skill and its components through

discussion, illustrations, and demonstration of the skill given by the expert. S/He learns about the purpose of the skill and the condition under which it proves useful in the teaching-learning process. His/her analysis of the skill into components, leading to various types of behaviours, is to be practiced. The teacher trainee tries to gain a lot about the skill from the demonstration given by the expert. S/He discusses and clarifies each and every aspect of the skill.

2. **Skill Acquisition Phase:** On the basis of the demonstration presented by the expert, the teacher trainee plans a micro-lesson, a lesson for practicing the demonstrated skill. S/He practices the teaching skill through the Micro-teaching cycle and continues his/her efforts till the level of mastery is attained. The feedback component of micro-teaching contributes significantly towards the mastery level acquisition of the skill. On the basis of the performance of teacher trainee in teaching, the feedback is provided for the purpose of a change in behavior of the teacher trainee in the desired direction.
3. **Transfer Phase of Micro-teaching:** After attaining the mastery level and command over each of the skills, the teacher trainee integrates all these skills. The transfer to actual classroom teaching is done during this transfer phase.

2.10.1. Analysis of Teaching:

We have discussed that teaching is a complex process. To reduce the complexity of teaching, it is analyzed into simple teaching activities performed by the teacher during the teaching-learning process. The main objective of all these activities is to promote learning among pupils. These activities may be explaining, illustrating with examples, questioning, writing on the blackboard, drawing figures, etc. These verbal and non-verbal activities are called teaching activities.

Therefore, these specific teaching activities/arts/behaviours, which are observable, definable, measurable, and demonstrable and can be developed through training, are known as teaching skills. The teacher uses these skills in pre-instructional, instructional, and post-instructional stages in order to achieve the pre-determined and specified objectives. Therefore, teaching consists of a number of interrelated teaching skills, which occur at the different stages of teaching.

2.11 Teaching Skill

- A teaching skill is the behaviour of the teacher which facilitates the pupils' learning directly or indirectly.
- A teaching skill includes all the arts and behaviours of the teacher which maximizes pupils' learning.
- A teaching skill is the art of the teacher which makes communication between the teacher and pupils sufficiently.

Components of Micro-Teaching Technique:

1. Micro-Teaching Situations - These consist of the size of the class, the length of the content, and the teaching method. There are 5 to 10 pupils in the class and the teaching period ranges from 5 to 20 minutes. The content is presented in a unit.

2. Teaching Skill - The development of the teaching skills of the pupil-teachers is properly attended, such as lecturing skill, skill of black-board writing, skill of asking questions, etc.

3. Pupil-Teacher - During training, various capacities are developed in a pupil-teacher, such as the capacity of class management, the capacity of maintaining discipline, and the capacity of organizing various programmes in the school, etc.

4. Feedback Devices - Providing feedback is essential to bring changes in the behaviour of the pupils. This feedback can be provided through video-tape, audio-tape, and feedback questionnaires.

5. Micro-Teaching Laboratory - Necessary facilities for

feedback can be gathered in a laboratory.

2.12 Steps of Micro-Teaching Technique:

1. Defining a Specific Skill - Some specific skill is defined in the form of teaching behaviour and the knowledge of this defined skill is provided to the pupil-teachers. It includes fixing up of those objectives along with the skill which are to be achieved through the skill.

2. Demonstration of the skill - The skills are demonstrated through the micro-teaching lessons. This demonstration can be done by the teacher or a video-film of the skill can also be screened.

3. Micro-Lesson Plans – The pupil-teacher prepares micro-lesson plans concerning some specific skills training or by using that skill. These lesson plans are for the duration of 5 to 20 minutes.

4. Teaching a Small Group – The pupil-teacher teaches a small group of students. This group consists of 5 to 10 pupils. In this step, the teaching-task of the pupil-teacher is video-taped. If there is no provision of video, then any teacher can supervise the teaching task of the pupil-teacher. Other associate pupil-teacher can also supervise the teaching task of a pupil-teacher. As the teaching task of the pupil-teacher is over, his/her lesson is criticized.

5. Feedback – The information and suggestions provided to the pupil-teachers are known as feedback. This feedback is also an essential part of micro-teaching. In the absence of the feedback, the evaluation of this method has no meaning at all.

6. Re-planning, Re-teaching, and Re-evaluation – On the basis of the feedback, the pupil-teacher re-plans the lesson and re-teaches the re-planned lesson. After this, the re-planned and re-taught lesson is re-evaluated so that the pupil-teacher may get another opportunity to rectify his/her errors. The cycle of re-planning, re-teaching, and re-evaluation goes on till the pupil-teacher develops that teaching skill.

Advantages of Micro-Teaching

- It can be used in colleges.
- The pupil-teacher need not go to any school for the training of teaching skills.
- The number of students as well as the duration of teaching is less.

2.13 Meaning of Various Teaching Skills

1. Set Induction – It is the introduction of the lesson. This skill links the previous knowledge with the present knowledge. It is known as the skill of introduction or set-induction skill.

2. Stimulus Variation – It is the changing of gestures and positions by the teacher. If a teacher does not change his gestures and positions during the teaching process, it becomes boredom and the pupils lack interest. Hence, it is necessary to provide the training to the teachers in the skill of changing the gestures.

3. Probing Questions – It is concerned with the questions to be asked about the content in more depth. This stimulates the cognitive development of the pupils.

4. Illustration – There are two teaching methods—continuous lecturing method and demonstration method. The pupil-teachers should explain the concepts through examples and by displaying pictures and charts. It is called the illustrating skills.

5. Closure – It is to finish some task in class. The pupil-teacher exhibits various behaviours and if we divide these behaviours in smaller units, these are termed as ‘Skills’. When a pupil-teacher delivers lecture and sums up in an attractive way, the skill is termed as ‘Closure Skill’. In the absence of proper closure, the lesson remains ineffective.

6. Lecture – It is concerned with the effective presentation of the content. The teacher leaves his/her

impression by using many techniques and tactics through this skill. Sometimes, it is known as ‘Communication skill’.

7. Skill of Explaining – It is used for explaining or connecting links to link the statements or systematic information. In short, when a teacher shows his/her behaviour while explaining the pupils about ‘What’, ‘Why’ and ‘How’ regarding some facts, principles, and concepts, that behavior constitutes the skill of explaining.

8. Use of Blackboard – It is very essential in the class. Its use also needs special training. The necessary components of blackboard work are legibility, rationale of blackboard work, etc.

9. Use of Audio-Visual Aids – It is essential to make the teaching task more attractive and effective. Its use also needs a skill. Hence, the training of using Audio-Visual (A.V.) Aids to the teachers is also desirable.

10. Skill for Class Management – Various activities are performed in order to create proper environment for learning in the classroom. These activities include both social and educational. The performance of these activities needs special skill. These activities manage the class. This is named as ‘Skill for Class Management’.

11. Increasing Pupil’s Participation – It is concerned with increasing pupil participation by the teacher. Pupil’s participation means pupil’s direct observable behaviour. This includes both responses and reactions of the pupils along with their own new activities.

12. Recognizing Attending Behaviour – On the basis of the pupils’ behaviour, the teacher selects his/her own activities. The teacher also categorizes the interesting and boring activities.

2.13.1 Micro-teaching Skill

A skill is a specific behaviour or activity which requires doing on particular work of job or task. The performance of

the concerned activity is automatically improved through its learning and practice. Teaching activity involves different skills which are essential for effective teaching.

A teaching skill has been identified by N.L. Gage (1968) as “Teaching skills are specific instructional activities and procedures that a teacher may use in his classroom. These are related to the various stages of teaching or in the continuous flow of the teacher performance”.

Teaching constitutes a number of verbal and non-verbal acts. A set of related behaviours on teaching acts aim at specific objectives. These may be called as a teaching skill. All these teaching skills contribute to good teaching. These skills can be defined, observed, measured, and controlled by means of practice.

Micro-teaching concentrates on specific teaching behaviours. Here, the complex act of teaching is broken into simple components. Only a particular skill is practiced and mastered during the session. ‘How to teach’ is considered more important than ‘What to teach’.

The Australian Advisory Committee on Research and Development in Education has analysed teaching into 140 skills. Allen of the Stanford University (1969) has identified 14 teaching skills. In India, B.K. Passi has given a list of 13 teaching skills. M.K. Jangira and Ajit Singh (1982) of NCERT provide a list of 20 teaching skills.

Stanford University has given the following list of the teaching skills.

1. Stimulus variation
2. Set induction
3. Fluency in question
4. High order questions
5. Probing question
6. Silence and non-verbal cues

7. Reinforcing pupils participation
8. Illustrating and use of examples
9. Divergent questions
10. Planned repetition
11. Completeness of communication
12. Recognizing attending behaviour
13. Lecturing and
14. Closure

Dr. B. K. Passi (1975) in his book, *Becoming Better Teacher* has given the following list of teaching skills:

1. Writing instructional objectives
2. Introduction of the lesson or Set Induction
3. Fluency of questioning
4. Problematical questions
5. Explaining
6. Illustration
7. Stimulus variation
8. Silence and non-verbal cues
9. Reinforcement
10. Increasing pupil's participation
11. Use of Black Board
12. Achieving Closure and
13. Attending behaviour of the pupils

Definitions of Microteaching skill:

- Microteaching or Teaching skill is defined as a set of teacher behaviour which is especially effective in bringing about the desired changes in pupil-teachers.
- According to **Singh**, "Teaching skill is a set of teacher behaviours which are effective in bringing about desired changes in pupils".
- **Menon** defines teaching skill as "a group of behaviours which can be developed through practice and can be used in an equally efficient manner in situations other than these utilized for its practice".

2.13.2 Comparison between Micro-teaching and Traditional Teaching:

Micro-teaching	Traditional teaching
<ul style="list-style-type: none"> ❖ Objectives are specified in behavioral terms. ❖ Class consists of a small group of 5 to 10 students. ❖ The teacher takes up one skill at a time. ❖ Duration of time for teaching is 5 to 10 minutes. ❖ There is immediate feedback. ❖ Teaching is carried out under controlled condition/situation. ❖ Teaching is relatively simple. ❖ The role of the supervisor is specific and well defined to improve teaching. ❖ Patterns of classroom interaction can be studied objectively. 	<ul style="list-style-type: none"> ❖ Objectives are general and not specified in behavioral terms. ❖ Class consists of 40 to 60 students. ❖ The teacher practices several skills at a time. ❖ The duration is 40 to 60 minutes. ❖ Immediate feedback is not possible. ❖ There is no control over the situation. ❖ Teaching becomes complex. ❖ The role of the supervisor is vague. ❖ Pattern of classroom interaction cannot be studied objectively.

2.13.3. Microteaching skills and their components:

S. No.	Skill	Components
1.	Probing Questions	Prompting, seeking further information, redirection, focusing, increasing critical awareness
2.	Explaining	Clarity, continuity, relevance to content using beginning and concluding statements, covering essential points
3.	Illustrating with Examples	Simple, relevant and interesting examples appropriate media, use of inducts, deductive approach.
4.	Stimulus variation	Body movements, gestures, change in speech pattern, change in interaction style, pausing, focusing, oral-visual switching.
5.	Reinforce ment	Use of praise words and statements, accepting and using pupils' ideas, repeating and rephrasing, extra vertical cues, use of pleasant and approving gestures and expressions, writing pupils' answer on the black board.
6.	Classroom Managemen t	Calling pupils by names, Making norms of classroom behaviour, attending behaviour reinforced, clarity of direction, checking non-attending behaviour, keeping pupils in Eye Span, checking inappropriate behavior immediately.
7.	Use of blackboard	Legible, neat and adequate with reference to content covered.

2.13.4 Skill of Explaining

Explaining skill makes the pupils to understand the ideas, concepts, and principles, a teacher has to explain vividly. Explanation is a set of inter – related statements made by the teacher related to an idea or phenomenon. In order to be a good listener, the teacher trainee has to develop the following components

Components:

- **Cognitive Link (CL):** While introducing a new concept, the teacher has to follow the principle of ‘known to unknown’ establishing a link between the old (already known) concepts and the new one. A new concept, if it is complex, can be introducing and developed only through a series of sub-concepts. A new concept and the sub-concepts must be linked with one another logically.
- **Use of illustration (ILL):** A new concept is to be adequately illustrated in terms of vital situations or life experiences. Illustrations also include citing examples and non-example (if needed and if possible) illustrations must serve the purpose of concretizing the concerned abstract concepts.
- **Comparing and contrasting (CC):** Some concepts are often so closely interrelated that the pupils may find it difficult to discriminate between them. This may bring effective attention of the learner. His/her component serves the purpose of discriminating between the two related but different concepts.
- **Meaningful repetition (MM):** By repeating a brief description of a concept, a term or a definition at regular intervals, the ideas get fixed in the minds of the learners. Repletion must be purposive, deliberative, meaningful, and relevant. Over–repetition creates boredom to the learners. As such over-repetition should not be used.

2.13.5 Black Board Writing Skill

Black board is the powerful teaching aid to teach from KG to PG. Black board is the visual aid which is widely use in all sections of education and training. Though the development of information and communication technology is reducing the chalkboard work, it is the most suitable for giving a holistic picture of the lesson. A good black board work brings clearness in perception and it can be suitably used for displaying notes and diagrams during a lesson and for working through calculations in a classroom situation.

The components of the skill of use of black board are:-

1. Legibility (L)
2. Size and alignment (SA)
3. Highlighting the main points (HMP)
4. Utilization of the space (US)
5. Correctness (C)
6. Position of the teacher (PT)
7. Eye contact with pupils (ECP) and
8. Cleaning of black board (CB)

Components:

- **Legibility (L):** Legible handwriting of the teacher on the blackboard draws the attention of the learners and encourages them to improve their handwriting. Illegible handwriting irritates the learners and results in maximum mistakes. The teacher should see that a clear distinction is ensured between every letter. Adequate space is to be maintained between individual letters and words to make the handwriting more legible.

- **Size and Alignment (SA):** In black board writhing, the size and alignment of the letters is very important. The size of the letters on the black board should not only be uniform but also the size of the letters should be large enough to be read by the students in the last row. The size of the capital

letters should be as nearly vertical as possible without being diverged from the line.

- **Highlighting Main Points (HMP):** The teacher should underline to highlight the main points or words on the black board. Coloured chalks should be used suitably to draw the learner's attention on the main points.

- **Utilization of the Space (US):** For the proper utilization of the space, important words or statements should be written on the board. Overwriting on the letters should be avoided as it makes the black board work untidy. Only essential materials should be retained on the blackboard and unnecessary words should be rubbed off.

- **Correctness (C):** The teacher should be careful about the correct spelling, punctuation, grammar, etc., while constructing sentences on the blackboard. While writing on the black board, inadequate knowledge of English grammar or mistakes done by the teacher reduces the attentiveness of the learners in the classroom.

- **Position of the Teacher (PT):** At the time of writing, the teacher should stand on one side of the blackboard with an angle of 45 degree, so that the written work on the black board is visible to the learners. This means the teacher's position should not be in between the learners and the black board.

- **Eye Contact with Pupils (ECP):** The teacher should maintain eye contact with his/her learners at the time of writing on the board. This controlling interaction maintains discipline and sustains the attention of the learners. Too much or too less eye contact will be counter production in the classroom.

- **Cleaning Of Black Board (CB):** The teacher should clean the blackboard from top to bottom and not spread dust in the room. S/He should rub the points on the blackboard after the student notes them down. After the completion of the

lesson, the teacher should clean the entire blackboard before leaving the classroom.

2.13.6 Stimulus Variation Skill

Continuous use of the same stimulus for a long period reduces the attention in that activity. The teacher's behaviour influence the pupils' attention. Variation in stimulus secures more attention among the students.

The following components of the skill, stimulus variation, influence the teaching – learning process effectively.

1. Teacher's movement (TM)
2. Pupils' movement (PM)
3. Teacher's gesture (TG)
4. Sensory focus (SF)
5. Change in voice (CV)
6. Change in interaction pattern (CIP)
7. Pausing (P) and
8. Audio visual switching (AVS)

Components:

- **Teacher's Movement (TM):** The teacher should move from one place to another on the teaching dais and towards all the students to attract attention of the entire class and to focus the attention of the students to the teacher. The movement of the teacher secures and maintains the attention of the students.

- **Pupils' Movement (PM):** In this, pupils move from one place to another. The physical participation holds the pupils' interest and attention in this task in which they are engaged. Physical participation can be in the form of handling apparatus, dramatization, and writing on the blackboard.

- **Teacher's Gesture (TG):** Expression of feelings and emotions involving non- verbal behaviours are called gestures. Gestures consists of hand movements, eye movements, facial expressions, etc. Using of gestures

increase the effectiveness of verbal communication. Gestures: Eyes movement, facial expression, body movements, and movement of hands and legs.

- **Change in Voice (CV):** The teacher's voice dominates the entire class. Voice modulation, pitch, tone, and speed play a vital role in the classroom. While communicating, constant use of the same level of pitch, tone, and speed by the teacher makes his/her communication dull, inactive and has an adverse effect. So, the teachers should modulate their voice.

- **Sensory Focus (SF):** The movements, gestures, and change in the voice of teacher secure pupils' attention. The verbal statements and gestures together are known as verbal-cum-gesture focusing. Verbal-cum-gesture focusing is termed as a sensory focus. The sensory focus influences the attention of the students.

- ❖ Verbal Statement : Excellent

- ❖ Gesture : Nodding of head

- ❖ Verbal-cum-gesture: Excellent and nodding of head at a time.

- **Change in Interaction Pattern (CIP):** The interactive act of teaching is constantly a communication between the teacher and pupils as an initiatory or responsive act. The interaction is broadly of two types: Verbal and Non-verbal. This interaction is nothing but communication. When the teacher or pupil communicates non-verbally, interaction operates through gestures without talking. The main patterns of interaction between the teacher and the pupils are teacher-pupil interaction, teacher- group interaction, pupil-pupil interaction, and teacher-whole class interaction. The teacher should introduce variation in the interaction patterns to secure and maintain the pupils' attention.

- **Pausing (P):** Pausing is being silent for a few seconds. The silence indicates a pause during talk. Silence has a

meaning of its own and if it is used effectively, it helps in securing and sustaining the attention of the pupil.

- ❖ A short pause before saying something important is an effective way of attracting the pupils' attention.
- ❖ A pause of 3 seconds duration is considered appropriate for this purpose.
- ❖ If the pause is unduly long, it loses its effectiveness in serving pupils' attention.
- ❖ Appropriate pausing time: Response of the student to the teacher's question or change from one concept to another is: 3 seconds.
 - **Audio – Visual Switching (AVS):** Visual medium can be in the form of showing a chart, pictures, graph, map, model, or in the form of drawing pictures, figures and graphs on the blackboard. But, audio is used in the form of speech only.
- ❖ Only audio medium or only visual medium creates boredom in the class. A teacher while imparting knowledge to his/her pupils uses either audio or visual medium.
- ❖ A teacher should vary his medium in order to secure and sustain the attention i.e. from audio to visual, visual to audio, audio or visual too audio visual, vis – a – vis.

2.13.7 Reinforcement Skill

All pupils generally need social approval of their behaviour. When they answer a question, they are eager to know whether their answers are correct or not. When they are appreciated for the correct answers they are eager to continue their responses in future also. This increases their participation. The appreciation for correct responses is a positive reinforcement. The positive reinforcement is used for strengthening the responses or behaviours of the individuals. On the other hand, if the pupils are scolded or not encouraged

for their responses, they never participate in future. This kind of discouraging activity of the teacher is called negative reinforcement. The negative reinforcements are used for weakening or eliminating the undesirable responses or behaviours. These reinforcements are in the form of verbal and non-verbal.

These reinforcements are classified into four types as given below:

1. Positive verbal reinforcements(**PVR**)
2. Positive non-verbal reinforcements(**PNVR**)
3. Negative verbal reinforcements(**NVR**)
4. Negative non-verbal reinforcements(**NNVR**)

Components of reinforcement skill:

▪ **Positive Verbal Reinforcement (PVR) :** The verbal behaviour (statement) of the teacher accepts the students' feelings, repeats, rephrases the students' responses, surroundings student ideas, etc. Using responses words such as – excellent, fantastic, splendid, right , yes, correct, fine, continue, go-ahead, carryon, well done, etc., and extra verbal expressions such as ‘uh-uh’, ‘hm-hm’ etc., are positive verbal reinforcements.

▪ **Positive Non – Verbal Reinforcement (PNVR):** Using extra verbal cues like ‘um-um’, aha to encourage pupils while answering or writing the responses in the board, teacher's gestures, conveying pleasant feelings, approval of student responses such as smiling, nodding of head, delighted laugh, clapping, keeping eyes on the responding student and giving ear to the student indicate positive non-verbal reinforcements.

▪ **Negative Verbal Reinforcements (NVR):** Teacher's statements such as the use of discouraging words like, ‘no’ wrong, incorrect, stop it , non – sense, try something else, remark in a sarcastic way, I don't like what you are

doing, do not do like this, that is not good, etc., correspond to negative verbal reinforcements.

▪ **Negative Non- Verbal Reinforcements (NNVR):**

The teacher demonstrates his/her disapproval to indicate non-verbal expression of a student's inappropriate behaviour or incorrect response to his/her questions. Frowning, raising the eye brows, staring, disapproval by hands are negative reinforcements. The first two PVR and PNVR indicate the skill of desirable reinforcements whereas NVR and NNVR indicate the skill of undesirable reinforcements. Trainee should be encouraged to participate reinforces to increase pupil's participation. The undesirable reinforcements which affect students' learning adversely are to be avoided as far as possible. The teacher can withdraw the negative reinforcements in classroom interaction by practicing the reinforcement skill in microteaching.

2.13.8 Questioning Skill

Questioning has two aspects - Fluency in questioning and probing questioning.

- ❖ Fluency in questioning refers to the rate of meaningful questions asked per unit of time.
- ❖ Probing questioning refers to the depth in a pupil's response by asking a series of subsequent questions.

Let us now consider the fluency of questioning.

The questioning of the teacher stimulates thinking of the students. The teacher classifies and facilitates understanding of the concepts by questioning the students. In the teaching – learning process, questioning is a very significant technique. The new knowledge is assimilated with the previous knowledge by asking some questions. The questions develop curiosity among the students.

The effectiveness of questions depends on their particular use.

The types of questions are:

- ❖ Introductory questions

- ❖ Thought provoking questions
 - ❖ Prompting questions
 - ❖ Information seeking questions
 - ❖ Refocusing questions
 - ❖ Redirected questions
 - ❖ Increasing critical awareness questions
 - ❖ Open ended questions
 - ❖ High order questions
 - ❖ ‘Yes’ or ‘No’ type questions
 - ❖ Re-capitulatory questions etc.
1. The questions should be interesting and should arouse curiosity but they must be simple and undesirable to the students during the presentation of the lesson.
 2. Thought – provoking questions and probing questions are to be used.
 3. In recapitulation, recapitulatory questions are to be used.
 4. ‘Yes’ or ‘No’ type questions, elliptical questions, suggestive questions (echo questions), rhetorical questions, etc. should not be used.
 5. Questions should be grammatically correct, relevant to the topic discussed, specific and concise, put with proper speed and pause, put to the class with proper voice and not to be repeated unnecessarily.
 6. Questions for seeking further information are needed. The teacher asks prompting questions to lead to the pupils’ expected response. The teacher asks questions to increase critical awareness of the pupils about their responses.
 7. In the process of questioning, the pace should be appropriate by providing sufficient pauses. The voice of the teacher should be clear and audible to the learners with a pleasing tone and friendly manner.

Components of Probing Questions:

▪ **Probing questions:** The skill of probing questions involves going deep into student responses through step by step questioning with a view to elicit the required responses. Each question is followed by a variety of student responses such as to no response, wrong response, partially correct response, incomplete response, and correct response.

Let us consider the five response situations one by one.

▪ **No response situation:** No response situation may be there due to a student's inability to understand the questions, to structured response, or due to the lack of requisite facts, concepts, generalizations needed for the purpose of responding or the failure to recall the related facts.

▪ **Wrong response situation:** Wrong responses to a question indicate the lack of knowledge of facts, concepts and generalizations on the part of the student.

▪ **Partially correct response situation:** It represents the response parts, which are similar to the criterion or correct responses. The response reveals the partial knowledge of facts, concepts, and generalizations on the part of the students.

▪ **Incomplete response situation:** Sometimes when an incomplete response situation occurs, we infer that the either the student is not having the necessary facts, concepts or generalization in his memory or it may be due to his inability to understand or structure a response to the question.

▪ **Correct response situation:** Correct response situation refers to the statements expressed by the student, which completely satisfy the response.

These specific sets of behaviour (student response situation) are outlined in the ensuing skill components. The skill of probing questioning comprises component behaviours of seeking further information, redirecting, refocusing, and developing critical awareness. The components are:

1. Seeking further information (**SFI**)

2. Re focusing (**RF**)
3. Re directing (**RD**) and
4. Developing critical awareness (**DCA**)

▪ **Seeking Further Information (SFI):** Dealing with an incomplete response situation and partially responsive situation consists of eliciting additional information from the responding pupil to bring the initial response to the expected response in more complex and novel situations.

▪ **Re Focusing (RF):** To deal with ‘correct response situation’ the teacher refocuses on the pupil’s responses and wants the pupil to relax it to some area already learnt or requires the pupil to consider the implications of the given response in more complex and novel situations.

▪ **Re Directing (RD):** For more students’ involvement and to deal with ‘no response’, ‘incomplete response’ and partially correct response, the same question is redirected to more students for response.

▪ **Developing critical awareness:** This involves asking ‘why’ and ‘how’ of the correct response. The teacher expects the pupil to justify his response or explain its rationale. This process develops his critical awareness

2.13.9 Skill of Introducing a Lesson or Set of Induction

Success of teaching a lesson depends on its introduction. The attention of the students towards learning the matter starts with the introduction of the lesson. In this the new knowledge may be properly linked with the existing knowledge of pupils. The introductory questions should be based on the previous knowledge related to the present content and the teacher has to proceed from known to unknown. The skill of introducing a lesson establishes a rapport with the learners and facilitates concentration on his/her teaching. Effectiveness of introducing a lesson depends on the maximum use of previous knowledge and attention gaining of

the learners, adopting appropriate devices, continuity, and relevant questions or statements pertaining to the content.

Introducing a lesson significantly influences the learning of a new lesson. The various components of the skill involved in introduction of a lesson are:

1. Use of previous knowledge (**UPK**)
2. Preliminary attention gaining (**PAG**)
3. Use of appropriate device (**UAD**)
4. Arousing motivation (**AM**)
5. Relevance and Continuity or Sequencing of questions and Statements (**RC**)
6. Topic Declaration (**TD**)

▪ **Use of Previous Knowledge (UPK):** Previous knowledge of students refers to the level of achievements from previous experiences. Testing the previous knowledge of the students helps the teacher to establish integration between the pre-existing knowledge of the student and the new knowledge that the teacher wants to impart. Through this skill, the teacher knows the status of motivation, intellectual abilities, and socio-cultural background of the student.

▪ **Preliminary Attention Gaining (PAG):** In the beginning of a lesson, the students may not be in an attentive mood, being mentally unprepared for learning. The teacher's duty is to create a desire for learning among the students. The teacher attracts the students towards his/her teaching by doing some attractive activity and creating curiosity. To gain attention at the preliminary stage, interest or curiosity should be aroused among the students. The teacher can employ different attention attracting activities such as telling a story, recalling the previous experiences etc.

▪ **Use of Appropriate Device (UAD):** The teacher should make use of appropriate devices or techniques while introducing a lesson to motivate the students. The teacher

creates such a situation by the use of different types of devices such as:

1. Questioning
2. Use of examples, analogies, similarities
3. Story-telling, describing related instances
4. Lecturing, describing, narrating
5. Use of A.V. aids
6. Role-playing, dramatization
7. Demonstration, experimentation etc.

In order to motivate the learners, the use of such devices should be suitable to the age, experience, maturity, etc. of the learner. The devices could be relevant only if they are related to the aims of the lesson/content. Unrelated devices confuse the learners and do not contribute towards establishing a healthy rapport with them.

- **Arousing Motivation (AM):** The teacher should link the required previous knowledge with the present knowledge with motivation in introducing a lesson. The teacher should use the questions or activities to motivate the students towards the current topic or concept before declaring the topic or lesson.

- **Relevance and Continuity or Sequencing of questions and Statements (RC):** The teacher should use relevant and sequence questions to recall the previous knowledge, to generate motivation towards the lesson and attract the attention of the students.

- **Topic Declaration (TD):** The teacher should declare the topic or lesson after introducing the lesson. It indicates the beginning of presentation of the lesson. By this topic declaration, the students understand what they are going to learn in that period.

2.13.10 Demonstration Skill

Demonstration is an activity or process of teaching involving the showing of specimens or experiments or devices to explain and describe the concerned concept, idea, teaching point etc., in the teaching – learning process. That process makes the subject matter concrete with real life situation. The demonstration in teaching makes learning simpler and meaningful to the learner.

The components of demonstration skill are:

1. Appropriate topic, concepts, ideas, and teaching points (A)
2. Sequence order of presentation (SOP)
3. Adequacy of manipulative skill (AMS)
4. Creation of appropriate situation (CAS) and
5. Generalization (G)

- **Appropriate topic, concepts, ideas and teaching points (A):** The demonstration should be appropriate to the topic, concept, idea, and teaching point. The appropriate specimens, experiments, or devices should be related to the topic, concept, and teaching point in the demonstration to make teaching effective.

- **Sequence order of presentation (SOP):** The presentation material such as specimens or experiments or devices should be arranged in a sequence and presented in a systematic way. The sequential procedure in presentation of material indicates better preparation of the teaching learning activity.

- **Adequacy of manipulative skill (AMP):** In the demonstration of experimentation, the instruments or equipments should be repeatedly displayed in the teaching – learning process. Adequate manipulative or manual skills would certainly result in creating interest in the minds of the learners.

- **Creation of Appropriate Situation (CAS):** In the demonstration process, appropriate physical situation with proper aids, instruments, diagrams, gestures, movements, etc. should convey the idea appropriately. The demonstration arouses the curiosity of the learner.

- **Generalization (G):** Whenever the demonstration comes to an end, the teacher should conclude the theory and frame a rule or a principle. The teacher performs the demonstration to consolidate the learned points with the help of the learners.

2.13.11 Skill of Closure

In closure or recapitulation, the teacher can consolidate the main points by raising a few questions based on the topic taught. The questions should be logically linked to cover the whole lesson as summary of the lesson. S/He may use charts, models, diagrams etc. for consolidation of the lesson. The questions may be oral or written by using nonverbal media including experimentation. The students can use this situation in solving the problems in a new situation or in different situations. The teacher can review the past knowledge of the students to provide future learning in the form of homework or assignment.

The various components of the skill closure / Recapitulation are:

1. Consolidation of Major points (**CMP**)
2. Providing opportunity to apply new knowledge to a new situation or different situation (**OP**)
3. Linking previous knowledge to new knowledge and new knowledge to future knowledge among the students (**LK**) and
4. Home work or Assignment (**HW**)

Consolidation of Major Points (CMP): The teacher should consolidate the major points of his/her presented content at the

closure or recapitulation process. It helps in remembering the important points in the lesson.

Providing opportunity to apply new knowledge to new situation or indifferent situations (OP): The students apply the newly gained knowledge in a new situation or different situation in the recapitulation. This opportunity is felt at the closure of a lesson. Without providing this opportunity, the students are unable to apply their gained knowledge to new or different situations.

Linking previous knowledge to new knowledge and new knowledge to future knowledge of the students (LK)

The teacher establishes a link from the previous knowledge to new knowledge and from the new knowledge to future knowledge by taking different examples.

Home Work or Assignment (HW): Homework or Assignment is an important task in closure. At the end of his/her teaching, the teacher provides homework or assignment to recall or to apply or to learn different situations.

2.14 Mini –Lesson

- It is a teaching training technique for learning teaching skills.
- It employs real teaching situation for developing skills and helps to get deeper knowledge regarding the art of teaching.
- A mini lesson is a basis precursor to a bigger or broader topic. It is a short lesson that can be taught in just a few minutes, but it can benefit the students in the future lessons.
- For instance, you may teach a basic topic like fact versus opinion by sharing a variety of statements and having students [INCOMPLETE]
- This practice may take only 20 minutes, but teaches a valuable lesson to the students and sets the foundation for further discussion of writing styles or reading concepts.

Practicing a Mini-Lesson with Multiple Teaching Skills

Name : xxxxxx
Subject : Biology
Topic : External features of a Bird
Date :
Time :

Objectives:

- Acquires knowledge of the technical terminology used to describe the external characters of a bird.
- Understands the significance of the various external features of a bird.
- Applies the knowledge in identifying birds.
- Develops skills in drawing and labeling the external characters of a bird.
- Appreciates the flying minstrels of nature.

Materials

- A pigeon (specimen)
- Stuffed birds
- Bird photographs
- Chart-external characters of pigeon

Content outline

- A bird is with a bundle of feathers with different colouration, boat shaped contour with flight adaptation.
- Birds have fore limbs modified into wings. Birds are bipeds.
- The body of the bird is divided into four regions: head, neck, trunk (body) and tail. The head consists of beak which is modified according to feeding habits.
- Lateral eyes with well-developed vision.
- External ear opening is completely covered by feathers.
- Neck is highly mobile.

- Entire body is clothed with feathers. The two wings and two legs are attached to the middle of the body.
- Tail varies in length and colour with the function to balance and direction.

2.14.1 Mini-Teaching skills

Important skills are as follows:

1. **Introducing:** A bird is an animal with a bundle of feathers with different colouration, boat shaped contour with flight adaptation.
2. **Explaining:** Birds have fore limbs modified into wings. Birds are bipeds. Birds are divided into two types: a) Flying birds. E.g. Pigeon. b) Running birds. E.g. Ostrich. The body of a bird is divided into four regions: head, neck, trunk (body) and tail. The head consists of beak which is modified according to feeding habits with the absence of teeth. Lateral eyes are with well-developed vision. Nostrils in the dorsal aspect of the upper beak present proximally. External ear opening is present completely covered by feathers. Tongue is modified according to the feeding habits. Neck is highly mobile (rotation 30.). The entire body is clothed with feather. The two wings and two legs are attached to the middle of the body. Legs are with 4 claws and modified according to the locomotion and feeding. Tails vary in length and colour with the function of balance and direction. Cloaca is present at the base of the tail.
3. **Questioning:** How are the forelimbs modified?
 - The legs of the Ostrich are strongly built because-----

 - Mention the different types of tails found in birds.
 - The external ear opening in birds cannot be seen because-----

4. **Carrying the stimulus:** There can be variation of teacher's position in the classroom while s/he is teaching. Variation in voice represents another dimension. Use of media like Bird photographs, specimen and chart showing the external characters of pigeon provide yet another area of vibration. There can also be variations in the classroom interaction pattern.
5. **Non verbal cues:** Positive non-verbal cues such as smiling, nodding the head, a delighted laugh, patting on the shoulder, asking the students to clap, etc. can be used while the class is going on. The students can be asked to clap their hands for correct answers given by a student.
6. **Reinforcement:** Positive verbal reinforces like saying good, very good, excellent, fantastic, splendid, right, yes, correct, fine, etc. can be used in the class for the desirable behaviour of the students like being calm, clarifying their doubts, answering the questions, drawing the pictures on the board, etc.
7. **Closure/Summing up:** The topic will be summed up as a bird is a living thing with a bundle of feathers with different coloration, boat shaped contour with flight adaptation. The body of the bird is divided into four regions: head, neck, trunk (body) and tail, the beaks and limbs are modified according to the feeding habit of the bird. Mention the names of birds that you know. Observe and examine the pigeon and locate its parts. Draw the diagram of a pigeon step by step and label the parts.
8. **Fluency in communication:** The topic will be discussed by explaining and interacting with the student by asking questions and making the students to observe the specimen, photos, and charts. The teacher uses the knowledge of effective verbal and nonverbal communication techniques as well as instructional media

and technology of foster active inquiry, collaboration, and supportive interaction in the classroom.

Observation and Feedback on the Practice of Integration of Teaching Skills:

The complex teaching act can be split into component skills, each simple, well defined, and limited. These skills can be identified, practiced, evaluated, controlled, and acquired through training.

McIntyre et.al (1977) defined teaching skill as a ‘set of related teaching behaviours which is specified the achievement of specified types of educational objectives’.

Passi (1976) defines teaching skill as ‘a group of teaching acts of behaviours intended to facilitate pupils learning directly on inertly’.

The teaching skills developed through training are to be observed by the peers/teacher educators. Immediate feedback may be given to the student-teacher individually using the feedback forms.

Integration of teaching skills feedback form:

Name of the student teacher:

Duration: 20 minutes

INTEGRATING SKILLS IN MINI TEACHING Assessment By Peers/Teacher Educators)				
Teaching Skills	Average (Score 1)	Good (Score 2)	Very Good (Score 3)	Total
Introducing				
Explaining				
Questioning				
Varying the stimulus				
Non-verbal cues				
Reinforcement				

Closure				
Fluency in communication				
Total				

Range of scores: 8 -24

Overall Assessment of Mini-Teaching

Average _____

Good _____

Very Good _____

Interpretation of scores

Average : 8

Good : 9-16

Very Good : 17 -24

Signature of the Observer

2.14.2 Understanding Major Steps in Teaching a Mini-Lesson

Instructional Procedures and Activities: Provide a detailed discussion of the mini-lesson (15-20 min.) using the following headings.

1. **Motivation:** This step is considered to be the preparatory step, wherein the teacher is trying to prepare the minds of the students to get ready to receive the subject matter. Hence, this step identifies the mental readiness of the students. The teacher will be able to check the students' entering behaviour before s/he starts teaching the lesson. Thus, testing of the students' previous knowledge develops interest in the minds of the students and helps to maintain the curiosity in the students.

2. **Presentation:** It is the key step and only through which the actual process of teaching is going to take place. Here, the aims of the lesson should be stated clearly and the heading should be written on the blackboard. We have to

provide situation for both the teacher and the students to participate in the process of teaching and learning. And the ultimate aim of the presentation is to make the concepts understandable to the students. Therefore, usage of simple language is recommended. Appropriate and specific examples and illustrations of the concepts will make a better understanding. The interest of the students in the subject matter should be maintained continuously by the way of asking questions from time to time in this stage. Use of instructional aids like charts, audio-visuals, specimens, etc. in an appropriate manner is strongly recommended during the presentation.

3. **Interaction:** Interaction in the classroom is done by speaking, sharing opinions, listening to others, and establishing a mutual consent. Students in the learning process interact directly with the object of learning and communicate in groups. It provides the ability of gaining mastery over the subject.

4. **Reflection:** Students are given opportunity to express their ideas, experiences, and opinions. Students will be cooperative, responsible, respect the opinions of others, honest in receiving information and will be able to give decisions.

5. **Summing –up:** This stage is meant for the teachers to know whether the students have grasped and understood the concepts taught or not. This can be achieved by reviewing the lesson by giving assignment to the students. Only through this step, achieving closure is possible.

2.14.3 Practicing a Mini-Lesson with Five Teaching Steps

Provide a detailed discussion of the mini lesson (15 - 20 min) using the following headings:

❖ Introductory Activities

1. Motivation (skill of Introduction – use of previous knowledge)

The teacher asks the students questions related to their knowledge of birds, as follows:

- What do you know about birds?
- Do you know how birds fly?
- Give the names of birds that you know.
- Name the bird which does not fly.

❖ **Development Activities (Presentation, interaction, reflection)**

2. Presentation

- The teacher announces the topic as, “External features of a bird” and writes it on the black board. (**Skill of Explaining – Cognitive link**).
- The teacher asks the student to catalogue the birds known to them. (**Recalls**)
- The teacher asks the students to observe and name the stuffed birds shown to them. (**Recognizes**)
- Birds have fore limbs modified into wings. Birds are bipeds.
- Birds are divided into two types: a) Flying birds. E.g. Pigeon b) Running birds. E.g. Ostrich. The body of the bird is divided into four regions: head, neck, trunk (body) and tail.
- The teacher uses aids like chart and specimen to show the body of the bird and to observe the streamlined body contour and identify the four regions. (**Skill of Explaining – uses of Illustrations**)
- The head consist of beak which is modified according to the feeding habits with the absence of teeth.
- Lateral eyes with well-developed vision.
- Nostrils in the dorsal aspect of the upper beak present proximally.

- External ear opening is present completely covered by feathers.
- Tongue is modified according to the feeding habits.
- Neck is highly mobile (rotation 30).
- Entire body is clothed with feathers.
- The two wings and two legs are attached to the middle of the body.
- Legs are with 4 claws and modified according to locomotion and feeding.
- Tail varies in length and colour with the function of balance and direction.
- A cloaca is present at the base of the tail.

3. Interaction: (Skill of Questioning – specificity)

- Give some examples for flying and running birds.
- How are the forelimbs modified?
- The legs of the Ostrich are strongly built because-----
-----.
- Mention the different types of tails found in birds.
- We cannot see the external ear of the bird? Why? The teacher points out by lifting the feathers that the external ear openings in birds cannot be seen because it is completely covered by feathers.

4. Reflection: (Skill of Stimulus Variation- Audio visuals)

- The teacher asks the student to observe and identify the birds from photographs and drawings. (**Identifies**)
- The teacher now shows the charts illustrating different regions and asks the pupils to identify the various parts of the bird. (**identifies**)
- The teacher asks the students to observe the specimen and locate the upper eyelid, the lower eyelid and nictitating membrane. (**locates**)

- The teacher points out the neck which is highly mobile (rotation 30). Then the teacher asks the students to examine the neck of the bird (Recognises)
- Now the student observes the diagram of the pigeon and compares it with the actual specimen. (Comparing)

5. Concluding Activities (Summing Up/closure)

The bird is an animal with a bundle of feathers with different colouration, boat shaped contour with flight adaptation. The body of the bird is divided into four regions: head, neck, trunk (body) and tail. The beaks and limbs are modified according to the feeding habit of the bird. Observe and examine the pigeon and locate its parts. Draw the diagram of a pigeon step by step and label the parts.

❖ Evaluation and Assessment

List how the pre-service teachers (peers) will demonstrate their learning. That is, how will you know the mind-lesson has been successful?

Distribute a copy of both Assessment formats (skills & Steps) to the pre-service teachers (peers)

Observation and Feedback on Integration of Teaching Steps in Mini- Teaching

Name of the Student-teacher:

Duration: 20 minutes

INTEGRATING THE STEPS IN MINI TEACHING (Assessment by Peers/Teacher Education)				
Teaching Steps	Average (Score 1)	Good (Score 2)	Very Good (Score 3)	Total
Motivation				
Presentation				
Interaction				
Reflection				
Summing Up				

Range of scores: 5 -15

Overall Assessment of Teaching Steps

Average _____

Good _____

Very Good _____

Interpretation of scores

Average : 5

Good : 6 -10

Very Good : 11-15

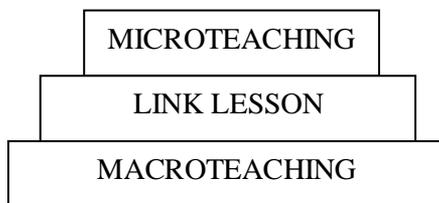
Signature of the observer

2.15 Link Practice (Integration of Teaching Skills)

In micro-teaching technique, teaching skills are practiced one by one separately. At a time, only one skill can be practiced. While practicing one skill, the use of that particular skill is maximized and the other related skills may also occur taking indirect role. Skills practiced in isolation have no meaning unless they are integrated in teaching. Hence, after attaining mastery in various skills, opportunity should be given to the teacher trainees to teach in real situations integrating the skills mastered already. So, separate training programme is necessary for this purpose. This programme is called Link practice. Link practice is a bridge between micro-teaching and full-class teaching, where micro-teaching skills are effectively integrated and transferred.

There is a big contrast between micro-teaching and full class teaching. In micro-teaching, there is a scaled down process in terms of class room size, skills, scope of the lesson, time, etc. Micro-teaching is practiced under stimulated conditions. In macro-teaching, in addition to the existence of macro elements, there are also classroom management problems. In link practice, the trainees are given chance to teach the real pupils.

There are many methods for link practice. One of the methods is that after practicing three sub skills separately, the trainee may combine all the three sub skills in a lesson of 10 minutes. He then practices another three sub skills separately and links them. He then combines all the six sub skills in a single lesson of 15 minutes. And so on till the entire sub skills are combined in a macro lesson of 40 minutes and teaching a full class.



S.No.	Particulars	Microteaching	Link Lesson	Macro teaching
1.	Time	5-7 min	20-25 min	40-45 min
2.	Size of the Class	5-10 students	20-25 students	40 plus Students
3.	No of skills	1 skill	3 to 4 skill	All the skills

Link practice sessions are arranged with about 20 pupils for around 20 minutes, i.e., the normal class period. The trainee prepares a series of eight short lessons on a single unit and teaches each lesson for 20 minutes using appropriate skills particular to the content. The number of lessons used in link practice is flexible but selected topics should be adequately covered. The teaching skills namely ‘Set Induction’ and ‘Closure’ cannot be practiced in micro-teaching session in isolation. So, in link practice, the trainees also include these skills. At the end of each lesson, the trainee should get a feedback about the lessons.

REVIEW QUESTIONS

1. Explain the microteaching cycle
2. Elucidate the principles and phases of microteaching
3. Explain briefly how microteaching skills indicating the components of each skill.
4. What is link lesson and what is the needed for it?
5. What is link lesson? What are the advantages of practicing link lesson and how it performed?

Chapter 3

PLANNING FOR TEACHING

3.1 Planning for Teaching

Planning is the most essential component for successful and effective instruction. One needs to have a good plan if s/he wants success in the work. A plan is a blueprint, which assists in the efficient, economical, and smooth conduct of any activity. Planning helps in organizing and developing the work in the most efficient manner. Lesson planning is the basic skill that teachers must know for imparting knowledge in a better way. Advance planning aids help in envisaging the teaching-learning situation and also help the teacher in making alterations in the teaching-learning process accordingly.

- ❖ Planning begins with the goals of teaching-learning situation. It should be done in the terms of the goals to be achieved.
- ❖ The other advantages are: It helps in the setting of objectives, the specific learning outcomes, the strategies of teaching, and makes the textual matter related in a more meaningful manner.
- ❖ Teaching is an activity which requires careful advance thinking and planning. Therefore, for effective teaching, sufficient and elaborate planning should be done so that appropriate objectives, the specification and the teaching strategy could be employed.
- ❖ The teachers are expected to know well in advance about what she/he is going to teach her/his students. Successful teachers perpetually seem to be good planning.

The teacher has to plan the teaching activity in three stages:

- ❖ **Year plan:** This plan is meant for the whole academic year. This determines the content to be taught in various periods of a year.
- ❖ **Unit plan:** This plan is for teaching a single unit. This includes organization of the selected materials into meaningful segments of activity and experience.
- ❖ **Lesson plan:** The plan is required to teach a lesson and for the daily work in the classroom.

3.2 Year plan

The whole educational system relies on proper planning. The school plans its activities, the parents plan the education of the child, and the teacher plans her academic activities. Appropriate planning helps in systematic and organized deliverance of the content and the related activities. The concept of planning is objective-based. As the school plans to achieve the educational aims, a teacher plans for the entire academic year. Year planning is nothing but a sequential “organization of the topics” to be taught in a year. A teacher makes a year plan, for the teaching activities, which is meant for the whole academic year.

3.2.1 Characteristics of the Year Plan

A science teacher needs to plan her teaching for the entire academic year. At the beginning of the year, the teacher should plan the methods and strategies of teaching s/he is going to follow. The teacher has to divide the whole subject into small sets of related facts. These related facts are then structured into meaningful material, which should be based on psychological and logical principles of learning. To make the science learning more interesting, the teacher should consult the teachers from other fields and develop a good correlation in the teaching of the subject. A year plan has to be flexible as it acts as a guide to the systematic organization of classroom teaching. It should not restrict the freedom and

innovations of the science teacher. A year plan is implemented and its feasibility is evaluated at the end of the academic year. The required changes are incorporated and the year plan is modified accordingly. If the teacher is able to complete the syllabus according to the year plan, then the plan could be considered as a valid plan and should be recommended for the next academic year.

Essentials of the Year Plan

The following points should be kept in mind while preparing a year plan:

- ❖ Achievement of the educational objectives
- ❖ Arrangement of the topics
- ❖ Correlation of the subjects
- ❖ Teaching methodology followed
- ❖ Resources available
- ❖ Seasonal and natural situations

3.2.2 Principles for the Year Plan

For an effective year planning, science teachers need to follow certain principles and those principles are:

- ❖ The concepts should proceed from simple to complex.
- ❖ Unknown subject matter should follow the known subject matter.
- ❖ Division of topics should be for each week followed by each month.
- ❖ The periods should have a fixed duration.

3.2.3 Importance of the Year Plan

Adequate year planning is very important in the teaching- learning process because of many advantages. Some of them are mentioned below:

- The year plan helps the teacher in smooth conduct of the teaching activity.
- The entire syllabus to be covered in a year is divided into weeks. The content is divided into simple logical units and sub-units and the topics to be divided into the individual

periods. This helps in the easy preparation for the classes.

- Periods required for teaching different units are also mentioned in the year plan.

- The year plan not only deals with the details of classroom instruction spread over the entire academic year but also includes the schedule for examinations, co-curricular activities like excursions, discussions, debates, and workshops.

- Methodical year planning leads to effective teaching.

3.2.4 Steps in Making the Year Plan

The following steps should be followed while preparing a year plan:

1. The subject matter should be divided into small teaching units.
2. The objectives of the lesson should be identified.
3. The time required for teaching the units should be calculated and noted in the form of periods.
4. The time duration required for achieving these objectives through teaching-learning should be calculated.
5. The co-curricular activities like science fairs, field trips, and project works should also be mentioned in the year plan.

Some general points which are to be considered while making a year plan include:

- ❖ Total working days in the academic year
- ❖ Total number of holidays
- ❖ Tests and examinations to be conducted
- ❖ Working days of a teacher excluding the leaves

The teacher has to consider the above points and calculate the number of periods allotted for the science subject. The total number of periods required for teaching the entire content should be calculated. The teacher should utilize some of the periods for conducting demonstrations and

examinations. The year plan has to be prepared by keeping in mind the total periods.

Model format of a year plan

S. No.	Name of the Month	Name of the Unit	Name of the Sub-unit	Objectives KUASI	Achieved AAV
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Number of Periods	Activities to be conducted	Whether completed in time or not	Teacher's Signature	Signature of the Head Master
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Objectives:

K – Knowledge

S – Skill

A – Appreciation

U – Understanding

I – Interest

V – Values

A – Application

A – Attitudes

3.2.5 Advantages of a Year Plan

Preparation of a year plan helps the teacher in many ways:

- To complete the syllabus in time
- To maintain the teaching discipline
- To achieve the educational objectives
- To evaluate the credibility of teaching methodology and strategies followed
- To undertake necessary modifications as and when required
- To allot time for activities other than teaching

3.3 Unit Plan

A unit is a large block of subject matter, which includes a series of meaningful activities designed to achieve the purpose of education i.e., to provide the appropriate learning experiences and bring about significant behavioural changes in the student. According to the present concept, a unit also includes the procedure of presentation of

the subject matter, which means the unit is not only a block of content but also a method in itself.

Therefore a 'unit' can be described as:

- An integrated whole
- A threshold, which includes a systematic arrangement of teaching methods, materials and learning experiences.
- Something which brings about the desired behavioral changes in the learner.

Definitions of Unit plan

Some of the important definitions of a unit are:

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

According to Wisley: “The unit is an organized body of information and experience designed to effect significant outcomes for the learner.”

According to Morrison: “The unit may be defined as a means of organizing materials for instructional purpose which utilizes significant subject matter content, involves pupils in learning activities through active participation intellectually and physically and modifies the pupil’s behavior to the extent that he / she is able to cope with new problems and situations more competently.”

3.3.1 Criteria for a Good Unit

While planning a teaching unit, the following points should be kept in view:

- It should keep in view the capabilities, the needs, and the interests of the students
- It should allow a variety of demonstrations, experiments, field trips, projects, etc.,
- It should also consider the background and previous experiences of the students.
- It should provide experiences, which are new and interesting for the students.

- It should have an appropriate length to maintain the interest of the students throughout.
- It should consist of material, which looks familiar and related to the topics. Unfamiliar and strange material should be avoided.
- It should be flexible so as to allow the above average pupils to go beyond the limits of the unit.
- It should be associated with the physical and social environments of the students.
- It should help to foresee and satisfy some of the future needs of the students.
- It should be a part of a series that allows continuous development year after year.
- It should be the product of the mutual planning of teacher and students as much as possible.

3.3.2 Types of Units

There are two types of units. They are: resource unit and teaching unit.

- **Resource unit:** The unit which consists of material which provides information about the teaching activities, teaching aids, and different learning experiences is considered as resource unit.
- **Teaching unit:** It is the unit which is developed by the teacher to teach the required content in a classroom. It is based on the information provided by resource unit.

3.3.3 Content of a Unit Plan

The following contents are to be included in a unit plan:

- **Overview of the unit:** Here the emphasis should be given to the outlines or summary of the subject content included in the unit.
- **Instructional objectives:** Relevant instructional objectives to be achieved at the end of the unit should be identified.

- **Content analysis:** The important concepts to be taught during the teaching process should be emphasized.
- **Teacher learning activities:** All the activities of the teacher and the students during the teaching-learning process should be given.
- **Teaching aids:** The various teaching materials like charts, models, specimens, demonstrations, and any field activities to be conducted should be mentioned.
- **Evaluation of knowledge gained by the students:** After the completion of teaching every unit, evaluation of the knowledge gained by the students should be done through a test, either oral or a written test.
- **Worksheets:** The teacher should provide a worksheet for immediate evaluation at the end of each lesson.
- **Bibliography:** The different reference books and audios and videos utilized during the teaching the unit should be mentioned.

3.3.4 Steps in Unit Planning

While planning the unit, the teacher should bear in mind the aims and the methodology of teaching. The teacher has to select the instructional objectives, analyze the contents, identify the appropriate teaching methods, and teaching aids and evaluate the learning outcomes.

The various steps involved in the unit planning are:

- **Preparation or motivation:** Students should be provided with a purpose to achieve and should be motivated to accomplish the task. Introducing the topic and correlating life situations or giving examples for the topic could motivate students. The motivation as far as possible should be natural and self-directed and the teacher should not by any means force them. Students by themselves should be able to overview the unit they are studying and find out its scope. The process of motivation should not be

restricted to the beginning of the lesson but should continue throughout the lesson.

- **Testing of previous knowledge:** The second step that should follow motivation is testing the previous knowledge of the students. This is an important step, which gives insight into the abilities of the students. Through this test, the teacher may avoid repetition of the content and also comes to know about the comprehension capacity of the students.
- **Presentation:** This step provides new experiences to the students. Here, the teacher needs to present the content in a clear, precise, and interesting manner by including the teaching materials, aids, and other classroom activities. While providing new experiences, the teacher should see to it that the experiences available to the students are based on their capacities and acceptance level.
- **Organization of learning:** The students must be provided with the opportunity to organize the content that they learnt so that they could establish the relationship between the new experiences and be able to assimilate them properly in their minds. The organization could be done in the written or oral form.
- **Summarization:** At the end of the unit, the entire unit is summarized in a systematic order to bring all the learning together. Summarization could also be done at intervals during the progress of the unit. Usually, organization and summarization go together.
- **Recapitulation:** During the teaching of the unit, it is quite possible that some part of the unit might have not been understood by the students or might have been forgotten by them after sometime. To compensate this limitation, the teacher should revise the new experiences taught during the presentation. The unit is revised by asking

simple questions to the students regarding the topic. It is not necessary to do recapitulation only at the end of the unit. One can also do at a number of places during the progress of the lesson.

- **Evaluation:** This last step is meant to check the achievement levels of the students. Self-evaluation is the best option to test the students' capacities. This test may be oral or written and could be conducted in between the lessons. They may be given tests in the form of performance tests, interviews, self-check test, puzzles, etc. The final evaluation test is given at the end of the unit to give grades to the students as well as to check the effectiveness of one's teaching methodology. Based on the evaluation results, further remedial measures should be planned.

3.3.5 Advantages of Unit Plan

Some of the important advantages in unit planning are:

- ❖ It is based on aims and objectives of teaching.
- ❖ It creates interest and curiosity in the learners.
- ❖ It makes the teaching-learning clear, precise and more comprehensive.
- ❖ It vitalizes learning and makes the learning process more life-like.
- ❖ It develops the content knowledge of the teacher.
- ❖ More disciplined teaching and learning is observed.

3.3.6 Disadvantages of Unit Plan

There are some limitations noticed while planning for the unit. They are:

- ❖ It requires committed and hardworking teachers.
- ❖ Confusion sets in when the topics are unrelated and unsystematically arranged.
- ❖ Evaluation is difficult to do at lower stages.

Model format of a unit plan

PROFORMA 1

Class.....

Subject.....

Name of the Unit

Major objectives of the unit

S. No.	Concepts (Topics)	No. of Lessons required	Time required (in Periods)	Scope of the subject content	Procedure to be adopted (indicate the method of Teaching Aids
1.					
2.					
3.					

After completing proforma '1', a detailed unit plan should be prepared according to proforma '2'.

PROFORMA 2

Concepts (From Proforma '1').....

Lesson No.

S. No.	Sub-concepts	Behavioural Objectives	Procedure (Teacher-pupil activity)	Pupils assignments	Evaluation
1.					
2.					
3.					

3.4 Lesson Plan

Lesson planning is virtually the pre-active phase of teaching.

According to **Lester B. Stands**, “A lesson plan is actually a plan of action”.

According to **N.L. Bossing**: “lesson plan is the title given to a statement of achievements to be realized and the specific meaning by which these are to be attained as a result of the activities engaged during the period”.

Bining and Bining have explained the structure and purpose of lesson-plan in their definition as follows: “Daily lesson planning involves defining the objectives, selecting and arranging the subject matter and determining the method and procedure”.

According to **W.M. Ryburn**, “To teach we must use experience already gained as starting point of our work”.

I.K. Davis has defined the lesson plan in the following manner: “Lesson plan must be prepared for there is nothing so fatal to a teacher’s progress as unpreparedness”.

It therefore includes the working philosophy of the teacher, his/her knowledge of philosophy, information about and understanding of his/her pupils, comprehension of the objectives of education, knowledge of the material to be taught and difficulty to utilize the effective methods.

- A lesson plan gives a detailed description of the unit or the content of subject matter, which a teacher teaches in a period of fixed duration.
- It gives an outline of the contents that are taught in a classroom during a period.
- A lesson plan provides a guide line for planning the instructional strategies, teaching materials and the learning experiences to be provided to the students.
- It helps in evaluating the learning outcomes of the students.

- In short, a lesson plan is a plan which reflects a picture of various teaching strategies employed to create a proper learning environment in the classroom in order to achieve the prescribed instructional objectives.
- The teacher should be very clear about the aim of the lesson and should plan according to it.
- The teacher should also try to correlate the lessons with various kinds of activities like physical, social, and environmental related to the students.
- Introduction and presentation of lessons and the teaching aids, which are going to be used for these lessons, should also be included in the plan.
- The teacher finally can evaluate the plan according to the aim of set for the lessons.
- After planning the unit, we have to concentrate on each lesson plan. Lesson plan is actually a plan of action. The teacher has to decide his/her work in a particular period. S/He has to plan his tools and materials.
- Lesson plan is a teacher's mental and emotional visualization of classroom activities. For successful and effective teaching, lesson plan is very essential. Lesson plan explains the objective to be fulfilled and the teaching methods and aids to be used.
- A lesson plan is a blue print, a guide map, a creative piece of work and the chart for classroom teaching in one personal. It is a systematic approach for the development of concepts, skills, understanding, etc.

So, lesson plan is an experience in anticipated teaching. Its focus is mainly a learning. The vivid imagination of the class room situation, speaks of the classroom experience. For effective anticipation experience, the re-requisitions are:

- Mastery over subject matter, the materials, and activities

- Through knowledge of the environmental forces, i.e. previous knowledge and experience of the learner.
- Understanding of psychology of mental process and laws of learning.
- Understanding of teaching techniques – goals, aims, skills, methods, etc.

3.4.1 Need and Importance of Lesson Plan for Teacher-Education Programme

The lesson plan has significant role in planning and organizing teaching with the following reasons:

- In teacher-education programme, the lesson planning provides the guideline to pupil-teachers during their teaching practices.
- It provides awareness of teaching objectives and structure of content and the teacher has to perform his/her activities in the direction to achieve the objectives.
- The sequence of the content is to be presented and finalized by task analysis in lesson planning.
- The perceptive mass of the learner is developed or encouraged by linking the new knowledge with the previous knowledge of the students.
- The use of teaching aids, techniques, strategies and tactics is pre-determined in the presentation of the content.
- It maintains the sequence of content presentation and prevents the teacher to deviate from the topic.
- The teaching activities are related to learning structures with the help of scientific lesson plan.
- It determines the suitable places of reinforcing and controlling the student behaviour during teaching.
- The classroom teaching activities are organized by considering the students' individual differences.

- The effectiveness of a teacher depends on a good lesson plan. It develops reasoning, decision making ability, and imagination in the pupil teachers.
- The micro-lessons are helpful in developing specific teaching skills.
- The pupil-teacher gains confidence in performing classroom teaching activities.
- The teacher needs to plan the lesson, as it helps in an orderly procedure of teaching.
- To accomplish the instructional objectives
- To build up effective teaching strategies
- To evaluate the learning outcomes by recalling the steps in the curriculum
- To cater to the abilities and needs of the individual students.

3.4.2 Principles of a Good Lesson Plan

The following are the important principles for a good lesson plan:

- ❖ A good lesson plan should proceed from simple to complex, known to unknown, concrete to abstract, whole to part and back to the whole.
- ❖ It should follow the instructional objectives and specifications.
- ❖ The teaching aid should be generally and appropriately used.
- ❖ The activities should be relevant and properly selected.
- ❖ The evaluation procedures should be suitable to the lesson.
- ❖ It should induce the power of reasoning, analysis, and critical thinking among the students.
- ❖ It should indicate definite assignments for the students.
- ❖ There should be extra information about the topic and other available reference materials.

3.4.3 Characteristic of an Effective Lesson Plan

The following are the important characteristics of a good lesson plan:

- **Objective based:** The objectives of the lessons should be clearly defined and the plan of the lesson should be based on these objectives. It should mention about instructional objectives. Objectives should be in written form.
- **Relevant teaching aids:** A good lesson plan should include how and when teaching aids are to be used. Teaching of any lesson should be supported by a set of appropriate teaching aids like charts, graphs, pictures, diagram, maps, etc. Therefore, it is essential to make preparation of an ideal lesson plan.
- **Primary knowledge:** The previous knowledge of the students will decide the course of new knowledge. Therefore, an ideal lesson plan should be based on the previous knowledge of the student so that the student may not face any problem in acquiring the new knowledge.
- **Division of lesson plan into units:** An ideal lesson plan should incorporate all the essential steps of all the three types of lesson plans. They are knowledge lesson, skill lesson, and appreciation lesson. Each lesson should be divided into units so that the students can understand it easily.
- **Use of simple language:** An ideal lesson plan should emphasize on the simplicity and clarity of the subject and the mental capacity of the students. The lesson plan should be subject – oriented rather than stressing on the language.
- **Determination of activities:** If the activities to be performed by the teachers and the students are determined in advance, the planning of the lesson will be easy and effective.
- **Use of strategies, tactics, techniques, and teaching aids:** A teacher should have a good command over general

principles of teaching, so that he/she can use the strategies and the techniques accordingly in the lesson plan.

- **Correlation:** To allow the students to get the knowledge as a whole, there should be correlation in a good lesson plan.
- **Illustration:** An ideal lesson plan should incorporate illustrations and examples related to the daily life of the students and also have effective illustration throughout the period.
- **Teaching from memory level to reflective level:** A lesson plan with developmental and thought-provoking questions can lift the student from memory level to reflective level.
- **Time sense:** A lesson plan prepared according to the mental level of the student and the duration of the period can prove to be an ideal one. The time assigned to each teaching step should be mentioned clearly in the lesson plan.
- **Use of Black Board:** The black board summary of each and every unit that is taught should be written on the black board in short but complete sentences.
- **Evaluation:** A good lesson plan should also mention the method of evaluation to assess the performance of the students and obtain the feedback from them on the lessons.
- **Homework:** To check the level of acquired knowledge through class room learning, the students should be provided with the homework. A good lesson plan should include relevant home assignment.

3.4.4 Requirements for a Planning a Lesson

A teacher needs to possess the following to plan her lessons:

- ❖ A mastery over the content
- ❖ A thorough knowledge of the process of teaching and learning
- ❖ An understanding of the relevant methods and techniques to be used in the classroom

- ❖ An overview of the instructional objectives and specifications of teaching biological sciences
- ❖ Knowledge of the individual differences and psychology of the learners.

3.4.5 Advantages of Lesson Plan:

1. A good lesson plan helps the teacher to act orderly and proceed systematically while delivering the lessons. He/she will have a good control over the lesson delivery and therefore haphazard teaching can be avoided.
2. Through proper lesson planning, the teacher can get clear aims for the students according to their interests, attitudes, etc.
3. As a good lesson plan is present and appropriate, it provides a lot of confidence and self-confidence to the teachers, which again helps the teachers in effective teaching.
4. Lesson planning helps the teacher in deciding the definite objectives and in achieving the teaching goals.
5. It makes classroom teaching interesting, systematic and organized.
6. It guides the teacher in sustaining the interest of the students and organizing some activities.
7. A good lesson plan helps the teacher to give good assignments to the students.
8. Lesson planning saves time and the students will be able to understand the subject content effectively. In this way, they also form certain desirable attitudes and behaviour patterns.
9. Lesson plan inculcated in the teaching process discourages repetitions.
10. It enables the teacher to understand and use the most relevant method of teaching the lesson.

11. A good lesson plan correlates with social and physical environment and also considers the needs and interest of the student.
12. The micro lessons are useful in the development of specific teaching skills.
13. Lesson planning assures a proper connection of the new lesson with the previous lesson.
14. Lesson planning ensures a proper consideration of the learning process and definite choice of appropriate learning procedures.
15. The effectiveness of a teacher depends on a good lesson plan. It develops reasoning, decision-making ability, and imagination.
16. Lesson planning provides an adequate evaluation of learning outcomes.
17. It eliminates the chance of trial and error in teaching.
18. It helps to visualize the needs of the mixed ability of the pupils.

3.4.6. Demerits of Lesson Planning

- Lesson planning makes the teaching process more difficult because of complicated lesson planning process.
- More time is always needed by teacher to plan a lesson.
- Sometimes, simple subject-matter becomes more complicated.
- It has no flexibility and puts the fresh teacher in new helpless situations.
- Teacher cannot teach a lesson independently.

3.4.7. Difference between Unit Plan and Lesson Plan

A lesson plan elaborates, basically, on the objectives of a particular lesson and how teaching is planned in a way to achieve those objectives. A unit plan, on the other hand, covers a wider area; a unit that can include many lessons. Furthermore, a unit plan includes goals broken down in terms of lessons, the outline of the content intended to cover and cross-curricular references, etc. A lesson plan is usually prepared by the teacher who teaches that particular lesson in the class. However, a unit plan is applicable to many teachers and those who play administrative roles in a school and is effective for a semester. Moreover, a lesson plan can include personal aims for teacher development, unlike unit plans.

Table: Difference between Unit Plan and Lesson Plan

	Unit Plan	Lesson Plan
Definition	A teacher's plan for teaching an individual lesson	Plan for a unit, which consists of many lessons
Prepared by	Individual teachers	Sectional head or head of the department
Number of lessons and time	Covers only one lesson and may take only a few hours	Covers many lessons and take a longer time period
Aims	Can include personal aims for teacher development	Can be used for curriculum review

3.5 Approaches to Lesson Planning

Different people use different approaches to develop a lesson plan. The common approaches used are:

1. Herbartian approach
2. The evaluation of approach or Bloom's approach.

3.5.1 Herbartian Approach

The major contribution of the Herbartian movement was the class lesson plan suitable for any class size or organization. The lesson plan reflected a conceptualization of education that placed an emphasis on order and planning, which were necessary to sit the requirements of large classes.

- According to **Herbart**, the best method of instruction is to present material that is related to a previous interest of the student. Herbart's theory denies the existence of faculties and emphasizes the unique role of subject matter in the development of mental and moral abilities.
- **John Fredrik Herbart**, a German Philosopher, and a great educationist divided teaching units into five steps. His approach is based on a perceptive mass theory of learning. It was greatly influenced by classical human organization theory.
- Although the previous knowledge of the students is taken into consideration, the other aspects such as their abilities, attitudes, and values are not considered. But still, this is the method of approach that is widely used in teaching of various school subjects.
- **Herbart (1776-1841)** combined enlighten ideas of reason with growing faith in systematic approaches, planning, and organization.

3.5.2 The Herbartian lesson plan:

1. Reminds students of knowledge already learnt
2. Presents new materials
3. Compares new materials to prior knowledge
4. Generalizes a central idea
5. Applies the new knowledge to some other situation

6. Finds the effectiveness of teaching through recapitulation

This approach employs six steps, which are generally called as the Herbartian steps of lesson planning. They are as follows.

1. **Preparation or Introduction:** The student should be in a position to acquire the new knowledge that is imparted to him/her. For this purpose, the teacher should acquaint himself or herself with the previous knowledge of the student. So that, they can correlate the new knowledge with the earlier knowledge. This helps in bridging the gap and it also leads a student towards the aim of the lesson.
 - ❖ By analyzing the previous knowledge of the student and introducing the new lesson by explaining aims and objectives.
 - ❖ By asking relevant questions that exposes their ignorance and arouse interest and curiosity to learn more and something new.
 - ❖ By using different types of teaching aids such as charts, maps, or pictures.
 - ❖ The teacher should keep in mind that this step should be short and concise and the duration of this step should not exceed five minutes.

How can a teacher start the lesson?

- ❖ By asking two or three interesting questions with the help of the aids, that is, pictures, charts, or models.
- ❖ By asking questions from the content – matter previously taught.
- ❖ By discussing a situation and illustration it with the help of a relevant story.

2. Presentation: Presentation of the content-matter should be preceded with the mention of the aim of lesson. Once the aim of lesson is made clear to the students of the classroom, both the students and the teacher have a common focal point to concentrate, that is, to reach the objective of the lesson.

This is the step where there is equal participation of the students and the teacher in the teaching-learning process.

A sort of heuristic attitude prevails during the whole teaching process. Questioning becomes one of the most important devices that is used in this method. Use of other teaching aids can enhance the interest of the students towards the lesson and it can be made comprehensive. Development of black board summary is also necessary.

3. Comparison or Abstraction: Some illustrations are given to the students and they are asked to compare them with other illustrations or facts. This is one of the important steps, which compels a student to draw a generalization or a definition based on the result of the comparison and abstraction.

4. Generalization or Definition: This step is a result of the reflective thinking of the students. This knowledge gained in the earlier steps is used in this step to draw generalizations, formulations, and rules with the help of comparison or abstraction. The aim of the lesson is achieved in this step, which is completed by answering the questions raised in the earlier steps. Now, the students are ready to use the knowledge they have gained by applying them in real life situation.

5. Application: This is the step where students use the acquired knowledge in favourable and unfavourable situations. The validity of the generalization is determined, whether it is temporary or permanent. The generalization stays in the minds of the students and do not leave their consciousness soon.

Forms of application:

- ❖ Solving problems
- ❖ Writing an essay or an article
- ❖ Drawing maps or charts
- ❖ Preparing some models
- ❖ Doing some practical work
- ❖ Getting of new type tests.

7. **Recapitulation:** This is last step. Putting some suitable questions on the topic to the students can test the understanding and comprehension of the subject matter by the teacher. This will also help the teacher to find out whether his/her method of teaching is effective and successful or not.

3.5.3 Merits of Herbartian Lesson Planning:

The following are the advantages of the Herbartian lesson planning approach:

- ❖ It follows logical and psychological aspects and therefore incorporate the basic principles of learning.
- ❖ It is an easy and simple approach of lesson planning.
- ❖ The content matter is given utmost importance.
- ❖ It employs deductive thinking in learning.
- ❖ It is the method that can be used to teach any subject of the school-science subjects, social studies, and languages.
- ❖ It uses previous knowledge of the students to impart the new knowledge.
- ❖ This approach can be used in any size of the class or organization.

3.5.4 Demerits of Herbartian Lesson Planning

Although the Herbartian lesson plan is the most widely used approach in lesson planning, it has some demerits. They are as follows.

- ❖ It mainly emphasizes on the content matter.
- ❖ It confines teaching only to memory level.
- ❖ It ignores the attitudes and requirements of the students.
- ❖ It helps in achieving only cognitive objectives whereas it cannot be employed to achieve the effective and psychomotor objectives.
- ❖ This approach is highly dominated by the teacher.
- ❖ It does not provide the opportunities for the students' creativity and originality as it is highly structured.

❖ Emphasis is given presentation.

3.6 Bloom's taxonomy:

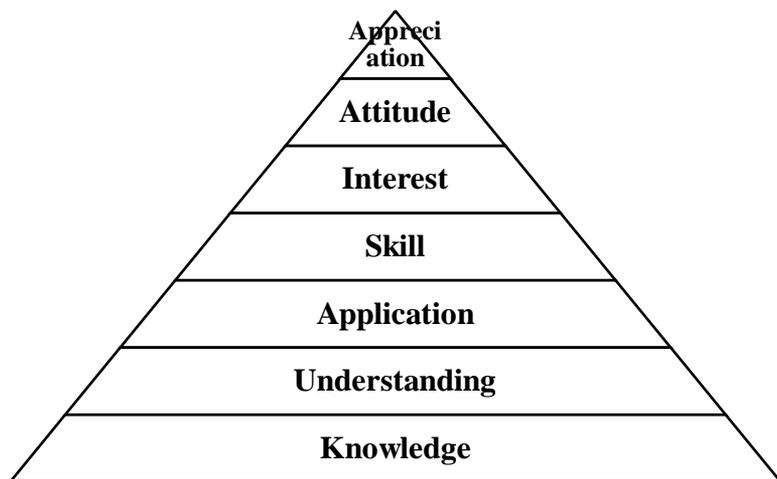
Bloom's Taxonomy enables the students to learn the concepts from basics to complex.

Bloom's taxonomy provides the opportunity for the teachers to design different classroom experiences for students. These experiences are very helpful to promote critical thinking and constructive approaches to learning. Bloom's evaluation approach signifies itself as a means for planning and implementing the student-centered classroom as it provides a precise language for articulating the intended outcomes of teacher's instructions, which are expressed in terms of student learning. It also allows the teacher a tool for decoupling critical thinking skills from content, the primary emphasis of instruction in the traditional classroom. Because of this, the focus of classroom instructions becomes the attainment of student skills and competencies rather than enhancing the teacher's self-knowledge or content specifying the learning outcomes, which display different levels of learning.

The taxonomy offers an improvement over the behavioural objectives. Behavioural objectives provide the teachers a way to state learning outcomes accurately.

The following three steps were given by B.S. Bloom under the evaluation approach.

- 1. Formulating Educational objectives**
- 2. Creating learning experiences and**
- 3. Evaluating the change of behaviour**



1. Formulating educational objectives:

- ❖ The end result of any activity is known as objective. The educational objectives are concerned with the cognitive, effective, and psychomotor changes in the behaviours. The following points should be kept in mind while identifying and formulating educational objectives.
- ❖ There is significant difference in various school subjects. Therefore, different objectives are achieved by teaching various school subjects.
- ❖ The structure of the content, need, and level of the student, political and cultural needs, and socio-economic conditions form the basis in determining the objectives of teaching.
- ❖ While formulating the objectives of learning, the growth and development of the student should be kept in mind, because some contents are taught at different stages of development.
- ❖ The comprehension levels and the behaviours of the students should be considered while formulating the learning objectives.

- ❖ The objectives are written after identifying the behavioural terms.

2.Creating learning experiences:

The table provides different types of learning experiences employing different teaching strategies to achieve different teaching objectives.

3.Evaluating change of behaviour:

The learning experiences bring desirable changes in the behaviour of the students. The type of change in the behaviour denotes the effectiveness of the learning experiences. There are three types of change in behaviour. They are – cognitive, affective, and psychomotor. Cognitive is for mental skills (knowledge), affective is growth in feelings or emotional areas (attitude), and psychomotor is for manual or physical skills (skills).

Training often requires to these as KAS, SKA, OR KSA (Knowledge, Attitude and Skills). This taxonomy of learning behaviours can be taught as “the goals of the training process” that is, after training session, the learner should have acquired these new skills.

1. Cognitive objectives: The cognitive domain involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns and concepts that serve in the development or intellectual abilities and skills.

2. Affective objectives: This domain includes the manner in which we deal with things emotionally, such as feelings values, appreciation, enthusiasm, motivations, and attitudes. The five major categories listed in order are:

- ❖ Receiving phenomenon
- ❖ Responding to phenomenon
- ❖ Valuing
- ❖ Organization
- ❖ Characterization

3. Psychomotor objectives: The psychomotor domain includes physical movements, co-ordination, and use of the motor skill areas. Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures or techniques in execution.

3.6.1 Merits of Bloom's Lesson Planning

The following are the advantages of Bloom's approach in preparing lesson plans:

1. Specification of the objectives is with the help of the preparation of the two dimensional charts.
2. This method is based on psychological and scientific principles.
3. Content analysis is done.
4. Objectives are written in behavioural terms.
5. Teaching objectives are achieved by organizing the teaching activities.
6. The teaching activities are related to learning structure.
7. It has a greater scope for improving or changing the learning experiences or teaching activities.
8. It is a method of preparing lesson plan, where teaching becomes purposeful and objective oriented.

3.6.2 Demerits of Bloom's Lesson Planning

This method has the following demerits:

1. Personal factors of the teachers influence the planning and organization of the teaching activities.
2. This method does not provide scope for the creativity and originality of the teacher since it is highly mechanized and structured.
3. Teaching activity has no specificity, because it is concerned with more than one domain.
4. While writing objectives in behavioural terms, the mental abilities are not taken into considerations.

3.7 Steps Involved in a Model Lesson Plan

While planning a lesson, the teacher has to divide the lesson into logical sequence, which can be understood easily by the students.

A lesson plan is based on the following theoretical assumptions.

- Preliminary knowledge or abilities required
- Steps followed in writing lesson planning
- Evaluation of lesson planning

The following steps are also to be planned if the lesson plan has to be appropriate and successful.

1. **Preliminary knowledge and abilities:**

A perspective biology teacher needs an understanding of the preliminary knowledge upon which lesson plan is developed.

- Identification of teaching points or concepts
- Writing specific objectives
- Developing learning activities
- Selecting appropriate teaching strategies
- Identifying relevant institutional materials
- Writing the test items.

2. **Steps in Lesson Plan**

- **General information:** It gives the information about the trainee-teacher. It also provides information about name of the school, class subject, unit, subject, topic for the lesson, class, duration of the period and the date.
- **Identification of teaching points:** The lesson is carefully read. The major and sub concepts are identified to make teaching and learning easy. The content that is to be taught in the class has to be determined. The teacher has to identify the teaching points that are the main themes of the topic to be explained. These are the major concepts to be dealt in a lesson.
- **Teaching aids:** Use of proper teaching aids helps the biology teacher to clarify the structural and functional

aspects of the topic. It helps to motivate the pupils and makes them learn effectively. Teaching aids should be used skillfully at appropriate time. The common teaching materials like the black board, chalk pieces, scale or a pointer are necessary in a classroom. In addition to these materials, charts, models, preserved specimens, glass wares, and apparatus can also be used as specific teaching materials for better comprehension of the subject content.

- **Writing instructional objectives:** General and specific instructional objectives should be provided. These objectives reflect learning outcomes. So careful thought should be given in writing instructional objectives.

The teacher should identify the instructional objectives that are to be achieved as part of the lesson. They have to specify the specific learning outcomes acquired by the students as a result of the teaching learning process.

- **Introduction of the lesson:** Introduction of the lesson prepares the students for learning.

In introduction the teacher can

- Review or test the previous knowledge of the students
- Motivate the students for learning
- Introduce new knowledge

Set Induction is the skill which is related to the introduction of the lesson. A lesson may be introduced effectively by presenting a demonstration, using teaching aids, asking thought provoking questions, or relating a story in brief. This part is mainly concerned with the attention of the pupils. So, the time taken for introducing the lesson should be about 3 minutes.

- **Development of lesson:** This is the body of the lesson. This is concerned with the development of the learning activities. This step involves the context method, teaching aids, and the ability of the students. Content is based on which

learning activities are planned. So the teacher has to select teaching concepts and organize in order. Based on this content the learning activities should be developed.

Based the learning activities method, the teaching aids should be selected for easy acquisition of concept.

The teacher has to bear in mind the age, maturity, and the interest of the pupils. To make sure of effective teaching-learning process, evaluation may be carried out at every stage. The teacher provides generalizations and applies the concepts to the real or natural situations.

- **Recapitulation:** Recapitulation helps in recalling the lesson learned and to find out the extent to which teaching is effective. Recapitulation may do through questioning or written examination. This helps in reviewing the lesson as well as evaluating the knowledge gained by the students. The teacher can observe whether the students have understood the lessons and achieve the objectives of the lesson.

- **Assignment:** Home assignment helps the learner to study and apply the acquired knowledge. It includes the activities that are given to individual students or in groups. The activities are designed in such a way as to develop their curiosity, creativity, and scientific skills and also bring out their originality. These assignments may be small time projects also.

- **Follow up activity:** This helps in the application of the knowledge gained in real life situations and helps in the achievement of the objectives which develop the appreciation and interest in the students.

- **Format of lesson plan:** The lesson plan proforma varies with varying lesson plan. The most common proforma that is used in schools is given below.

Preliminaries:

LESSON PLAN

- Name of the student :
- Name of the training institution :
- Name of the co-operating school :
- Subject :
- Class :
- Sub-Unit :
- Date :
- Duration of the period :
- Teaching method used :
- Teaching aids and others :
- Instructional materials used :
- Teaching main points :
- 1.
- 2.
- 3.
- 4.
- 5.

General instructional objectives

The pupil

- 1. Acquire knowledge about.....
- 2. Understands.....
- 3. Applies the knowledge of
- 4. Acquires the skill of drawing.....
- 5. Develops interest in.....

Specific instructional objectives

The pupil

- a) defines.....
- b) explains.....
- c) differentiates.....
- d) compares.....
- e) uses

- f) draws.....
- g) collects/prepares.....

Previous knowledge :

Steps, objectives and specification	Content analysis	Learning experience	Evaluation
<p>1.Introduction Motivation Declaration of the topic</p> <p>2.Lesson development</p> <p>3.Recapitulation</p> <p>4.Assignment</p> <p>5.Follow up activity</p>			

Signature of the Supervising Teacher

Signature of the Student Teacher

3.7.1 Sample Format of a Lesson Plan

The lesson plan proformas vary with varying lesson plan. The most common proforma that is used in schools is given below.

PRELIMINARIES

Name of the student:

Name of the institution:

Name of the school:

Subject:

Class:

Unit:

Subunit:

Date:

Duration of the period:
 Teaching method used:
 Teaching aids and other:
 Instructional materials used:
 Content analysis:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Instructional objectives

Specifications

S.No.	Steps	Content	Obj/speci	Teacher activity	Pupil activity	Teaching aids	Blackboard work	Evaluation
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1. Introduction

- a. Testing previous knowledge
- b. Declaration of the topic
2. Presentation
3. Recapitulation
4. Assignment
5. Follow-up activity

Model Lesson Plan

Planning for Effective Instruction

Preliminaries:

Name of student trainee :

Name of the Institution :

Subject : Biology

Class : VIII

Unit : The Human Body and Health

Sub-unit : Eye

Topic : Structure of Eye

Date :

Teaching material (Aids): Charts showing structure of eye and coconut, charts showing Rods & Cones, and camera

Content Analysis

- Eye is a photoreceptor.
- Eye is protected from strong light and dust by eyebrows. Eyelashes and Eyelids.
- Tears are secreted by lacrimal glands present in the eye.
- Eye is almost spherical in shape with 3 external layers. 1. Sclerotic layer, 2. Choroid layer, 3. Retina.
- The outer sclerotic layer is tough and fibrous.
- The front portion of sclerotic layer is called cornea.
- The middle choroid layer has a number of blood vessels.
- Iris functions as a diaphragm.
- The pupil is occupied by the lens.
 - The retina is the inner most layer of the eye ball.
 - Retina has Rods & Cones.
 - Rods consist of Rhodopsin.
 - Cones consist of Iodopsin.

The messages from eye to the brain are carried by the optic nerve.

Instructional Objectives and Specifications

S. No.	Objectives	Specifications
1.	Knowledge: The pupil acquires the knowledge of Eye and its structure.	<p>The pupil: Recalls: The importance of Eye. Recognises: The 3 layers of Eye and its functions.</p>
2.	Understanding: The pupils understand the functions of 3 layers of eye - sclerotic layer, choroid layer, and retina.	<p>The pupil:</p> <ul style="list-style-type: none"> • Illustrates the functions of Eye. • Identifies the functions and relationship between 3 layers of the eye.
3.	Understanding:	<ul style="list-style-type: none"> • Explains the structure of Eye. • Differentiates between Rods and Cones.
4.	Application: The pupil applies the knowledge of Eye and its importance in new situations.	<ul style="list-style-type: none"> • Analyse that light travels from an object passing through the cornea and the pupil and is focussed by the lens on to the retina. • Give reasons as to why we cannot see colours in dim light but can see in bright light.

5.	<p>Skill: The pupils develop skill in</p> <ul style="list-style-type: none"> • Drawing the diaphragms of Eye, Rods & Cones. • Observes the charts showing structure of Eye. • Develops skill of scientific expression. 	<p>The pupil:</p> <ul style="list-style-type: none"> • Draws accurate and neat diagram of Eye - its structure. • Draws the Rods & Cones • Labels the parts of eye correctly. • Observe the charts. • Uses appropriate terms to describe the part of Eye. • Develops clarity of expression. • Organises his thoughts systematically.
6.	<p>Interests: The pupils develop the in human sense organs & their functions. They gather new information about them.</p>	<p>The pupil:</p> <ul style="list-style-type: none"> • Enjoys the observation of charts & models of eye. • Reads new books & collects extra information on all the sense organs.
7.	<p>Scientific Attitude: Pupils develop scientific attitude towards human eye.</p>	<p>The pupil develops:</p> <ul style="list-style-type: none"> • Curiosity to know more about sense organs and their functions. • Develops ability to express and record biological data.
8.	<p>Appreciation: The pupils appreciate the function of eye as a sense organ.</p>	<p>The pupil:</p> <ul style="list-style-type: none"> • Assimilates the knowledge of structure of Eye. Understands the significance of eye as an important sense organ in human body.

REVIEW QUESTIONS

1. What is lesson plan?
2. List out and explain the steps included in a lesson plan which is followed in now a days.
3. Explain the importance of lesson planning
4. Select a lesson plan from standard 9. Content develop a lesson plan indicating the various steps involved.
5. Describe a format of a lesson
6. List out the characteristic of good unit
7. What is unit plan? What are the advantages and limitation?

Chapter 4

INSTRUCTIONAL STRATEGIES

4.1 Instructional Strategies

Before commencing on the path of studying or teaching a subject, the question arises as to why that particular subject is to be studied or taught. The answer of this very question helps us in setting up the definite aims and objectives for the teaching of that subject. In order to achieve these objectives, we try to plan and arrange the suitable learning experiences in the form of the curriculum. Lastly, we try to think about the methods to be adopted for providing the desired learning experiences to the students. These methods of teaching are determined after careful analysis of the experiences gained over the years. The methods of teaching Biology as prevalent today in our schools may be named as below-

1. Lecture Method
2. Lecture-cum Demonstration Method
3. Laboratory Method
4. Heuristic Method
5. Project Method
6. Assignment Method
7. Problem Solving Method
8. Inductive –Deductive Method

Let us discuss a few of the most useful methods of teaching general science out of these above methods.

Table :Teaching Method

S. N o.	Teaching centered method	Pupil centered method (within class)	Pupil Centered method (Socialised Techniques)	With Instructional Technology
1.	Lecture Method	Laboratory Method	Seminar method	Programme d instruction
2.	Demonstration method	Heuristic method	Symposium	C.I.A.
3.	Biographical Method	Project method	Workshop	Teaching machines
4	Historical method	Assignments method	Panel discussion	Personalised instruction
5	Team Teaching	Discussion method		

Teacher Centered Method

4.1.1 Lecture Method

It is the most convenient and inexpensive method that can be adopted for teaching sciences in our schools. It hardly requires the use of any scientific apparatus, experiment, and aid material except the chalk-board. That is why it is often named as ‘chalk and talk method’. However, it proves a great helping hand in covering the syllabus rapidly within the limited time and meagre resources.

The form of the Method

For making use of this method, the teacher prepares his lecture about a particular topic from the text books and other available sources and then delivers it in the prescribed period to his/her students. There is hardly any interaction or exchange of communication between the teacher and the students. The students remain quite inactive by being the passive listeners and recipient of the knowledge that usually comes to them as showers of the rain. The teacher here usually adopts an attitude of no concern for what is being heard or

grasped by the students. The merits and demerits of the method are listed below.

Merits of Lecture Method

- ❖ It is an efficient method of delivering a large amount of content to a large group of students.
- ❖ A single teacher can handle the entire class without using any other aids.
- ❖ An easy method of teaching where the teacher can use his/her own style.
- ❖ It helps in maintaining a logical sequence of the contents.
- ❖ A lot of information can be provided without any overlapping.
- ❖ Abstract concepts can be taught with ease.
- ❖ Introducing and summarizing a lesson becomes very easy.
- ❖ Syllabus can be completed in time.
- ❖ A well- presented lecture creates interest in a subject.
- ❖ Good lectures motivate and inspire the learners and develop their critical thinking.
- ❖ A lecture can complement the text material.

1. Economically Useful: Lecture method is useful from the economic point of view by proving inexpensive in the following grounds.

- It does not require the use of scientific apparatus, equipments, or other aid materials.
- A single teacher is able to face a number of students in a crowded class by the help of this method.

2. Time saving: This method saves time by proving a quick method of teaching. With the help of this method, a large quantum of knowledge and information can be transmitted in a short span of time thus providing enough scope for finishing the prescribed syllabus in the stipulated time.

3. Easy and convenient: It is quite easy and convenient for the teacher to deliver his prepared lecture without bothering

about any practical demonstration or students' participation. It is also very easy for the students to listen to what the teacher says without taking pains of performing experiments or observing carefully the demonstrated facts.

4. Useful in special situations: In certain situations, lecture method not only proves to be useful but also becomes essential:

- ❖ While introducing a topic
- ❖ While summarising the subject matter
- ❖ While giving instructions before performing any experiment in the laboratory
- ❖ While explaining complicated and difficult experiments
- ❖ While giving historical accounts of scientific events, scientific discoveries, and inventions or describing life-history of some insects or creatures
- ❖ While describing the life of great scientists and their achievements.

Demerits of Lectures Method

Psychologically unsound: This method lays emphasis on the content of the subject matter and is not at all concerned with the needs and requirements of the child. It neither allows the development of the child's natural faculties nor cares for their tastes and interests. The child here remains quite passive and does not get proper opportunities for the development of his/her personality.

1. **Not helpful in the proper development of the mental powers:** Lecture method is not at all suitable for the development of many of the mental abilities of the children. They are forced to sit idle and listen to the lecture of the teacher. There are hardly any opportunity for being actively involved in the processes of reasoning, thinking, critical observation, experimentation, drawing inferences, etc. In this way, this method fails to help the students in developing their mental faculties.

2. **Contrary to the major aims of science education:** While talking of realising the aims of teaching General Science, this method runs quite contrary to the very nature and spirit of sciences. The child has to listen to the talks delivered by the teacher without getting any opportunity for practising and experiencing the information conveyed to him. In such a situation, we cannot expect from him/her to get engaged in the independent useful thinking for training them in the scientific method of problem solving. Similarly, it is not possible to provide opportunity for the children to develop scientific attitude with the help of this method. In this way, the major aims and objectives of teaching science, pertaining to the development of scientific attitude and training in scientific method cannot be achieved through lecture method.
3. **No gain of practical knowledge:** In lecture method of teaching, there is no scope of self-observation and testing. The dictum 'Learning by doing' has no place in it. It is why proper knowledge of General Science cannot be obtained by students with the use of this method.
4. **Difficulty in understanding the subject:** Students face difficulty in grasping the subject matter for the following reasons:
 - (a) General Science is better understood by observation and experimentation by the students themselves as compared to simply listening to the lectures.
 - (b) The lectures are generally delivered very fast; while the capacity of retention by the students is much slower. Therefore a major portion of the lecture gets lost by the students.
 - (c) The lectures are delivered in certain sequence. If a student, for some reason, has missed any portion of it, s/he likely fails to understand the rest of the lecture.

(d) The teacher considers the end of his/her responsibility immediately after delivering his/her lesson. S/He does not care whether a certain student is listening to him or not, or whether his/her lecture is going above the heads of the students.

(e) **All teachers are not good speakers:** They are not able to explain difficult and complex point and as a result, the students have to suffer a lot.

From the above discussion, it may be concluded that the lecture method, in its pure form, is quite unsuitable to teach General Science up to high school classes and specially the primary classes. It breeds one-sided traffic in the process of teaching and learning and makes science as a store piece of knowledge or a thing to say, listen or cram without the least opportunity to apply in practical situations. In this way, it may prove a great obstacle in the realization of the aims and objectives of teaching General Science. However, if modified in a proper way by intermixing it with the practical methods like demonstration or laboratory method, it can prove reasonably effective at the higher class of secondary and higher secondary stages.

4.1.2. Demonstration or Lecture-Cum-Demonstration Method

It may be adjudged as the most practicable and useful method of teaching General Science in the available circumstances of our schools. Science can never be told or talked about. It is very practical subject, the study of which needs richer experiences in the form of self observation and experimentation on the part of every pupil. However, to arrange for such learning experiences to all students in the school may not be possible or even feasible on account of so many reasons. Neither our educational system nor the available circumstances in the form of material and human resources permit us for the organisation and gaining of the

individual practical experiences. The only suitable alternative in such a situation lies in the form of demonstration or lecture-cum-demonstration method in which the scientific facts and principles are practically demonstrated as well as explained to all the students of the class simultaneously by the science teacher.

The Form of the Method:

In the presentation of the subject matter, the teacher makes use of both the lecture and demonstration method in a well integrated way. What is to be conveyed through explanation, narration or lecture is necessarily be supplemented through the practical demonstration of the objects, instruments, and phenomena. For example, while teaching photosynthesis, demonstration of the presence of sunlight, water, chlorophyll, and oxygen is quite essential for deriving conclusion about their essential presence in carrying out photosynthesis by plants. In this way, facts and processes are first demonstrated through the relevant experiments and then students are helped to generalize and learn the related facts or principles. In this way, this method helps all the students of the class simultaneously to gain practical richer experiences with the common demonstrations exhibited by the class teacher. The students can use both their eyes and ears simultaneously for the gaining of learning experiences. They can get opportunity for the active participation by asking questions or helping the teacher in the demonstration work.

The teacher while demonstrating the experiments goes on asking questions to test their knowledge. The students are also able to ask questions regarding the experiment and get their doubts and difficulties removed. They may also be called by the teacher to get desired assistance in carrying out the demonstration work.

Merits of Lecture-Demonstration Method:

1. **Active Participation:** The students do not remain passive at the time of demonstration but are free to ask questions for explanation of any aspect, they do not understand. They are also free to give their suggestions. The teacher does not confine himself/herself only to lecturing but s/he is active in showing and explaining the experiment relevant to his/her lesson.
2. **Helps in mental development:** In demonstration method of teaching, the students watch the experiment and other teaching aids shown by the teacher which excite the students' imagination for the correct inference and gives ample chance to develop their faculties of observation, reasoning, deep thinking, and other mental abilities. This method of teaching inculcates the habit of scientific thinking, acting, and viewing everything scientifically.
3. **Helping the task of the teacher:** Every teacher wants his/her students to easily understand his/her lesson but it is not possible only by delivering a lecture. S/He must use proper teaching aids and also must demonstrate relevant experiments. It will take much lesser time for the teacher to achieve his/her aim. By demonstration of experiments, a lot of time and efforts are saved in bringing home the scientific facts to his/her pupils.
4. **Clear and permanent knowledge.** The knowledge obtained by observing the experiment and by understanding the working of apparatus at the time of demonstration, becomes quite clear and can be remembered for a long time. By observing demonstration of the things and events, the students understand the facts and principles of General Science

easily. Children are interested in all activities and take part actively in General Science experiments. The enthusiasm of the children in the demonstration of experiments makes them remember the facts and the principles in General Science for a long-time.

5. **Economical method.** In the present circumstances in our country, we cannot think to provide apparatus to each and every individual to perform experiment by himself/herself. At this juncture, the use of demonstration method of teaching is the most convenient and economical one. The things are demonstrated and experiments are shown by the teacher and all the pupils actively observe and get the relevant practical experiences then and there. In this sense, this method is not only effective but also economical, as it saves a lot of expenditure on a large number of the apparatus for each experiment. At the same time there is a lot of time saved.

Demerits and Limitations of Lecture-cum-demonstration method:

1. **Lack of opportunities for developing practical ability.** As the experiments are done by the teacher and the students do not get chance of performing them individually, there is no possibility of the practical ability for carrying out any experiment in future. Lectures or demonstrations simply are insufficient in conveying full knowledge of the apparatus or the instrument used in the experiment. Actual performance of the experiment and handling of the apparatus are of prime importance for developing real taste for sciences.
2. **Inadequacies due to psychological reasons:** The most effective scientific method of teaching is “Learning by doing” but the spirit of this is altogether absent in the case of demonstration method. The urge of students for doing

experiments with their own inferences is not fulfilled. In this way, this method fails to provide opportunities for the development of creative, constructive, and inventive faculties of the children. Thus, from psychological point of view, this method is imperfect and insufficient.

3. **Practical limitations and problems:** This method needs a lot of preparations before-hand and number of precautions and faculties are demanded for deriving desirable success in this method. A few of these are cited below:
 - (a) For demonstration method to be successful, it is necessary that the number of students should not be large.
 - (b) It is presumed in this method that all the students will remain attentive and alert in observing the whole process of demonstration. However, it is difficult for every student to be very attentive and be able to watch the whole experiment carefully.
 - (c) Demonstration method cannot be made very effective by an inexperienced teacher, who is not able to sustain the attention of his/her students. It is also not possible if the teacher does not get sufficient time for preparing his/her lesson or if there is paucity of material and equipment needed for the demonstration work.

Suggestions for the Success of the Demonstration Method:

1. It is very essential to ensure that all the students of the class are able to observe the demonstration of the experiment properly. The lecture room should be in the form of gallery i.e., one step above the other, otherwise the students of the back benches will not be able to watch the demonstration properly. In this case, following suggestions will be helpful:
 - (a) If the teacher is a good disciplinarian, s/he can allow the back benchers to sit on the writing tables in order to raise their seats for having a good view of the demonstration of experiment.

- (b) The teacher at his discretion may allow the back-benchers to stand in a semi circle around the demonstration table.
 - (c) If the audience is large, a big mirror may be fixed on the demonstration table in such a way that a full view of the demonstration activities is received by looking at the image formed in the mirror.
 - (d) The demonstration-table should be well lighted so that the apparatus used is properly visible. The principle of a proper background should also be followed properly. For example, a black object should not be shown against a black back ground like the classroom black-board.
 - (e) The demonstration-apparatus should be large in size, the gradation on it should also be in bold letters and figures.
2. The teacher should be well aware of the aims and objectives of the demonstration s/he is showing to the students.
 3. The teacher should test all the parts of the apparatus and chemical before doing the experiment in front of the students. He should ensure the success of the experiment by trying it before hand. The failure of the experiment in the classroom is detrimental to the faith of the pupils in the teacher. No amount of excuses by the teacher is of any help in this direction. Therefore prior practice before demonstration is very much desirable. In such a case, the teacher gains a lot of self-confidence. If, by chance, there is some breakage of the apparatus or some other mishap, s/he should not lose his/her balance of mind. S/He should pose question to the students to find the cause or causes of failure of the experiment. Then the teacher should himself/herself explain the short-comings of the experiment. S/He must repeat the experiment next day successfully to gain the confidence of the pupils.
 4. The apparatus and instruments for demonstration should be stored in a definite order especially on the

demonstration table the apparatus should be kept from left to right. They should be used for demonstration in order and they should be kept away. There should be no crowding of the apparatus on the table. One experiment should be shown at a time and no useless and extra apparatus or instrument should be left on the table.

5. The experiments to be shown must conform to the standard and mental ability of the students. As far as possible, the things known and familiar to the students should be used in the experiment.
6. Very complicated experiments of long duration with long drawn results become uninteresting and less educative. Therefore, care should be taken to avoid such situations.
7. The demonstration work should be directly connected and related to the topic currently taught in the class.
8. The teacher should attract the attention of the pupils during demonstration just like a magician and keep it sustained throughout. The pupils should be kept active and also kept participating in the experiment being done so that they may also acquire proficiency in it.
9. During demonstration the teacher should adopt 'Heuristic' approach throughout. The students should be asked to draw inferences and results of the experiment instead of telling them in advance. The laws and principles should be inferred and deduced with the help of students after the experiments have been shown or demonstration work has been done.
10. In order to make the demonstration meaningful and more effective, it will be wise to make use of teaching aids like charts, pictures, photographs, models, cinema reels, slides, etc, as suited in a particular situation.
11. In addition to the above, the teacher should make use of the black-board placed behind the demonstration table for writing out the summary and the result of the

demonstrated experiment and for drawing the sketches of apparatus and processes.

4.1.3 Biographical Method

The method which incorporated the study about funding of knowledge in certain field in respect of the life of the contributor is called Biographical Method. Though this method is extensively used in the disciplines like social science, history, etc., it still adds subjects like science including biology. For example, the subject genetics cannot be studied without knowing the life history of Johan Gregor Mendel, since his researches were all done as a practice in his lifetime which he conducted in his monastery; later studies revealed that he undertook a number of works pertaining to genetics as part of his routine life. It is also best exemplified with references like Darwin, Edward Jenner and so on.

This method not only addresses the contributions of the scientist, but also addresses the life in which the scientist had gone in his pursuit of experimentation including the hardships, the knowledge about the techniques, apparatus, their counterparts, scientific development at the time of their life, improvisations, etc. Finally, this method is probably the history of achievement and the achiever.

Incorporation of this method has numerous advantages and the most important is that the method would encourage people to develop research aptitude and to positively stereotype the scientist by whom they have been inspired. This would develop the right attitude and interest in subject of biology.

4.1.4. Historical Method

History concerns itself with the unique evolution of man in his/her activities as a social being. It deals with human potentialities in their teleological connections. For example, the history of the developments in biology can be elaborated with facts and findings of man in biology naming the names

of the scientists who contributed to a particular development. History does not seek what is common to the social facts of the past; it does not attempt to generalize to establish laws. It could not if it would, for it deals with the facts that have occurred but once, that will not occur again, and a generalization assumes repetition.

Historical Method is useful in teaching lower grades; lower grades are particularly interested in fascinating stories and events. This can be achieved by teaching them with illustrating the life history of super heroes who changed our lives with their scientific inventions and discoveries in their ages.

4.1.5 Team Teaching

First developed in 1955 in Harvard University, this concept travelled to Britain in 1960, where it was developed by J. Freeman. In Chicago University, Facis Chase used team teaching for effective teaching.

Meaning and Definition of Team Teaching:

1. Carlo Olson—“An instructional situation where two or more teachers possessing complementary teaching skills cooperatively plan and implement the instruction for a single group of students using flexible scheduling and grouping techniques to meet the particular instruction.”

2. David Warwick— “Team Teaching is a form of an organization in which individual teachers decide to post resources, interests and expertise in order to devise and implement the scheme of work suitable to the need of their pupils and facilities of their school.”

Thus, Team Teaching is a type instructional organization involving teaching personnel and the students assigned to them in which two or more teachers are given responsibility of working together, for all or significant part of the instruction to the same group of students.

The teachers participating in the team teaching decide or determine their activities themselves. In spite of this, the teachers assemble all the resources, interests and expertise, thus, the team teaching is a well- organized system of teaching in which many teachers impart instructions to a group of students in a co-operative manner. These teachers plan the teaching and execute it for the group of students co-operatively. The plan of the teaching methods, time, and the process are so flexible that the necessary changes in the programme of the team teaching can be brought about according to the teaching objectives and abilities of the teachers.

Characteristics of Team Teaching

1. It is a teaching method.
2. Two or more teachers participate in the teaching.
3. It is based on co-operation.
4. All the teachers participating in the team teaching apply their resources, abilities, and experiences.
5. All the involved teachers plan teaching cooperatively and execute it.
6. Evaluation is also made on co-operative basis.
7. The needs of the pupils, schools, and existing resources are also considered.
8. Various aspects of any topic of one subject are taught by two or more teachers turn by turn.
9. Its main aim is to make the teaching-learning more effective.
10. Isolation among the teachers is removed.
11. The entire responsibility does not fall only on one teacher but it is shared by others too.
12. The teachers decide their activities themselves.
13. It is a technique of creating instructional conditions.
14. Its plan is flexible.

Objectives of Team Teaching

1. To make the best use of attractive abilities, their interests, and expertise in teacher's community
2. To make the classroom teaching effective according to the interests and capacities of the pupils
3. To encourage flexibility in grouping the pupils. In this, the grouping of the pupils in a subject is done according to the interest and aptitudes of the pupils
4. To increase the quality of the instruction

Principles of Team Teaching

1. Duration according to importance — To allot much time to an unimportant subject makes the team teaching ineffective. The duration should be decided on the basis of the subject's importance.

2. Level of Instruction according to pupils — During team teaching, before imparting instruction to the pupils, the initial behaviours of the learners must be observed and the level of the instructions should be according to the pupils.

3. Objective Based Supervision — The type and the method of *supervision* depend upon the objective of the group. Therefore, the objectives of the group must be kept in mind at the time of supervision.

4. Appropriate Size and Composition — In the present times, the fixed size of the class is an old story. The size of the group changes according to the objective of the team-teaching. Therefore, the size and composition of the group of the pupils should be appropriate according to the objectives of the group and learning experiences.

5. Appropriate Duties Assigned to Teachers — It is necessary for team teaching that the division of duties and responsibilities of the teachers should be appropriate. These duties should be assigned to them according to their academic merit, interests, and their personality traits. Hence, in team teaching, the team members are selected very carefully.

6. Proper Learning Environment — The team teaching is successful if a proper learning environment is provided, such as a provision of library, laboratory, workshop, etc.

Types of Team Teaching According to Source:

1. From a Single Department—In this, teachers come from a single department. Such type of arrangement is done for secondary and higher secondary classes. It is possible only if there is more than one teacher for one subject.

2. From various department of a Single Institution—In this, a team of teachers of different subjects is formed and such team is used in training institutions, such as teachers in Psychology, Philosophy, and Sociology etc. are included in a team and the teaching task is organized very easily. For example, training for B.Ed., and M.Ed., etc. In short, team teaching encourages interdisciplinary teaching.

3. From a Single Department of Various Institutions—In this, specialists from other institutions are also invited. Such team teaching can be managed at every level and for every topic. This provision of team teaching proves much useful where there is only one subject teacher. Such team-teaching encourages co-operative teaching. The effective use of this team-teaching becomes more possible in the city where there are more than one training institutions.

Procedure of Team Teaching

1. **Planning**—The plan of the team-teaching is prepared. In order to prepare a plan of team-teaching, the following activities are performed—

- Determining the objectives of team-teaching
- Writing the objectives of team-teaching in behavioural terms
- Identifying entering behaviours of pupils
- Deciding the topics for teaching
- Preparing an outline for teaching a topic

- Assigning duties to the teacher, looking at the interests of the pupils and their skills
- Determining the level of the instructions
- Deciding the evaluation techniques
- Creating learning environment and teaching material

2. Organization—

- The teacher asks some initial questions in order to decide the level of the instruction. Only then he can set the level of the instruction.
- The communication techniques are selected keeping in view the pupil's knowledge of the language.
- A teacher delivers lead lecture while the other member-teachers of the team listen to it. They note down the important points specifically which are difficult for the pupils to understand them.
- The other teachers of the team also deliver lectures and clarify various elements.
- Pupils' activities are reinforced. The teacher encourages the pupils.
- The pupils are asked to perform certain tasks in the class.

3. Evaluation of the Results:

- Decision is taken regarding the achievement of objectives and performances by the pupils.
- Necessary modifications are introduced in the planning and organization phase on the basis of evaluation.
- Oral and written questions and practical methods are followed. Each question evaluates some objective.
- The shortcomings and problems of the pupils are diagnosed and remedied.

Advantages of Team Teaching

1. **Improving Quality of Instruction**—It improves the quality of instruction.
2. **Economical**—It is economical in terms of time and energy.
3. **Disciplining**—It helps in maintaining the discipline in the class.
4. **Exposure of Group to more specialists**—Its main contribution is that the pupils can have maximum opportunities of facing maximum specialists. The pupils can gain the advantage of specific knowledge of the different teachers.
5. **Development of the professional status of the teacher**—It develops the professional status of the teachers because this provides them the opportunity of reading new literature. In team teaching, the teacher himself/herself labours hard.
6. **Development of Human Relations**—Team-teaching provides opportunities of developing human relations. Human relations are very essential for social adjustment.
7. **Opportunity for free discussion**—It provides many opportunities to the member-students for participating in the discussion. It provides stimulus to the ideas of the pupils and teachers.
8. **Developing Character**—Team-teaching develops the strong will and responsibility of participating among the pupils and the teachers.
9. **Flexibility**—The school building, school staff, and other resources of the school can be used very flexibly. Team-teaching helps in getting rid of traditional time-table.
10. **Evaluation**—It can be best utilized in the step of evaluation. All the teachers get opportunity of evaluating the task of every teacher. Essential suggestions can be provided so that the necessary modifications can be applied. In the traditional teaching system, no teacher bothers for the task of the other teacher. By team-teaching, all the teachers can be

assembled and they can be told about their teaching.

Limitations of Team Teaching

1. **Costly Method**—It is costlier than the traditional teaching. Per head, its cost is more than the traditional teaching.
2. **Lack of Accommodation**—In comparison to the traditional teaching, more rooms and furniture are required. Hence, due to the scarcity of space and building, the effectiveness of the team-teaching becomes doubtful.
3. **Lack of Co-operation**—Its basis is co-operation. But sometimes teachers hesitate to co-operate with other teachers. Hence, co-operation from all the teachers cannot be expected.
4. **No Delegation of Power and Responsibilities**—It needs the division of powers and responsibilities which are lacking in the present school management because no manager will like to delegate his powers.
5. **Disregard to the Dynamics of Small Group**—No specific type of guidance can be imparted because during team teaching, school staff cannot function like a football team.
6. **Lack of Research Work**—Being a new concept, it lacks research work. It is being used on the basis of trial and error method.
7. **Conflict in the Role of Teachers**—Different teachers have different roles which increase the load of team-teaching member teachers. One teacher considers the other's role as a hurdle. In such conditions, the teachers face tough time to maintain the balance and co-ordination.
8. **Diversification in the Views of Teachers**—When different teachers work together, it becomes difficult to eliminate diversification in their views. Unification in their ideas becomes very difficult, when some teachers want to make the curriculum more comprehensive, while others want to delimit it, it becomes very difficult to deal with such situation.

9. Conflict between Change and Traditionalism—There is always a possibility of conflict between new methods and traditionalism. The emerging new methods have created unrest and panic among traditional teachers. Such teachers try to resist these changes.

10. Lack of Flexibility—If such flexibility is not possible, then the success and effectiveness of the team-teaching will be almost zero.

Pupil-Centered Method

4.2.1 Laboratory Method

Biology is a science which cannot be taught only through lecture and demonstration methods. It is about doing the experiment and experiencing it live. ‘To learn science is to do science. There is no other way to learn science’ (Indian Education Commission report 1964-1966). In today’s classrooms, there are numerous ways of teaching biology like the laboratory classes or other integration of technology into teaching but it is the laboratory classes that provide practical exposure to the subject. It occupies a pivotal role in teaching of any branch of science. Without laboratory approach, science cannot fulfill its objectives.

In any laboratory classes, experiments are conducted as per level, age, and stage norms. It teaches the students how experiments are conducted in controlled climatic conditions where the external influences are minimized. To conduct these classes, a fully equipped laboratory is mandatory, at least in higher secondary stages, where instructions, demonstrations, and practical sessions are conducted in laboratory. It should be equipped in such a way that it should cater to the needs of students.

Advantages of Laboratory Method

1. It engages almost all senses of the student thus giving maximum pleasure in learning.
2. It broadens the curiosity and interest of the students by

rechecking the facts which they have seen theoretically.

3. They get a first hand opportunity to know and to work directly which is best considered the most desired in learning.
4. It makes the student aware of practical way of proving the facts, concepts, theories, ideas, etc., through self-interest and of their own.
5. They get trained in handling various apparatus, instruments, scales, graphs, specimens, and equipments during course of work.
6. They get experience in Scientific Method by observation, collection, interpretation, and conclusions with appropriate precautionary measures.

Types of Laboratory Method

Based on the number of participants in an experiment this method is divided into two major types. They are Individual system and Multiple or Group system.

a. Individual system:

It is a method where the students are allowed to do the experiment individually with the available apparatus or equipments. That is its like 1:1 ratio with the experiment and the experimenter. This is further divided into two subtypes: they are a. Event front system and b. Rotation method.

7. Event front system:

In this system the students are allowed to do the experiment at the same time simultaneously. In order to conduct a system like this the laboratory should be equipped with all the apparatus according to the number of students.

Merits:

1. In this method, it is easy to compare the results with the other students.
2. It encourages healthy competition among students as it is conducted at the same time.
3. It is the easy method for teachers to give instructions for conducting the experiments.

4. It is easy to arrange all the apparatus at a fixed time, since all the apparatus are same for the experiments.

Demerits:

1. It requires more number of apparatus and it is normally an expensive method.
2. It requires enormous storing space as well as laboratory space.
3. In this method, lethargic students may copy the results of others making supervision and evaluation is a big problem.
4. It is hard to give a guarantee that students are working in their self-interest.

a. Rotation Method

In this method, the students are asked to work on different experiments at a given time. Once that particular experiment is over the next experiment is given to the students; likewise all the students are asked to complete their experiment in rotation.

Merits

1. The maintenance of apparatus is comparatively easy.
2. All students get an opportunity to finish all the required experiments which is not possible in the other method.
3. Teacher can attend to the students individually.
4. Very minimum storage space is needed as it requires only a few apparatus at a time.

Demerits

1. Supervision is hard for the teacher and a single teacher cannot handle it alone.
2. Instruction cannot be given to all the students at the time of experiments.
3. Time specification for the experiment cannot be fixed as it differs from experiment to experiment.
4. This method never allows the students to repeat the experiment as it is given in rotation.

b. Multiple or Group System

Two or more students are allowed to do a single experiment in this method. The arrangements require more space than the normal method as it should accommodate two or more students to experiment at a same time.

Merits

1. It is a convenient method while considering the inadequate number of apparatus and space available for doing experiments.
2. It develops teamwork and cooperation.
3. It develops interest and healthy competition when one or more groups are involved.
4. It paves way to share ideas with teammates which brings about a lot of knowledge input for the teammates.
5. Slow learners will get good assistance from their teammates which bring about motivation and pleasure in doing experiment.

Demerits

1. Interested students alone can take part fully in this method.
2. Copying of results will happen with their teammates.
3. Some students lose interest if one or two in their group dominate.
4. Complicated and advanced instruments cannot be given to groups.

4.2.2 Heuristic Method

In this method, the students learn by exploring. The teacher's role is that of the path setter who rectifies the faults at the proper time. As the children work and perform experiments, they attain new knowledge. The exponent of this method was Prof. Armstrong. According to him "The soul of the learning of science is exploration. The students should explore the facts and principles themselves". In this method, the student works as an explorer. The student does not have knowledge of experiment in the beginning. He has to perform

several experiments to obtain required information and principles. He also has to study the related literature.

Merits

1. The students develop scientific tempore.
2. This method makes them exact and brings them closer to truth.
3. The students' observation power is developed and their thinking ability is enhanced.
4. The students develop interest and capability to labour harder.
5. The students develop qualities of activeness, self-confidence, and self-dependence.
6. This method prepares students for life.
7. The knowledge obtained is more stable.
8. Contemplation and awakening increases in the students.
9. The whole work is completed in the class, so there is no need for homework.

Demerits:

1. The pace being slow, the whole curriculum cannot be completed in a fixed time period.
2. The students find it difficult to draw conclusions.
3. The teacher has to make special preparations to use this method.
4. This method is not applicable for junior classes.
5. For this method, a good laboratory and a good library are required.
6. More money is spent.
7. Difficult to impart education to larger groups.
8. Not good for weak students.

Suggestions for improvement:

1. Heuristic method should be realistic.
2. Few selected lessons should be taught by this method instead of the whole curriculum.
3. The teacher should be alert and conscious towards

his/her duty.

4.2.3 Experimental Method

Biology is a scientific topic. Thus, this should be learned through experimental method. For teaching this subject, the laboratories are a must. The laboratory makes teaching of Biology more meaningful and interesting. In the laboratories, the students learn about facts and laws of different branches of Biology and check their truthfulness and learn to make practical use of them. In this method, the students become very active and learn themselves. The student finds the answer to the curriculum related problems under the guidance of the teacher. He himself notes down the figures of his observations and on the basis of calculations, draws conclusions.

Merits:

1. The children learn by doing. Thus, their interest is developed and the knowledge acquired is of permanent nature.
2. This method removes the demerits of collective teaching.
3. Helps in developing the habit of self-study.
4. The knowledge acquired by this method is more meaningful.
5. The students learn the application of principles of Biology in different situations. Thus, they fully understand the principles and concepts of Biology.
6. Students learn the use of apparatus fully and correctly.
7. The students enjoy as they remain active.
8. The students make use of their eyes, ears, nose, and hand and thus all their senses are developed.
9. This is a natural method of exploration. The children, in order to acquire knowledge, perform the practicals with great joy and enthusiasm.
10. This method helps in increasing the self-confidence of the students and they find themselves more capable and competent.

11. Individual attention can be given to the students. Their weakness can be identified and proper help can be given.
12. The students get a training of scientific methods while working in a laboratory.

Demerits:

1. This method requires a number of apparatus and laboratories. In places where these are not possible, this method loses its importance.
2. In this method, the students are to be checked and proper instruction should be given or this method becomes mechanical. If proper instructions are not given, a lot of time will be wasted by the students.
3. Individual attention cannot be paid to classes with larger number of students.
4. A lot of time is required to attain a small amount of knowledge. Thus, for a vast syllabus, this method is impractical. This method involves a lot money and strength.
5. Due to financial constraints, schools are not able to adopt this method.
6. This is not fit for small students.

Suggestions for Improvement:

1. In case of large number of students in a class, they can be divided into groups and then this method can be adopted.
2. The teacher should give complete instructions and keep a check over the students. In absence of these, the students may learn something wrong instead of correct knowledge.
3. The students should be made to understand the instructions properly prior to the starting of experiments.
4. The students should be helped whenever required.

4.2.4 Project Method

W.H. Kilpatric, a student of John Dewey is the exponent of this method. According to him, "Project is that activity which is performed with complete attachment in a

social atmosphere to achieve the goal”. Prof. Stevenson has called the Project method as problem solving method which is achieved in natural circumstances.

In this method, a problem is posed to the students and they find solution to it. The student works according to his/her interest and willingness.

Principles of Project:

1. Principle of Purposiveness
2. Principle of Activity
3. Principle of Reality
4. Principle of Utility
5. Principle of Freedom
6. Principle of Social Development.

For appointing and restraining each project, these principles are stressed upon—

Steps of Project Method

There are some definite planned steps necessary for going up with the project method mentioned as below:

1. Providing a situation
2. Choosing and purposing of the project
3. Planning of the project
4. Execution of the project
5. Evaluation of the project
6. Recording of the project

Let us now discuss these steps one by one.

1. **Providing a situation:** First of all, attempts are made to provide a situation to feel a necessity for choosing and working in a project. Most of the time, there are spontaneous upsurge of such situations. While at others, the teacher has to plan for the creation of such situations. The students may spot out a problem while having discussion in the classroom, while working in the laboratory or engaging themselves in extra-

curricular activities, going on some excursions, visiting some places of scientific or of general interests, and so on.

2. **Choosing and purposing:** After having confrontation with some genuine problem, the students may be persuaded to think a possible solution for it by selection an appropriate project. In the light of the many alternatives suggested by the student, they are persuaded to choose the best appropriate project subject to the availability of the resources in hand and the derivation of maximum educational advantages out of it. The objectives and purpose of choosing this project should then be made clear to all the students after having useful discussion.
3. **Planning of the project:** Every project for its useful implementation needs a careful planning. Therefore, all efforts should be made by the students for chalking out a detailed strategy to carry out the chosen project. Under the active guidance of the teacher, the students should be made to hold lively discussion, have consultation with suitable experts, and utilise library or other resources for the planning of their project. The duties and responsibilities, individually or collectively in the small groups, should also be distributed among them at this stage and decision about the collection of finances, etc., should also be taken for carrying out the project.
4. **Execution of the project:** The project is a joint venture and hence its successful execution needs the combined efforts and joint responsibilities on the part of all students related with the project. What is planned at the planning stage is thus made the subject of implementation at this execution stage. Every member of the group works whole heartedly with a sole

purpose of its successful execution. The difficulties of any are solved by mutual cooperation under the guidance of an experienced teacher. Here, students may get valuable opportunity for having theoretical understanding and practical application of the many facts and ideas of the subjects of their curriculum.

5. **Evaluation of the project:** Evaluation is a continuous process and for having evaluation of the project work, efforts are made to have review and assessment of the individual and group work of the students from time to time. Discussions are held to have a free and frank exchange of ideas, self or group evaluation for improving the execution activities of the project or seeking changes in the planning and procedure in any aspect or dimension of the execution work. In the end, when the project is fully executed, an overall assessment in terms of what is being done, whether the goal is achieved or not, difficulties felt or lesson learned is made by holding an useful discussion.
6. **Recording of the project.** There should be a truthful and proper recording of the work and events related to every steps of the project. How the project was chosen, how it was planned, and executed, what difficulties were faced and what results have been achieved, should be adequately recorded for future reference as well as improvement.

Criteria of a Good Project:

1. A project should have clear objectives that should be feasible enough to be conducted by the students.
2. Learning should be helpful for the students in solving their real life situations.
3. A good project should encourage good interests along with a sense of cooperation.
4. It should give the students a good democratic feel in doing

without any coercion.

5. The project should provide good opportunity for both the students and the teacher actively.
6. It should foster students' ability and experience.
7. It should be economical and time saving.
8. It should integrate real life situations so as to give real life experiences through study.

1. Selection of a Project—The teacher should create such circumstances that the students start formulating projects. The teacher and the students should discuss these projects independently. As far as possible, the student should get a chance to formulate a project. The teacher should give necessary suggestions.

2. Preparation for an outline—After the selection of the project, a programme should be prepared for the completion of the project. The students should be given full freedom to discuss the project among themselves. After an outline has been chalked out, the students should be given various responsibilities according to their capabilities and all this should be noted down. *E.g.* The project is '**Preparation of Botanical Garden**'. The measurement of land, the shape of the garden, names of plants to be planted, procuring seeds or saplings, required tools, manure, etc., should be discussed and different responsibilities should be given to different groups of students.

3. Execution of programme—After the outline of the programme has been prepared, the work should be started accordingly. The students start working on the responsibilities which have been given to them. The students have to acquire various types of knowledge to complete their responsibilities. The knowledge thus attained is more permanent. The teacher encourages the students, supervises their work, and makes changes if required.

4. Evaluation—After the project is completed, the teacher

and students together evaluate it. Based on the objectives of the project, its success or failure is discussed. The students discuss their work and rectify their mistakes and recollect useful knowledge.

Types of Projects:

In Biology, various types of projects can be prepared and the students get practical knowledge. The projects can be of the following types—

1. **Creation related projects**—Like Botanical garden, museum, aquarium, terrarium, vivarium, and construction of apparatus type of projects.
2. **Observation related projects**—Excursion and educational tours can be arranged to study the flora and fauna, and climate of different places. Their special characteristics can also be observed.
3. **Consumer related projects**—*e.g.* Agriculture, Horticulture, etc.
4. **Collection related projects**—Collection of different types of plants and animals, birds, herbs, shrubs, pictures, models, charts, etc., from different places and of different periods.
5. **Recognition related projects**—Classification of different flowers, fruits, seeds, roots, and creatures.
6. **Dissection related projects**—*e.g.* Taking sections of plants, animals, roots, stems, flowers, fruits, etc., and studying their internal formation.
7. **Problem related projects**—*e.g.* Problems related to food and nutrition, improvement in health, etc.

Merits

1. It develops interest in the project thus bringing out the intrinsic motivation of the students.
2. This method involves participation of team-mates and hence it promotes cooperation and interaction among the group members.
3. Project method revolves around real life situations and

thus gives the best in dealing with real life situations in later life.

4. Projects are selected and planned with students themselves; hence it is student-centered way of learning with the maximum participation of students' activity.
5. Students' learning by this method makes them learn the mistakes they make during the pursuit.
6. Challenging projects test the ultimate ability of one's potential.

Demerits

1. It requires a lot of planning and execution on the part of teacher for carrying out a project.
2. It consumes money and time depending upon the project. It cannot be given frequently due to this concern.
3. Not every activity in the project gives the deep knowledge about the project thus leaving the superficial knowledge to the learner in many things.
4. Not all the references can be made with books as the project gives a lot of new knowledge to the students.
5. It is an expensive method for both the teachers and the students as well as to the management.

Suggestions for Improvement:

1. Project should have definite objectives.
2. All students should be given responsibilities according to their capabilities.
3. All figures should have graphical representation.
4. The students should be given the freedom to interact among themselves.

4.2.5 Inductive and Deductive Methods

Inductive Method: In inductive method of teaching, the pupils are led from particular instances to general conclusion. Concrete examples are given and with their help, students are helped to arrive at certain conclusions and principles. In this method, the child is led to discover truth by himself/herself.

Inductive method is a very suitable method for the teaching of Sciences, Mathematics, and Grammar. **Example:** When we drop a book or a stone, it falls on earth.

These examples lead us to generalize that all substances are attracted by earth (Law of gravitation).

Merits of Inductive method

7. This method helps in developing **Scientific attitude** among students.

8. Knowledge is self-acquired and is soon transformed into wisdom.

9. Inductive method is a Scientific method and helps to develop scientific mindedness.

10. This method is logical as well as psychological. Learning by doing is the basis of this method.

11. It develops critical thinking and habit of keen observation.

12. The method affords opportunities to the students to be self-dependent and develops self-confidence.

13. It develops the habit of being intelligent and hard working.

14. It makes the lesson interesting by providing challenging situations to the students.

Demerits

(i) Inductive method is not good in the case of lengthy conclusions. Moreover, it is said that the pupils might not be able to achieve at complete generalization.

(ii) It is not possible to apply this method in solving and understanding of all the topics of science.

(iii) It is lengthy and time-consuming method.

(iv) The method can be considered complete and perfect if the conclusions are verified through deductive method.

It is possible that the students may draw conclusions very hastily and these may be based on insufficient data and, therefore, may be wrong.

Deductive Method

Deductive method is the reverse of Inductive method. In this method, rules, generalizations, and principles are provided to the students and then they are asked to verify them with the help of particular examples. We proceed from general to particular and from abstract to concrete. The teacher's work is much simplified by giving a rule and asking the pupils to verify it by application to several concrete examples.

Merits:

1. This method is very suitable for small children who cannot discover truths for themselves. They get ready-made material.

2. The teacher's work is simplified. S/He gives general principles and the students verify them.

3. It is a time saving method since the students will not have to go through the analysis or explanation in finding out a universal truth.

4. It is a speedy process and the syllabi can be easily covered.

5. This method supplements induction and thus helps to complete the process of induction-deduction.

Demerits and Limitations:

4. This method is rather unnatural and unpsychological since the children do not find out the facts or principles by themselves.

5. The method does not impart training in scientific method.

6. This method does not help to develop scientific attitude.

7. The method fails to develop self-confidence and initiatives in the students.

8. This method encourages memorization of facts, which are soon forgotten.

Both Inductive and deductive methods of teaching are not opposite things. They supplement each other. Induction should be followed by deduction and deduction by induction. Our approach should be Inductive-cum-deductive. The Combination of two methods is the best method for teaching Science, Mathematics, and Grammar etc

4.2.6 Scientific Method

Science is knowledge of the real nature of the Universe. Any real conception from any portion of the universe, fully or partially verified, constitutes a scientific concept. To achieve comprehension of natural phenomenon, we apply the Scientific Method. The Scientific Method is not unique or fixed, it has variations but the results must be acceptable in agreement with observations.

Steps in Scientific Method:

In general terms, we should follow a systematisation to obtain a valid deduction about something. This systematisation is summarised in the steps of the Scientific Method.

Observation:

The first step in any investigation is observation. Observation consists of setting our attention on a portion of the universe. Through observation, we identify specific realities or events from the cosmos by means of our senses. Once the observation is executed, the researcher elaborates one or more questions, generally generated by the curiosity of the observer. These questions constitute a problem. The questions must match with the observed phenomenon and must adhere to objectivity.

The investigator should always bear in mind that questions that begin with “why” are always very difficult but is not impossible to answer. The objective investigator prefers to start with questions such as “what”, “how”, “where”, or “when”. The question could also be “What is it for?”

Through Inductive Reasoning, the observer then tries to give one or more logical answers to these questions. Each answer is a tentative introduction that can serve as a guide for the remainder of the investigation. These preliminary solutions to a question are called Hypotheses.

Hypothesis:

Hypothesis is a tentative statement that can be submitted to experimentation, to verify whether it is false or true. After s/he has enunciated one or more hypotheses or proposed explanations, the researcher can then elaborate one or more Predictions, which must be consistent with the observations and hypotheses. To do this, the researcher uses Deductive Reasoning. Each hypothesis should be submitted to an exhaustive test called Experimentation.

Experimentation:

The results of experimentation will determine the final character (false or true) of the hypothesis. Experimentation can be performed in diverse ways, but controlled experimentation is a characteristic of the Scientific Method, to the extent that other simpler systems are not viable for the purpose of science. Generally, in controlled experimentation, we need two groups to test: one group is called the control group or witness group, and the other group is called the experimental group. Both the control group and the experimental group are subjected to the same conditions, excluding the variable that has been chosen for the study. The control group is not submitted to the change, while the experimental group is. The results are observed and the differences between both the groups are registered. If the investigator notes a difference between both the groups, then an answer can be deduced. As the investigation advances, false hypotheses are rejected one by one, until only plausible verifications remain of the hypotheses initially presented. When a hypothesis is proved true, scientists then process a

final statement, which, in science, is called a Theory.

A theory is a partially or totally true statement, proven by means of experimentation or natural and observable evidences, for one time and one place only. If a theory is verified as true for all times and places it would then be considered a law. A scientific Hypothesis is a provisional solution for a question generated through the observation of an event. The hypothesis can be false or true; so each hypothesis must be tested by experimentation.

4.2.7 Assignment Method

Assignment method is important as it develops permanent understanding behaviour. Its goal is to provide contemplation to the students. According to Leonard Douglas, “Assignments can be long or short, easy or difficult, general or different etc., its relation to the lesson or a Portion there of is found throughout the year.”

All the three aspects of Biology, namely Theory, Demonstration, and Experimentation can be explained to the students with the help of this method. The topic is divided into small assignments and given to the students to complete within a fixed time period. The students work in the Libraries and Laboratories, wherever required. The teacher supervises from time to time and helps in removing the difficulties. The student keeps a record of the work completed by him/her.

Merits:

1. Each student works according to his/her capability.
2. The teacher has to give proper guidance.
3. The students develop the habit of working by themselves.
4. The students develop the habit to fulfill their responsibility.
5. This method is an entrance of all aspects of Biology.
6. More stress is laid on practical work.

Demerits:

1. The responsibility of the teacher increases in giving work instructions to the students.
2. It is more time consuming.
3. This method is not useful in the absence of good libraries and laboratories.

Suggestions for Improvement:

1. Assignment should not be given daily.
2. The assignment should be related to the topic.
3. The assignment should be in accordance with the age and capability of the student.
4. There should be provision for proper guidance.
5. The assignment should be clear and objective.
6. The assignment should be meaningful.
7. The students should be motivated to work.

4.2.8 Discussion Method

According to Lee “Discussion is a group education work. In this the students discuss a problem together”. In this method a topic is taken and the teacher encourages the students to discuss it. S/He (the teacher) develops the lesson with the help of the answers and reactions of the students. In this method, there is ample space for interaction among the teacher and the students. For the success of this method, it is important that the students should be given freedom of expression. All the students should be encouraged to express their views but there should be control over the situation or circumstance.

4.2.9 Problem Solving Method

In the words of Hammonds Carsie, “Problem solving in teaching refers to the task making decisions or doing things that the learner wants to make or to do, the nature of which he is able to understand but for which at the time he has no solution.” The method of problem-solving is a result of necessity. In this method the student puts forth his/her topic related problem in front of other students and they start finding

a solution to it according to their interest and capability. In this method, the problem should be placed in front of the students in clear words and should be according to the understanding experiences of the students. The student does the synthesis and analysis of the problem with the help of the teacher and tries to find the solution.

This method has the following steps:

1. Selection of problem
2. Presentation of problem
3. Collection of facts
4. Drawing an outline
5. To reach a satisfactory conclusion
6. Evaluation
7. Graphical representation of the work

Merits:

1. Students learn to find the solution of their problems by themselves.
2. They develop the power of observation and argumentation.
3. They are capable to generalize.
4. They are familiar with the process of the collection of data, evaluation, and drawing inferences.
5. They learn to use old facts in new references.
6. They develop a feeling of working together.
7. This is a motivating method.
8. This is based on “Learning by doing”.

Demerits:

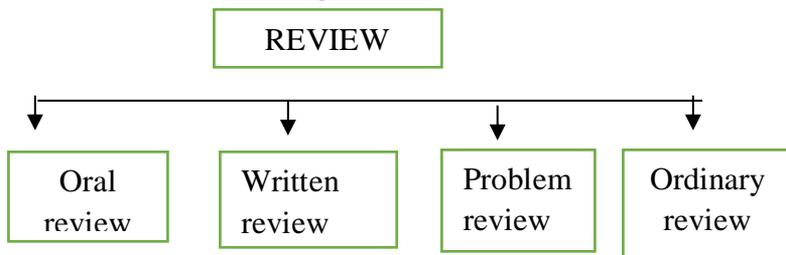
1. It is wastage of time and energy.
2. There is always a doubt of drawing wrong conclusions.
3. In order to practice this method, capable teachers are required.
4. This method is not suitable for junior classes.

4.2.10 Review Method

The teacher prepares the lesson, ponders over the

important points, and tries to locate which topic would be more useful for the students, the number of lessons already taught, and those left over. Review also helps the teacher to find the shortcomings of his/her teaching and what all s/he can do to remove them.

According to LawranceUrdang “Review is the process of going over a subject again in study or recitation in order to fix it in the memory or summarize the facts, criticism, imply carefully examining something, making judgments and putting the judgment into written form”. Review has been divided into the following divisions:



Merits:

1. It is effective for higher classes.
2. With the help of this method, the teacher can achieve his/her objectives.
3. The method is helpful in making the knowledge permanent.
4. This is an informal method.
5. Any of the facts can be critically examined.
6. The teacher teaches and remains active.
7. The students develop the habit of synthesis and analysis.
8. The students form the habit of studying in the library.
9. This method is very helpful in research work.
10. The students learn to study independently.
11. It is helpful in internal evaluation.

Demerits:

1. It is not useful for junior classes.
2. This method is more time consuming.

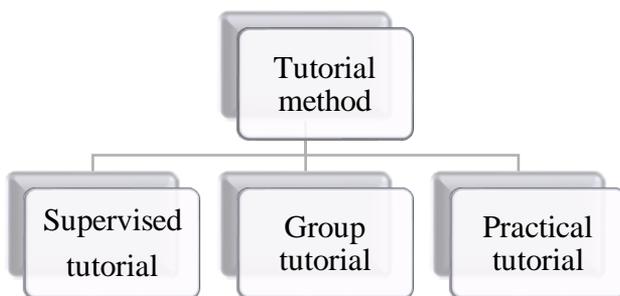
3. The students are dependent on the teacher for instructions.
4. This method is not very helpful for a class having students with mixed mental level.

Suggestions for Improvement:

1. The students should be given topics for review according to their capability.
2. The time period for review should be fixed.
3. The objectives should be fixed in order to know why a review is being conducted.
4. While reviewing curriculum and while fixing the topic, the availability of reference books should be taken into consideration.
5. Review of the students as well as that of the teachers work should be conducted.

4.2.11 Tutorial Teaching Method

Tutorial method is a method of teaching which can be used individually or for groups. To define this method, LawranceUrdang has written, “A session of intensive instruction by a tutor. It is system of education in which instructions are given by tutor (teacher) who also acts as a general advisor”. In this teaching method, the class is divided into small groups. The teacher goes to these groups, tries to locate their problems and helps them to find their correct solutions. In the tutorial, besides the personal problems of the students, problems related to their studies are also taken care of. That is why this method is also known as ‘Intensive Instruction’. High level of knowledge and sentimental objectives can be achieved through this method. This method is useful for teaching small children and adults. Tutorials are of the three types.



In supervised tutorial, the teacher and the students take part in personal talks and discussions. In group tutorials, average students are given special guidance and in practical tutorial, physical dexterity and laboratory works are given. Psychomotor processes are studied and their solution is found. This method is very useful in the development of values in the dull and bright students alike.

Merits:

1. It takes care of the remedial aspect of teaching.
2. The problems of the students are solved by making use of their previous knowledge.
3. It helps in achieving high levels of knowledge and sentimental objectives.
4. This method helps in improving the achievement level of the students.
5. This method can be used for individuals or groups, as per the requirements.

This is very true that, “Tutorial strategy is best suited for the development of application, evaluation, synthesis, expression, communication, rest and attitudes. It involves simple to complex tasks or abilities (in a problem solving situation closed as well as open ended) involving new unfamiliar areas” In this process, the students are given small hints orclues in the beginning which are gradually withdrawn while solving

the problems.

Demerits:

1. The teacher is able to solve only the problems related to his/her own subject. They do not take interest in other subjects.
2. The teachers sometimes pay attention only to a selected set of students, whereas, in a tutorial, attention should be paid to each individual of the group.
3. Some students do not give opportunity to others to speak.
4. The various groups develop competitive spirit.
5. The teacher should have knowledge of the psyche of the students.

Suggestions for Improvement

While using this method—

1. The teacher should remain impartial and pay attention to all the students.
2. The teachers should be allotted tutorial classes according to their experience, interest, and specialization.
3. The main objective should be to solve the problems of the students.
4. All students should be given equal opportunity to put forth their problems and ideas.
5. As far as possible, the process of group formation should be psychological.
6. Along with improvement teaching, the objective of this method should be development of routine problem solving skills.
7. Proper attention should be paid to avoid rivalry and jealousy among students.

4.2.12 Discovery Method

This method deals with the initial stages of development of research work conducted in connection with an invention. Under this method, the students are placed in the situation of

the discoverer or inventor, beginning with the first inventor to the latest discoverer. The students are kept in a situation in which they are able to see how the faith of various inventors changes with the facts related to new discoveries and inventions from time to time and also how one principle leads to the other or one principle changes into another.

In this method, the students can evaluate the differences between various facts and assumptions. Mr. Garg (1973), clarifying this method, writes, “Assumption is true till the time it can explain all the present events- They can see the process of development of scientific principles and events i.e. from initial assumption, to final discovery”.

The originator of this method is J. S. Burner. According to him, “In this method the students discover new facts/knowledge in an original manner as per their mental level, age, class, and other related facts. The facts are explained in a manner by which they give a sense of new facts”. This method makes the students active and develops their power of reasoning and observation.

Merits

1. This method makes the students explorers and helps them in becoming conversant with the methods of exploration.
2. This method makes use of observation, thought, and perception and develops these senses.
3. This method helps in understanding social and scientific facts rather than learning them.
4. This method helps in development creative thinking.
5. This method is helpful in achieving the high level objectives of knowledge and expression.
6. The students are able to discover new knowledge and try to retain it permanently.
7. The students develop the qualities of analysis and synthesis.
8. Through the medium of this method, the students are able

to understand how social changes can be brought about with the help of scientific inventions.

9. The students are able to learn how one principle is converted to another and how new principle is formed.
10. This is an interesting method for students.
11. The knowledge acquired by this method is permanent.

Demerits

1. This method is not applicable to all subjects or topics.
2. In this method, the process of teaching is slow.
3. The students remain active but do not get a chance to become sharp.
4. This method is more useful for brilliant students.

This method is prevalent in some schools of Maharashtra. There the students of classes VI, VII and VIII have to prepare a thesis based on this Method. The experiment of writing of thesis is proving to be quite popular there. Some people are unable to differentiate between Discovery and Juristic Methods. The given table highlights the differences between Discovery and Heuristic Method.

Table

Differences between Discovery and Heuristic Methods

Discovery	Heuristic
This method is extensively used to obtain knowledge of facts related to social issues.	This method is used extensively to gain knowledge of scientific topics/subjects.
This method is related to the ancient incidents or events.	This method is related to the present.

The explanation of facts becomes subjective.	In this method, the students become familiar with the curriculum in an objective manner.
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4.2.13 Question-Answer Teaching Method

The question-answer teaching method is an ancient method being used since the time of Socrates. That is why this method is also known as ‘Socrates Method’. According to Socrates, the question-answer method follows three basic steps—

1. Formation of questions in a systematic manner.
2. To place them collectively in front of the students so that their curiosity to learn new facts is aroused.
3. To develop a relation between the answers given by the students and giving them new knowledge.

* In this method, questions of low, middle and high degree are used.

Merits:

1. The students become active during this method.
2. They become curious towards new knowledge.
3. This is based on psychological principles.
4. This method is useful for training institutes and also in training small children.
5. The power of thought and expression is enhanced.
6. This method helps in the development of the lesson.
7. This method helps in the recapitulation and recall of the topic.
8. The question-answer method can provide the knowledge regarding specific problems and difficulties of the students.
9. This method is useful in the evaluation of the knowledge of the students.

Demerits:

1. Sometimes, this method becomes mechanical and becomes

uninteresting.

2. Special training is required for the execution of this method.
3. Formulation of good questions is an art in which everyone is not proficient.
4. This method is not complete in itself but the help of other methods like lecture method is also required.
5. This is not very useful for higher classes.

Suggestions for Improvement:

1. The questions should be short, clear, and to the point.
2. The questions should be inter-related.
3. The questions should be formulated keeping in mind the level of the students and the nature of the curriculum.
4. The language of the questions should be easy.
5. The questions should be posed in clear voice, correctly, and in complete sentences.
6. In between the question-answer, humour plays an important part or humour gives an important contribution.
7. The questions should be distributed evenly among all the students.
8. The use of 'Yes/No type or Suggestive type' of questions should be avoided.

4.3 Innovations in Biology Teaching

In the modern times, many experiments are being conducted and explorations are being done in the field of education. New techniques have been formulated in the field of teaching Biology, with the help of education and psychology to make the teaching more interesting.

In the methods of teaching of Biology, the following techniques are found to be more useful—

1. Investigation
2. Enquiry
3. Field Trip
4. Team Teaching
5. Seminar Presentation

6. Micro Teaching
7. Programmed Instruction
8. CAI.

4.3.1 Investigation Technique

Under this technique, it is important that the student does some investigation through his/her experimental work. By the investigation technique, the students learn the basic facts of Biology and they develop the aptitude to recognise the truth. This is true that “In Science Investigation, since, they require knowledge of scientific facts as starting point for further discovery through the use of scientific method, which is really nothing more than precise, logical thinking”.

In the absence of Investigation technique, teaching of Biology is incomplete. The following are the steps of this technique.

- 1. Question/Problem for investigation**—Every investigation begins from a question. A good question is that which has been thought by the student. In order to find a solution to that question, the teacher suggests a number of books and journals. If the student is able to find the answer to his/her question, then there is no scope for investigation. But if the student is not satisfied with this knowledge, s/he plans to investigate, in order to obtain an answer for his/her question. This project is prepared with the help of the teacher.
- 2. Drawing an outline**—The student draws an outline on the basis of the facts s/he has collected from various books and journals in order to find an answer to his/her question.
- 3. Blue-print for experiment**—After preparing an outline, the blueprint or design for experiment is prepared. Each step of the experiment is noted clearly and Dependent and Independent variables are thought upon. As per the requirement, control and experimental groups are formed. Again the instruments or apparatus to be used, its accurateness or correctness and usefulness is thought upon.

4. Actual conduction of experiment—On the basis of the outline prepared, the apparatus is collected and the actual experiment is conducted. Side by side, the student makes an objective observation and in the process, s/he keeps on writing down the facts, on the basis of these facts, s/he finds an answer to his/her problem. The teacher should help his/her student in preparing an explanation of the facts found during experimentation.

5. Writing the report of the experiment—After the completion of the experiment, its report is prepared under the following heads—

- a) Name of experiment
- b) Introduction—Chronological order of research work
- c) Outline
- d) Experiment—Topic, Apparatus, and Method
- e) Result
- f) Explanation of Result.

4.3.2 Enquiry Technique

In reference to enquiry technique, Nuffield Biology Teacher's Guide-V gives the information—

1. As far as possible, the students should come in contact with various problems to make them aware of the basic concepts.
2. An outline should be drawn.
3. The way to enquiry widens by performing practicals.
4. The questions put up in the form of enquiry leads the students towards practical.
5. Enquiry awakens a number of thoughts in the minds of the students and they readily participate in the discussions.

First of all, students demonstrate an experiment in the class. The observation or enquiries of the experiment awakens curiosity in the minds of the students. On the basis of these queries and by the way of discussion, limitations are fixed.

The students are then divided into groups. All these students collect basic tools and appliances and formulate hypothesis on the basis of enquiries. On the basis of these hypotheses, the students are again divided into groups; each group evaluates the given hypothesis and submits their report to the teacher. The teacher helps to select the valid hypothesis, explains it and attests it. In this manner, the student finds a solution to his queries. This method encourages the students to explore.

4.3.3 Personalised Instruction

No two individuals are physically and intellectually same. Because of this individual difference, the learning experiences, skill set, and past successes and failure of learning etc. are unique to the individuals. Children learn different things from others; they differ in what they need to learn and in what they already know. Hence, a wise teacher with prior planning and organisation can provide what they need to do learn. Personalised instruction is one such kind which caters the needs of the individual in accordance with his/her ability.

Definition

Personalised instructions are self-paced and are typically designed for students in large that are most appropriate for a learner as an individual. The Personalised System of Instruction fits into several paradigms, but is most closely aligned with direct instruction. It fits with direct instruction by requiring student to work on course modules independently.

Burton, Moore and Magliaro (1996) described PSI (Personalised System of Instruction) as an interlocking system of instruction, which consists of sequentially progressive tasks. The major components in the system include pre-specified objectives and self-paced modules.

Five essential features of a personalised course according to Keller-1968:

1. It “permits a student to move through the course at a **speed** commensurate with his ability and other demands upon his time”: a self-pacing feature.
2. It “lets the student go ahead to new material only after demonstrating mastery of that which preceded”: progressively sequential units
3. Lectures and demonstrations are no longer “sources of critical information”. Instead, they are vehicles of motivation.
4. Teacher-student communication is mainly conveyed via written words.
5. Use of proctors, “which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the personal-social aspect of the educational process”

Advantages of personalised instructions

1. PSI helps to overcome the challenges of heterogeneous classroom by catering to the individual’s unique needs and abilities.
2. PSI allows the learning to happen at the learner’s pace based on his/her ability.
3. It provides maximum development of the potentialities of the learner.
4. PSI gives a thorough learning by giving comprehensive understanding of each concept.
5. PSI allows the individual to overcome the difficulty and doubts through the learner himself.

4.3.4 Programmed Instruction

Historical Background

The term programmed instruction has been coined from principles of operant learning, developed in psychological laboratories on the basis of experimental studies conducted on animals by B.F. Skinner of Harvard University. These have been applied with considerable success to the development of self-instructional programmed

books and teaching machines. B.F. Skinner and his associates had first started 'programmed learning' in 1943 by conditioning a pigeon to role a small bowling of shaping behaviour in a laboratory experiment. It brought the strategy of programmed instructions. When B.F. Skinner attended the opening day at his daughter's schools, he found that most of the classroom teaching is ineffective. Thus, he wanted to improve the classroom instruction and teaching.

He attempted to apply his operant conditioning theory of learning to teaching and preparing instruction. He published a paper entitled 'Science of Learning and Art of Teaching'. It provided the momentum to the concept of programming. He claimed that desirable change can be brought out by giving a continuous feedback or reinforcement for desired responses. The operant conditioning is more significant for human learning. B.F. Skinner (1954) attempted to apply the principles of learning to education and to the use of teaching machines. Thereafter, Sidney L. Pressey designed a teaching machine for testing purpose. While Skinner has not emphasised assignments and questions for assessing the student performance, B.F. Skinner tried 'Linear Programming'. Norman A. Crowder (1964), a psychologist in U.S.A., developed a new strategy known as 'Branching Programming' or 'Intrinsic programming'. He laid emphasis on task analysis rather than learning condition. In this technique, content is presented and multiple choice questions are asked to diagnose and to ascertain whether the learner could follow or not. If s/he could not follow, the remedial instruction is given for improving the learning outcomes. Thus, programmed learning is also named as programmed instruction and instructional technology. The idea is that since teaching is broad, vague, and ill-defined term, instruction is a purposeful, orderly, and controlled sequencing of experiences to reach a specified goal.

Definition

1. **Smith and Moore**, “Programmed Instruction is the process of arranging the material to be learned into a series of sequential steps, usually it moves the students from a familiar background into a complex and new set of concept, principles and understanding.”

2. **Susan Markle**, “Programmed learning is a method of designing a reproducible sequence of instructional events to produce a measurable and consistent effect on behaviour of each and every acceptable student.”

3. **Harold W. Bernard**, “Programmed learning refers to the arrangement of instructional material in progressive sequences.”

4. **Michael J. Apter**, “Programmed instruction is a method of instruction in which the information to be taught is broken into small units which are to be presented to the student (usually in written form) in a carefully planned sequence. Each unit or ‘frame’ contains not only information but is also terminated with a question.”

To include on the basis of the above definitions, programmed learning is a method of individualized instructions in which the educand receives information relating to his/her own needs in progressive sequences but in small units. The educand remains active and proceeds at his/her own rate. S/He knows immediately, whether s/he is right or wrong. Thus, programmed learning is a method which makes effective use of programmed books, language, laboratory teaching machines, films, radios, televisions, tape-recorders, and the teachers.

Characteristics

Negative Characteristics

1. **Not a Test**—It is a teaching method and not a test. It helps the students in learning the material.

2. **Not an Audio-visual Aid**—It is not a part of the new

technology of education.

3. **Not a Panacea**—It is not a technique of imparting knowledge.

The educands learn at their own rate. The gifted educands learn quickly and backward educands learn at a slower rate.

6. **Not a Solution**—It is not a solution for shortage of capable teachers.

Positive Characteristics

1. **Individualized Instructions**—It is a method of individualized instructions. The information is presented according to individual needs. It maximizes the rate and depth of learning. It motivates the students and fosters understanding.

2. **Logical sequence of material**—The subject-matter of programmed learning is presented into logical sequence of small steps. By proceeding in small steps, the possibility of committing error is eliminated.

3. **Interaction between the learner and the programme**—In programmed learning, emphasis is laid upon the interaction between the learner and the programme. It requires the learner to be active.

4. **Immediate knowledge of results**—Programmed learning provides immediate knowledge of results. At each step, the educand is informed of how s/he is doing. S/He immediately knows whether his/her answer to a question is right or wrong.

5. **Organized nature of knowledge**—Programmed learning lays emphasis upon the organized nature of knowledge. It requires continuity between the easier concepts and the difficult ones.

6. **Learner's own speed**—The learner moves at his/her own speed in a programmed learning situation. Thus, learning takes place at individual's speed rather than in general rates.

7. **Constant evaluation**—Constant evaluation is

possible by the record of students' responses in a programmed material. It is possible to improve the quality of programmed materials through checking the number of errors at each step. Thus, students' progress may be evaluated by looking into the various types of responses produced by the learners.

Fundamental Principles

1. **Small steps**—A programme is made up of a large number of small and easy steps. One learns better in small steps, since the likelihood of errors is reduced in small steps.

2. **Active response**—Programmed learning is based on the principle of active response. A student learns better if s/he actively participates in the lesson and s/he learns the best if s/he is actively responding while learning.

3. **Immediate confirmation**—The student learns the best if his/her answer is confirmed immediately. Therefore, immediate confirmation serves as a kind of motivation or reinforcement.

4. **Self-pacing**—In programmed learning, each student proceeds at his/her own rate or pace. It is common knowledge that some students naturally learn more rapidly or more slowly than others. One learns the most effectively if one learns at one's own pace. This principle is based on the individual differences in the process of teaching and learning.

5. **Evaluation**—Constant evaluation is yet another fundamental principle of programmed learning. It helps students to learn and grasp the material given in each frame.

The aim of this arrangement is not to test the student but to improve the quality of the programmed materials by checking the number of errors at each step.

Assumptions

Programmed Instruction assumes that a student learns better under the following situations—

1. By being active
2. If s/he is motivated to learn by confirming his responses

3. If the content matter is presented in small steps
4. If s/he commits minimum errors in his/her learning.
5. If the sequence of content is psychologically valid.
6. If the pre-requisites are specified on the part of the learner.

Objectives

1. To help the students to learn by doing.
2. To provide a situation to learn at his/her own pace.
3. To help the students to learn without the presence of a teacher.
4. To present the content in a controlled manner and in logically related steps.
5. To study by himself/herself and assess his/her own performance by comparing it with the given answer.

4.3.5 Type of Programming

The following are the main types of programming:

1. Linear Programming—This was developed and used by Skinner and his associates. In the linear style, the subject-matter is divided into very small steps, each of which is called a frame. Each frame, in its turn, requires the student to do something. When the student has given his/her response, s/he confirms it with the correct response provided in the programme. There is a provision for self-pacing. Therefore, the linear programmed learning has all the principles mentioned below—

- (i) Information given in small steps
- (ii) Active responding of the student at each step
- (iii) Immediate knowledge and results
- (iv) Self-pacing

2. Branching Programming—The branching or intrinsic style (method) of programming is invented by Norman A. Crowder. He defined it as a programme which adapts to the needs of the students without the medium of an extrinsic device such as computer. The frame size and the amount of information given are larger than that of the linear

programme. A student starts by multiple choice questions designed to test the student's learning of the material. If the student chooses the correct answer, s/he is told that his/her answer is right and s/he is led to the next learning item. If his/her answer is wrong, s/he has to go through a discussion where s/he is told what was wrong with the answer. S/He is then taken to the original item and allowed to select the right response again.

Branching programmes may be produced for use on a teaching machine or in a book form. The book form is known as a 'scrambled text' because the pages do not follow in a normal sequence. The student is directed to different pages of the book according to the choice of the answer. S/He is instructed to press a particular button on a teaching machine according to the choice of the answer. The programme is presented on the film which is seen by learner on screen. An error-counter records each incorrect answer chosen.

3. Mathetics Programming—The term 'mathetics' has been derived from the Greek math meaning 'to learn'. Thomas F. Gilbert originally formulated the basic concepts of mathetics. As K.P. Pandey puts it, "Mathetics is defined as the systematic application of reinforcement theory to the analysis and construction of complex repertoires which represent mastery of subject-matter." The unit for mathematical sequence is called j exercise. The size of the exercise is determined by the rise of the step a student can reasonably take at the moment. In order to determine the effectiveness of the courses of instruction, a detailed analysis is made of the behaviour of the student and the responses indicated. In writing mathetical programmes, the basic steps involved are as follows:

- (i) Data collection and task analysis
- (ii) Prescription for mastery
- (iii) Characterization and lesson plan

- (iv) Exercising writing
- (v) Editing

Steps in Preparation of Programme:

K.P. Pandey has listed the following steps in the preparation of a programme for learning:

1. Selection of units—Selection of a unit to be programmed is the first step in preparation of programme. The programme should begin with a small unit as far as possible. The student should not have a tendency to select a very wide and general topic. In a very wide and general topic, s/he will commit mistakes and meet frustrations.

Lysaught and William have suggested the following six criteria for the selection of unit to be programmed.

- **Programmer's own field of study**—The topic selected for a programme should belong directly to programmer's own field of study.
- **Ease**—Ease in the handling of material is another criterion for the selection of a unit to be programmed.
- **Length**—Another criterion for the selection of a unit is its length. Length of the unit should be determined according to the desired objectives for the subject-matter. Instead of programming a full course in mathematics or grammar, it is better to take a unit of the course.
- **Depressed level of learning**—Notorious stumbling blocks of learners must be programmed.
- **Logical Order of material**—Logical order of material is an important criterion to be followed in the selection of a topic to be programmed.
- **Special students' needs**—Special students' needs are also an important criterion in selecting a topic for programme.

2. Writing assumptions about learners—Characteristics of the learners or the audience for whom the programme is being prepared should be written fully and accurately. The programmer should mention assumption about their age,

interests, abilities, or skills, ambitions and background. The assumptions about the learners should be written in objective, concrete, and specific terms. Cumulative records, achievement tests, intelligence tests, aptitude tests, case history, and above all, personal experiences of the programmer as a teacher or learner prove useful in having a complete picture of the learners.

3. Defining Instructional Objectives—Instructional objectives should be defined in behavioural terms. The following points should be kept in mind in this connection:

- **Guide for selection of subject-matter and teaching method**— Statement of instructional objectives should provide a guide selecting the subject-matter, the teaching methods, and the materials to be used during the instruction.
- **Guide for Evaluating Instruments**—Each objective should be stated in terms of the performances of the students rather than the performance of the teacher.[is it correct?]
- **In terms of the performance of the student**—Each objective should be stated in terms of the performance of the student performance rather than the performance of the teacher.
- **In terms of terminal behaviour**—Each objective should be stated in terms of learning process rather than learning product.
- **In terms of one general outcome**—Teaching should be stated in a way that it includes only one general learning outcome rather than a combination of several outcomes.

4. Defining pre-requisite knowledge and skills—Pre-requisite knowledge and skills should be defined in behavioural terms. It helps to draw line of demarcation in respect of elements of the mastery or terminal behaviour which the programmer wants to develop. A careful study of prerequisite knowledge and skills should be prepared in terms of an empirical study conducted on representative sample of learner for whom the

programme is being prepared.

5. Preparing a criterion test—A criterion test shows the entire range of terminal behaviour which has to be developed through the programme. It determines the success or the failure of the programme. While developing a criterion test, the programmer should think very carefully about the situations which will evoke the desired behaviour. The whole structure of a criterion test should be reviewed by a person expert in the subject-matter as well as in techniques of testing. After this, the entire test should be administered on a representative group of subjects. The choice of words, the use of language, and the relevance of each test item should be properly analysed. To quote Dr. K.P. Pandey, “A good criterion test is one which reflects representative elements of the universe of behaviour which have been considered as the terminal behaviour.”

6. Developing contents—In the end, specific outline of content to be programmed should be developed. At this stage, the programmer should write the complete information. S/He should list all the relevant examples, concepts, illustrations, i.e., diagrams, maps, charts, etc., which are to be included in the content of a programme. The authenticity of the subject-matter should be ensured. The order in which the instructional matter is to be presented should also be decided. Subject-matter should also be presented according to the level and needs of the students.

Dynamics of Programming

Programme development is a highly dynamic process. The making of it is a very challenging and time-consuming exercise which requires mastery on the subject-matter as well as that of various techniques of programming. The programmer must have a scientific inclination to study the nature of behaviour, its various forums and levels. S/He has to be very skilful and pragmatic in writing a programme. S/He

should put his/her decisions in respect of the terminal behaviour and the content structure into an effective form.

Stages of Programme Development

- Preparation
- Constructing or Writing the Programme
- Evaluation

1. Preparation and Preparatory Adjustments

Peter Pipe suggested the following points before getting down to details:

1. Be prepared to find that preparation accounts for at least 25 percent of your total time.
2. Do not bother about attaining perfection in one step before you begin the next.
3. Preparation requires hard work for which there is no substitute.
4. One should not rely on one's memory to keep track of new ideas.

Steps of Preparation Stage:

1. Selection of a topic (unit) to be programmed
2. Writing assumptions about learners
3. Defining objectives in behavioural terms
4. Defining pre-requisite skills in behavioural terms
5. Writing a criterion test
6. Developing the content outline

Consideration in Selection of a Topic to Be Programmed

- It should be selected directly from the programmer's own field of study. The following yardsticks must be applied in the selection of the unit.
 - ❖ Is it something the learner must know?
 - ❖ Is it difficult for him/her to find a good explanation from other sources? If the answer is negative, the programmer must select that topic.
- The subject-matter should be simple.
- One should select short units which one can use, evaluate,

and revise in a fairly brief period.

- One should select a unit from a field which is usually considered a stumbling block to the learner. The criterion of case and length should not be ignored.
- Arrangements of items should be simplified by keeping in view the logical order of the material.
- Special needs of the students should also be taken into consideration.

2. Constructing or Writing the Programme

Stages for the construction of a programme

1. Planning Stage

2. Writing Stage

3. Testing, Revising, and Editing Stage

Specific Skills Needed in Each Stage

Planning stage

- Skill in writing behavioural objectives
- Skill in defining pre-requisite skills
- Skill in content analysis
- Skill in preparing a criterion test

Writing stage

- Skill in writing frames or modules
- Skill in differentiating the structural and functional ingredients or frames or modules
- Skill in using prime and prompts
- Skill in ordering and arranging frames in a proper sequence

3. Testing, Revising and Editing Stage

- Skill in individual testing which requires establishing a rapport.
- Skill in obtaining evidence about the worthwhileness of the programmes
- Linguistic skill
- Editing skill

4.Evaluation

- The programmer must list the basic assumptions about the learners in both objective and concrete terms.
- S/He should describe the age, gender, skills, interests, and ambitions of the learners.
- S/He may judge the ability of the learners from the scores obtained on intelligence, aptitude, achievement test etc.
- She/He should know the socio-economic status of his/her learner.
- She/He should know the educational level of the parents of the learner.
- She/He should be quite frank in writing assumptions about learners.
- She/He should not be concerned about its length or its literary style.

4.3.6 Computer Assisted Instructions (CAI)

Meaning of CAI:

Computer has contributed a lot in each and every sector of life. Computer assisted instruction (CAI) has emerged as an effective and efficient media of instruction in the advanced countries of the world. In fact, CAI is being used in formal and informal education at all the levels. In India too, computer has been introduced in most of the areas such as data processing and decision making. It also has an impact on the working methods of research and development in the fields of science and technology. The computers are being used in almost all the areas of life i.e., transportation, communication, national defence, scientific research, and education.

Definition of CAI

The computer assisted or aided instruction may be defined as the use of a computer as an integral part of an instructional system; the learner generally engaging in two-

way interaction with the computer via terminal.

History of CAI

CAI is a natural outgrowth of the application of the principles of programmed instruction or learning. The main objective of programmed instruction is to provide individualized instruction just of fulfill the special needs of the individual pupil. In order to achieve this objective, some efficient device is required. This device should be flexible and it can store huge amounts of organized information. The device may enable a person to use some selected parts of the stored information. A computer fulfils all these requirements. It can store the organized information; it can process the information suiting the needs of individual learner. In short, CAI covers the entire educational system by proving itself a useful tool in teaching various subjects.

Origin of CAI

If we see the origin of a computer, we shall find that some technicians attempted whether a machine could be programmed to interact with man. The first commercial computer was operative in 1951 in Census Bureau. First CAI attempt was made around 1961 when the University of Illinois produced Programmed Logic for Automatic Teaching Operation (PLATO). Hence, the use of computer in general education started from the early sixties.

Use of CAI

There are two contradictory views regarding the use of computers in general education—

1. CAI provides opportunities for systematically organized maximum learning for all learners. It provides complete individualizing instructions. The increasing amount of information and lack of qualified teachers make the use of CAI very essential.
2. The second view-point is its criticism. The critics see computer as an agent of destruction of human qualities.

According to them, no computer can match a person's versatility and the emotional aspect. CAI mechanises the human brain. In other words, human beings are converted into machines.

There are many educationists and psychologists who have been trying to find out ways in which electronic information processing may help the teacher in individual instruction. One of the important and prominent approaches is to use computer as a teaching machine. This approach is referred to as computer aided instruction or computer assisted instruction, abbreviated as CAI.

Computer aided instruction is a substantial innovation. A computer is a high speed data processing machine. The first large mechanical computer, called as an analytical engine, was designed during the nineteenth century by Charles Babbage, a British Mathematician for computing astronomical and mathematical tables. The equipment was not of much success.

During the later part of the nineteenth century, Herman Hollerith developed a machine for processing cards in which information was stored by means of punched holes. This machine was used to speed the tabulation of Census results in U.S.A.

One of the early computers operating on the basis of electric pulses rather than mechanical switching was placed in operation at University of Pennsylvania in 1946. This machine was named as Electronic Numerical Integrator and Computer (ENIAC).

Basic Assumptions of CAI

1. CAI can be arranged for 4000 students simultaneously. It can cope with the problem of quality and quantity in education.
2. One can learn at one's own pace, receive immediate and personalized feedback, i.e., completely individualized instruction.

3. In CAI, each learner's performance during the course and on the test is automatically recorded and can be fed back to the teacher so that s/he may promptly evaluate the learner's performance and use the data in designing the best teaching strategy for the learner in future.

4. It can be used in all types of teaching-learning programmes. Any lesson in any subject can be programmed for CAI provided that the lesson material can be represented in words, pictures, and experiments to be presented to the students.

Operations in CAI

CAI system has been used at all levels of education ranging from elementary school to post-graduate study and in job training in almost all subjects. Atkinson (1968) designed a programme for teaching-reading to infants. The child first must learn to identify letters. This task of identifying letters is done in three stages of the programme.

1. **First Stage**—A model letter appears on the projector connected with a computer, while three letters are presented on the screen. Then the recorded voice instructs the child to look at the letter on the projector. Different letters are shown on the projector. Training is imparted to the child in identifying the letters.

2. **Second Stage**—At this stage, the child masters the identification of single letter. During this phase the child learns to discriminate pairs of letters.

3. **Third Stage**—During this stage, two-three letters combinations are presented on the screen. The child is asked to touch one symbol out of the two combinations which are identical.

A recorded voice asks the child to touch and say the word that would be formed by combining the letters on the side and top of the screen. Errors made by the child can be automatically recorded in the computer. The child thus

receives practice. The drills that various learners receive may be entirely different from each other. After the mastery of simple reading skills, the child proceeds to acquire successively more complex skills. Computers have been designed to store and retrieve vast amount of information.

Instructional Modes of CAI

In the field of instructions, a computer plays a major role. In these computer assisted instructions, it interacts directly with the learners while presenting lessons. The computer delivers instructions directly to students and permits them to interact with the computer through the lessons programmed in the system. There are various instructional modes which can be facilitated by computer assisted instructions (CAI)—

1. Tutorial Mode—In tutorial, information is presented in small units followed by a questions. The pupil's response is analyzed by the computer and appropriate feedback is given. The pupils are allowed to work on their own paces. The more alternative programmes available to the computers, the more adaptive the tutorial can be to individual differences.

2. Drill or Practice—In this mode, the programme leads the learner through a series of examples to develop dexterity and fluency in using the skill. All correct responses are reinforced. Only on achieving the mastery by the learner, the computer will proceed further.

3. Discovery Mode—Here, inductive approach is followed. The problems are presented and the pupil solves those problems through trial and error. It is just like laboratory learning. It aims at the deeper understanding of the results obtained from discovery. Hence, complex problems can be solved.

4. Gaming Mode—This mode may or may not be instructional, but it is recreational. Sometimes learning takes place through games. This mode is especially meant for

young children.

5. **Simulation Mode**—Here, the pupil faces scaled down approximation of a real life situations. Hence, realistic practice takes place without involving any risk.

6. **Problem Solving Mode**—Problem solving can be readily achieved provided the typical computational capability of the computer is available and there is a type-writer and display response device with remote control to the two-way communication. The students need to know how to communicate using a computer and how to solve his/her problem

Kinds of CAI

In computer, linear and branching programmed learning is used. It meets the needs of many students. It functions like a super machine. It interacts with the pupils. The computer keeps the record of each pupil's responses. On the basis of these responses, it is further decided which information is to be provided to the students. In case of an incorrect response, the computer also hints at correct response. In this way, each pupil is cared and feedback to each and every pupil is provided.

Use of CAI

1. It is the main sources of receiving facts and information from the teachers and the pupils.
 2. Drill and practice opportunities are provided to the pupils.
 3. It is useful in the form of learning laboratory.
 4. It is important in solving administrative problems.
 5. It is helpful in evaluation process.
 6. It is useful in framing time-table.
 7. It is useful in preparing pay-bills.
 8. It is used in developing various skills.
7. **Inquiry Mode**—Inquiry mode is the third type in

CAI application. In this, CAI system responds to student's inquiry with answers which were stored. In this mode, the instructional staff must learn how the system operates.

8. Author Mode—CAI is used to support instruction by generating sets of materials for a student's use. In generating concept learning materials, these might be sentence forms which have blanks in them each of which is to be filled by a word or a set of words, i.e., inserted into the blanks by computer according to the set of instructions.

9. Logo—This system was developed by Feurzeing and Papart at MIT. Logo is a simple programming language which can be taught to children. This programme provides instructions which can be used to produce pictures on screen. Children, who learn LOGO, make up their own programmes to draw flowers or faces or generate designs on the screen.

Advantages of CAI

The main advantages of a CAI system are related to the degree to which it permits the individualization of education, particularly instructions.

1. The capability of individualizing both the means and of instruction.
2. The capability of doing research.
 - (i) On teaching under controlled conditions.
 - (ii) Under conditions which individualize instruction in a particular way.
 - (iii) On various modes of teaching.
 - (iv) Ability to collect detailed records of student performance.
- (v) Permits evaluation of effectiveness of the teaching procedures as well as teaching materials.
- (vi) The capability of developing ways of assisting teachers and authors in the development of instructional materials.
- (vii) The capability of evaluating alternative media used to implement and support instruction.

Computer aided instruction (CAI) means using

computers to teach people, it does not mean teaching people to use computer or teaching people about computer technology.

Computers can be used in education in three different ways:

- (i) To reinforce present educational system.
- (ii) To revolutionize the present educational system.
- (iii) To lay the foundations for future systems of education to come.

Role of Teacher in CAI

It is feared that the use of CAI in teaching-learning will relegate the place of the teacher. To some extent, its use may eliminate teachers from the teaching scene. But this fear is false and baseless.

CAI has proved powerful tool for the teachers in the instructional process. Of course, there is some change in the teacher's role.

CAI directly interacts with the students and with the teachers individually. Teachers are to play their role in CAI. Human teachers cannot be eliminated from teaching-learning process. We can highlight the role of a teacher in CAI in the following manners:

1. Use of New Tools—CAI provides the teacher some change in using new tools. This use will enhance the person's satisfaction. Also, it will increase the individual's efficiency. The CAI can compute huge amounts of data accurately and rapidly. It can produce elaborate graphs and drawings.

2. Compatible with Like Teaching—CAI is compatible with teaching. It can be used side by side. CAI is a flexible system of instructions. It can very promptly evaluate the performance of a student. The teacher can devote his/her time for more creative activities.

Experts Needed in CAI

Computer aided instructions need the help of the following

experts—

1. **Computer Engineer**—A computer engineer is a technical person who knows about the basic principles and techniques of programming.
2. **Lesson Writer**—The lesson writer is an expert who is familiar with lesson writing. Lesson writers may be an experienced teacher or an experienced teacher may be a lesson writer. S/He knows the theories of learning.
3. **System Operator**—S/He knows the system operation thoroughly and can cope with all commonly occurring failures of software and hardware in the system.

Limitations of CAI

1. The computer fails to appreciate the emotions of students. The emotional climate created by a teacher in the direct classroom interaction with the students is absent in CAI.
2. CAI programmes do not solve the psychological or educational problems. Computer programmes or conventional type do not work like human beings at all.
3. CAI fails to develop essential features language competency where the ability to generate or construct meaningful sentences is essential.
4. It was pointed out that some students got more tired than conventional study or felt like quitting the study.
5. CAI cannot appreciate the student's artistic endeavour and cannot strengthen his/her friendship and deepen his/her perception with those who are around him/her.
6. The peripheral equipment puts constraints in the ways in which a student can interact with the computer.

4.3.7 Computer Managed Instructions (CMI)

In computer managed instructions, the computer gathers, stores, and manages information to guide the students through individualized learning experience.

Computers are being used in administrative and management, these days, such type of use of a computer is known as

computer based learning, for example in disbursing the salaries of the teachers and other employees. Computer is not used directly in teaching-learning process, but it is used as an helper in teaching-learning process. If a teacher is made free by assigning his/her other duties to the computer such as administrative, managemental activities, then s/he can utilize his/her spare time in an effective manner in the classroom.

In this way, the main function of the computer is clerical. Generally, the following are the main administrative and managerial functions of the computer—

1. This can prepare question papers, can evaluate them. Their scores can be analyzed for evaluation or modification purposes.
2. This can collect the examination or evaluation scores.
3. This can help the teachers in preparing time-table.
4. This can help in various clerical jobs such as preparing teacher's salaries, completion of their presence records, etc.

It is very clear that the computer has become an integral part of our daily routine. Computer literacy is today's necessity. Hence, it is needed to include the computer education in secondary curriculum. On this purpose, a project class was started in 1984-85. It stands for computer literacy and studies in schools. It was started in 248 selected schools. Then later on, 2,522 more schools were included in this project. Under this project, each school was provided with BCACOROY micro-computer systems with other devices. This object has the following objectives –

1. To provide detailed computer knowledge to the pupils.
2. To provide knowledge to the pupils by doing themselves.
- 3 To provide various experiences of computer education in the various fields of life.
4. To remove various misconceptions regarding computers.
5. To provide knowledge about computer application

according to own environment.

4.3.8 Teaching Machine

Teaching Machines are mechanical or digital devices used for presenting a program of instructional material. The Teaching Machine presents an integrated abstraction of the computer-we-program(different from the more familiar computer-we-use) which allows students to follow, in a consistent and revealing way, the unfolding state of the machine as code is processed.

There are many types of Teaching Machines. In general, they all work on the same method, which is to present a question, have the user indicate the answer, and then provide the user with the correct answer. Some machines may be extremely simple, such as test sheets or books are programmed that the students locate the answers to the questions later. For instance, a book may pose a series of questions, providing spaces for the answers, and then give the correct answers on a different page. Another device may use a plastic cover to hide all but the question and the space for an answer; when the question is answered, the cover is pulled down to reveal the correct answer and the next question. One type uses chemically treated paper so that if the correct answer to a question is marked, the paper turns its colour. A more complicated machine presents multiple-choice questions in a window, with various keys to press, to indicate the correct answer. The following question appears only if the correct answer is chosen.

All Teaching Machines depend on a program, that is, a series of questions presented that provide a student with a certain amount of challenge as well as a chance to learn.

Advantages of Teaching Machines

1. They are particularly useful in subjects that require drill, such as arithmetic or a language.
2. Users can proceed at their own pace and also have an

- opportunity to review their work.
3. If the machines are used in a classroom, they relieve teachers from some of the time-consuming aspects of drilling students.
 4. It allows them to give more attention to individuals with specific problems or to concentrate on some particularly difficult area of instruction.

4.3.9 Seminar Presentation

Meaning and Definition

Seminar is an instructional technique of higher learning which involves paper reading on a theme followed by the group discussion to clarify the complex aspects of the theme. It generates a situation for a group to have guided interaction among themselves on a theme which is generally presented to the group by one or more members. The person who presents the theme should have studied the theme thoroughly to make selection of relevant material. The collected material is presented in the form of a paper which is circulated among the participants in advance or before the paper reading. It provides the structure of the theme, to facilitate its communication.

Objectives of Seminar

(A)Cognitive Objectives

1. To develop the higher cognitive abilities—analysis, synthesis, and evaluation as compared to the situations involving human interaction.
2. To develop the ability of responding in this manner would involve higher cognitive actions—valuing, organizing and characterization of quick comprehension of the situation, examination of it against the knowledge, s/he possesses and construction of his/her reactions to the situation.
3. To develop the ability of keen observation experiences and feelings and to present them effectively.
4. To develop the ability to seek clarification and defend the

ideas of others, effectively.

(B) Effective Objectives

1. To develop the sense of tolerance and opposite ideas of others.
2. To develop the sense of co-operation with other colleagues and respect the ideas and feelings of others.
3. To develop the emotional stability among the participants of the seminar.
4. To acquire the good manners of putting questions and answering the questions of others effectively.
5. To develop good manners and skills among the participants.

Various Roles in Seminar

1. **The Organizer**—An organizer plans and prepares the whole programme of the seminar. S/He decides the topic or theme of the seminar and assigns different aspects of theme to different persons who play the role of speakers. The date, time, and place are decided by him/her. S/He also suggests the name of convener of the seminar. S/He prepares total schedule of the seminar.

2. **The President**—The participants proposes the name of a chairman, who is well acquainted with the theme of seminar. S/He must know its rights and duties as chairman of a seminar. The seminar's activities are inducted by the convener who directs the whole programme, encourages the participants to take part in discussion, and keeps the discussion on the theme of seminar. In certain situations s/he also takes part in the discussion. S/He provides sufficient opportunities to each participant.

At the end, s/he summarizes the discussion and presents his/her view-point on the theme. S/He also thanks the speakers, participants, guests, and observers.

3. **The Speakers**—The organizer assigns topics to the speakers who study the topics thoroughly and prepare papers.

Cyclostyled copies of the papers are distributed among the participants before the commencement of the seminar, so that they may also prepare themselves on the theme. It encourages the discussion to last long. The speakers should be ready to defend their positions. They should have tolerance for anti-ideas or criticism of others.

4. The Participants—There may be 25 to 40 participants in the seminar. The participants of the seminar should be well acquainted with the theme. They should appreciate the performances of the speakers. They should be able to seek clarification and ask questions. They should place their own ideas regarding the theme on the basis of their experiences. They should address the president for seeking clarification. They should not ask questions directly to the speakers.

5. The Observers—Some guests and observers are also invited and allowed to observe the activities of the seminar. They should be allowed to discuss and present their observations with the permission of the chairman.

Procedure of the Seminar

Participants in a seminar have guided interaction among themselves on a theme which is generally presented to the group by one or more members. The person who presents the theme should have studied the theme thoroughly beforehand. This would mean the selection and organization of relevant material. This organized material is put in the form of a paper and circulated among the members in advance. The paper helps in structuring the theme, facilitates its communication and focuses on the scope for discussion. After the theme is presented, it is discussed by the group. During the discussion, participants may (*i*) seek clarifications of the theme presented, (*ii*) make observations in the light of their knowledge and experience regarding the theme, and (*iii*) raise issues relating to the theme for further analysis and evaluation.

Proceedings

Proceedings of the seminar are guided by a Chairman who should be knowledgeable about the theme. His/her role would be to keep the discussion on track, stimulate maximum participation, and consolidate the view-points expressed at appropriate stages. As an instructional technique, seminar seeks to provide maximally for interaction among the members. Therefore, sufficient time should be allowed for the discussion session. If this necessitates cut down the time for presentation, it could be done since the main purpose of the presentation is to initiate the discussion.

Interaction

The interaction in a seminar is similar to the field of forces in machines. Different view-points or opinions expressed represent the forces in varied directions. However, unlike physical forces which at times result in zero when acting in opposite direction, the different view-points or even opposite opinions will not result in neutrality but will induce further thinking among the participants. This stimulation for further thinking should be reckoned with significance as the net instructional value of the seminar. When there is an agreement of ideas among the individual members, these may be considered as forces acting in the same direction and thereby having a reinforcing affect on the individual's view on the theme. In either case, the individual is benefitted as s/he is either led to further analysis and evaluation of his/her view-points, or helped in validating and thus strengthening them.

Advantages of a Seminar

1. It has the potential to develop several abilities among the participants.
2. Ideas tend to develop due to the stimulation of thinking brought about through interaction, different higher cognitive abilities like, analytical and critical thinking, synthesizing and evaluating.

3. Affective attributes like tolerance for other's views, openness to ideas, co-operation with others, emotional stability and respect for other's feelings may be inculcated among the participants during the course of such sessions.
4. The norms of behaviour for the group in the seminar situations are the same as those of a democratic society. Deliberate efforts have to be made to adhere to these norms during the course of seminar discussions. It would gradually inculcate the affective attributes in the participants.
5. Seminar develops better learning habits. While preparing for presentation and participating in the discussion, learners get induced to pursue independent study, engage in post-seminar discussions, covering the themes discussed as well as related ones and develop critical outlook to any idea thereby leading the learner to self-initiated learning is more permanent in nature.
6. Seminar makes the instruction learner-centred and provides learning through enquiry based on the natural inquisitiveness in human beings.
7. Seminar establishes natural learning at all levels of instruction though it is mainly confined to higher education.

Types According to Levels of Organization

- i) **Mini Seminar**—Mini Seminar is organized to discuss a topic in a class. Its purpose is to train the students for organizing the seminar and play different roles. It is a stimulated situation for the students. Such seminars should be organized before the main seminar.
- ii) **Main Seminar**—Main Seminar is organized at departmental level or institutional level on a major theme. All the students and staff members take part in main seminars. Main seminars are organized weekly or monthly in departments. Generally, specific themes are selected for main seminar.

- iii) **National Seminar**—A National Seminar is organized by an association or organization at national level. Experts on the theme are invited for seminar. The secretary of the seminar prepares the scheduled theme, time, dates, days, and venue. NCERT organizes such seminar at national level, Education Technology, Population Education, Trends of Education, Distance Education, Non-formal Education, Quality control of educational research in India.
- iv) **International Seminar**—International seminars are organized by UNESCO and other international organization on very broad topic, or theme such as students' unrest or activism, Innovations in teacher-education, and Examination reform, etc. A nation can also organize such seminars on an international theme.

Limitations of Seminar

1. It cannot be organized on all the content of a subject-matter. Its theme should be such on which discussion may be held.
2. It cannot be used at all levels of education but only on higher level of education. As the members of seminar should have social and emotional maturity, it cannot be used in lower level of education.
3. When habitual speakers dominate the discussion, they do not provide opportunities for others to take part in the seminar. Thus, the discussion confines only to a few persons rather than whole group.
4. When groups are formed propounding—anti-ideas and favourable ideas on the theme, both try to win over the other. Therefore, the purpose of the seminar is not served. The chairman should discourage such type of discussions.
5. Opposite groups among the participants try to oppose even the constructive or relevant ideas of its opposite group.

6. Criticism is made for the sake of criticism. The instructional situation of such discussion is not conducive for learning.

4.3.10 Symposium

The symposium comprises of brief talks by experts on particular field commonly of two or more people on a same or general topic. After this, it normally follows group- discussion and questioning period. The group for the discussion is usually divided into smaller groups with a particular phase of the general topic assigned for each group. The group head appointed for each group will facilitate the discussion in a separate place. After 15 -20 minutes of discussion period, these sub-groups will meet again, whereby the group heads will present the points that have been discussed with the participants. Finally, after the presentation of the heads of the sub-groups, time will be given for questioning and further discussion.

In another case, the members of the symposium will form a panel for brief discussion after a brief talk by one or more experts. In this, the audiences are allowed to ask questions once after the panel finishes the discussions.

Advantages

1. It provides varied experiences and knowledge of subject through the experts.
2. The expert's speech itself is a motivating factor that makes the symposium interesting. The motivation is further enhanced if the topic is controversial.
3. The attention and interest of the participants are sustained if the speakers are changed periodically.
4. It provokes diverse question from the audiences.

Disadvantages

1. It is less systematic in presentation.
2. Topics in discussion are normally restricted to lesser numbers.

4.3.11 Workshop

Various activities like collecting information, solving problems, performing test, etc., in relation with the subject are collectively termed as workshop. It is in different forms for different subjects. Workshops generally serve the purpose of easing up any particular task; it may be through practice, drill or training. A workshop is a well-planned activity of various kinds in order to perfect the learning experiences. Workshops should be assisted with resource persons like teacher or instructor where they can assist the students in learning or in doing. These resource persons may later evaluate the learning outcomes.

Steps in conducting workshop:

1. Selecting the problem
2. Justifying the problem
3. Setting objectives of the problem
4. Organising the group to deal with the problem
5. Deliberations for analysing the problem
6. Reporting the deliberation
7. Exchanging views and finalising them
8. Report of conclusion
9. Follow-up

This is essentially a group method where a student finds organising it and execution of the same; motivating all the members of the group is not easy and it needs an experienced teacher to handle the situation at any point of time. Not all the topics can be achieved through workshop. It still stands as an effective method in teaching of biology.

4.3.12 Panel Discussion

It is a method in which knowledge of the resource person, who is an expert in a particular field, will be disseminated to the audience through audience. In panel discussion the experts are made to sit in a semi-circular shape and a moderator will be appointed to moderate the discussion. A topic of common interest will be discussed in this method.

All the members are allocated time and situation to share their ideas as questions, suggestions, and other inputs, which will be discussed in a panel. The moderator organizes the session and finally summarises and concludes.

Merits

- 1.Participation of the audience is through question and answers.
- 2.In a panel discussion, broad topics can also be discussed with the members deliberating each topic of their interest.
- 3.Panel discussion maintains an element of suspense as what will be the next topic of discussion.

Demerits

- 1.It is time consuming.
- 2.It is not systematic and sometimes leads to some other area or topic.

In this lesson you have learnt about various student-centered methods. For effective classroom instruction, the teacher should use different methods at appropriate time. The combination of methods is highly effective in classroom teaching. Various studies proved that an integrated approach would minimize the disadvantages of both the approaches practiced separately. Appropriate combinations of the methods would be effective for teaching Science and Mathematics.

4.3.13 Supervised study method

The supervised study method is not a complete method in itself. Thus, it is used along with the other methods. The related literature to any problem is distributed to the students in printed or cyclostyled form. Before distributing the literature to the students, instructions are given highlighting the important points. Then a fixed time period is given for study of literature. The students study the literature and find answers to their problems. After reading the matter, the students are asked to keep it aside and then the teacher

develops the lesson with the help of questions and problems.

Merits

1. Reading habit is developed.
2. Knowledge of methods of reading is obtained *i.e.* how to read a particular portion.
3. The students concentrate on the literature. Their interest in reading is kept intact.
4. The students study their problems themselves and find solutions to them, thus they have mental satisfaction.
5. It is convenient for the teacher also. S/He does not have to tell everything to the students.

Demerits

1. Where it is not possible to make and distribute copies of the subject- matter, there this method cannot be used.
2. The teacher has to search and rewrite the related literature.

Suggestions for Improvement

1. All the copies of the literature should be checked and amended whenever required before distribution to the students.
2. The subject-matter of the literature should be according to the level of the students.

4.4 Textbook

Textbooks play a very important role in learning and teaching process. Therefore, it is important that these books are able to deliver knowledge to the readers. They are not mere printed materials but they enable the students to appreciate and understand the principles and concepts and their relevance in their daily life.

Functions of a science textbook

A science textbook must be in accordance with the aims of science teaching.

Some of them are listed below:

- A textbook helps in forming correct ideas regarding the concepts and principles of science. Most of the books

available nowadays for primary or secondary school level are simply narrating the facts. If the teachers are repeating the same without any activity assigned to students, it implies they are defying the purpose of the textbooks.

- Textbooks develop a scientific attitude in the pupils and make them understand the scientific methodology in them. They create love for science, proper attitude, and the habit of solving the problems scientifically. They instigate the curiosity in them and make them investigate further into the subject.
- A textbook helps in furthering the knowledge, which students may acquire from laboratory experience and field trips.
- Textbooks supplement the understanding of the pupil. Textbooks help the students to proceed in the right direction and to attain the right conclusion for a problem or discussion.
- Textbooks are economical for the reason that they can be used for many years.

Textbooks supply facts and develop the appreciation and understanding of concepts and principles of science. Textbooks are authentic source for the students as well as teachers. They provide relevant and required information in an unambiguous way. But not many books that are written today follow the required guidelines. Those books are written of a low quality or of low standard. Not only the mechanical features of these books, but also the method of treatment of subject matter and flow of the language are faulty. They are written only for the purpose of writing, caring a little for the knowledge they provide. Quantity is preferred over quality. Hence it has become an utmost necessity to frame certain criteria for developing a good science textbook.

Characteristics of a Good Science Textbook

For developing a good science textbook quality should be preferred over quantity and the authors must utilize sufficient time to think and write the subject. There are certain criteria for a good science textbook.

The following are the criteria for selecting a good science textbook:

- The level of the textbook must match with the intellectual level of the students.
- The writing style should be simple and lucid.
- The supplementary activities for the science topics must be suggested.
- The content should be illustrative in nature.
- The textual material should possess clarity and should be organized in a systematic manner.

The level of a student in terms of vocabulary and reading must be carefully considered before going for a book. Often it is seen that teachers use advanced books for teaching. This may seem good for the teachers but at the same time it will be difficult for many students to follow the same.

The literary style is related to the readability of the book. Some important points to be considered are:

- Number of concepts per sentence
- Length of sentence
- Continuity of thought
- Presence and absence of unrelated thoughts.

Textbooks should be thoroughly analyzed before being prescribed. They are analyzed by using scoring cards. The two sample scorecards are

A) Hunter's score card and B) Vogel's score card.

Louise F. Vogel developed an evaluation scale in which major criteria are grouped as given below:

- Qualification of the author
- Organization

- Content
- Presentation
- Accuracy
- Readability
- Adaptability
- Teaching Aids
- Illustration
- Appearance

Author—qualification and experience

The author who is having certain experience and qualification should be encouraged to write the textbook. Experience is very important while writing a textbook because if a person has handled classes for secondary or at any other level, s/he will have a definite insight and depth regarding what the students need from the textbook, how to make it interesting, the changing techniques in dealing with students, etc.

Mechanical features of science text book

- The paper, print, and binding of the textbooks should be attractive.
- The books should have diagrams explaining the phenomena talked about. The picturesque manner of conveying things may be incorporated to make the books more attractive; at the same time it penetrates the brains of the pupil and they understand the things well.

The subject organization

- The subject should be developed in a sequential manner. Care must be taken regarding the level of maturity of the student in grasping the concepts.
- The textbook must be consistent with the objectives of science teaching. It should try to impart scientific attitudes and the disciplinary and cultural values to the students. It can also suggest the various projects that can be handled by the readers.

- Chapters should begin with introduction and end with summary. This provides a fast review and insight about the chapters read.
- The headings and sub-headings should be self-explanatory.
- Each textbook should have contents at the beginning and index at the end. This provides a quick search for a topic inside the book.
- A very important aspect is the way it should be written, that is the level of language used. If the author uses some complicated words, the students may not be able to understand and they may stop reading it further. The books should be written in a simple language. The used scientific terms can be provided in glossary at the end of the book.
- Examples are important, as they make the student understand and also provide them with problem-solving techniques.

Principles of Writing Textbooks

UNESCO Planning Mission has set certain principles to write textbooks. They are as follows:

- It should be according to the requirements of the syllabus and also help in its improvement.
- The facts should be modern and comprehensive.
- Science should be correlated to the real of practical life.
- The aim of the content of the textbook should be in shaping integrated modern scientific world outlook.
- Problems of research and their results in the form of established facts should be incorporated in the contents so that students get interested in the science subject.
- Textbook should act as a tool in teaching-learning process.

The Position of Science Textbooks

The establishment of National Council of Educational Research and Training improved the position of the science textbooks.

The Central Committee for Educational Literature has set up panels and editorial boards for 13 subjects. These books are written in Hindi and English and later they are translated into regional languages by the state governments.

NCERT has also set up editorial boards and expert panels for the production of modern textbooks and supplementary educational material.

NCERT had played a very important role in the past few years. It has published textbooks for biology, physics, mathematics and chemistry for secondary classes. These books are quite cheap also.

The Ishwarbhai Patel Committee Report recommends that there is no need for language textbooks for classes I & II. One for language, one for Mathematics and one for environmental studies is must for classes III-IWV.

For classes V-VIII, it is necessary to provide textbooks for each area of study, clubbing the related fields in one.

The number of pages can be reduced and the language used must be a clearly understood.

Analysis and Evaluation of a Science Textbook

The position of science textbooks was very disheartening after the independence. The establishment of NCERT has filled the lacuna as it has taken up the task of preparation of good textbooks for the school curricula.

The teacher while recommending a good textbook has to consider a number of criteria. Two score cards have been developed for rating the textbooks.

- Hunter's score card.
- Vogel's spot check evaluation scale.

Hunter's score card

- Educational rank of the author
- Mechanical makeup of book
- Psychological soundness
- Subject matter
- Exercises
- Self-help

A. Hunter's Score Card

S. No.	Hunter's Score Card	Points
1.	Educational rank of the author	50
2.	Mechanical make -up and cost	100
3.	Psychological Soundness	300
4.	Subject-matter	250
5.	Literary Style	110
6.	Learning Exercises	140
7.	Teacher's help	50
Total		1000

Vogel's Spot -Check Evaluation Scale

The following criteria have to be taken into consideration

- Textbook
- Author
- Publisher
- Copyright year
- Price
- Total score

1. Qualifications of the author

- The author should have experience in teaching the subject s/he has written.
- The author should have advanced degrees in the related subjects.
- The author's view and philosophy should be in harmony

with the school curriculum.

2.Organization of the content

- A central theme should correlate all the topics in the textbook.
- The textbooks should be organized into units.
- The units should be related to one another through related topics.
- The chapters should be graded in difficulty.

3.Content matter

- All the contents should be linked.
- Latest advancements in science should be included.
- Historical developments of science should be given a place.
- Social significance of science should be stressed.

4.Presentation of the material

- Introduction of a new topic should follow inductive approach.
- The scientific method and problem solving approach should be stressed.
- Informal and interesting way of presentation
- Important principles to set in bold or italics

5.Accuracy of the material

- All items on the pages are in the index
- The items are scientifically correct
- Personification is avoided
- No ambiguity in the content presented

6.Readability

- The words and sentences are simple and easy to understand.
- Applications are given for abstract principles

7.Adaptability

- The textbook caters to individual differences.
- It takes the slow learners, average and gifted students into consideration.

- No partial attitude towards rural and urban pupils
- Non-controversial treatment of all topics
- It's well into the curriculum and the needs of the community.

8. Teaching aids

- Summaries, questions and problems are adequate.
- References are in annotations.
- Appendix material is useful.
- The teacher's manual is very useful.

9. Illustrations

- The illustrations are modern.
- The photographic representations are large and clear.
- The diagrams are well-labeled.
- They are related to the learning experiences.

10. Appearance

- The appearance of the cover is attractive.
- The size and shape of the textbook is handy.
- The design is pleasing.
- The type or print is easy to read.

REVIEW QUESTIONS

1. Write short notes on Biographical and Historical methods of teaching.
2. What are the requisites of a good demonstration?
3. What is team teaching? Explain its characteristics.
4. What is lecture method of teaching? State its merits and demerits?
5. Explain 'Computer Assisted Instruction' and its uses.

Chapter 5

SCHOOL CURRICULUM

5.1. Introduction

Curriculum is a conceptual plan and dynamic entity to achieve the requirements of the people of a country. Science Curriculum is designed as per the aspirations of the leaders and the people of the society, organized by researchers in science education, guided by the administrators and implemented by the science teachers in schools. Curriculum needs review because the subject matter of science and the views of the people are not static. Education department is a part in the Ministry of Human Resources Development. Science education is related to the Ministry of Science and Technology. In our country, NCERT is the professional body, which enriches the science Curriculum and reorganizes it every ten years. Resource utilization of any nation is feasible through the enhancement of professionalism in the field of science and technology. Science Curriculum is designed to achieve the objectives of science.

5.2.1 Meaning of Curriculum

- The word “Curriculum” began as a Latin word which means “a race” or “the course of a race” (which in turn derives from the verb *currere* meaning “to run / to proceed”).
- In education, a Curriculum is broadly defined as the totality of students’ experiences that occur in the educational process.

5.2.2 Definition

- **Kerr** defines Curriculum as, “All the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside of school.”
- **Braslavsky** states that Curriculum is an arrangement among communities, educational professionals, and the state on what learners should take on during specific periods of their lives, furthermore, the Curriculum defines “why, what, when, where, how and with whom to learn.”
- **Kearney and Cook:** “Curriculum is a complex of more or less planned and controlled conditions under which students learn to behave and do behave in their various ways”.
- **Cunningham:** “It is a tool in the hands of an artist to mould his material according to his ideals in his studio”.
- **K.G. Sayidain:** “The Curriculum is primarily an aid in the process of adjusting the child to the environment in which he functions from day to day and in the wide environment in which he will have to organize his activities later”.
- **Secondary Education Commission:** “Curriculum, does not mean only academic subjects traditionally taught in the school, but it includes totality of experiences that a pupil receives through the numerous activities that go on in the school, classroom, library, laboratory, workshop, playground, and in the manifold informal contacts between the teachers and the pupils”.
- **Alexander and Saylor:** “Curriculum is the total effort of the school to bring about desired outcomes in the school and out of school situations”.
- **Smith, Stanley and Shores:** “Curriculum is a sequence of potential experience set up in school for the purpose of disciplining children and youth in group ways of thinking

and action”.

- **Beauchamp:** “Whatever the mode of expression, the subject matter is the substantive hard core of the Curriculum”

5.2.3 Characteristics of Curriculum

The following are the important characteristics of Curriculum:

- **Curriculum is dynamic:** As the society’s scientific beliefs and the social needs change from time to time, there is a need for revision of science Curriculum. No single Curriculum is suitable for all the times. The Curriculum has to change in accordance with the change in social strata due to industrial growth, scientific process, and social advancement.
- **Curriculum is related with the aims and objectives:** Aims and objectives of the people in a society have to be fulfilled through the experiences provided. These experiences are planned and spelt out in the Curriculum. The different stages involved in the Curriculum process - formulation of objectives, selection of learning experiences, selection of the content, organization of the content, and evaluation - make the Curriculum a scientific process. It is no more based on a rigid tradition but supported by psychological, philosophical, and social considerations.
- **Curriculum involves evaluation:** Evaluation is a modern concept of the traditional examination. The evaluation is concerned with the results with reference to aims and objectives whereas the old system is the results with reference only. The goals and aims are balanced in evaluation.
- **Curriculum is a broad and comprehensive process:** Curriculum is much more than

classroom instruction. It is not confined to the four walls of the classroom. All the experiences provided by the school both inside and outside the school are under Curriculum.

5.2.4 Curriculum Styles

There are basically three types of Curriculum styles. They are:

- **Instrumental Curriculum:** In this type of Curriculum, more emphasis is placed on the utility value or vocational value of science. It makes learning an intense competition among students. The basic approach in such a Curriculum is disciplinary and emphasizes the acquisition of knowledge or information. The teacher dominates the scene in this type of Curriculum.
- **Interactive Curriculum:** This type of Curriculum is society-oriented and lays more emphasis on the social development of a child. In this type of Curriculum, classroom instructions become an interactive or a cooperative process. The approach is interdisciplinary and the Curriculum is loosely structured and consists of learning packages.
- **Individualistic Curriculum:** This approach is also interdisciplinary and major emphasis is laid on the personal development of the child. It helps in the creative development of the child. The students base this type of Curriculum on self-calculation.

5.2.5 Objectives of the Curriculum

1. To draw out, cultivate, excite, and inspire the full development of each student.
2. To create an atmosphere in which students will learn to think critically and constructively and seek the truth and solve problems.

3. To help the students in establishing values through intimate acquaintance with the humanities, the arts, the natural sciences, the social sciences, and the religion.
4. To develop the character of students, integrity, honesty, judgement, co-operation, friendliness and goodwill.
5. To prepare men and women for citizenship in a democratic society where freedom and liberty go hand in hand with law and justice and where responsibility, national and international, is the characteristics of the individual.
6. To meet the needs not only of more students, but also of students with a wide range of ability, aptitudes, and interests.

5.2.6 Concept of Curriculum

The term Curriculum refers to the lessons and academic content taught in a school or in a specific course or program. The concept of Curriculum is a dynamic as the changes that occur in society. In its narrow sense, Curriculum is viewed as a listing of subject to be taught in school; while in a broader sense, it refers to the total learning experiences of individuals not only in schools, but in society as well.

To accommodate difference of view, Hamid Hasan (1988) tells that Curriculum concept can be evaluated in four dimensions, that is

1. **Curriculum as an idea** yielded a pass through research and theories, especially in the field of education and Curriculum.
2. **Curriculum as a plan written** as materialization of Curriculum as an idea; what in it loads about target, materials, activity, appliances and time.
3. **Curriculum as an activity** representing execution of Curriculum as a plan written; in the form of study practice.
4. **Curriculum as a result** of representing consequence of Curriculum as an activity, in the form of Curriculum target

namely reaching of change of certain ability or behaviour from all educative participants.

5.2.7 Principles of Curriculum Development

Etymologically, the term “Curriculum” is derived from the Latin word ‘Currere’ which means ‘run’. Thus, Curriculum means ‘a course to be run for reaching a central goal’. In recent years, the term Curriculum has come to mean all the planned activities and experiences which are available to students under the direction of the school. In the words of Kerney and Cook, “It is a complex of more or less planned or controlled conditions under which students learn to behave and to behave in their various ways. In it, new behavior may be acquired, present behavior may be modified, maintained or eliminated; and desirable behavior may become both persistent and viable”. Curriculum includes both the curricular and co-curricular activities. It is the sum-total of good learning experiences that the students have in order to achieve the goals of education which determine the direction of these experiences.

Child-Centered Education – Curriculum should be child-centered. The interest, needs, capacities, abilities, age, and the level of intelligence of children should be kept in full view and close attention while constructing a suitable Curriculum.

Relation with Life – Only the subjects which are directly relevant to actual living because of its irrelevance to the actual living conditions of children should be included in the Curriculum. The old and prevalent Curriculum is under heavy fire.

Utilizing Creative and Constructive Powers – Those subjects should be assigned a prominent place in the Curriculum which develop the creative and constructive capacities and abilities of children. Raymont rightly says, “In Curriculum that is suited to the needs of today and of the

future, there must be definite bias towards definite creative subjects”.

Interrelation of play and work activities – The learning activities and experiences should be made so much interesting while constructing a Curriculum that a child gains knowledge and learning from them in the play way spirit, finding them very interesting and captivating. According to Crow and Crow, “The aim of those who guide the learning process should be so as to plan learning activities that the play attitude is introduced”.

Knowledge of Culture and Civilization – Those subjects, activities, and experiences should be included in the Curriculum which convey the knowledge to the children and understanding of their cultural values and civilization. The Curriculum should preserve and develop culture and civilization.

Totally of Experience – The integrated whole of human experiences should be included in the Curriculum as one unit. The Curriculum should include both the literary and academic subjects as well as the sum total of varied human experiences which a child receives in the school campus, in the classrooms, on the playing fields, in the libraries and laboratories and through the various informal contacts with the teachers and other educationists. The Secondary Education Commission Report lays down “Curriculum does not mean only the academic subjects, but it includes the totality of experiences”.

5.2.8 Achievement of wholesome behavior pattern – Curriculum subjects, activities, and experiences should inculcate in the children social and moral qualities which shape courteous behavior towards others. Crow and Crow aptly remarks, “The Curriculum should be so framed that it may help the children in the achievement of wholesome behavior patterns”

Utility – Curriculum should include those subjects, activities and experiences which are useful to the present as well as the future life of children. Irrelevant and useless material should find no place in the Curriculum. The dead wood in the present Curriculum should be removed and replaced by the needful and relevant materials.

Forward Look – Curriculum subjects and materials should be forward looking so that the child will be able to solve the various problems coming before him/her in the immediate as well as remote future, and also to find out the suitable solutions and achieve harmonious adjustments with the changing conditions and situations of life in progressive ways. This capacity for adjustment should also enable the child to modify the environment according to his/her needs.

Variety and Flexibility – Different children have different inherent interests, aptitudes, urges, tendencies, capacities, and abilities. Due to these variations and differences, there should be enough flexibility and elasticity in the Curriculum to suit the varieties. The Secondary Education Commission Report (1952-53) says, “There should be enough variety and elasticity in the Curriculum to allow for individual differences and adaptation to individual needs and interests”.

Education for Leisure – The problem of utilizing leisure time gainfully is of considerable magnitude in modern times. It is generally noticed that people have no plan to spend this time effectively. They often waste it or rather kill it. A good Curriculum should develop capacities in the children to spend their leisure time in a useful manner.

Inclusion of all life activities – According to Herbert Spencer, the prime aim of education is to achieve complete development of individuality. Hence, all those activities and subjects should be included in the Curriculum which promote physical, mental, moral, social, and political development of a child in a harmonious manner.

Relationship with community life – Full consideration of local needs and situations should be kept in mind while constructing Curriculum. All those social beliefs, attitudes, traditions, and problems of community life should be given due place to make children understand them well and realize their responsibility towards them. The Secondary Education Commission Report lays down, “The Curriculum should be vitally and organically related to community life”.

Developing Democratic Spirit – As India has accepted the ideal of a democratic republic, Curriculum should contain and emphasize those activities and experiences which promote democratic spirit, feelings, and attitudes in the children together with democratic behavior pattern based on democratic ideals and values.

Correlation – The impact and importance of a Curriculum is destroyed if it is broken into unrelated fragments and unconnected units. On the other hand, if the integrated approach is employed in teaching various subjects, then this correlation leads to wider and deeper understanding and wholesome knowledge. Hence, the Curriculum should keep various units interrelated and lay stress upon correlation.

5.2.9 Types of Curriculum

❖ **Subject-centered Curriculum** – It lays more emphasis on subjects in comparison with children. It is also known as Book-centered Curriculum because of its emphasis on book knowledge and book learning. This type of Curriculum is in general vogue in India:

- It is psychological because it pays no consideration to the natural interests, needs, and capacities of children.
- It is rigid.
- It cannot lead to wholesome development of an individual.
- It does not promote democratic feelings and attitudes.
- Its aims are clear.

- Its organization is easy and intelligible.
- It is easily changeable.
- Its contents are definite and pre-determined. Hence, both the teachers and the students know their tasks respectively.
- It is based upon a clear cut specific ideology of education and sociability.
- It can achieve an effective correlation among various subjects.
- It facilitates examination and testing.

❖ **Experience-Centered Curriculum** – Experience-centered Curriculum is that in which experiences are regarded as more important for the development of a child in comparison with emphasis on subjects as in the subject-centered Curriculum. Experience centered Curriculum attaches prime importance and immense value to the experiences of a child.

- Its aim is generally indefinite and not clear.
- It employs greater duration of time.
- Its organization and steps of knowledge are not specific and proper.
- Its organization of activities and experiences are not clear-cut, specific, and systematic.
- Vast funds and resources are needed for its implementations.
- It essentially needs very capable and intelligent teachers for its successful implementation.
- By developing the mental constructive and creating capacities of children, it promotes in them a sense of self-discipline and qualities of leadership.

❖ **Activity-Centered Curriculum** – Activity-centered Curriculum is that in which various activities are emphasized in a specialized manner and form. John Dewey says emphatically that by means of activity-centered Curriculum, a child will develop interest in useful and

purposeful activities which will promote his/her development to the fullest extent possible.

- ❖ **Child-Centered Curriculum** – Child-centered Curriculum is that in which greater importance is attached to children in place of subjects. It is constructed according to the interests, needs, and capacities of children so that they develop their personality in a harmonious way. Montessori, Kindergarten and Project method are examples of child-centered Curriculum.
- ❖ **Craft-Centered Curriculum**-It is the Curriculum which lays great emphasis on the training of various crafts such as spinning, weaving, wood work, leather work, mental work, etc. Educational processes are developed around the basic crafts. Basic education is the most significant example of such a Curriculum.
- ❖ **Correlated Curriculum** – It signifies the intimate correlation among various subjects in the Curriculum. It is more a methodological rather than a type of content. This Curriculum emphasized knowledge is one whole. Instead of presenting knowledge in segments before children, it should be presented as an integrated whole through correlation and integration.
- ❖ **Core-Curriculum** - In core-Curriculum, some subjects are grouped together as essential or compulsory subjects while many others become optional. The study of the basic subjects is known as core-Curriculum. It is necessary for all children as a child is free to choose one or more optional subjects according to his/her interests and capacities. This type of Curriculum is a gift of the American educational system. Under it, both the individual and social type of activities is provided to a child so that s/he develops his/her insight, intelligence and capacity to solve all the incoming problems of life and become a dynamic, efficient, and

socially useful citizen. Core-Curriculum seeks to develop both the individual as well as the society more and more.

Merits

- So many subjects are taught together.
- Teaching is time bound for various subjects.
- It is child-centered.
- It gives practice and real life experiences to solve social problems.

5.2.10 Curriculum Organization

The aims and objectives of science teaching cannot be achieved mechanically by merely selecting the content as per certain accepted principles. It depends largely on how the content materials are organized and presented in Curriculum. The role of the teacher is also equally important. In our country, teachers depend upon textbooks prepared or prescribed by the Department of Education for the selection and organization of the content for their science courses. They have no choice. They have to follow the courses of study. However, even within such rigid confines as these, the teacher will have to select and organize to some extent.

Organization of content material should provide for the effective learning of facts, concepts and principles. Facts are learned by experiences, in a variety of ways. Order is important in planning the organization of materials so that opportunity is provided for receiving experience with concepts and principles to provide for the enlargement of understanding. It should provide a natural method of learning that is psychologically sound. Materials should be so ordered, for purposes of instruction, that learning experiences lead naturally towards the objectives sought.

Determinants of Curriculum

The main determinants of the Curriculum are:

- Objectives

- Content or subject matter
- Method and organization
- Evaluation

All the four determinants are in turn affected by Philosophy, Sociology, and Psychology.

- Objectives:** An objective may be defined as an intended learning of a Curriculum or the goal towards which a school sponsored activity is directed.

Educational objectives may be of three

types: Philosophical, Sociological, and Psychological.

The main goal of the Curriculum is to achieve these three objectives.

- Content or subject matter:** The content helps in determining the nature and types of learning experiences that should be provided to the students. It also evaluates the tools to be employed for this learning. Knowledge of content is essential for the rational action. Basic knowledge is essential for knowing the concepts, and principles and to discover the new facts.
- Methods and organization:** Educational objective is achieved only if proper method is selected. Classroom teachers' organization of learning activities acts as a functional aspect in achieving the concept of education. A teacher is responsible for creating conducive atmosphere for informal and formal interactions between teacher-student, student-student, and student with oneself. Therefore, the Curriculum depends on the organization of the content and the learning experiences.
- Evaluation:** Technical evaluation is the integral part of the Curriculum. The achievement of the educational objectives is the measure of the effectiveness of the Curriculum, which is assessed with the help of evaluation. Evaluation is not confined to the end of the lesson or a chapter; instead it is a

continuous process, i.e. during the lesson. It clearly shows the teacher's goals and point-of-view of life science teaching.

Evaluation is one of the techniques to assess the student's progress and it helps in getting the feedback from the students. It also helps in assessing and modifying the teaching procedures. Hence, we can say that Curriculum is never static.

5.2.11 Process of Curriculum Development

Curriculum is a basic cycle involving the processes of analysis, design, implementation, and evaluation. Curriculum planners set up goals, plan out the experiences, select the content, and assess the learning outcomes. Curriculum development is an orderly process of coordinating the various elements of time, space, materials, and equipment. The cycle of Curriculum development guides the process of Curriculum improvement.

The cycle of Curriculum development is analysed as -

Analysis: The step of analysis identifies the values and sets up goals. The objectives are set up keeping the following in mind. They are:

- The Curriculum should match the students' mental development.
- The introduction of the topics should be on concrete level.
- More emphasis is on experimental work or learning by doing.
- Ambiguous and doubtful contents should be excluded.

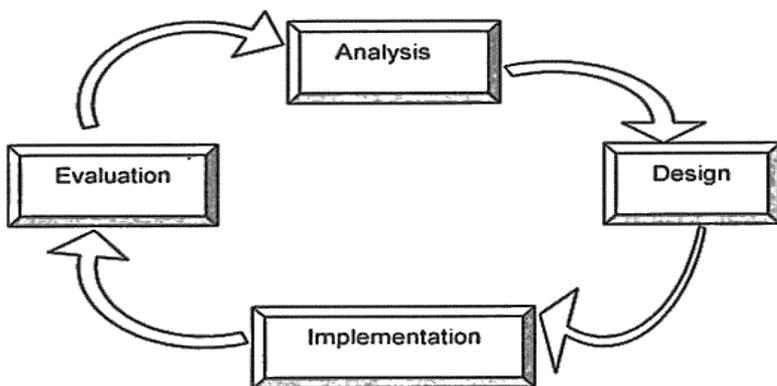
Design: After framing the objectives and deciding the content, the data must be organized into an action plan, which identifies what is to be done, the changes to be made, and the time needed to bring about the changes. Usually, designing the curricula is carried out in the workshops organized at the national level.

Implementation: This stage involves the execution of the

Curriculum designed. It includes the application of the resources and training for providing the required skills. The implementation of the science Curriculum involves:

- Training the teachers in advanced techniques by carrying out in-service programmes for the teachers.
- Improving the infrastructure facilities in the laboratories. Developing proper scheme of evaluation procedures.

Evaluation: The Curriculum framed should be properly evaluated to assess the achievement of the desired objectives. Evaluation helps in identifying the drawbacks and aids in improving the Curriculum. The role of evaluation completes with the returning of the pointer to the analysis stage. This completes the development of Curriculum cycle.



Curriculum Development Cycle

5.2.12 Approaches Involved in Curriculum Organization

Organization of Curriculum is based on a number of approaches. The major approaches of Curriculum organization are:

- **Topical approach:** This is the simplest of all approaches. Based on the importance, the topics are selected and

placed in a systematic order. Topics, which are relevant to day-to-day life and today's world, are included in the subjects of higher classes. They may not provide the continuity of the knowledge. Sometimes, this may lead to defective syllabus due to imbalance, lack of sequence, and lack of coherence in the Curriculum. This arrangement makes the teaching- learning process very interesting and suits their psychological needs. In this approach, topics of immediate interests to the pupils are selected carefully and lessons are developed in an interesting way.

But this approach has its own limitations. A piece of information is related to many sources. Now, where to include it to get the maximum benefit becomes a problem. Another serious limitation is about the teachers. They have to be all-knowing and versatile. The other danger is that the development of the topics becomes artificial and hence uninteresting.

- **Logical approach:** Science is nothing but accumulated and systematized body of knowledge. The knowledge becomes meaningful if the contents are arranged in a logical order. This way of arrangement is quite in consensus with adult thinking and in the higher stages of education this approach is based on hierarchy or level of difficulty. It is also called as funnel approach. It caters to the needs of the learner. Framing of the Curriculum takes place based on the psychological principles such as readiness, transfer of training, reinforcement, etc. The Curriculum includes simple topics followed by difficult topics.
- **Subject-centered approach:** Importance is given to the entire content of the subject. The topics in it are arranged accordingly. It stresses the acquisition of factual knowledge because facts lead towards the general

development of the subject. The sequence involves acquisition of the facts, acquisition of concepts by students and then followed by practical work.

- **Activity approach:** The subjects are important and the teaching is centered on the activity base method in it. Any theory teaching should follow practical method. It depends on the teacher's flexibility. Learning by doing is the principle followed in this approach. The four criteria of activity approach are as follows:

- Use of experimental approach
- Instruction based on problem solving
- Observation and interpretation of results
- Facts and principles taught to the students should be in accordance with the needs and requirements of the students as well as the society.

- **Integrated Curriculum:** Importance is given to all the subjects and teaching is carried out in an integrated manner. It tries to inspire the pupils to have a coherent view of science by establishing the numerous links between the various branches of science. In India, the integrated approach for science teaching is widely used.

- **Concentric approach:** This approach involves addition of knowledge from basic to advanced level. It is a continuous process. In this method, the various topics which are to be introduced are developed gradually. The general science syllabus gives scope for this way of approach. Here, all topics are taught in all classes, the difference being only in the depth of the content matter. As the child grows, the subject also grows in ever widening concentric circles. The child may not be able to understand the advanced principles and concepts of a topic at lower stages. Hence, in this system, complicated content areas are presented only when the child is mature enough for that it

otherwise, simpler facts are being dealt with in the lower grades.

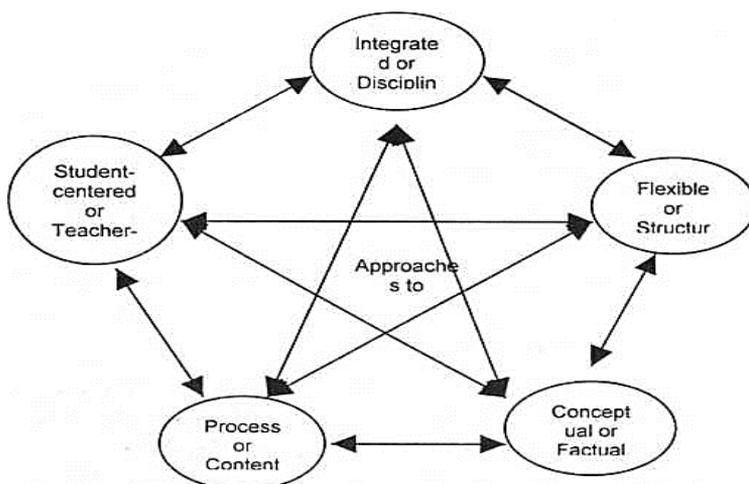
This system becomes highly successful if one teacher handles the subject continuously in different years. If different teachers handle the subject in different classes, there will be the danger of too much of repetition and the subject loses its freshness and power of appeal. The teacher should be very careful to see that the charm of the subject is not exhausted in the first year itself. As Elizabeth Zechariah says “there should be always new problem to be solved, new difficulties to be overcome, new mysteries and wonders to be seen”.

- **Conceptual approach:** The Curriculum is based on concepts. The facts and concepts are arranged in a hierarchical manner. They are developed in a meaningful way as they are all related to each other.
- **Process approach:** This approach is totally based on experimentation. It mainly deals with the experimental processes in science teaching.
- **Unitary approach:** In this approach, the entire Curriculum is divided into units, sub-units, lessons, and topics. Lessons are all related to each other from basic level to advanced level. Each unit ends with some activity. The textbooks follow this approach.
- **Environmental approach:** Any individual is part of the physical, social, and cultural environment. Therefore, he/she will have more affinity towards the Curriculum, which is framed according to the environment. Environment planner for the Curriculum will emphasize on the following aspects of the environment:
 - Natural environment: Forests, mountains, and atmosphere
 - Social environment: Public places like market and

theatres

- Cultural environment: Festivals, exhibitions
- Physical environment: Industries, agriculture

Fig: Approaches to Curriculum



5.3.1 Defects in the Existing School Science Curriculum Objective of Science Curriculum

The present day science Curriculum has the following objectives:

- Providing a continuous and sequential experiences to the students
- Approaching science conceptually rather than factually
- Introducing different methods of instruction with the nature of scientific enterprise and with various process of science
- Providing deeper insights into the philosophy, history and methods of inquiry of science
- Providing effectively for 'individual differences' abilities, needs, and interests
- Optimizing use of local skills and resources and
- Providing for built-in mechanism and continuous and

critical reevaluation.

5.3.2 Functions of Science Curriculum

There is an increasing hunger for quality science and technological education among the students and parents. The quality depends on the planning and implementation of the Curriculum.

The functions of science Curriculum are:

- To provide continuous as well as sequential experiences right from the very beginning of the school from the secondary school on into the college;
- To approach science conceptually rather than factually, with less emphasis on the technical application of science and to use those methods of instruction which familiarizes students not only with the nature of scientific enterprises but also with the various processes of science which lies at the heart of scientific method
- To provide deeper insights into the scheme of the structure of science, that is its philosophy, history. and methods of inquiry.
- To make the maximum use of local skills and resources
- To provide for built-in mechanisms which provide for its continuous and critical re-evaluation.

5.3.3 Defects in the Present Curriculum

Curriculum is the whole amount of experiences that the child receives within the school campus. As Curriculum implies a totality of experiences, which the child receives, it needs to be modified and upgraded in coordination with the changing educational scenario. The field of life sciences has seen a spurt of knowledge development. The life science Curriculum is not up to these expectations and has many drawbacks. Curriculum should be dynamic but not static. Only if the Curriculum has continuous change in it, it can be a living one. Some of the drawbacks are as follows:

- **It is narrowly conceived:** In science Curriculum, emphasis is given on acquiring knowledge rather than understanding the true nature of science. It is considered more a product than as a process. But, in fact, science is a product as well as a process. It is the process that helps to build the product in science. Therefore, framing of science Curriculum should be in accordance with the above aspect.
- **Bookish and theoretical:** The Curriculum has become theory-oriented, today. It mainly emphasizes on gaining knowledge and facts rather than developing scientific thinking, appreciation, interest, problem-solving skills, manipulation, and experimentation. Science Curriculum is framed in accordance with the examination point-of-view. This has to be changed and it should be prepared by giving importance to practical experiences.
- **Consists of out dated topics:** The topics of the subject are dealt for years without up-gradation. Day-to-day developments are not dealt with in the syllabus.
- **Curriculum in examination point of view:** Much importance is given to examinations of the academic year. All the activities are directed towards preparing the students for the examinations. Many co-curricular activities are ignored and importance is given to the exams, which help in acquiring only bookish knowledge. Parents and teachers also stress the students to perform well in the exams and they too ignore the true nature of science.
- **Psychologically not sound:** Science Curriculum should be flexible in accordance with the psychological needs, interests, and abilities of the students. The Kothari Commission recommended that science education should be linked with agriculture for rural students and with

science and technology for urban people. The framework of the Curriculum also depends on the varying backgrounds. There is little difference in the curricula formed for boys and girls and between the rural and urban students.

- **Curriculum is rigid and not uniform:** Children are more interested in real-life experiences of their surroundings. But the Curriculum is not framed according to these needs of the students. It deprives a child from direct contact with the environment. It is completely isolated from the environment, making it meaningless. It is the responsibility of the teacher to suit the content to tap the resources of the environment to the students. A teacher should not follow the rigid pattern of activities prescribed in the Curriculum.
- **Curriculum load:** There are complaints from parents and community that school Curriculum has become very heavy and is responsible for development of stress among students and thereby affecting their normal developments. The problem of Curriculum load is a complex one and has its roots in many related issues. The NCERT is presently revising the national Curriculum framework and this is one of the major problems that is being taken care of.
- **Preparation of teachers:** Pre-service preparation and in-service training of teachers are major problems in implementation of Curriculum. Given the huge number of teachers and geographical character of the country, management of in-service programmes is indeed a challenge. Efforts are being made to address the problem through direct and distant mode (and through teleconferencing). A collaborative mechanism is being evolved by agencies like National Council of Educational Research and Training (NCERT), National Council for

Teacher Education (NCTE), and Indira Gandhi National Open University (IGNOU) along with the State Councils of Educational Research and Training (SCERT) and District Institutes of Education and Training (DIET).

- **Methods of assessment:** The present assessment/evaluation system in science education is a major bottleneck in bringing improvement in the education system of our country. Unfortunately, what is not relevant to examination is not considered relevant in teaching and learning. Framework of assessment used is not conducive to the development of problem-solving skill among the pupils, given the fact that instruction is mainly assessment-driven in our country. Further, assessment of practical work is not attached and much importance is given to theory which results in utter neglect of practical work in school education.

5.3.3 Drawbacks of Biological Science Curriculum

- Outdated topics are included in the Curriculum.
- Practical work is given less emphasis.
- Advanced concepts in life sciences are not included in the Curriculum.
- Relationship between bio-science and other science curricula is not recognized.
- More emphasis is given to taxonomy and morphology, ignoring the advanced physiological and molecular biological aspects of study.
- Curricula are prepared with the theoretical examination point of view.
- Technical and vocational skills are given less importance.
- Psychological principles are not followed. Needs and abilities of the learner are not realized.
- No encouragement is given to the creative and gifted child.
- Curriculum is not concerned with day to day activities

5.3.4 Improvement of Bioscience Curriculum

Suggestions given by Kothari Commission are as follows:

- School Curriculum should be upgraded through research and should be undertaken by University Departments of Education, Training Colleges, State Institutes of Education, and Boards of School Education.
- There should be a periodical revision of curricula based upon research.
- The preparation of textbooks and teaching-learning materials should be taken up on a large scale.
- Orientation programmes for teachers to the revised and curricula should be organized
- Schools should be given the freedom to device and experiment with the new Curriculum suited to the needs.
- Ordinary and advanced curricula should be prepared by State Boards of School Education in all subjects and should be introduced in a phased manner in schools, which fulfill certain conditions of the staff.

The Subject Teacher's Associations in different school subjects should be formed to stimulate experimentations and the upgrading of the Curriculum

5.3.5 Qualities of a Good Bioscience Curriculum

- Bioscience Curriculum should be in accordance with the changing needs of the individual.
- Its basis should be aim and value-oriented.
- It should cater to the social requirements.
- Student's creativity and reasoning skills should be given prime importance.
- It should be framed according to the age and maturity level of the students.
- It should help in developing problem solving, decision making, and creativity and self-confidence aspects within

a student.

- A bioscience Curriculum should maintain a balance between curricular and extracurricular activities.

Bases of Curriculum

According to Secondary Education Commission, the Curriculum should be based upon the following aspects:

- Totality of experiences
- Variety and elasticity
- Relation to community life
- Training for leisure
- Integration and correlation

5.3.6 Reforms in the Present Curriculum

The most recent reforms implemented in the country are given below:

- **Improvement of Science Education in Schools:** To improve the quality of science education and to promote scientific temper, a centrally sponsored scheme, 'Improvement of Science Education in Schools' has been operational since '88. Under the scheme, 100 percent assistance is provided to the States/Union Territories for provision of science kits to upper primary schools, upgradation of science laboratories and library facilities in senior/secondary schools and training of science teachers. The scheme also provides for assistance to voluntary organizations for undertaking innovative projects in the field of science education.
- **Environmental Orientation to School Education:** A centrally sponsored scheme by this name was initiated in '89. The scheme envisages grants to the States/UTs for various activities including review and development of curricula of various disciplines at primary, upper primary, and secondary levels with a view to infusing environmental concepts therein; review and

development of textbooks on ‘Environmental Studies’ at primary and upper primary levels; review of strategy for imparting environmental education at upper primary level; development of teaching-learning materials; and organization of suitable innovative work experience activities. To achieve these objectives, the scheme also envisages assistance to voluntary agencies.

- **Computer Literacy and Studies in Schools:** The Department of Electronics, in collaboration with the Ministry of Human Resource Development, initiated a pilot project, ‘Computer Literacy and Studies in Schools (CLASS)’ from the year 1984-85. The project was modified and converted into a centrally sponsored scheme from year 1993-94. The aims of the projects are:
 - To provide pupils with an understanding of computers and their use;
 - To provide hands-on experiences;
 - To ‘demystify’ computers to young school-goers, and
 - To familiarize pupils with a range of computer applications and with the computer’s potential as a controlling and information processing tool.

Meanwhile, the Information Technology Action Plan (1988), which makes significant provisions for integrating computers into the schooling process, has been adopted by the government. As a consequence, the Ministry of Human Resource Development has launched a ‘new school-computing program called the “CLASS 2000”. CLASS 2000 has the following three components:

- i. Computer Literacy in 10,000 schools;
- ii. Computer-aided learning in 1000 schools; and
- iii. Computer-based education in 100 Smart Schools which will become model centers for other schools.

The NCERT developed the Blueprint for Smart Schools upon

which the concept of computer-based education would develop. The NCERT is committed to provide all possible on-line and off-line support to the above venture.

5.3.7. National Curriculum Framework

More than a decade has passed since the formulation and implementation of National Policy on Education, 1986. The content and process of education, the whole approach to education in general, and science education in particular, need a fresh look so that the school Curriculum is dynamic enough to respond to the changing national priorities and long-term developmental goals of the country. Since the last revision of the school science Curriculum, a number of important developments have taken place, which will have a decisive role in formulation, design, and development of science curricula. Firstly, our understanding of ‘how students learn science’ has changed significantly. From process approach to science education, we have moved to a constructivist approach. Secondly, the last two decades have seen emergence of a new taxonomy of practical skills, which is now internationally accepted and widely used. These aspects have to be taken care of in the design of learning materials for children and also in the technology of teaching and assessment. Thirdly, and probably the most significant development has taken place in the area of information technology. This is not only going to change the shape of the end product but it is also going to influence the content and process of science education as well.

NCERT has developed a new discussion document on National Curriculum Framework for School Education. This document has been prepared after a gap of twelve years, the earlier one having been prepared in the year 1988. The document has highlighted many new concerns and issues relating to all the years of schooling—Elementary to Senior

Secondary stage. The document has five major chapters—Curriculum concerns and issues, organization of Curriculum at elementary and secondary stages, organization of Curriculum at higher secondary stage, examination and evaluation and implementing and managing the system.

NCERT developed the first Curriculum Framework “The Curriculum for the 10-year School - A Framework in 1975” in response to National Policy on Education, 1968. The next National Curriculum Framework “National Curriculum for Elementary and Secondary Education - A Framework” was developed in 1988 in response to the National Policy on Education, 1986. On both the occasions, these professional documents were prepared in consultation with practitioners, experts, individuals, institutions, and others within the framework of National Policy on Education, 1968 and 1986, respectively. A perusal of National Policy on Education, 1986 and 1992 as also of the corresponding Programme of Action documents would clearly reveal that the Curriculum development and renewal exercises should be taken up after every five years.

NCERT released the National Curriculum Framework for School Education in November 2000, following intensive discussions and debates at various forums across the country. The Framework provides guiding principles for reshaping the Curriculum for schools. The stupendous task of framing the new Curriculum in agreement with those principles lies ahead.

The Curriculum Framework recognizes that the new information technology has begun to challenge what schools try to teach and the whole basis of assessing the knowledge and skills that students acquire. It accepts that the process of education can no longer ignore the social and psychological impacts of the technology. It also acknowledges the possibilities that global information sharing opens up. All this

affects the way people think and learn and therefore has profound implications for education at all levels.

This Curriculum Guide and Syllabus for Information Technology in Schools is an immediate offshoot of the Curriculum Framework. Designing a course of study that would integrate information technology into schooling is no easy task, for the technology changes faster than our ideas. Still there are certain basic principles that have longer half-lives; they define the prospect of this emerging area in school education. Implications of all these have been elaborated in the Curriculum Framework. Together, they underscore the urgency for:

- Formulation of plans for integration of computers into the Curriculum, and go beyond, for making information technology a part of the schooling process.
- Creation of a framework for enhancing learning opportunities in the electronic environment across the Curriculum.
- Access to global information sources
- Provision for professional development opportunities for teachers that would enable them to act as facilitators of learning.
- Designing flexible curricular models which would embrace interdisciplinary and cross-disciplinary thinking, and
- Developments of attitudes that are value driven and not technology-driven.

5.4.1. Problems in Adapting Curriculum to Local Needs and Resources

Teaching of Biology faces several problems in India. Some of these problems are regarding Curriculum, text-books, laboratory work, teachers, methods of teaching, and

evaluation. In India, teaching of Biology has been oral in character with some demonstrations thrown in. At lower stages in schools, there are either no laboratories or experiments are seldom performed. Aims and objectives have been talked about but most of these are not implemented. The Curriculum is not organized psychologically. Text-books are written traditionally without keeping the process of learning in view. Methods of teaching life sciences are dull and ineffective. Teaching is aimed at the performance of the students in examinations and not at real learning. Training in scientific method of working, problem solving, creative thinking and development of scientific skills, interests, attitudes and application of the knowledge are neglected. There is lack of research in Biology teaching. Its contents are old and deteriorated by the different media of instruction throughout the country.

- ❖ Problems of Curriculum
- ❖ Problems concerning Text-Books and Reading Materials
- ❖ Problem concerning Laboratory Work
- ❖ Problems concerning Biology Teacher
- ❖ Problems concerning Methods of Teaching
- ❖ Problems concerning Evaluation
- ❖ Defects in Practical Examinations

1. **Problems of Curriculum**—In India there are different kinds of school courses, such as High schools (two years course after eighth class or middle stage), Higher secondary course (three years course after eighth class). The new pattern 10+2 is still in its way of implementation—

(i) **In High Schools**—there is no Biology Curriculum as such but it forms only a part of General Science Curriculum. The students learn little beyond gaining some familiarity with a few plants and animals and an elementary idea about

digestion, respiration and photosynthesis. There is no laboratory work. A few models, slides, charts, specimens, etc. are shown while teaching in the classroom. Biology Curriculum does not fulfill its aims and objectives of teaching.

(ii) **In higher secondary schools of eleven year duration**—there is a general science Curriculum up to middle stage and the condition of teaching up to this stage is as that in high schools. At Higher Secondary stage, the old syllabus was divided into Botany and Zoology. It included too much of technical terms and definitions. There were no topics relating to human body, relating to daily life activities, and to the future careers of the students who discontinue their studies after this stage.

(iii) **NCERT Curriculum**—N.C.E.R.T. developed a modernized traditional Curriculum for Higher Secondary classes in which Biology was elective subject for science students. Here the subject matter is dealt according to the major groups of plants and animals and the classical branches of Biology. Though balanced to some extent, the Curriculum did not include knowledge regarding the daily life activities and vocation, for the students terminating their studies after Higher Secondary stage.

(iv) **10+2 System of schooling**—Here, general science is taught compulsorily up to 10th class. Students can select this subject in 11th class. Biology forms a part of general science Curriculum up to 10th class. N.C.E.R.T. has developed a new Curriculum from 6th to 10th and up to 12th class. The Curriculum is balanced but it places too much burden on the students. Scrutinizing and rewriting of the syllabi is going on and a final form of the Curriculum is yet to be decided.

2. Problems concerning Text-Books and Reading Materials—The content of the text-books is determined by the type of Curriculum.

• **Text Books**—There were college books available for

Botany and Zoology for Higher Secondary classes till N.C.E.R.T. produced a textbook for Biology. The content of the earlier books were dominated by the use of technical terms and definitions. Their subject matter was not organized according to the learning processes of students at this stage. The Higher Secondary system was shown apathy in its implementation. The new text-book of Biology was available in English. It was later translated into Hindi but not in regional languages. The new books under 10+2 system have a large volume of content matter. But these books have not been favoured. So, condensing and rewriting of the subject matter is going on.

- **EasyNotes**—The problem regarding text-books is further aggravated by the production of ‘made easy’ and matter of facts books in the markets. Students incline more on these. Though these books contain nothing more than definitions and brief notes on the more important topics which the student can memorize.
- **Teacher’s Guides**—There are no guide books for the teachers and help books for students regarding laboratory work and further reading.
- **Shoddy Production**—The existing stock of books leaves much room for improvement regarding printing and illustrations.

3. Problem concerning Laboratory Work—Most of our schools have no laboratory facilities for teaching Biology. There is over simplification of laboratory work. Field work and experimentation have no place in it. There is more emphasis on bookish knowledge. The students are often not acquainted with the beautiful fauna and flora of their own locality. In higher secondary schools, students attend the laboratory twice a week for 70-80 minutes on each turn. They spend most of their time in observing and dissecting the

various plants and animals included in their syllabus, in making labelled diagrams of the entire or dissected specimens, in copying figures from charts and books, and in looking through the microscope. They also get some chance to observe the setup of a few experiments in plant physiology. They rarely have the opportunity of looking into any experiment to its completion. The teacher who has to look after a class of 30—35 students, cannot manage to demonstrate the experiment without a laboratory assistant to help him/her. There is no scope for students to find out something for themselves through experimentation. Most of the laboratory work recommended for higher secondary classes includes morphological and anatomical studies of some plants and animals included in their theory syllabus, and a few experiments in plant physiology. No field work, projects or work in laboratory techniques has been recommended.

4. Problems concerning Biology Teacher—Secondary Education Commission in India (1952-53) recommended that students in higher secondary schools should be taught by post-graduate (M.Sc.) trained teachers. However, the salaries of teachers are not adequate to give them the dignity and status which their work demands. Their chances of promotion are very less. Teaching profession attracts the least promising men and women. There is an acute shortage of really good trained teachers. In some schools, teachers teach life sciences up to middle stage do not have any biological background. In many schools, science graduates teach this subject for all the three years at higher secondary stage. Heavy duty (30— 35 periods of 40—45 minutes each per week) and poor remunerations prevent the teachers from putting their heart into the work. They are often on the lookout for non-teaching and more prosperous jobs. Training remains stereotyped. Training institutions do not produce well trained teachers.

They are not told about new methods of teaching, techniques of evaluation, proper use of teaching aids, and organization of co-curricular activities or undertaking of projects and problem solving. They are not trained in laboratory techniques.

5. Problems concerning Methods of Teaching—Even where postgraduate teachers are available for higher secondary classes and graduate teachers for lower classes, the teaching remains stereotyped and sometimes even unbalanced. Post graduate teachers are specialized in classical biology—either botany or zoology. They may do full justice to one branch but do a step motherly treatment to the other. The teachers' initiative is often crushed by the traditional Curriculum. Due to the pressure of dead weight of examinations which often demands little more than good memory, teaching becomes dull and lifeless.

Only lecture method or lecture demonstration method is utilized in teaching. Performance in the class rooms remains poor in demonstration. The teachers do not employ investigatory approach while working in the laboratories or undertaking demonstrations. Improved Methods of teaching like problem solving, project method or field work and excursions are not utilized. So, they are not able to develop scientific method of working in students.

6. Problems concerning Evaluation—In India, teachers do not have any standard tools for measuring the learning of the subject matter in Biology at different stages of schooling. They generally employ essay type tests in which some questions are set from so called important parts or topics of the books. The essay type examinations are not valid, reliable, objective, or even practicable. These can be employed for testing the depth of knowledge, comprehension, and application but there is generally learning by rote memory, without adequate understanding of the subject

matter. Hence, new type of tests or objective type tests is becoming popular due to their high validity, reliability, objectivity, and practicability. These objective type tools are not foolproof and cannot be employed where one wants to test the depth of knowledge, power of comprehension, and application of the knowledge.

7. Defects in Practical Examinations—In India, Biology practical examinations suffer from certain defects. Examiners are generally influenced by personal relations. They are sometimes prejudiced. Students' performance is evaluated on the basis of practical note books which contain neatly copied diagrams and sketches. The skills of observations, handling of apparatus, drawing, etc. are not evaluated by at the spot checking.

5.5.1 Curriculum Development in India

National Council of Educational Research and Training (NCERT)

After the inception of N.C.E.R.T. (India), a Text Book for Higher Secondary Schools was developed by Biology Panel. In this the approach, treating the material was modernized traditional. Regarding knowledge included the content was balanced. But treatment is according to groups of organisms or branches of biology. Preparation and testing of material on biology teaching by N.C.E.R.T. with the help of UNESCO and other agencies has been going on since 1968 and balanced Curriculum have been developed.

The National Council of Educational Research and Training (NCERT) is an apex resource organization set up by the Government of India, with headquarters at New Delhi, to assist and advise the central and state governments on academic matters related to school education.

NCERT has been the key player in all the aspects of science education in schools. Its first major attempt was made

in 1975 when it published the Curriculum framework for the first ten years of schooling. This was built up around the recommendations of the Kothari Commission. The Commission emphasized that primary stage science teaching should be related to child's environment to facilitate understanding of internationally accepted symbols of scientific measurements and use of charts, maps, and tables. At the upper primary stage, it recommended acquisition of knowledge and ability to think logically as well as to draw conclusions and make decisions. At the lower secondary stage, science was recommended to be developed as a discipline of mind and knowledge. Newer concepts of physics, chemistry and biology as well as the experimental approach for learning of science were to be emphasized. The Commission also recommended science courses at advanced level in selected lower secondary schools for talented students with necessary facilities of staff and laboratory. It also emphasized linking science teaching to agriculture in rural areas and technology in urban areas. The new Curriculum developed by NCERT was critically received, particularly for being heavy in Classes IX and X. Basic features of the curricula were appreciated and put to implementation practically throughout the country. The magnitude and extent of success at implementation however, remained a point of discussion. The 1986 National Policy on Education and its revision in 1992 took note of all the past achievements and experiences and formulated the following statements on science and mathematics education:

- Science and Mathematics education will remain as core subjects in the first ten years of school education.
- In order to develop scientific temper and to attain other goals, it is necessary to define the objectives to be fulfilled through science education.

- Involvement of community, non-government, and voluntary agencies are required to pool the resources by establishing network arrangement between different institutions. Efforts should be made to generate manpower at the grassroots level spearhead the implementation of ideas stated in NPE.
- Special programmes are needed for the educationally backward states and educationally backward schools of the society. This is necessary for the removal of disparities, attainment of women's equality, and education of Scheduled Castes and Scheduled Tribes and other educationally backward sections and areas.
- For universal enrolment and retention, improvement in the quality of education is necessary. Each student learns in a different way and each student has the right to learn. The teaching/learning of science and Mathematics should be designed in such a way that it serves that basic right. Science and Mathematics education at the elementary level will be so designed that instead of loading the child with content information it should provide him/her with the joy of learning.
- Science education will be extended to the vast numbers who have remained outside the scope of formal education. This is to be kept in mind while planning science and mathematics education for non-formal system.
- Science and Mathematics Curriculum will be designed for the secondary level for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology-based society.
- Science and mathematics Curriculum for general education will be implemented in the pace setting schools with sufficient scope for innovation and experimentation.

- Science up to Class X should be treated as one. The laws and principles of science, which are operating in the environment, should be used for creating desired teaching/learning situations. The performance of activities will be given top priority in the teaching/learning of science.

5.5.2 National Institute of Education

The National Institute of Education (NIE) in New Delhi through its various departments carries out research and development functions related to pedagogical aspects of Curriculum; prepares prototype curricula and other supplementary instructional material; develops school education-related database and undertakes experiments in preschool, elementary, and secondary stages to nurture all-round development of the learner.

5.5.3 Biological Sciences Curriculum Study (B.S.C.S.)

The Biological Science Curriculum Study (BSCS) was organized in 1959 by the American institute of biological science. It was necessitated by the inadequacies and defects found in the conventional way of teaching Bio- science. BSCS differs from conventional method in treating biology in three different aspects.

- It shows unity among topics.
- Lays emphasis on molecular and physiological aspects.
- More stress on practical work

Main functions of BSCS is to:

- Evaluate the content of the present biology course.
- To produce classroom material for average students at secondary school level.
- To produce textbooks and handbooks for the teachers.
- To produce lab manuals for laboratory work.

The BSCS was mainly based on 9 major themes.

- ❖ Science as investigation and enquiry
- ❖ History of biological concepts
- ❖ Complementary of structure and function
- ❖ Diversity of type and unity of pattern
- ❖ Change of organism through time as evolution
- ❖ Genetic continuity
- ❖ Organism and its environment
- ❖ Regulation and homeostasis
- ❖ Biological basis of behaviour

The BSCS has developed three textbooks, teachers' handbooks and laboratory manuals as part of instructional materials. They selected three patterns of textbooks with different approaches, but all within the general framework of BSCS objectives. They are referred to as Blue, Green, and Yellow versions.

Blue version: Biological science - Molecule to Man (molecular approach). This book approaches the study of biological science from molecular level with emphasis on recent advances in physiology and biochemistry.

Green version: High school biology textbook. The approach is through the study of ecology and behavioral aspects of biological science. Emphasis is on biological communities and biomes.

Yellow version: Bioscience textbook - called an enquiry into life, follows The Biological Sciences Curriculum Study (B.S.C.S.) started its activities in January 1959. Financial support to this organization was given by National Science Foundation (N.S.F., U.S.A.). Over 2000 biologists and especially competent persons had contributed to the development of various programmes of B.S.C.S., within ten years of its inception approach. The book is organized into four major concepts of Biological unity, Bio-diversity,

Biological continuity and Biological interaction. Stress is given on cellular level of organization. In addition to all the textbooks, teacher guides and other laboratory manuals are also prepared. As part of the supplementary material, teachers' handbooks, evaluation aids, BSCS film programmes and BSCS research problems were also developed.

The objectives of B.S.C.S.:

- To produce modern biology courses (text-books) for the spectrum of students who take biology in high school.
- To develop special resource materials for the teaching of these courses as teacher help books, laboratory blocks, films-equipment, etc.
- To formulate programmes and materials for in-service and pre service education of the teachers.
- The revision of biological science Curriculum content of biology and its aim is of periodic change and it has been a regular practice.
- B.S.C.S. identified seven levels of Biological Organization, these are Molecular, Cellular, Organ and Tissue, Individual Organism, Population, Community and Biosphere. At every level of biological organization, students learn some common as well as diverse phenomena about living things.
- At molecular level they learn the structure and types of molecules in living systems and their role in metabolism.
- At cellular level, they learn about the various constituents of cells, cell divisions and cell as unit of life.

- At organ-tissue level, they study the organization of cells in the form of tissues and their special functions and further the various tissues in associations forming various organ systems as digestive, nervous and skeletal systems.
- At organism level, the students learn about the functioning of organisms, their diversity in nature, reproduction, energy utilization and their behavioural interactions.
- While undertaking studies at population level, they learn about growth maintenance, food requirements, competitions, population changes, and population problems, etc.
- At community level, they come to know the structure of various communities, dominant species, community relationships, food chains and food webs, matter cycles, interaction of organisms with the physical environment etc.
- At the world Biome or Biosphere level, they learn the biotic and abiotic relationships of ecosystems, relationship among various ecosystems of biosphere, changes along time and man's place in the biosphere.

The B.S.C.S. team was convinced that there should be nine themes in the preparation of reading materials for the students. Out of them, seven should relate to the content and two with the organization of the matter.

B.S.C.S. considered six levels, along which the students can organize their learning products and these were: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. This B.S.C.S. team adopted a three dimensional model in developing and organizing the subjects matter.

During the summer of 1960, the B.S.C.S. assembled

three writing teams of high schools biology teachers and university research biologists, about equal in numbers, to prepare preliminary trial materials in terms of the new conceptual schemes. During 1960-61 school years, B.S.C.S. materials were taught in 1QD schools. Based on feedback, courses were rewritten during 1962 and tried in 500 schools. In 1963, the material was again written and tried in 950 schools. On the whole the B.S.C.S. materials had been tried and tested on over 1000 teachers and 1,50,000 students before the first edition (1963) of the B.S.C.S. three books came out.

The basic Curriculum programme of B.S.C.S. consists of three distinct biology text books (written by each team) and related materials for the use of 10th grade American High School. Originally, the three versions were classified in terms of their approach to biology. These are also known by the colour of their covers.

1. Molecules of Man (Blue Version).
2. High School Biology (Green Version).
3. Biological Science—An Inquiry into Life (Yellow Version).

Limitations

- As whole of the B.S.C.S. material is based on the same goals and conceptual schemes, those books are more alike than different. There is an estimated overlap of 70% in topics but the topics are not treated identically. The remaining 30% is particular to each text book and in treatment. The B.S.C.S. texts are quite different from the traditional biology.
- In content and organization, the B.S.C.S. Versions have served to break the traditional patterns of biology courses in which organism were treated according to their classes regarding their structures and functions. The course design, sometimes called fern-frog organization, was laid down around 1860.

- In general B.S.C.S. versions concentration is minimal in organ-tissue concepts and concentration is more on molecular and cellular at one hand, and community, population, and world biome at the other.
- The degree of emphasis upon these topic areas is different for each B.S.C.S. text-book. The blue version laid emphasis on molecular levels and physiological aspects; the Green Version relates more to community and population aspects while the Yellow Version has its emphasis on cellular classical and evolutionary aspects.
- The 1968, 1973 and 1977 editions of the above mentioned versions contain upgraded information about new developments in Biology but the emphasis is on the same major concepts. It appears that the revised versions have somewhat more topics in common than the 1963 versions although the treatment of these topics remains unique to particular versions.

5.5.4 Nuffield Foundation Science Teaching Project

Nuffield Foundation Science Teaching Project arose from a general interest in Curriculum development in science in U.K. It is a charitable educational foundation. The essence of Nuffield course in Biology is “science for all”. The main intention was to provide a balanced and up-to-date view of the subject suitable for pupils who leave the school at the age of 16. The course is designed to foster a critical approach to the subject with an emphasis on experimentation and enquiry rather than mere assimilation of facts. Issues like relationship of structure and function, adaptation and interaction of organism and environment are given stress in the course.

The main aims of the Nuffield Science Project are:

- To make science an accessible subject to all the pupils in the schools.

- To make science a practically useful tool in the hands of students.
- To develop course material that will help the teachers in presenting the science subject in a lively and exciting manner.
- To develop the interests and curiosity to learn science.
- To develop an approach of experimentation and enquiry rather than mere assimilation of facts
- To develop in essence a new approach to teaching.

The Nuffield Biology project course falls into two categories- The Introductory course which has a general approach and the second course which is a Quantitative course with greater emphasis on experimentation and reasoning. The Nuffield project has developed textbooks, teacher's guides, films and visual aids. They stress on enquiry and process approach. All these provide a qualitative insight into the subject of science.

- **Textbooks:** Designed with a variety of teaching approaches. These provide a clear indication of overall structure of the course, investigatory approach to subject matter, laboratory experiments and manuals.
- **Teacher's guide:** These are available for various textbooks which help in the methodology of teaching.
- **Films and visual aids:** Supplemented with the films, film loops are made available which are silent.

Nuffield Science Programmes emphasise on enquiry and process approach rather than facts. They stress on qualitative insight rather than quantitative approach.

5.5.5 National Talent Search Scheme

The National Talent Search Scheme has been started by N.C.E.R.T., New Delhi in 1963. It is meant to locate scientific talent of the gifted children up in the ladder. Through this scheme, a promising student now is

able to pursue his/her studies up to Ph.D., in Engineering, Medicine, and social sciences including commerce without any financial liability. Not only this, even the employment is ensured after completing the studies.

Objectives of this Scheme:

This scheme is carried out for fulfilling the following.

- ❖ To stimulate scientific talent by a process involving competition and by recognition of merit.
- ❖ To help talented students to continue their studies up to Ph.D., level.
- ❖ To provide programme in science to such scholars in view to nurturing their talent.
- ❖ To encourage schools to take more active interest in conducting a search for scientific ability.
- ❖ To help in building up a body of future scientists to contribute to scientific advancement, both in pure and applied fields.
- ❖ To create consciousness among educationists for improving the Curriculum in science subjects.
- ❖ To improve methods of teaching and evaluation techniques in schools.
- ❖ To fix up the students in contract basis in higher institutions and help them to pursuing higher education up to Ph.D. level.

Details about the Scheme:

For the National Talent Search Scheme, State level Exams (First Stage) are to be conducted and on the basis of the state level written test and prescribed number of candidates are to be admitted for the National Level Examination (second stage), that will be conducted by the N.C.E.R.T., New Delhi.

State level Examination

To select candidates for All India Level Examination (2nd stage testing), a State level written test (1st stage testing)

is to be conducted every year by the state. Social science put together in the aggregate total (i.e. 180/300) in the IX standard Annual Examination and now studying in the Standard X in their school are alone eligible to appear for the examination.

All students above aggregate marks, appearing in X standard in all type of recognized schools including Kendriya Vidyalayas, will be eligible to appear at the State Level Test from the state in which the institution is located. The states may, if seem necessary; prescribe other eligibility conditions or examination fee.

Scheme of Examination at State Level:

Each State/Union Territory shall hold a written examination consisting of the following:

Test	Duration	Max Marks	Qualifying Marks
Mental ability Test (MAA)	1 ½ hrs	100	40*
Scholastic Aptitude	1 ½ hrs	100	40*

- ❖ In case of S.C. /S.T. candidates qualifying marks shall be 32.
- ❖ The General Mental Ability Test will be compulsory for all candidates.
- ❖ In the Scholastic Aptitude Test, candidates will have to answer items on any four subjects of the eight subjects given below.
 1. Physics
 2. Chemistry
 3. Mathematics
 4. Biology
 5. History
 6. Geography
 7. Civics and
 8. Economics

The two tests shall be administered separately. Therefore, the booklets for both the tests and the answer-

sheets shall be printed and distributed separately.

The medium of examination shall be English or regional languages as provided in the Constitution of India.

Each State/Union Territory shall recommend a number of candidates for the second level test to be conducted by N.C.E.R.T. The candidates shall be recommended based on merit in the written examinations held at the State Level. No correspondence from the unselected candidates is to be attended. The examination will be conducted in all the Revenue District Head Quarters. The venue of the Examination will be notified by the respective Chief Educational Officers and put upon their Notice Board sufficiently in advance.

A. National Level Examination Eligibility:

Only such students studying in the class X and duly recommend by the States/Union Territories on the basis of State Level screening test shall be eligible to appear at the National Level examination conducted by the N.C.E.R.T. These candidates shall be informed about their Roll Numbers, date, venue and time for the written examination conducted by N.C.E.R.T. through a registered letter at their address given by the State/Union Territories in the bio-data cards while recommending the names of candidates to the N.C.E.R.T.

Centres:

There is only one centre in each State/Union Territory for the National Level Examination. Normally the candidates belonging to a state shall be allotted the centre in the same State.

Scheme of Examination at the National Level:

The written examination shall consist of Part I -

Mental Ability Test (MAT) and Part II- Scholastic / Aptitude Test (SAT). Scheme of tests shall be under:

Test	Duration	Max. marks	Qualifying Marks
Mental Ability Test	1 ½ hrs	100	40*
Scholastic Aptitude Test	1 ½ hrs	100	40*
Interview		25	No qualifying marks

In the case of S.C./S.T. candidates qualifying marks shall be 32.

Both the written tests shall be administered separately. Booklets for both the tests and answer-sheets shall be printed and distributed separately.

The medium of examination shall be English or regional languages as provided in the Constitution of India.

In Scholastic Aptitude Test, the candidate shall have to answer questions of any four subjects out of the eight enumerated below:

- | | |
|----------------|--------------|
| 1. Physics | 2. Chemistry |
| 3. Mathematics | 4. Biology |
| 5. History | 6. Geography |
| 7. Civics and | 8. Economics |

There should be no prescribed syllabus for the above mentioned tests. However, the standard of questions or items shall be confirming to the levels of class X public examinations.

- Both the tests are objective type having multiple choice type questions or items.
- There shall be no negative marking.

- Candidates shall be called for the interview on the basis of this merit. They shall be informed through registered post.

Results:

The final results (awards) shall be declared strictly on the basis of merit in the National Level written tests and the interview.

Rate of Scholarships

S. No.	Stages	Emoluments
1.	+2 stage	Rs.150/- per month for 2 years +Rs 200/- per annum as book grant
2.	Upto Post-graduate degree level course in basic/social science and first degree level professional courses in Engineering/medicine.	Rs.200/- per month upto second degree course in basic/social sciences including commerce. i.e. MA/M.Com/M.Sc/ and first degree in Engineering and medicine +Rs.300/- per annum as book grant.
3.	Second degree level course in Engineering/Medicine.	Rs.400/- per month during the course irrespective of discipline

The rates of scholarship shall vary according to the income of parents in the following manner:

1. For the income group up of Rs.1000/- per month, scholarship as shown above.
2. For the income group above Rs.1000/- per month, 50% of the rate of scholarship as shown above.

5.6.1 Science Library

Books are a treasure for a lifetime. They are our lifelong friends. Books widen our knowledge, they are a source of inspiration, and develop positive and healthy

attitudes. They help in proper utility of leisure. According to RamyKollier, “Books are a guide to the youth and an entertainment for the old age”. Research has demonstrated that good school libraries make a difference to students’ learning and achievement, and the school library has been identified as the agency which, by planning an effective match of its programmes to the educational objectives of the school, can make a vital contribution to education.

5.6.2 Importance of School Library

Secondary Education Commission emphasizes the importance of library and states, “the library will be the hub and the center of the intellectual and literary life of the reorganized school and play the same part for all other subjects as the laboratory plays for science subjects or the workshop for the technical subjects”.

According to Oliver Lodge “Part of education should consist in familiarity and practice, with the looking up of details, with the use of books in general, not only of books of reference”.

S.R. Ranganathan writes “In a school that educates pupils for a changing world, the school library should be a live workshop”.

5.6.3 The Role of the Library in Schools

The library plays an important role in the school set-up. The availability of books other than their course material helps the students to develop awareness of various other aspects of science other than those in the Curriculum. Both the students and the teacher become independent users of information and get benefited. The establishment of a science library inculcates reading habits in the students. It supports and enhances the essential learning by providing adequate resources, library personnel, and instruction. Students are

greatly benefited by the library because:

- They read more and develop a greater potential for success.
- They develop the reading skills which increase their knowledge of the complex world of information.
- The needs and interests of students are catered to by the access to the library.
- Their learning improves when the library resources are integrated with classroom Curriculum.
- They utilize their leisure in a proper manner by visiting the library and developing their knowledge.

5.6.4 Objectives of a Science Library

- To encourage the students to acquire scientific knowledge as well as general knowledge.
- To help the students acquire good reading and self learning skills.
- To improve their critical thinking skills.
- To supplement the knowledge of classroom learning.
- To train the students to obtain extensive information on the topics in their Curriculum.
- To teach the students proper utility of their leisure time.

5.6.5 Limitations

The Secondary Education Commission has pointed out that our school libraries are for name and do not help the students in any way. School libraries are not functional in our schools mainly because we are not much influenced by the latest developments in education. The lack of financial resources as well as non-recognition of the importance of the library facility in the schools by the authorities has led to a meager development of library resources in the schools. The failure is mainly considered due to the attitude of the teachers (system) and the students towards it. The other reasons are:

- The acquisition of knowledge is restricted to the

Curriculum. The students study only their course books to pass the examination.

- Our examination system restricts the students to their textbooks. It does not encourage them to know extra information.
- The teachers and students have not understood the importance of the inculcation of the reading habits in the children.
- The libraries are not properly organized and maintained. Lack of funds hinders the development of the libraries.
- The books are beyond the comprehension of the students.
- The books are outdated and do not suit the interests of the students.

5.6.6 Science Libraries and their role in teaching of science:

- A separate science library should be arranged in each and every school.
- General science books should be kept in such libraries.
- A separate section for the reference books should be allotted and the reference books should not be issued to homes.
- A separate section on teaching methodology should be kept for the teachers.
- A science library should work under the supervision of science teacher. A small group of students may help the teacher in his/her activities.
- The teacher should encourage the students to read and ask them to prepare a brief review of the reference books.
- A cross-reference index should be maintained in which teacher and students should briefly mention the information about the books they read.
- A science library should provide a complete set of science books to the students.

- A science library should also provide some science manuals for the laboratory.

5.6.7 Functions of a Science Library

The science library should reflect the objectives of the school, through the nature of collection of the books and the services it provides. It should be the focal point of the school setup. The science library should provide individualized learning opportunities to the students. It should help the students in the development of important skills like reading, thinking, and self-learning skills.

The important functions are:

- To develop the reading habits in the students.
- To cooperate and complement the learning of the teachers and the students and supplement the classroom knowledge.
- To provide adequate facilities for proper usage of leisure time by students and teachers.
- To help the teachers in updating their knowledge.
- To store the books and other reading materials in an easily accessible and convenient way to be used by the students and teachers.
- To reduce the chances of indiscipline in the school.

5.6.8 Organization of a Science Library

A science library should be organized under the supervision of a science teacher. It should be equipped well with the different types of books and other resources. The finances and the funds should be considered while equipping the library. The selection of the books is an important process. The books should be relevant, cheap in their cost, and simple in their language. They should cater to the needs and interests of the learners and also should be related to the Curriculum. Some general science books may also be kept in the library.

The books should be good in quality as well as in quantity. A wise selection is required for the making of a good and useful library.

The main components in the effective organization of a school library are:

6. Accommodation
7. Finance
8. Selection of books
9. Arrangement of the resources

Accommodation

Accommodation or space for the science library is important. The library may be housed in the science department or near the science lab or a separate room may be, if provided. The space must be convenient for the students to visit the library and read the books. It should be accessible to all the students. It should be away from noisy areas. It should be properly ventilated. Adequate space should be provided for the collection of books like textbooks, reference books, fiction, non-fiction, newspapers and magazines, journals, general knowledge books, etc. Space should also be delimited for the computers and Internet facilities.

Finance:

The major drawback for the organization of school libraries is non-availability of financial resources. The school managements rarely or meagerly allocate budget for the school science library. It is imperative on the science teacher to appraise the school authorities about the importance of the library and allocate at least a standard amount of money for the science library. Funds may also be collected from the enthusiastic public or the community resources.

Selection of the books:

The library books should cater to the needs of the teaching-learning process in the schools. The composition of these books must be broad enough to cover a particular subject at different levels. Therefore, the library should provide different kinds of science books, textbooks and journals covering different branches of science like botany, zoology, physics, and chemistry as well as related disciplines like medicine and agriculture. Books on discoveries, inventions in science and books on scientific hobbies should also be placed in a science library. To encourage and inspire the students, inspirational books such as autobiographies of great scientists and philosophers could also be bought. Reference books on a wide range of topics dealing with science and other subjects and science magazines and journals should also be kept for reference. Some standard books on methods in teaching should also be purchased. To acquaint the students with the recent developments in science and technology, some books may be procured. Books dealing with other subjects like geography, environment, physiology, etc., could also be kept for an interdisciplinary approach. To stimulate the scientific hobbies among the students, books on photography, computers, television, etc., should be provided.

Arrangement

Proper arrangement of books in the library enhances its appeal. The books should be kept in an orderly systematic manner for effective usage of the library resources. The library should be divided into different sections. Books should be categorized into various categories; they can be arranged either in racks or almirahs in different sections. All the books are given accession numbers and they are entered into the registers. The storage racks should be labeled. The journals and magazines should be made available to the students. The furniture should be properly organized. The entire

arrangement of the library premises should be orderly and systematic and should provide academic ambience. The science library should be a busy, active place where students should feel comfortable and make the best use of the learning resources available in the library.

5.7 Computers and the Library

The school library serves the teachers and students as a media centre. Books and computer technology can combine to increase literature appreciation among the teachers and students. The usage of the Internet makes the high school library serve as an instructional centre for students and teaches them how to effectively search for information, how to evaluate the vast amount of information available, and how to accurately cite the information used. As an instructional centre, the library offers the opportunity for students to learn library research skills to become self-sufficient library users and to develop individual reading habits. The advancements in the fields of computers and the information technology have resulted in the development of computerized information in the form of virtual and digital libraries. The usage of these systems helps the students to access any amount of information from any corner of the world.

5.8 Virtual Library

The Virtual Library stands for data stored on networked hard drive, which makes up the Internet and other computer networks. It provides detailed information about any topic and provides full-text articles from a number of periodicals, journals, magazines, and the thousands of classics and academic textbooks such as e-books online. They provide the global databases on any book ever printed. (This includes encyclopedias and almanacs, including the world are leading interactive science encyclopedias, as well as dictionaries on science). Students get an access to these libraries and gain

wider knowledge. They get exposure to the huge amount of knowledge and improve their learning efficiency.

5.9 Digital Libraries

The electronic versions of the textbook libraries are Digital Libraries. These libraries occupy a very important place in the schools. Digital libraries offer a unique and unprecedented resource through which teachers can facilitate access to any amount of scientific information and data. Digital libraries can provide teachers with a feasible way to let students pursue their own interests within the bounds of the Curriculum and without creating an enormous amount of extra work in providing students with materials to support their investigations. The ready availability of material information makes it feasible for students to conduct meaningful investigations using digital library resources as part of their classroom activities and doing research in the classroom.

REVIEW QUESTIONS

1. Enumerate the principles of curriculum construction.
2. Write a note on the following
 - a. Subject-centered curriculum
 - b. Activity-centered curriculum
3. Discuss the steps involved in the construction of biology curriculum for secondary schools
4. Briefly explain the Nuffield Science Teaching Project.
5. Discuss the salient features of BSCS.

Chapter 6

TECHNOLOGY IN TEACHING BIOLOGICAL SCIENCE

6.1 Educational Technology

Educational technology can be conceived as a science of techniques and methods by which educational goals can be realized. Educational technology also means the mechanization of educational process.

In short, educational technology, in its wide sense as understood today, includes the “development”, application and evaluation of systems, techniques and aids in the field of learnings. As such, its scope encompasses educational objectives, media and their characteristics, criteria for selection of media and resources, management of resources as well as their evaluation.

The various technological media are used to communicate the needed factual information to students and they are capable of doing this perhaps more accurately and efficiently than a teacher. So, today, “students acquire knowledge through the various media and behavioural change via the teacher”.

Definition

According to B.C. Mathis “Educational technology refers to the development of a set of systematic methods,

practical knowledge for designing, operating and testing in school”.

Robert A. Cox has defined the term educational technology as the application of scientific process to man’s learning conditions which has recently come to be called educational or instructional technology.

6.2 Hardware Approach

Educationists categorise the concept of educational technology in to two approaches viz. the hardware approach and the software approach.

The hardware approach is based on the application of engineering principles for developing electro-mechanical equipments for instructional purposes. Film projectors, television, tape recorders, teaching machines, computers, etc. are called educational hardware. This approach is the result of the impact of scientific and technological development during the present century. Hardware approach mechanises the process of teaching so that teachers would be able to deal with more number of students with less expenditure and time in educating them.

6.3 Software Approach

Software approach uses the principles of psychology for building in the learner a complex repertory of knowledge or modifying his/her behavior. It originates from the pioneering works of Skinner and other behaviourists. The programmes such a technology produces are often called

‘software’. Newspapers, books, magazines, educational games, flash cards may also form the parts of software. Software approach is characterized by task analysis, writing precise objectives, selection of appropriate strategies, immediate reinforcement of responses, and constant evaluation.

6.4 Educational Broadcast / Telecast

In the present day, radio broadcasts from a powerful transmitter can be received at very distant places. Transistor receivers do not require any main power supply, but could be operated by dry cells. The radio besides being a mass media of communication can also play a major role in imparting instruction to school children. Such of these broadcasts are called as educational broadcasts. These broadcasts are made during specific days at specific school hours mainly for the benefit of the educational institutions. These broadcasts are, on curricular subjects, based on the prescribed syllabus, sequenced to synchronise with the class lessons. These broadcasts will considerably help the teacher to supplement his/her classroom instruction. The teacher should prepare the students so that they will be benefited to a maximum extent by listening to a specific broadcast. S/He should plan for an effective listening and also prepare a suitable follow-up work for consolidation.

Unlike radio broadcast, television telecast has the added advantage of the all important visual experience which is

made more dynamic and meaningful by movement and sound associated along with the visual experience. Next to the home and school, television has a more profound influence on the education of a child.

Live programmes and films can be telecasted in television. Television has all the advantages of a projected aid and the dynamism of film. To produce and telecast a programme, a number of steps are to be followed. Since the programmes are announced earlier, the institutions can prepare the students in advance to view and listen to the telecast. TV provides multimedia learning experiences.

Many telecasts, in addition to programmes exclusively for schools, can be considered educational in a general way and viewed by the students with advantage. Hence Educational Television (ETV) includes Instructional Television (ITV) also and both are together called as Educational Telecasts.

6.5 Edger Dale's Cone of Experience

Dale's Cone of Experience is a visual model that is composed of eleven stages. Starting from concrete experiences at the bottom of the cone, it becomes more and more abstract as it reach the peak of the cone. Also, according to Dale, the arrangement in the cone is not based on its difficulty but rather based on abstraction and on the number of senses involved. The experiences in each stages can be mixed and are interrelated that fosters more meaningful learning.

According to one of the principles in the selection and use of teaching strategies, the more senses involved in learning, the better the learning will be; but it does not mean that concrete experience is the only effective experience that educators should use in transferring knowledge to the learners. Like what was mentioned above, the experiences in each stage can be mixed and are interrelated. Thus, a balance must be achieved between concrete and abstract experiences in order to cater and address all the needs of the learner in all the domains of development and also in order to help each learner in their holistic development.

The generalization about the Cone of Experience that was presented above is not enough. Actually, we should try to go deeper into each of the component of the cone since Educational Technology basically revolves around the Cone of Experience. By going one-by-one, starting from concrete to abstract, we will understand many different components of the cone that will help us in grasping the real meaning of educational technology.

Direct Purposeful Experiences.

These are the first hand experiences which serve as the foundation of learning. In this level, more senses are used in order to build up the knowledge. Also, in this level, the learner learns by doing things by himself/herself. Learning happens through actual hands-on experiences. This level explains and proves one of the principles in the selection and use of

teaching strategies. The more senses that are involved in learning, the more and the better the learning will be. This level also proves that educational technology is not limited to the modern gadgets and software that are commercially available nowadays. This shows that even the simple opportunity that you give to each child could help them learn.

The Contrived Experiences.

In this level, representative models and mock-ups of reality are being used in order to provide an experience that is as close as reality. This level is very practical and it makes the learning experience more accessible to the learner. In this stage, it provides more concrete experiences, even if not as concrete as direct experiences, it allows visualization that fosters a better understanding of the concept.

The Dramatized experiences

In this level, the learners can participate in a reconstructed experiences that could give them better understanding of the event or of a concept. Through dramatized experiences, learners become more familiar with the concept as they immerse themselves to the “as-if” situation.

The Demonstrations

It is a visualized explanation of important facts, ideas, or process through the use of pictures, drawings, films, and other types of media in order to facilitate clear and effective

learning. In this level, things are shown based on how they are done.

The Study Trips

This level extends the learning experience through excursions and visits on the different places that are not available inside the classroom. Through this level, the learning experience will not be limited to the classroom setting but rather extended to a more complex environment.

The Exhibits

The level of study trips is followed by exhibits. It is somewhat a combination of some of the first levels in the cone. Actually, exhibits are combination of several mock ups and models. Most of the time, exhibits are experiences that is “for your eyes” only but some exhibits includes sensory experiences which could be related to direct purposeful experiences. In this level, meanings and ideas are presented to the learners in a more abstract manner. This experience allows the students to see the meaning and relevance of things based on the different pictures and representations presented.

The television, motion pictures and so on

The next levels would be the level of television and motion pictures and still pictures, recordings, and radio. For television and motion pictures, it implies values and messages through television and films. On the other hand, still pictures, recordings and radio are visual and audio devices that can be

used by a group of learners that could enhance and extend the learning experience.

The Visual symbolic and Verbal symbolic

The last two levels would be the Visual symbolic and the Verbal symbolic. These two levels are the most complex and abstract among all the components of the Cone of Experience. In the visual symbolic level, charts, maps, graphs, and diagrams are used for abstract representations. On the other hand, the verbal symbolic level does not involve visual representation or clues to their meanings. Mostly, the things involved in this level are words, ideas, principles, formula, and the likes.

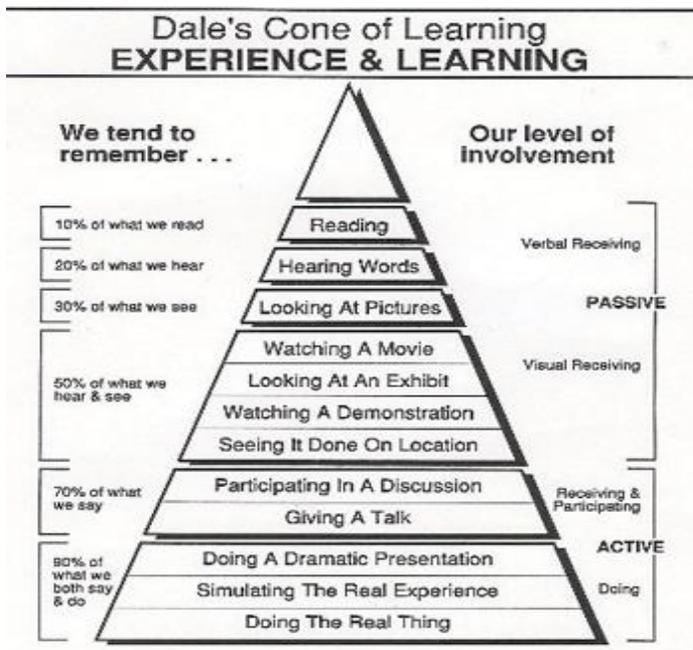
After going through the different components of the Cone of Experience, it could be said that in facilitating learning, we can use varieties of materials and medium in order to maximize the learning experience. One medium is not enough so there is nothing wrong in trying to combine several medium for as long as it could benefit the learners.

Through the levels provided by the Cone of Experience, it could be said that concrete experiences must be provided first in order to support abstract learning. Lastly, staying on the concrete experiences is not even ideal because through providing abstract experiences to the learner, the more s/he will develop his/her higher order thinking skills which is important for more complex way of thinking and for dealing with more complex life situations.

Through understanding each component of the Cone of Experience, it could be said that Educational Technology is not limited to the modern gadgets that we have right now but rather it is a broad concept that includes all the media that we can use to attain balance as we facilitate effective and meaningful learning.

Modes of learning in Cone of Experience

Edgar Dale introduced the Cone of Experience which demonstrates a progression from direct, first-hand experience to pictorial representation and on to purely abstract, symbolic expression to this picture:



The Cone of Experience corresponds with the three major modes of learning:

- **Enactive (direct experience)** - Enactive or direct experience involves practicing with objects (the student actually ties a knot to learn knot-tying). Enactive experience involves concrete, immediate action, and the use of the senses and body.
- **Iconic (pictorial experience)** - Iconic experience involves interpreting images and drawings (the student looks at drawings, pictures or films to learn to tie knots). Iconic experience is once removed from the physical realm and limited to two or three senses.
- **Symbolic (highly abstract experience)** - Symbolic experience involves reading or hearing symbols (the student reads or hears the word “knot” and forms an image in the mind). In symbolic experience, action is removed nearly altogether and the experience is limited to thoughts and ideas.

6.6 Audio Visual Aids

Audio visual aids are the different types of tools that appeal to the sense of hearing and vision and are used in classrooms for presentation of abstract information. These materials may be used to convey meaning without complete dependence on verbal symbols or language. Some audio-visual activities like going on a field trip, dramatizing an event in history, or demonstrating an experiment are in the nature of processes or experiences. Some like motion film or filmstrip need a projector to handle it. Some others like a chart, a photograph or picture need no equipment and can be directly used. Experiences of this type will be classified under visual category. Magnetic tape or disc recordings belong to audio category. Hence the term “audio-visual aids” designates in common usage of both processes and material things.

Educators now often refer to describe the fields of audio-visual educators as “**educational communication technology**”, “audio-visual media”, “learning resources” and “instructional or educational media”.

The older term “Audio-visual materials in education” is replaced by the newer term “**Educational Technology or Instructional Technology**”. This is mainly due to the dynamic expansion of the field of A.V. education and the exciting new developments that promise much more for the future. The main objective of the use of educational technology is the improvement of learning.

Eric Ashby (1967) has identified four revolutions in education.

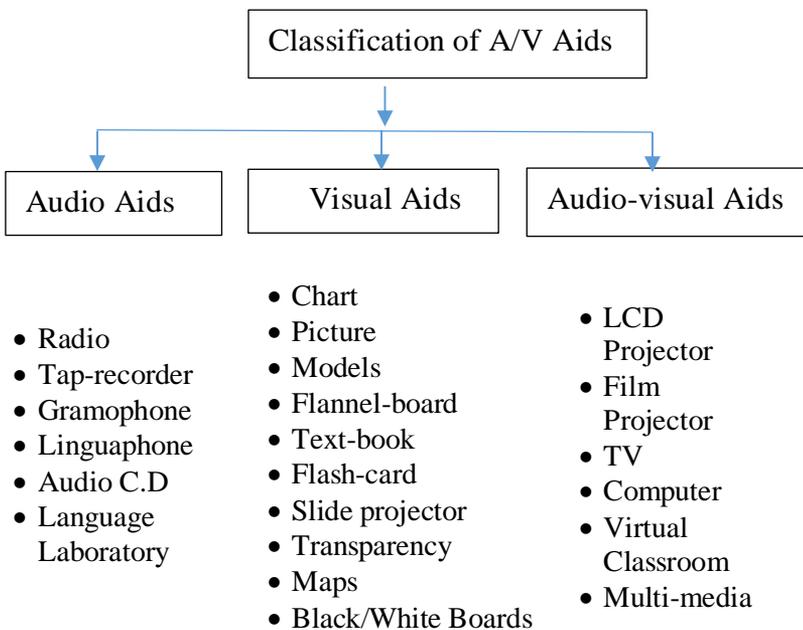
1. The first revolution occurred when societies began to differentiate adult roles and the task of educating the young was shifted, in part, from parents to teachers and from home to school.
2. The Second was “the adoption of the written word as a tool of education”.
3. The third revolution came with the invention of printing and the subsequent wide availability of books.
4. The fourth revolution is the development in electronics, notably those involving the radio, television, tape recorder, and computer.

6.6.1 Classification of A.V. Aids

Sensory experience forms the foundation for intellectual activity and learning. For long, the common practice to communicate knowledge has been by means of written and oral language. But language has many limitations that may contribute to learning difficulty. The modern educators recognize such basic values as concreteness,

enrichment, clarity and dynamic interest in audio-visual materials. The number of aids for teaching has become so numerous that even the most abstract can now be presented to the pupils in a concrete way by means of more than one aid. All the teaching aids that come under audio-visual aids can be broadly categorized under two heads namely projected and non-projected aids.

When a projected aid is used, an enlarged image of the material is projected on a screen kept at a distance from the projector. The room is either totally or partially darkened. A projected aid is bound to be more effective than a non-projected aids since a darkened room reduces distraction and the bright image on the screen secures the attention of the audience easily. It will make the aid more attractive; motion will make the aid more dynamic; and motion associated with sound will be more effective and attention-compelling than the non- projected aids. They are further classified as follows



6.7 Projected aids

A projected aid is suitable for large groups as well as small groups. The projected image could be made large and bright to enable everyone in the large group to perceive details. The following are some of the projected aids which can be used in teaching any subject especially Biology.

6.7.2 Video Cassette Recorder and Player

The VCR or VCP helps to enhance the educational and entertainment values of TV. The instruments and the software needed for them such as video cassettes are available in a variety of makes and at lower prices. The pre-recorded cassettes on different school subjects are now available in the market at cheaper prices. The school should possess a VCR or VCP and a TV. Then these recorded cassettes can be played to the students. The play in colour with associated sound makes viewing dynamic and its impact on the viewers considerable. The play can be done in one or more TVs simultaneously facilitating large audience viewing in different classrooms. New projection TV systems with 6' to 10' screens and facilities for front or back projection are available nowadays.

By using VCRs, the teacher can record the educational TV programmes telecasted over networks of educational interest and value and replay whenever necessary. Animal planet, National Geography, Discovery channel etc., are some of the channels which telecast life histories, adaptations, food habits, movement, reproduction, parental care, and such other activities of plants and animals. UGC programmes on classroom teaching and learning are telecast by Doordharsan channels. These could not be seen by the students as they are telecast during school hours. The teacher can record these telecasts using VCR and replay them to the students whenever they have time.

Now, Compact Discs(CD) have occupied the place of video cassettes. A number of educational programmes are available on CDs. To use CDs the teacher requires a VCD player and a TV. VCD players and TV are very cheap now. Operating a VCD player is easy and it is more portable and versatile than any other projected aid. Educational CDs are now available on all the subjects in the market which are ready to help the teacher in his/her teaching.

6.7.3 OHP and transparencies

The name overhead projector (OHP) comes from the fact that the projected image is behind and over the head of the speaker or teacher. In overhead projection, a transparent visual is placed on a horizontal stage on top of light source. The light passes through this transparency and then is reflected at an angle on to the screen at the back of the speaker or teacher. OHP is not a new one and it was used in World War II for teaching the recruits in armed services.

Overhead projectors are designed for direct or indirect projectors. The projectors designed for direct projection use either Halogen Lamps, linear or pea (650w) or in some cases 30 volt locomotive head lamp, worked with a transformer.

The overhead projectors designed on the principle of indirect projection use the tubular projection lamps (750 or 1000w) as in a film projector. OHP should not be used continuously for long periods. The lamp should not be touched with hand while in use. The lamp can be put off after use but the fan should be allowed to work till the lamp

container cools.

Method of Preparing Transparencies

- **Hand-drawn Transparencies**

The required visual is drawn or written on a whitepaper. The acetate sheet is placed over the paper and kept in position by paper clips or pins. The sketch is carefully traced using ruling pen or marker pen or colour chisel marker. If the transparency is required for permanent use, the impression carrying surface should be protected by either clear varnish spray or keeping another acetate sheet over it.

Good line drawing and typewritten impressions can be made on acetate sheet using hecto-carbon paper. The procedure is the same as that of using ordinary carbon paper over plain white sheet.

- **Photographic Transparencies**

Employing reflex printing process, negatives on reflex printing papers can be made of complicated diagram or rare pictures printed on books or composed diagrams using Indian ink. With these negatives, positives can be printed on sensitized dia-positive acetate which is available in rolls or as sheets of 10”X12”.

- **The Diazo Process**

To make large number of copies of transparencies, diazo chemical coated acetate can be used along with the master drawing on the translucent paper. The two are kept together

exposed to sunlight or ultra-violet source for 2 to 3 minutes. The image will develop on exposure to ammonia vapour. Beautiful coloured overlays can also be prepared by this process.

- **Copying Machines**

These Machines produce the positive and negative transparencies from the original material. In the infra-red copying machine, the transparency film is placed in contact with the original. In just 4 seconds a transparency can be obtained on black and white. OHP can be used for the presentation of material in step-by-step fashion and sectional fashion using overlays. Small live aquatic animals may be kept in a flat glass dish and get projected. Leaf profiles, flower petals and details can be projected. Even dynamic demonstrations can also be shown.

Advantages of OHP

- It gives large image. The teacher can always face the students or audience.
- This can be used even in lighted room. Its weight is less and it can be used with flexibility and versatility.
- It can be used for personalized presentation. Homemade and low cost transparencies can be used in OHP.
- Transparencies or OHP sheets are prepared from tri-acetate film rolls of minimum thickness.
- The tri-acetate sheets are now available in required and suitable sizes. They can be suitably mounted on cardboard mounts. Poster boards make attractive

mounts.

- Matter can be permanently written on acetate sheets using quill or ruling pen or rapid mat pen with special Indian ink or acrylic markers with special inks.
- Temporary erasable impressions may be created with china graph pencils also called glass marking pencils and water colour markers with special inks.
- These impressions can be removed by wiping it with a dry cloth or cotton waste. Acetate sheets may be cleaned with a sponge dipped in detergent or soap solution.

6.7.4 Slide Projectors

Slides are projected by an instrument equipped with a powerful light source in a lamp house and carriers for holding slides of suitable sizes. It is a simple mechanism and the essential elements in it are the same as in filmstrip projector. Usually a double slide carrier is fitted in the projector so that when one slide is being projected on the screen, a second slide can be kept ready. When the class views the second slide, the first slide can be removed and another can be inserted in its place. There is a “thumb mark” or guide marker on the upper right hand of each slide.

Most 2”X2” slide projectors today use drums or cartridges in which many (100 or 200) slides can be loaded in proper sequence in advance. The projectors can be operated and focused by remote controls. It is also possible to record the narration in a tape recorder and the latter may be hooked up to the projector in such a way as to give the necessary

commentary without the help of the teacher.

6.7.5 Film Projector

Film as an aid to teaching is inferior to direct experience. But in some cases, film will be able to provide the expected learning outcome better than even direct experience. The bright image on the screen with the associated sound is more realistic if it is in colour. It provides a vivid and dynamic visual presentation.

Films can be classified as entertainment films and educational films. Educational films may be further subdivided into general educational films and classroom films. Classroom Films on curricular subjects are produced for promoting learning in a specific curricular subject. Educational films are produced to provide general knowledge. Educational films should be devoid of antisocial activities and abnormal behaviour.

The equipment used to project film is called as film projector. Educational institutions use 16 mm projectors. There are many different 16mm film projectors made by various manufacturers. Each has its own distinctive characteristics and advantages but all are similar in principle.

The principle involved in a film projector is that an object kept in between ' E ' and ' $2f$ ' of the lens will produce a real image beyond ' $2E$ ' of the lens on a screen. In the film projector the object is the transparent film. The film unwinds from the feed roll and goes through the picture head where it

is illuminated by the light source and is then projected on the screen. Then the film passes through the sound head to give sound.

Advantages of Films in Teaching

The films present certain meanings involving action or motion. This compels attention which help in permanent retention. Fast and slow motion can be shown to occur at normal speed, making analysis, and appreciation possible. Events like crystal growing, plant growth, flower blossoming etc., which occur over days can be made to appear to occur in seconds. This presents materials that cannot be seen by the human eye and even by microscope and telescope.

Films are of different gauges. They are 35 mm, 16 mm, 8 mm standard films, 8 mm super films and 70 mm films.

6.7.6 Closed Circuit Television (CCTV)

In CCTV, the signal is sent to the receiver using co-axial cable. Hence the range is limited to the length of the cable. CCTV can be used to a very great level of advantage in educational institutions. Its uses are as follows:

- Increases the range of instruction to one or more locations beyond the classroom.
- Magnifies, exhibits, and demonstrations which are normally difficult to see in a classroom situation.
- Provides opportunities for exchanging professors and courses between one institution and another linked to a circuit.

- Enables institutions to present televised instruction in accordance with their own schedules and needs.

In teacher training institutions, CCTV with video tape recorder can be used to record performances of the student teachers during “Micro teaching sessions”. Video tape provides the necessary feedback.

CCTV is used in many medical colleges in developed countries. When an operation is being performed, it is not possible and desirable to admit a large number of persons inside the theatre. But the entire operation can be covered using a single television camera or a battery of cameras located at vantage points. The signal from the proper camera can be fed to the viewer by the monitor system.

In the same manner, lectures, dissection of animals, and sectioning of plant parts can be seen by many students using a CCTV.

6.8.1 Non-Projected Aids

These aids are the form of visuals that cannot be projected using an equipment. They convey meaning mainly through relatively conventionalized symbols that are nearer to reality, perceptually than verbal symbols. The following are some of the non-projected aids that could be used in the teaching of Biology and other subjects.

6.8.2 Charts

Any visual information developed on the chalk board by the teacher in the presence of students is bound to be most

effective. This will be more effective when the teacher uses colours to stress specific aspects. This is not always possible. The diagram may be a difficult one or it may involve more time to draw or the teacher may find it more difficult to draw in the presence of the students. On such occasions, a chart is of much help and handy to the teacher. The teacher can prepare the chart whenever s/he finds it convenient. S/He can make use of the artist or the students with drawing skills for this purpose. The diagram in the chart should be in a bigger size with all the components drawn in different and distinct colours. At present, sketch pens in colour are available for drawing lines even 4-5 mm thick. The most commonly used types charts include outline charts, tabular charts, flowcharts, and organization charts.

The suitable chart used by the teacher will result in considerable saving of time. The same chart could be used over a number of years. Tree charts, Time line charts, Technical diagrams and process diagrams are also commonly used in classrooms.

Readymade charts are available for use in teaching in almost all areas for all the subjects. But it is not difficult for any teacher to prepare a chart. In fact, a teacher would find a chart prepared by him/her incorporating his/her own ideas and lines of approach of the specific topic to be more useful to him/her. The chart should be large; every detail depicted should be visible to every student in the class wherever s/he is

sitting. The chart should not contain too many minute details or too much written matter making it necessary for any observer to come near and see. Flip charts and flow charts are the two types of charts used for different purposes suitable for them.

6.8.2 Models (Static and Working)

The use of models for teaching purpose should definitely be highly effective. Models are concrete objects, some considerably larger than the real object, some small replicas of objects which are too large to be seen as a whole, mostly three-dimensional, or sectional to explain clearly the structure or functions of the original. In many cases, working scale models of the original are used where the specific action of the original is duplicated and could be explained easily. Models offer a kind of short-cut or substitute for the real things and sometimes models can be more effective than reality. An object is a real thing; but a model is just a recognizable three dimensional representation of it. Specimens are objects that are representative of a class or a group of similar objects.

Any concrete object shown to the students will enable them to have a correct concept of the object and since the model is a replica of the original, they will have a clear concept of the structure and mode of working of the original.

It is possible to easily explain the structure, function,

and working of the original, using the model.

Models may be static or working. Static models are the models which the teacher or the students can use but they cannot move by themselves.

Working model is the one which functions and enables the students to learn by its working. A working model will secure immediate attention and will serve as motivation. Stimulation of interest could be utilised to the fullest advantage. Models should be used only if it is not possible to get the real objects to the classroom or when the real objects would not be helpful to give a better explanation.

Cardboard, plastic materials, plaster of paris, wood, metal, PVC Acrylic materials and thermocol are some of the materials used for the preparation of models.

6.8.3 Flash Cards

The flash cards are compact visual aids. Teaching can be made more meaningful and interesting with the help of flash cards. The flash cards are approximately 10X12 inches in size which are fished before the students to get their attention and to emphasise important points in the lesson. They should contain brief and stimulating messages. The message should be presented in a step by step manner for its easy understanding. The number of cards should be restricted to ten or twelve in a period.

The flash cards may be prepared by just writing the contents on a card or on a thick plain paper. A large piece of

cardboard too can be purchased and cards of 10X12 inches or 4X4 inches shall be cut from it. The lettering on these cards may be written simply and legibly. Nowadays alphabet stencils of different sizes are available in the market which can be used to write letters on these cards. Cards of different colours can be made to attract the attention of the students. Coloured letters can also be used on the cards for lettering purpose. Attractive figures, diagrams, illustrations, cutout pictures, and cuttings from magazines can be made use of in the preparation of flash cards. These cards can be used in all subjects effectively.

6.8.4 Pictures

These may be hand-drawn or photographic reproductions which are self-explanatory. Good picture should have good quality, good composition, good contrast and sharpness, effective colour and should communicate the idea clearly. They are complete by themselves and do not require any lengthy explanation. These are a still opaque representation of a scene or object or plant or animal. Such pictures cost less and are readily available and can easily be made and used; but often they are of small size, lack in depth and motion. Worthwhile pictures can be preserved for future use by suitably mounting them on a backing surface. The usual way of fixing a picture is to make use of gum or rubber cement on the backing surface and placing the picture on it and pressing it uniformly. Dry mounting is another method of

permanent mounting.

6.8.5 Chalk board

Even in the present day, when the teacher can make use of visual aids like OHP, CCTV, etc., the chalk board, also called as black board, remains the most commonly teacher used visual aid in the classroom, lecture room, and laboratory. The use of chalk board is highly essential, particularly for the teaching of languages, science, mathematics, technology and to a smaller extent in teaching other subjects. The teacher can vitalise teaching through good, clear, well-proportioned illustrations developed in the presence of students, making good use of coloured chalk to emphasise or differentiate specific points, aspects, or details. The modern chalk board is not black but made in different colours, mostly in pleasing green.

Chalk board provides a very convenient surface where the teacher can develop subject-matter visually in a manner and at a pace to suit the subject and the students.

The traditional blackboard is made with a large surface fabricated with wooden planks and coated with dull black paint. The board was supported with an easel. This type of board is being replaced by wall boards even in schools.

The wall boards consists of either the plank board fitted to wall surface or a rectangular portion coated with suitable paint. Chalk board surface should never be finished with glossy paint.

Modern chalk boards are made up of the following different types of writing surfaces.

4. Paint coated pressed wood
5. Dull finished plastic surface
6. Vitreous coated steel surface
7. Ground glass board

Ground glass board is the ideal board for the modern classroom. The construction is easy and very little effort is necessary to write on the same. It can be made in a variety of colours.

The chalk board should be so positioned that the surface is well lighted and the entire surface will be in full view for any student seated in the last row and any teacher of average height will be able to reach any portion of the board easily. A rectangular box is fitted at the bottom of the board to hold the chalk piece and duster.

The chalk board can be used to write assignments, spelling lists, definitions, outlines, and summaries. Facts, ideas, and processes can often be illustrated with the help of drawings, sketches, and other visual symbols.

6.8.6 Flannel board

In the modern age, flannel boards have special importance. These are prepared by mounting a flannel cloth very tightly on 18”X24” or 36”X48” piece of plywood or on a hard board. Then, on it, various pictures, maps, sketches, and graphs etc., related to different subjects are displayed. In order

to display on the flannel board, sand papers are pasted on the back of the pictures, maps etc. This makes these pieces sticking to the flannel board. After using them, these can be removed easily or retained for future use. These flannel boards can be used very conveniently for teaching languages especially foreign languages and mathematics to the lower classes and history, geography, civics, economics, mathematics, and science to the higher classes. Hence, every teacher should use this instrument as the need arises.

6.8.7 Magnetic Boards

A magnetic board will be useful to show the relative movements between the elements of visuals. A magnetic chalk board becomes more versatile due to the additional facility of visuals that could be made using chalk. A sheet of iron (G.I. or M.S.) that attracts a piece of magnet can be used for magnetic board. Steel - backed chalk boards specially provide the added utility of a surface that can be used either for chalk board or magnetic board or both in combination can be installed. Small, ceramic magnets can be fixed to the back of the display cutouts by fevicol.

Pockets of thin sheets may be pasted at suitable locations on the back of the display. Proper sized ceramic magnets could be inserted in pockets, when display is to be used. This will enable the use of several displays without purchasing large number of magnets.

6.8.8 Bulletin Boards

These are commonly called as notice boards. The modern term for these is display boards. In well-designed modern school buildings, there are extensive bulletin board spaces in classrooms to display cases located at vantage points, and teaching walls made up of folded sliding panels which can be extended to form a partition between one classroom and another and at the same time provide a lot of display space. Varied and colourful displays communicate both information and incite interest and involvement, impart to a school and its classrooms a vitality needed for motivated and purposeful learning.

The bulletin board should be near the laboratory or science room. Apart from providing vitalized material, which supplements other sources of information, and as an effective motivational device, it provides opportunity for developing creativity, responsibility, and other abilities in the students.

The bulletin board should be fairly longer in size and made up of teak wood and should be provided with sliding glass doors which can be locked. The inner part of the board should be provided with dark coloured cork like material, so that the exhibits can be fixed on it with pins without much effort. The dark coloured background will attract the attention of the students and makes the exhibits appeal to the students.

Any information to the students can be put up in the bulletin board. Maximum educational value is derived if the

students are made in-charge of it and the teacher acts as a guide.

6.8.9 Exhibits

The sterile appearance of the traditional classrooms, libraries, and corridors of schools is recently giving way to warm, attractive, and flexible surroundings with a wealth of display materials or exhibits. The exhibits should be the result of active participation of students and the teacher. The students take keen interest in displaying some attractive materials and thus their creative ability is developed. The students should be encouraged to give regular contributions in order to keep the bulletin board dynamic.

The exhibits should be of some scientific interest. Interesting and important science news should be published. Newspapers and magazine cuttings of scientific interests should be exhibited. The activities of the science club, the science magazine published by the school, and the students who distinguished themselves in various activities should be notified. All information and instructions to students, rules to be followed in the classrooms, laboratories, playground etc. can be the exhibits.

6.8.10 Study Exhibits

A study exhibit is an organized visual arrangement of learning materials and is usually designed to present significant information on a given topic. The exhibit may include a wide variety of materials such as diagrams, pictures,

photographs, news clippings, three dimensional objects, and specimens. It may be planned by teachers or students or both. Exhibits may do motivational developmental and summarizing functions. A successful commercial exhibit must command attention, arouse interest, and involve the viewers in such a way as to buy the product. Similarly, school exhibits must be so arranged as to “sell” the idea for a new unit of study.

6.8.11 AudioPlayers

Tape recorder and audio CDs are the audio players. Tape recorder is used to record sounds on magnetic tape which can be reproduced at will as many times as required. When a new recording is made, the recording already contained in the tape is automatically erased. Sounds can also be recorded in CDs by using special instrument called audio writer which can be reproduced at will as many times as required. The sounds produced from the CD will be of more quality than the sounds produced from tape recorder. Educational audio CDs are available in the market on different topics and subjects. They can be bought and used in the classes with the help of Audio CD player which is available in the market separately as well as with tape recorder as two in one or five in one.

The uses of the tape recorder in education are as follows

1. It can be used to record educational broadcasts and for replay at suitable and convenient times.
2. It can be used to record music and sound effects for use

during staging of dramas in schools and cultural programmes.

3. It can be used to record the talk of important visitor to the school and this can be effectively used later.
4. It can be used very largely in language laboratories for giving speech-training and for correction of pronunciation defects.
5. Recordings of model talks by the teachers or experts in the languages can be frequently used.
6. Instructions for experiments or any activity can be recorded on cassette and the individual can listen to it by earphone and do the necessary operation without disturbing others.
7. Commentary to filmstrips or slides can be suitably recorded on a tape-recorder and the tape may be played back while the students view the filmstrip or slide pictures projected on the screen.
8. In teacher training institutions, a tape-recorder can be very effectively used during the “Micro-teaching” sessions. This will provide necessary feedbacks for discussions to improve the lesson.

Tape recorders are of two types, table model and portable type. Table model works in 230-240 volts of A.C. Portable models can be operated with dry cells. Magnetic tapes are used in these to record and replay the sounds.

6.9 Use of Internet in Biology learning

In a nutshell, internet is a whole branch of cables running around the entire globe, connecting millions of computers to each other. Technically, it is called a Wide Area Network or WAN. The main services provided by the internet are: E-mail, World Wide Web, Downloads chat and News groups.

By using www, the students can get a number of websites. These websites provide a number of textbooks and other reference books on different subjects and topics.

Biology can be learnt through internet by getting advanced information. Any doubt, question or clarification can be obtained through internet on any topic in biology from any textbook and country. The pictures and details of any plant or animal can be obtained. Details about all diseases can also be obtained. Details about any modern topic like biotechnology, genetic engineering, test tube babies, HIV, cancer, bioinformatics, biostatics, immunology and human diseases can also be obtained. Students can also get a printout of these information and store them for future use.

6.10 E-learning

The meaning of e-learning is electronic learning which means learning through electronic equipments. Radio, television, tape recorder, teaching machines, and computers are the most important e-learning equipments. These are the new and modern equipments which the students use in their learning. When learning takes place through these equipments, learning becomes interesting to the students and

as a result, the learnt materials remain in the students' memory for a longer period.

The teachers should come out of their traditional methods of teaching. When the teachers use any one of these electronic media, the teaching as well as the learning will be easy as well as interesting. The teachers and students should be able to use computers in education because computers will occupy the human life in the near future. Use of computers will be inevitable in our life and become part and parcel of our life without which we cannot do anything. So learning to operate computers and learning through computers is a must for both teachers and students. Any subject and any topic can be learnt through e-learning and internet.

6.11 Radio Lesson

Any teacher can know the complete details of the specific programme to be broadcasted on any particular day by looking into the booklet on educational broadcasts supplied free of cost to all educational institutions by the All India Radio. In order to organize a radio lesson for effective learning of the students, the teacher should follow the following steps:

a) Preparation: The teacher should create a very favorable learning situation by suitable preparation, exposition of needed subject areas supplemented by suitable aids wherever necessary.

b) Listening to the Programme: The radio should be switched on sufficiently early. The students should be

comfortably seated and the volume of sound should be kept a tie higher than necessary.

c) Feedback: To evaluate the 'learning outcome', suitable questions should be asked and based on the reply, verifications should be made wherever necessary.

d) Consolidation: Follow up work resulting in consolidation of acquired facts should be done by giving written assignments for completion at home by students.

e) Evaluation report: An evaluation report on any specific broadcast programme based on the feedback and results completed assignments by students should be prepared by teacher and sent to AIR.

6.12 Educational Television

Educational television (ETV) includes programmes related directly to an organized programme of formal instruction and is directed to individual viewers who come under non-formal education programme. In all these cases, suitable follow up work by the teacher is essential to consolidate the gain of knowledge.

The educational programmes are telecasted through satellites. INSAT-IB and EDUSAT are the two satellites through which educational programmes are telecasted to the entire country. The NCERT is producing Educational TV programmes with the help of many universities in different subjects and they are telecasted as UGC programmes for college students.

Lessons are prepared in different subjects in regional languages and also in regional television centres through satellite for school students. This is done even in our state. Teaching of Tamil was done by PulavarNannan in Chennai television long before.

Educational telecasts tend to bring into the classroom learning experiences that local teacher cannot arrange. These include costly demonstrations, complicated experiments, visual excursions to far off places, and current events. Such programmes produce good results.

6.13 Multimedia Computers

Media is best used in combination with a variety of other instructional materials and techniques. Each of these is chosen because of the particular contribution it can make to total learning experience. Both the teacher and students have become increasingly innovative in devising ways in which they put a variety of media together with other materials and techniques. The experiences may range from visual literacy activities to fairly complex individualized instruction sequences. Such a multimedia is provided by computers for individualized instruction. Computers teach by sound, by vision, by written format, ask questions, answer questions, plays and stores a large amount of information and make them available to the learner more rapidly than any other medium.

6.14 Power Point and its uses:

Power point is a software in the computers in which

we can store a large number of slides, films, photos, concept, etc., and can be shown and seen whenever we want. Using this facility, the teachers can store all the pictures, diagrams, and important concepts, laws, principles, etc., in the computer. When the teacher wants to show any of these items to the students, it can be retrieved quickly and shown to the students. Further, this facility is available in digital which means the quality of the pictures, photos, and other materials will be high and superior. A large number of pictures and photos, could be stored in this systems which is of a very great help to the teacher and students in their teaching and learning.

REVIEW QUESTIONS

1. What are AV aids? Why are they important in the learning of biology?
2. How are AV aids classified ?
3. Write a note on the following
 - a. Multimedia Computers
 - b. Power Point and its uses
4. Briefly explain the different methods of preparing transparencies.
5. Explain the concept of 'Educational Technology'

Chapter 7

LABORATORY IN BIOLOGY

7.1 Laboratory

Biology teaching has now become less concerned in presenting factual knowledge. It is felt that only chalk and talk method makes biology an uninteresting subject. Biology is essentially a practical subject and that the young students always like doing something rather than listening or observing. Hence, practical experimentation of the principles by the students can enable them to understand biology properly. Experimental study is indispensable to create scientific method of thinking among students. Facts become everlasting if students perform the experiments themselves. Psychologists have found that “learning by doing”, the most effective method of learning biology, has many advantages over other methods, such as reading about facts, principles, and concepts and their application and observing others doing experiments. Experiments done by students in the laboratory are firsthand experience.

The laboratory is commonly regarded as the heart of science teaching. The science laboratory provides opportunities to the pupils to understand the concepts and different ideas of science.

J.K. Sood has defined science laboratory “as the central place where students get an opportunity to conduct experiments and search principles of science”

7.2 Location and Types of Laboratories

A science laboratory should be located preferably on the ground floor and on the extreme side of the school

building if possible so that there is no disturbance to the laboratory. The open space outside the laboratory will be of much use to conduct some experiments outside in sunlight. Biology and general science laboratory should have North - South orientation to provide adequate sun light exposure.

There are three important plans of science laboratory

1. **Lecture room - cum - laboratory** plan as suggested by Dr. R. H. Whitehouse.

2. **Lecture - cum - laboratory** plan as suggested by the panel for Science Education in Secondary Schools, 1964.

These two plans are a combined one with a lecture room and a laboratory attached side by side. Half of the whole laboratory is used as lecture room and the other half as a laboratory to arrange practicals for one or more subjects. (Physical Science, Biological Science).

3. **All purpose laboratory:** The whole laboratory is used for all purposes namely for lecture and laboratory work.

7.3. Planning a Biology Laboratory

Before constructing the Biology laboratory, the following factors should be taken into consideration at the planning stage.

- The number of pupils working at a time
- The minimum space necessary for each pupil for comfortable working
- Limitation of number of Biology teachers in secondary schools.
- Need for ancillary accommodation for storage
- Designing the science classroom and laboratory in such a way that it could be used for science teaching for middle as well as for high school classes.
- Imperative need for economy

For high schools, it is enough to have general science laboratory or at best a Biology laboratory.

7.4. Care and Maintenance of Apparatus

Proper maintenance of laboratory materials like chemicals, apparatus, and other infrastructure will aid in enhancing their utility for a longer period of time.

Some points to be considered for proper care and maintenance of the laboratory materials:

- **Every item should be designed in a fixed place:** Each and every item in the laboratory should be given a fixed place. This will reduce the burden of adjusting the things and keeping the materials in proper order. It will be easy for the teacher and the students to receive and return the materials.
- **Registers should be updated regularly:** The laboratory stock registers should be upgraded regularly. The breakage register, the consumables registers should be maintained. This will help in understanding the position of the stock in the laboratory.
- **Items should be kept ready on racks for use:** The chemicals and other items like the burettes, pipettes, beakers and other glassware should be kept on the racks near the working benches or platforms for easy availability to the students.
- **Heavy items and cans should be kept at low levels:** The large items like the distilled water cans, large bottles containing the acids, and other chemicals should be kept at lower levels in the storage racks or cabins. This will prevent accidental breakage and accidents due to it.
- **Wooden items should be regularly polished:** The tables, working platforms, almirahs, racks and cabins should be regularly polished with rust-proof and acid-proof paints to maintain their longevity.
- **Minimum use of chemicals should be encouraged:** The science teacher should ensure very less wastage of

consumable materials in the lab. This will help in reducing the burden of finances in the lab maintenance.

- **Breakage of any item should be noted down:** The **laboratory** registers should be maintained in the lab. The data of consumables utilized, the breakage data, and the remaining stock should be clearly entered in the registers after every practical session.

This will ensure a clear idea about the stock in the lab.

7.5.1 Maintenance of Laboratory

Before purchasing various articles for the laboratory, the teacher should make adequate arrangement to buy shelves or almirahs to arrange those articles. If they are glass almirahs, the articles arranged in them can be seen from outside. The inner space of the almirahs should be large so that the articles can be taken out easily. In a general science laboratory, the articles should be arranged according to the subjects and in a biology or subject laboratory they should be arranged according to the topics.

All the articles in the laboratory should be cleaned daily. The teacher should check all the articles in the laboratory once in a week. He must have knowledge about the method of cleaning certain articles.

Iron Articles

To avoid rusting, these articles should be cleaned often with oil. For example, stand, pinch cocks, bone cutters, hammer, etc., may be cleaned in this way.

Wooden Articles

These should be polished often to avoid termites entering them. The upper portion of these articles may be coated with wax so that accidentally falling acid will not spoil them.

Stainless steel Articles

The articles like scissors, knife, and needles in the dissection set have to be wiped and cleaned with cotton and with oil after use.

Glass Articles

These can be cleaned by using potassium dichromate or soap powder. Lens of the microscope and magnifying glass can be cleaned with chamois leather.

In order to avoid missing of articles like stoppers, stop cocks, etc, from their respective equipments they may be tied to them with a string. Sometimes it will not be possible to remove the lids of bottles and the stoppers of burette. To prevent this, Vaseline should be applied to them after use and before putting them in the respective apparatus.

Rubber Tubes

These should be kept in a ventilated dark room after applying French chalk on them.

Microscope

These should be purchased along with microscope cases so that they can be kept in the cases safely. The objective and eyepiece lenses should be cleaned regularly. The teacher should check all the parts of the microscope while giving it to the students as well as taking it back from the students.

The balances should also be bought along with the boxes for use.

7.5.2 Chemical Substances

These should be filled in the bottles. Generally, narrow mouthed bottles are used for liquids and wide mouthed for solids. For experiments and preparing microscopic slides, dropping bottles can be used.

As said before, poisonous substances, inflammable substances, and chemicals should be placed in one almirah. It is better to place the poisonous substances alone in a separate almirah, which can be kept under lock and key. Acids can be

placed in almirahs, which are not tall. If they are kept in short almirahs, it will be easy to take them out.

All chemicals should be placed in bottles only. These bottles should bear the name of the substance. The name should be either typed or written in bold letters in a paper or card and then pasted on the bottles. The living being preserved in wet media should also bear this name slip. Dry mounts can also bear this slip. Sometimes, the materials in the bottle would have been changed without completely tearing the slip on the bottle. It should not be done so. The new slip should be pasted on it after completely removing the old one.

The broken articles should not be kept in a corner of the laboratory. All the used and broken materials should be completely removed then and there.

7.5.3 Preparation of practical timetable

Compiling the timetable for the lab is very essential. It helps in proper distribution of practical classes to all the batches of science students. It streamlines the distribution of lab materials and chemicals to all the batches. It also accounts for the provision of double or triple periods for the practical work. It also distributes the practical work among the teachers. The practical timetable should clearly state the name of the class, the batch, the time / periods, and the in-charge teacher in the timetable. It should be circulated among all the teachers and the students of the concerned classes. A notice-board should be fixed in the lab and all the batch-wise timetables should be displayed for easy reference.

7.5.4 Administration of the Laboratory work

Administration of a Laboratory comprises the following aspects:

- Organization of practical work
- Grouping of students
- Preparations for practical work

- Discipline or laboratory rules
- Instructions for the students
- Maintenance of observation books and records

(i) **Organization of Practical Work**

It is essential for a science teacher to complement her classroom lessons to the practical's conducted in the lab. Laboratory work can be categorized into three types:

- ❖ Demonstrations
- ❖ Practical work done by students and
- ❖ Project work

Demonstrations: The teachers give demonstrations to the students before initiating any practical work. They help the students to understand the practical skills involved in the experiments and also the concept and value of the experiments.

Practical Work: This could be done by students either individually or in groups under the guidance of the teacher.

Project Work: It could be given to the students to be done either in the laboratory or out-of-the-school based on the type of the project.

Requirements for Successful Laboratory Work

- Science teacher should be able to co-ordinate both the theory and the practical work. First hand information should be given to the students before starting any experiment.
- The students must be well aware of the aims and objectives of the experiments.
- Every student should maintain a record of the experiments, which s/he has done in the lab.
- Sufficient apparatus and materials should be provided.
- Demonstration by the teachers should be clear to all the students and they should participate actively in the process of experimentations.

Guidelines for teachers in organizing practical work

- The teacher should conduct demonstrations and also provide the students with instruction cards containing information about the experiments to be performed. It provides clarity to the students and saves time.
- The experiments should be properly done. Accurate readings should be noted down.
- In the record books, the data and the diagrams should be entered. The calculations should be worked out.
- Teacher should check and sign every student's practical book after the completion of the experimental work at the end of the practical session.
- Teacher should explain the care and accuracy of apparatus to the students.
- Teacher should emphasize on economy in the usage of chemicals and apparatus. S/he should make them easily accessible to the students.
- Teacher may be flexible and innovative in devising new methods or procedures, while working with large groups or with limited supply of chemicals and apparatus.
- A teacher should be cautious about accidents in the lab and in case of accident; s/he should provide first aid to the victims immediately.
- A teacher should create interest in practical work among the students by making them simple and easy.

(ii) Organization of Students

Depending on the available equipment and facilities, students could be grouped differently. Basically there are two plans for grouping students:

- ❖ Group Plan and
- ❖ Individual Plan

Group Plan

In this plan, all the students work on the same

experiment at the same time. The advantage of this plan is that the teacher could look after the activities of all the students and can give general instructions at one time. The only limitation associated with this plan is that it is feasible only when the adequate facilities and apparatus are available and strength of the class is low.

Individual Plan

When the number of students is more and available facilities are less, this type of plan is followed. It is a cyclic management of experiments. Students are divided into groups or individuals and they perform different experiments at different times. But the major disadvantages associated with this system are:

- i. The teacher has to give different types of instructions to each group.
- ii. Difficulty arises in supplying different chemical lab apparatus to different groups.
- iii. Co-ordination between theory and practical for all the students becomes impossible.
- iv. There is a good possibility of results being copied by the students.

(iii) Preparations for Practical Work

No matter what type of plan is adopted, the following things should be remembered during the preparation of any experiment.

- A teacher should see that the apparatus and chemicals are easily accessible to the students.
- He/she should also check the working conditions of the equipment's beforehand.
- He/she could provide a list of chemicals/apparatus required for the experiment to the laboratory assistant.
- Individual or group responsibilities could be posted on students regarding the care of their apparatus.

(iv) Discipline

A laboratory is a place of working with breakable substances, chemicals, and other materials and therefore a good discipline is required. In a disciplined lab, when the teacher speaks, all the attention of the pupils will shift towards him/her. To avoid movement of pupils in the lab, chemicals and apparatus should be kept at reachable and convenient places. The teacher should be very strict in laying guidelines on the behaviour of the students.

A list of general guidelines/laboratory rules should be kept in the lab. They are:

- Laboratory apparatus and materials are meant only for lab use.
- Any accident occurring during the experiment should be reported to the teacher immediately.
- Breakage of glassware, spillage of chemicals, etc., must also be reported to the teacher.
- Avoid misplacing of chemicals and reagent bottles.
- Stoppers should be put back on respective bottles.
- No test should be done without the instructions from the teacher.
- At the end of the experiment, the apparatus should be cleaned and returned.
- The work area (table/bench tops) should be kept clean and tidy.
- Students must follow the instructions from the teacher carefully and in case of any doubt, can seek clarification at once.
- A list of general precautions about the potential hazards of the chemicals, reagents, etc., should also be displayed.

(v) Instructions for the Students

- Students should have clarity of the aims and objectives of

the experiment before starting it.

- Students should be given an explanation about the procedure before starting the experiment.
- Special instructions and precautions to be taken should be explained to the students well in advance.
- The teacher should stress on the important practical techniques that make the experiment a success.

The following aids should be provided to the students in order to give complete and proper guidance:

Laboratory Manuals

A laboratory manual is an essential guide to laboratory work. It gives good practical guidance regarding the procedure, observation, and precaution. It is always better to follow the lab manual for systematic conduct of experimental work.

The laboratory manual provides:

- The aim of the experiment
- The apparatus and chemicals required
- The method or the procedure followed
- The formula for analysis
- Precautions for effective work
- Illustration of the experiment

Instruction Cards

Instruction cards are small postcard sized cards on which the instructions and guidelines for individual experiment are written. They provide a general guidance on the experiment like aim, apparatus, procedure, precaution, etc. On a card of about 6" x 4", a set of instruction cards are prepared by the teachers and given to the students while doing the experiment.

The instruction cards contain:

1. Procedure

2. Method to record the observations /data
3. Formulae and the method for calculations
4. Precautions to be taken for proper working

(vi) Maintenance of Observation Books and Records

The teacher should check the observation books of the students regularly and sign them. Records should also be submitted to the teacher for corrections. The teacher should encourage the students to maintain neat records with the calculations, observation, results, etc.

7.6.1 Laboratory Registers

The materials received should be properly checked and entered in the stock registers the same day. A correct and properly maintained record of articles is important to check any article at any time. The following registers are to be maintained in every laboratory.

1. Accession Register
2. Non-consumable Register
3. Consumable Register
4. Register of Breakages
5. Issue Register
6. Stock Register
7. Requirement Register

7.6.2 Accession Register

The materials received from the companies should be entered in this register in the following pattern then and there. This register will give an idea whether the amount allotted for the year has been spent, also an idea about the amount spent for buying the equipment and the amount paid to a particular company.

Date	The name of the article	Name of the company	Particulars about voice price of each	Quantity	Total price	Name of register in which entered with page no.

7.6.3 Non-consumable Register

Articles of metal, wood or any other thing of permanent nature, which are not liable to be broken or consumed, should be entered in this register. The cost of the apparatus that are used daily or occasionally and can be retained after the experiment should be entered in this register. Breakable articles made up of glass need not be entered in this register, but articles like the thermometer, lens etc, should be written in this register since they have specific measurements. Microscopes, dissection sets, razor, bone cutter, twig cutter, charts, and other apparatus should be entered in this register. This register contains the following columns.

Name of the Article:

Date	Number and date of invoice	Name of the company	Receipts	Issues	Balance	Remarks

All the articles should be entered in the alphabetical order in this register. Each article should be allotted a separate page. When new articles are bought they can be entered continuously. If any article becomes unserviceable due to break or wear and tear, the teacher himself/herself cannot remove it from the stock register. S/He should get permission from the Headmaster for such removal. S/He should condemn and remove any article from the stock register only after getting the Headmaster's permission.

7.6.4 Consumable Register

Articles that are liable to break, chemicals, and other materials that are consumable should be entered in this register. Test tubes, beaker, pipette, etc., and other chemicals can be entered. Chemicals can be written in the first portion of the register and other materials can be written after that. Articles should be entered in the alphabetical order. One page should be allotted for each kind of article. If the articles entered in this register are broken or consumed, the teacher himself/herself can remove them from the stock register. S/He does not need to get the permission of the Headmaster for this. At the end of the year, s/he should calculate the quantity of chemicals used and deduct this quantity from the total quantity.

Regarding some articles, the teacher cannot decide whether it is a non-consumable article or consumable article. If s/he cannot find out this, s/he should enter the name of the article in any one of the registers. All the articles received from scientific company should be entered in one register or the other.

In addition to this, the teacher may be entrusted with the responsibility of taking care of some other materials. For example, the equipment belonging to audio visual department can be given to the physics teacher. Otherwise the biology teacher who is in charge of the laboratory will also be in

charge of the audiovisual apparatus. Two registers should be maintained for this apparatus, non-consumable and consumable. A separate register should be maintained for museum specimens and garden tools.

Name of the Article:

Date	Number and date of Invoice	Name of the Company	Receipts	Issues	Balance	Remarks

7.6.5 Breakage Register

Apparatus are liable to break accidentally while arranging for the practical class or while doing the practical. The apparatus broken during such occasions should be entered in a separate register, which may contain the following columns. At the end of the year, all such items should be seen by the Headmaster. S/He must give order to auction such equipment and to condemn and remove the other equipments from the concerned stock registers. If the broken article is a non-consumable one, then the teacher should not remove it from the stock register without getting the permission from the Headmaster. Consumable items can be removed by the teacher himself/herself at the end of the year. So, the register maintained for this purpose is called register of breakages.

Date	Details of the broken article	The nature of breakage	Name of the stock register	Signature of the person who broke it	Signature of biology teacher	Headmaster's remarks

7.6.6 Issue Register

There may be four or five science teachers in a High School. But only one teacher will be in charge of the laboratory. If there are separate laboratories for different subjects, the senior most teacher of the subject will be in-charge of it. Other teachers may require some articles from the laboratory for their classes. At that time, the laboratory in charge should enter the articles given to the teachers in this register and get their signatures. When the articles are returned, s/he should make a note of its return. By doing like this some unnecessary troubles are avoided and the number of articles used by a teacher can also be found out.

7.6.7 Stock Registers

The apparatus purchased should be properly checked and entered. A stock register is used for the entry of items received and also to maintain a record of science apparatus. It helps in knowing the position of apparatus and chemicals and also helps while auditing.

Permanent stock register

It contains details of the items, which are liable to be consumed or broken. It can also include working to non-working models like charts, cameras, microscopes, etc.

Specimen of permanent stock register

Month & date	Particulars	Details of company rates	No. of breakage items	No. in hand	Signature of teacher

7.6.8. Requirement Register

The suggestions and ideas for improvement and addition of new resources to the lab are noted in a

requirement register.

Important features of a stock register

- All the pages should be numbered.
- The stock register should be divided into different sections for the entry of different items.
- Entries should be made according to the alphabetical order.
- An index must be left below the entries to facilitate additions.
- Breakage and consumed items should be entered in a separate column

7.7 Management of Safety

A laboratory is a dangerous place if not managed properly as it contains explosive chemicals and reagents, glasswares, poisons, etc. and with the increasing scientific progress, the corresponding hazards are also increasing. Therefore, laboratory safety is the most important task that a science teacher should know. Good laboratory practices are prerequisite for the management of safety in any laboratory. For this purpose, certain safety rules should be adopted and strictly followed.

7.7.1 General Safety Rules for the lab

The science students should follow the following rules to avoid any accidents in laboratories:

- i. In case of any accident, immediately report to the teacher.
- ii. Work should be done only under the supervision of the teacher.
- iii. Equipment should be handled only after reading the instructions.
- iv. Chemicals should be used only after receiving the instructions and precautions from the teachers.
- v. Laboratory apparatus should not be used without the

permission of the teacher.

- vi. Caution should be taken while handling and pouring chemicals and reagents.
- vii. Never pour back the reagents or chemicals into the bottles.
- viii. Chemicals spilled on the skin should be immediately washed with water.
- ix. If some chemical gets into the eyes, or falls on the skin, immediately wash with water.
- x. Working area should be cleaned before and after the experiment.

In case of accidents or injuries, first aid should be immediately provided. Therefore, first aid is an important requirement in any science laboratory. The science teacher should be trained in providing first aid to the injured to the students.

7.7.2 Accidents and First Aid:

Burns

In the laboratory, thermal burns may be caused by intense heat, flames, molten metal, steam, etc. Corrosive liquids or solids such as bases and acids can cause chemical burns. In electrical burns, electrical current passing through the body generates heat.

Skin Burns

First-aid treatment of skin burns encompasses the following:

- If the burn is electrical in origin, ascertain that the victim is not in contact with the power supply before touching him/her. If the victim remains in contact with a power source, unplug the device or shut off the main power switch at the electrical distribution panel.
- Seek immediate medical treatment for all electrical burns, even if they do not appear to be serious.

- Remove jewelry, including watches, from the burned area.
- Expose the burnt area, but avoid removing clothes that are stuck to the skin.
- If possible, immerse burnt surfaces in cold water for at least 10 minutes, or apply cold wet packs.
- Avoid applying lotions, ointments or disinfectants to a burn. First and second degree burns can be washed with soap and water after the cool down period.
- Cover first and second degree burns with a moist bandage; apply dry compresses to third degree burns and to entry and exit wounds of electrical burns.
- Do not burst blisters, as they form a natural barrier against infection.

Burns to the eyes

Burns to the eyes may be caused by chemical substances, heat (hot liquids, steam, open flames, molten metal, etc.), or radiation from welding procedures, laboratory lamps and lasers. Burns caused by ultraviolet, visible or near-infrared radiation may not produce symptoms until 6-8 hours after exposure. General first-aid procedures for thermal and radiation burns to the eyes are as follows:

- Prevent the victim from rubbing or touching the eyes.
- For heat burns, flush the eyes with cool water until the pain subsides.
- Cover the eyes with dry sterile gauze pads; apply a wet compress to the eyes if it is too painful to close them.
- Send the victim for medical care. If the burn is the result of exposure to a laser beam, advise emergency medical personnel of the characteristics of the laser and the distance between the victim and the laser.

Cuts

First-aid treatment for minor scrapes, scratches, cuts, lacerations or puncture wounds include the following:

- Wash the wound and the surrounding area with mild soap and running water.
- Remove any dirt around the wound.
- Cover the wound with an adhesive dressing or gauze square taped on all sides with adhesive tape
- Wounds caused by dirty, soiled or grimy objects should be examined by a physician, who will determine whether a tetanus immunization is needed
- If the wound was caused by an object that has contacted human blood or body fluids, the victim must be seen by a physician immediately, as immunization or post-exposure prophylaxis may be required.
- If a wound is bleeding profusely, the first-aider should attempt to stop the bleeding as quickly as possible.
- Elevate the injured area above the level of the heart, if possible, in order to reduce the blood pressure to the area of the wound.
- Apply direct pressure to the wound unless an object is protruding from it (in this situation, apply pressure around the injury). Direct pressure can be applied with the fingers of the hand, the palm of the hand or with a pressure dressing.
- If bleeding cannot be controlled with direct pressure, apply pressure to the arteries supplying the injured area. This involves compressing the artery between the wound and the heart, against a bone.
- Do not remove a dressing that has become soaked with blood, as this may interrupt the clotting process; apply an additional dressing on top of the first.
- Avoid over-tightening of the dressing; i.e., do not cut off the blood circulation to limbs.
- As a tourniquet completely stops the flow of blood to beyond the point of application, it should be applied only as a last resort, as in the case of a severed limb.

Needle stick injuries

Consult a physician immediately, as post-exposure prophylaxis or immunization may be required.

Chemical splashes to the skin or eyes

For splashes on the skin:

- ❖ If the splash affects a large area of skin, go to the nearest shower and rinse thoroughly for at least 20 minutes; remove contaminated clothing while in the shower
- ❖ For splashes involving a small skin area, proceed to the nearest drench hose, remove contaminated clothing and jewelry and rinse for 15 minutes.

For splashes on the eyes:

- ❖ Go to the nearest eyewash and rinse for at least 20 minutes.
- ❖ If you are wearing contact lenses, remove them as quickly as possible, while continuing to flush.
- ❖ Hold your eyelids open with your fingers.
- ❖ Roll your eyeballs, so that water can flow over the entire surface of the eye.
- ❖ Lift your eyelids frequently to ensure complete flushing.
- ❖ Cover the injured eye with dry sterile gauze pads while waiting for medical attention.

Poisoning

Toxic substances can enter and poison the body by inhalation, absorption through the skin, ingestion or injection. When assisting a victim of poisoning:

- ❖ Ensure that the area is safe to enter before attempting to aid the victim.
- ❖ Move the victim away from the contaminated area and provide first aid as required.
- ❖ Provide emergency medical personnel for the poisonous product. If the victim was overcome by an unknown poison and has vomited, provide the ambulance technicians with a sample of the vomitus.

- ❖ Always ensure that the victim receives medical attention, even if the exposure seems minor.

Fires

The immediate response depends on the size of the fire. Laboratory personnel should attempt to extinguish a fire only if it is clearly safe to do so.

Suspected fires

Students should familiarise themselves with the locations of the fire alarms and evacuation routes in the areas that they occupy. Anyone discovering smoke, strong smell of burning or smell of an unusual nature, should immediately:

- ❖ Alert the Building In-charge or Warden, Building Serviceperson or Building watchman.

Known fires

- ❖ Shout “FIRE!” repeatedly to give the alert.
- ❖ Pull the fire alarm.
- ❖ Evacuate the premises in a swift, orderly fashion using the stairway and/or fire escapes, but not the elevators, and following the instructions of Evacuation Monitors.
- ❖ Inform the Building in-charge or Warden of the location, magnitude the nature (e.g. electrical) of the fire, the open evacuation routes, individuals requiring assistance, and other pertinent details.
- ❖ Once outside the building, move away from the doors to enable others to exit.

Clothing fires

If the clothing is on fire, it is important not to run, as this would provide additional air to support the flames. Remember the “Stop, Drop and Roll” rule:

- ❖ Stop where you are

- ❖ Drop to the floor, and
- ❖ Roll to smother the flames

As soon as the flames are extinguished, go to the nearest emergency shower to cool burned areas with copious amounts of water. If someone else is on fire:

- ❖ Immediately immobilize the victim and force him/her to roll on the ground to extinguish the flames.
- ❖ Assist in smothering the flames, using whatever is immediately available, such as a fireproof blanket or clothing.

Hazardous chemical spills

In the event of a spill of a hazardous (volatile, toxic, corrosive, reactive or flammable) chemical, the following procedures should be followed:

- ❖ If there is fire, pull the nearest alarm. If it is not possible to control or extinguish a fire, follow the fire evacuation procedures.
- ❖ If the spill is in a laboratory, shop or chemical storeroom:
 - Evacuate all personnel from the room.
 - Be sure the hood/local exhaust is turned on.
 - If flammable liquids are spilled, disconnect the electricity to the sources of ignition, if possible.
- ❖ If the spill is in a corridor or other public passage way,
 - Evacuate all people from the area and close off the area to keep others out.
 - Call the emergency telephone number that is 103 and request additional assistance.

Natural gas leaks

Have the natural gas valves closed if it is not in use.

- Check that all gas valves have been turned off.
- Dial 103 if there is a confirmed gas leak.

Safety

There are many categories of hazards that might be encountered in a laboratory setting and situations can change frequently. Even after identifying and controlling all current risks, it is critical to remain open to the possibility that new unexpected dangers can arise. Periodically verify that the Laboratory Information Card (LIC) and other hazard warnings are current; advise Environmental Health and Safety whenever changes to the LIC are required.

Carry out weekly inspections on the condition of:

- fire extinguishers
- emergency wash devices such as eyewashes and drench hoses (run these for several minutes and update inspection tags)
- first aid kit contents
- fume hood and other ventilation devices
- tubing for circulating water, vacuum, gases
- chemical storage compartments

7.8 Structure and Design of a Biology Laboratory Furniture

Leaving the space occupied by worktables and almirahs in the laboratory, there must be at least 1.5 sq. m. of space for each student to do the experiments. For a total of 20 students, the laboratory must be of 20 m. * 10 m. size.

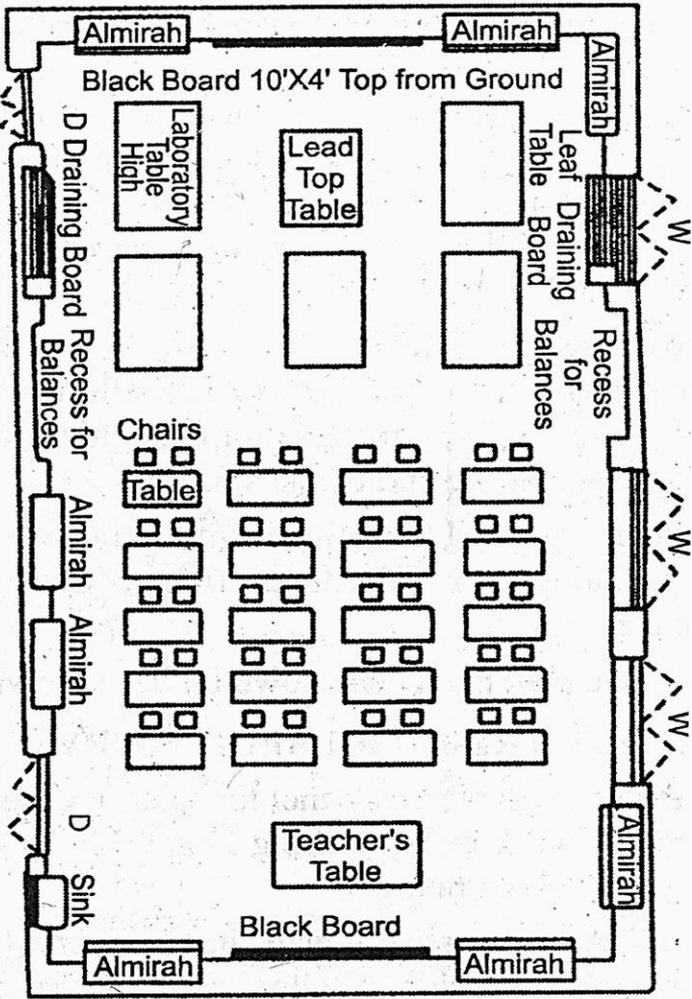


Figure: Lecture-Room-Cum-Laboratory Plan

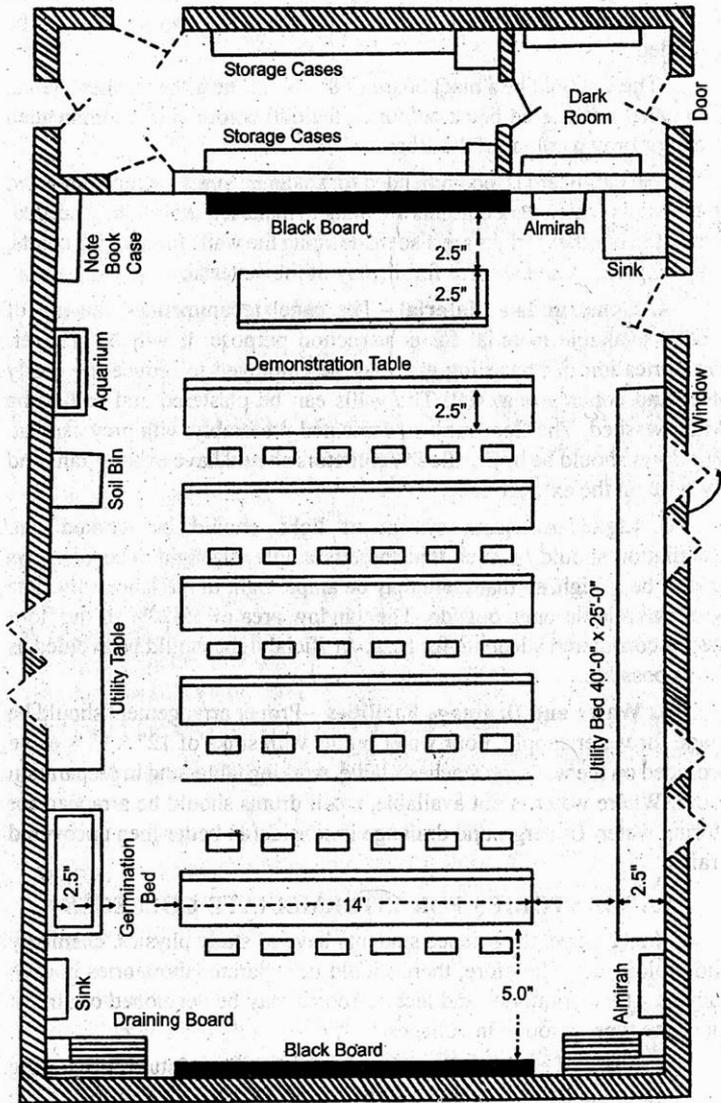


Figure: All Purpose Laboratory

Worktables must be arranged in the following manner:

1. The chairs and tables must be placed in such a way that the students face teacher in the laboratory. It is advisable to have worktables that allow the students to do the experiment from one side only, which will make the supervision of the teacher easier.
2. The arrangement should be in such a way that it is easy for both teacher and student to contact each other.
3. The upper part of the table must be made of teakwood.
4. The sinks must be attached to work.
5. A large demonstration table with water, gas, and electricity facilities must be placed in the laboratory.
6. Drawers need not be placed in students' worktables.

Ventilation and Light

There must be at least two doors for the laboratory in order to make it convenient for the students to go out at the time of emergency. They can be either on one side or on the opposite sides and they must open outside. In order to get free air and light, the windows must be placed at a height of 1 meter from the ground level. Tube light or mercury lamp is preferable than the ordinary lamp since they give uniform intensity of light without shadow and consume less electricity. Lamps that are connected to the pulleys are preferable for the biology laboratory.

Sinks

The biology laboratory is to contain two common sinks and one in demonstration table. There must be canals to take out the water that comes out of the sinks. Soap with soapbox must be kept in each sink. The holes in the sink can be closed with a plug that contains many small holes so that water can pass through the holes in the plug and the hard materials like paper, cork, and pieces of glass can remain in

the sink itself. There must be two bins made of either wood or iron in the laboratory to collect the waste materials.

Water facility

A tank can be constructed on the topmost part of the laboratory in order to supply water for the laboratory. The capacity of the tank must be at least 1000 litres. There must be a motor to lift water to the tank. Water must be taken to the sinks through the PVC pipes. There must be wheel valves for each tap to control the flow. The water coming out of the sinks must be taken out by separate canals and these canals must be closed with wooden planks.

Gas

Petrol gas is more convenient than coal gas. The equipment that prepares the gas can be set up separately: outside the laboratory or in a corner of the laboratory. This must be enclosed by asbestos sheets. The gas coming out from this equipment must be taken to the worktables through pipes. Each pipe must contain a valve to control the flow. The Bunsen burners used for the coal gas cannot be used for the petrol gas. A separate type of Bunsen burner is required for petrol gas. Now-a-days, liquid petrol gas is used in the laboratory.

Flooring

The cemented floor is more convenient for the hot countries. Cold countries have a floor of wooden pieces. If the cement flooring is sloping towards one direction, it will be easy for cleaning. Round Corners are preferred than straight corners.

Black Board

A large wall blackboard of the size of the demonstration table should be behind the table.

Notice Board

This can be placed in the verandah outside the laboratory where there is no window. It must be made of teak

wood and provided with glass doors and lock and key. This can be used to exhibit photos, scientific information, and instructions and rules for the students.

Preparation Room

This room is used for the teacher to do the experiment before actually conducting it in the classroom, to keep the often-required apparatus and to keep the apparatus of the incomplete experiments. So, this room must be adjacent to the laboratory. This must contain a long worktable with sink and water facility. It is better to have the storeroom adjacent to this room. There must be a way from the laboratory to the science teacher's room and to the preparation room.

Storeroom

All apparatus and materials can be stored in this room. Important acids can be kept in a separate almirah inside this room itself because the poisonous gas and materials coming out of chemicals may spoil the sophisticated equipments in the room. The required amount of the chemicals can be taken to the laboratory or class whenever needed.

Poisonous materials and chemicals should be kept in a separate cupboard with lock and key. The key must be always with the teacher. A slip written as "poisonous substances" can be pasted on the cupboard.

Darkroom

In biology, to conduct experiments on photosynthesis, it is necessary to remove starch from the leaves by keeping the plant in the darkroom. The room is useful for various activities conducted by science club. This room is useful to give training to the students in different branches of photography like developing, printing, and enlarging. This room should be always supplied with safe lights, free air, and water. There should be a cupboard setup in such a way that it will not allow the lights to pass through it.

Science Teachers Staff Room

This room helps the teachers to spend their leisure time usefully. The science or biology library can be in this room itself.

Special Room

To teach biology effectively, there should be separate rooms like museum room, aquarium room, and animal room.

Museum Room

This room can be used to arrange separately, with necessary description the rare apparatus prepared by the students stuffed specimens, wet specimens, and dry specimens.

Animal Room

Biology is the study of living beings. The teacher should help the students to dissect and understand the internal parts of plants and animals. But it is not possible to get all plants and animals in all seasons. So when they are available in plenty, the teacher must purchase and keep them alive in this room. Then they can be used when the need arises.

Projection Room

This is useful for screening slides, filmstrips and films. If there is no separate room like this, then the laboratory can be made use of. Since majority of projections are done only during daytime, there must be window curtains in order to make the room dark and exhaust fans in order to get free ventilation.

7.9 Preparation of Indent

Living plants, animals and other equipments are important for the teaching of biology. Indent gives a clear idea about-the number of equipments and the name of the equipments. The teacher has to prepare the indent: Preparation

of indent needs some basic ideas. If the laboratory is a new one importance, should be given to equipments which are daily needed like, beaker, test tubes, microscope, dissection box, measuring jar, chemical, etc. The quantity of these items should be greater than other materials. The next priority should be given to the occasionally used costly equipments.

The indent can be prepared easily by the teacher after studying all the biology lessons of different classes in school. When s/he studies the book s/he can understand the different experiments to be conducted and the different plants and animals to be studied. From this knowledge, s/he can prepare the indent. S/He should also mention the quantity of the materials required. When a laboratory is started in a school, a number of equipments have to be purchased for it. So, a large amount of grant will be granted by the government. In addition to this, every school will be getting additional grants for every year from the Government to meet the recurring expenditure.

The annual grant should be used for purchasing essential materials for the laboratory. The indent for this should not be prepared all of a sudden in one day. Instead the teacher should note down in a separate notebook the requirements of the students for the experiments as and when they do the experiments and based on that list only he should prepare the indent.

7.10 Procedure for the Purchase of Equipment's

The prepared indent should be sent to more than three scientific companies with required particulars asking them to give their lowest price list for the articles in the indent. The illustrated catalogues prepared by the scientific companies will help in preparing the indent with full particulars. When quotations from at least three companies reach the teacher, s/he can start preparing the comparative statement. The comparative statements should be in the following pattern.

S. No.	Name of the articles	Quantity	Price by the I Company	Price by the II Company	Price by the HI Company	Remarks

The company, which has given the lowest price for the articles, should be accepted. This does not mean that quality should not be considered. S/He should select better equipment at cheaper rates but care should be taken that quality should not suffer at the cost of money. If the material cost is much, it should possess some qualities. The material like dissection set made up of stainless steel will be costlier than that made up of ordinary iron. But the stainless steel equipment will not rust and will serve for a number of years. That is more beneficial than that made of Iron.

Regarding glass articles like test tubes, etc., Pyrex or corning is more qualitative than the ordinary glass apparatus. The glass apparatus made up of Pyrex or corning can be heated to a high temperature, that too directly. But the price will be four times that of the price of ordinary glass apparatus. But considering its quality and service for a longer period this is preferred more than the ordinary one. Instead of buying three dozen ordinary glass test tubes, it is enough to buy one dozen Pyrex glass test tubes. The chemicals made up of BDH are superior to that of other companies. The teacher should give instructions to the company to send the chemicals after properly sealing them in the bottles.

Materials like rubber tubes, rubber corks, etc., are often required for the laboratory. They can be of assorted size instead of a single size. All the materials bought for the

laboratory should be of better quality. The teacher is empowered to buy the quality materials even if they are costly.

After considering the above requirements, the teacher should send orders for the respective companies to supply the articles. When s/he receives the articles along with the price list, s/he should compare the price list with that of the quotation given previously to find out whether the price is the same. S/He should also check the quantity of the materials and breakage of glass apparatus and chemical bottles. If there is any deficiency or damage, it should be immediately communicated to the respective companies and arrangements should be made to return the equipment in order to get a new one or to reduce the price. These articles should be entered in the concerned stock registers.

In some cases, it proves beneficial to purchase the apparatus from the local firms or from one firm only. If possible, the teacher should go personally to the firm and get materials packed in his/her presence. This will save time as well as money, which is otherwise wasted in postage, etc.

7.11.1 Science Kits

A science kit is a small portable box containing the apparatus and equipment of science. The science kit helps a teacher to bring some authentic contact with practical science into the classroom. Its possible success depends upon the creativity and firmness of the teacher. These science kits are used as mini laboratories. These kits have been developed for effective science teaching by the central science workshop of the NCERT. These science kits provide low-cost and readily available equipment for effective teaching and practical work in science. These kits utilize low-cost and readily available materials in the local market.

Characteristics of a good science kit

- It contains the apparatus and materials required by

science teachers.

- It contains a set of materials for teaching individual science topics.
- Its contents are organized and arranged systematically.

Requirement of Science Kits

The Kothari Commission (1964-66) and other committees on science education have recommended the development of science kits. They suggested that with the introduction of improved curriculum and advancement in science and technology, apparatus, more effective, complicated technical devices have to be developed, and replace the conventional laboratories.

- The introduction of science as a compulsory subject in primary schools posed a serious challenge for teaching science and to face this challenge science kits came into the picture.
- It was practically impossible to provide facilities for science experimentations on such a large scale in schools. To meet this purpose, simple, inexpensive and improvised apparatus is required.
- The interest of poorly motivated students may be kindled when s/he is given the opportunity to work with a science kit that meets his/her needs and abilities.
- The science kit box contains all the things required by a science teacher for general experiments, like scissors, strings, pins, rubber bands, candles, blades, balloons, thread, measuring tape, matches, cello tape, pencil, nails, etc.

Types of science kits: The science kits are of two types:

- ❖ **Demonstration kits:** The teachers for demonstrations.

- ❖ **Students' kits:** The students use the kits for doing experiments.

The NCERT has developed different types of kits to be used at different stages. These are described as follows:

Primary School Science Kits

- ❖ These kits provide basic facilities regarding experimentation and are mainly used for demonstrations.
- ❖ They contain general items, consumables, chemicals, charts, and tables.
- ❖ They are meant for class III, IV, and V.

Middle School Science Kits

There are a total of six middle school science kits meant for class VI, VII, and VIII

- ❖ **Three Demonstration Kits:** They are a little advanced than primary level kits and are different according to the branches of science as physics, chemistry, and biology.
- ❖ **Three Student's Kits:** They are meant for experiments to be carried out by pupils.

High School Science Kits

These kits are meant for class IX and X

- Demonstration kit:** It is the most advanced type of kit meant for demonstrating important experiments covered within the curriculum.
- Pupil's working kits:** Students can take these kits home and can do their experimentation with the help of apparatus and materials provided in these kits.

Importance of Science Kits

- They are portable and cheap: Science kits, due to their small size, can be carried away easily and occupy less space. These are useful for both demonstrations as well as experimentation.
- They make the concepts of science simple: Science kits

provide good knowledge to the students as the experiments are done practically on their own. The diagrams regarding the experiment are drawn with the help of stencils provided in the kit. This makes the concept clear very easily.

- iii. They serve as a mini mobile laboratory: Science kits could serve as mini laboratories for schools, which cannot afford to maintain a big laboratory. Working tables are not required as the kit box itself could act as a worktable. Apparatus and materials contained in the toolbox substitute for the real apparatus and materials of a well-established laboratory. Different subject kits could be prepared with the help of the teacher and could be brought to the classrooms for demonstrations and experimentations.
- iv. They provide an opportunity for conducting the practical work: Practical sessions invoke the interest of the students in the subject.
- v. They help in stimulating the scientific interest and scientific thinking among the Students: The kits help in relating the theory learnt in the classrooms with the practicals. It helps to familiarize the students with the basic concepts and methods of science. They get the opportunity to think, reason out, observe, and conclude the experiments on their own. This develops the power of observation, critical thinking, reasoning, and analytical abilities in the students.
- vi. They help in developing experimental skills: Students develop experimental skills by handling various types of tools, equipments, and materials of science. These skills help them to solve different problems in their future life.
- vii. It helps in conserving the time and resources: The kits are small; hence the apparatus and instruments

are arranged systematically and are brought to the classroom with ease. There is no likelihood of breakage and the experiments require less time and resources.

Advantages of science kits: There are many advantages of science kits. They really help in bringing practical work into the classroom. The science kits are: -

- Economical
- Inspirational
- Portable
- Indigenous
- Follow a scientific approach
- Create interest
- Provide emotional satisfaction
- Help in learning by doing

7.11.2 Comparison of science kits and science laboratories

S. No.	Science kit	Science laboratory
1.	Science kit is a small portable laboratory.	A science lab is an elaborate establishment used to conduct practical work in science.
2.	The equipment and materials are simple and easy to handle.	Apparatus and equipments are large and fixed and are not easily accessible to students.
3.	The chemicals and apparatus are carried in the kit.	The chemicals and apparatus are stored and displayed safely in almirahs.
4.	A science kit is cheap and economical.	A science laboratory is a costly establishment.

7.12.1 Co-Curricular Activities:

Through literal meaning, the activities pertaining to the school curriculum may be referred to as curricular activities. Such activities are part and parcel of the instructional and other educational programmes entirely handled by the school staff,

The term co-curricular activities are relatively a new term. Previously, it was known as extra-curricular activities. In that time, the whole purpose of the school was conceived to be confined to the teaching of the subjects of the curriculum. Any activity outside the preview of such teaching was termed as ‘extra’, ‘side show’ or ‘mere waste of time’. In this sense, what we term today as co-curricular activities were taken as mere “extras”. It was believed that they encroached upon the proper domain of the school and interfered with its smooth functioning. Thereby, they were usually helpful in the extra time, if available, after the school schedule hours at the convenience of the school authorities.

This position has gradually undergone a change. These activities are no longer looked upon as mere “extras” but an integral part of the school curriculum. In the words of Secondary Education commission, “They are as integral part of the activities of a school as its curricular work and their proper organisation needs just as much care and forethought”. The result has been as such that those very activities previously called as extra-curricular activities are now taken as co-curricular activities. We can hardly distinguish between a curricular activity and some other activity of the school which as previously taken as extra-curricular. Both the types of activities are now considered complementary to each other in school programme. Commenting upon this trend, Sultan Mahyi-ud-din says: “The distinction between curricular and

Extra-curricular has been gradually disappearing in modern education practice, and co-ordination and integration of all the experiences of the pupil—intellectual, social, moral, emotional and physical has become the object of persistent efforts of the school that aims to be a real living, little world for the pupils.”

Summarising in brief, both curricular and co-curricular activities are the part and parcel of a school curricular and programme. They are intimately linked with one another. They should never be considered as a separate unit in themselves. Every curricular activity has its origin in co-curricular activity and both of them are designed to achieve the board objective of education. Therefore, it is very difficult to draw out a clear-cut demarcation between the curricular and co-curricular activities as far as their education importance is concerned. However, one thing is obvious that curricular activities are organised and conducted exclusively by the members of the school staff, particularly teaching personnel, whereas co-curricular activities are to be organised by the school council consisting of teachers and pupils. For the organisation of different types of such activities, according to the needs or requirement, different committees are setup and in this way students’ cooperation is well secured in deriving the best possible outcomes of these activities.

7.12.2 Important of Co-Curricular Activities

At the present age, education is not limited to the learning of 3 R’s. It is to cater for the development of the total personality of the children as to make them utmost useful to themselves and to the society and nation. Co-curricular activities play a significant role in the realization of such objectives. They are of immense value. Their values or

advantages in relation to teaching of General Science may be summarized as under:

1. **Academic Value:** Academic work has two aspects: theoretical and practical. Co-curricular activities supplement the theoretical knowledge of the classroom by imparting the practical experiences. For example, scientific activities like fairs, exhibitions, science clubs, etc., provide opportunities for the practical knowledge of the Science subjects.
2. **Physical Value:** While many of the Co-curricular activities in general science like excursion, organisation of museum, establishment of garden, etc., directly provides opportunities for the physical exercises and movements of the pupils. Other co-curricular activities also indirectly contribute towards the physical welfare or development. These activities provide a useful channel for the superfluous energy of the pupils and also help in the social adjustment which in turn contributes towards the proper physical development.
3. **Psychological Value:** Co-curricular activities satisfy the psychological need of the pupils. Their psychological values are just as below:
 - (i) They provide the best means of canalizing the instincts of the children into healthy and fruitful channels. They are in a way a 'Safety value' for the surplus energy of the pupils. Various instincts like curiosity, pugnacity, hoarding, gregariousness, constructiveness, self-assertion, sex, and self-abasement are properly satisfied as well as sublimated through these activities.
 - (ii) The emotional energy is also properly utilized though the co-curricular activities. Catharsis and sublimation of various emotions and the proper form of outlet or

expression through these activities helps in the proper training of emotions.

- (iii) These activities also help in meeting the individual differences of the students in terms of their varying tastes, temperaments interests, aptitudes, capacities, and talents.
 - (iv) These activities provide variety to the school curricular programme. They are helpful in removing monotony and dullness and make the school environment lively and enjoyable.
4. **Civic and Social Value:** Various civic values and social virtues are inculcated among the students with the help of co-curricular activities. Co-operation, team spirit of we-feeling, spirit of toleration of other's views, graceful followership, sportsmanship, fellow feeling, service to others and consciousness towards the assigned responsibilities are some of the values that are achieved though the organisation and participation in the co-curricular activities.
 5. **Cultural value:** Co-curricular activities especially having link with the cultural aspects prove quite valuable in providing opportunities for the preservation, promotion and transmission of our cultural heritage. Organisation of lecture, debate, and symposium on the subjects of historical in forests, discoveries and inventions of Sciences. Organisation of museum, exhibitions, and celebrations of various days of scientific interests are some of the examples of such activities.
 6. **Aesthetic Value:** Development of aesthetic sense is another objective which may be properly achieved though the co-curricular activities like establishment of garden, museum, organisation of excursion, adoption of scientific hobbies, etc.
 7. **Recreational Value:** Co-curricular activities provide valuable means for the proper utilization of leisure to the

students. They provide opportunities for reducing the monotony of academic work and prove to be healthy recreative agents.

8. **Disciplinary Value:** Co-curricular activities by utilising the surplus energy of the students and sublimating their instincts and emotions help in the maintenance of constructive discipline. The various civic, social, and moral values inculcated among the students help them in acquiring self-discipline. Moreover the students find themselves quite busy through the participation in these activities and hence have no idle time for mischief making.
9. **Leadership Value:** Different co-curricular activities provide ample scope for the training in leadership. Every activity organised in the school requires a leader from the students for its organisation. In this way, various activities organised from time to time provides numerous opportunities for leadership. The teacher in-charge of that particular activity remains these to help the leader in acquiring various traits and qualities of leadership and in this way co-curricular activities provide a valuable means for the leadership training.
10. **Vocational Value:** The co-curricular activities having productive value and vocational bias help in deriving economic advantages. They prove a means for earning while learning and also provide a solid base for the future vocational adjustment.

7.12.3 Organisation of Co-curricular activities in Teaching

The organisation of curricular work alone in the schools is not sufficient for helping the students in the realization of the set objectives of teaching General Science in our schools. It needs some or the other co-curricular activities

being organised in our schools. A few important activities especially helpful in this report may be mentioned as below:

7.12.4 Excursion or Field Trips

Need and Importance

General Science for their effective teaching and purposeful learning need first hand experiences through real objects and natural events. There occurs many occasions for the teachers while teaching in the class room or working in the laboratory that s/he feels quite handicapped in providing to his/her students these necessary first hand experiences. In order to compensate for it, it is desirable to take the pupils on field trips or excursions to show the desired objects or processes connected with General Science so that they may be able to acquire first-hand knowledge of the same. In short, the benefits derived from the excursions may be summed up as below:

- 1.Helps to clarify the subject matter.** The experience gained during excursion helps in understanding and clarifying many concepts, and processes related to science. For example, a variety of animals and wild life, industrial processes and products, operations of complicated machines, marine objects and events concerning natural and physical surroundings, etc. cannot be studied properly in the class room only through their reading or descriptions. Their study is more effective and purposeful when such things and events are observed in actual situations and excursions definitely can provide such opportunity.
- 2. Creates Interest:** Real interest in the study can be conveniently generated through the visits and excursions where the related objects and events may be observed in detail within the natural set-up. A thing or process observed

or enjoyed by one at the time to excursion is able to create more interest than the more reading or listening about it.

3. **Provides entertainment:** Educational excursions help in breaking the boredom and monotony of the class room. The change of environment thus provided may prove quite helpful in refreshing them and thus generating a new zeal and enthusiasm for the further learning in the subject.
4. **Establishes contact with outer world:** The students get opportunity to come out from the narrow boundaries of class rooms, and home for entering and enjoying the life of the outer world. Here, they get new experiences for widening their mental horizons concerning the facts and principles of both physical and like sciences.
5. **Developed scientific attitude:** Excursions help the students to move out from the narrow boundaries of classrooms and homes for entering and enjoying the life of the outer world. Here, they get new experiences for widening their mental horizons concerning the facts and principles of both physicals and like sciences.
6. **Helps in the collection of useful material:** Through scientific excursions, students get proper opportunity of collecting specimens of different rocks, ores, soils, metals, etc, and similar other objects for the school science museum. They can also collect different kinds of leaves, flowers, stems, roots, seeds, etc. And can preserve them for the future study. Similarly, from sea shores, many specimens of different shells, sea animals, fishes etc., can be collected by the students for keeping in their science museum. In this way, excursion may prove a quite valuable source for the children to satisfy their hoarding urge as well as potent for getting things and objects for the museum.
7. **Generates spirit of co-operation:** Excursion helps in developing the spirit of co-operation among the students. When the students go out in a group with a common aim

under the guidance of the teacher, they work together, helping each other or invoking others help in their outdoor activities. Therefore, a sense of fraternity and responsibility towards each other is developed through the activities performed during excursion.

8. Provides opportunities for the selection of the projects:

During excursions, students come in touch with a variety of things, events or processes and may feel the curiosity of knowing in detail about them, collecting their specimens or desiring to remain in their constant touch. Such sort of feelings generated in the students may give birth to the necessity of choosing a suitable project or selecting a suitable problem for being used in the project or problem method of teaching science.

7.12.4.Organisation of Excursions or Field Trips

Excursion, for its effective execution and desirable outcomes, need to be organised in a very systematic and popular way. A biology teacher while organising an excursion must usually take care of the following things for deriving the maximum educational benefits.

1.Choice of the place of excursion: In planning for excursion, the top most priority should be given to the wise decision about the place of excursion. Generally, it should be based upon its relevance to the subject and topic being currently dealt within the classrooms. For example, if the students are learning about certain seasonal crops etc., it will be wise for them to go out from time to time to visit some nearby agriculture farm to get direct experiences concerning the processes of toiling, manuring, sowing, weeding,

harvesting, etc. In the same way, we may arrange field trips to gardens, mountains, forests, seashores, etc. According to the actual need for the purposeful study in the relevant subjects, the students interested in chemistry may visit chemical industries and those interested in physics may go to engineering enterprises. A visit to a planetarium may also prove quite rewarding for learning about the heavenly bodies and universe. In this way, the derivation of relevant educational benefits should be given prime consideration for selecting the place of excursion. However, the other things like the feasibility in terms of expenses, seasons, time available and convenience in arranging excursion, should also be given due weightage for making such choice.

2.Preparation of Excursion: After making the choice of the place of excursion, the teacher must take care of the things related to the preparation and planning. For this purpose one needs to take care of the following:

- (a) Teacher must obtain the due permission of the authorities of the institutions and the willingness of the students and their parents for proceeding to the excursion.
- (b) In case the place of the excursion or trip is far away, proper arrangements of transport e.g., hiring of buses or reservation in the railway trains etc. must be made quite in advance. If students' concession is available for the journey, it should also be procured well in time.
- (c) Permission from proper authorities to visit the desired places during the planned excursion must also be obtained beforehand. Similarly, correspondence and confirmation about the reservation of rooms in hotels, rest houses or guest houses must also be made well-in time to avoid inconvenience.
- (d) What is to be collected from the students and shared by the institution for meeting out the expenses towards excursion should be collected by the teacher well in time.

The account of the same should be kept with the help of the students.

- (e) The aims and purpose of excursion should be made clear to the students. They should also be given complete knowledge of the planned schedule concerning the places of visit much before starting to their excursion.
- (f) Students must be instructed to carry on all the necessary articles for individual needs. However, proper arrangement for the food of the students during excursion should be properly planned beforehand by the teacher in-charge.
- (g) Full co-operation of the students must be secured in the management of the entire affairs concerning excursion. This can be done by assigning the responsibilities to the students through a number of committees like Food Committee, Property Care Committee, Travelling Committee, Finance Committee, Entertainment Committee, and Committee for the collection of objects for Science Museum, etc.
- (h) The students should be given full instructions beforehand for maintaining discipline and adopting necessary precautions while travelling and visiting the planned places.

The Necessary Precautions during Excursion

During exertion of the planned excursion, the teacher should remain quite alert and active for its successful execution. Caring in the following way may usually serve his/her purpose well in this direction-

1. The teacher should try to keep his/her students under control and in perfect disciplines especially when they are out for a visit in a group of places involving some risk. In this connection, all precautions regarding the safety and security

of the students must be properly kept by teacher through the active co-operation of the students.

2. As far as possible, the planned schedule of the visit to different places during excursion must not be unnecessarily disturbed or changed. It remains always fruitful to maintain punctuality and adhere strictly to the set programmes for avoiding unnecessary inconveniences in terms of getting accommodation and access to the place of visit.
3. During excursion, the teacher should take all precautions about the lodging and boarding facilities as well as for the health of all the members of the excursion team. It is better to have a doctor along with this team in addition to a first-aid box for meeting out any emergency.
4. The students should be made to listen carefully to the guide of the place of visit and should be asked to collect and note down the full information related with the objects and events observed for the purpose of being utilised in their study of the respective subjects.
5. During excursion, the teacher's guidance and help should be readily available to the pupils for solving their difficulties and answering the relevant scientific queries.
6. In addition to derive educational gains pertaining to the student of biology from excursion, it should also result in providing relaxation and entertainment. During excursion, for this purpose, there should be some sort of light entertainments from time to time organised as group cultural activities for removing the elements of boredom and monotony. Students should also be helped to derive maximum pleasure and entertainment through sightseeing or observation of the various objects and events.
7. It is also the responsibility of the teacher to see that everyone from the excursion team as well as what is being carried or collected from the excursion remain safe and intact.

The Work after Excursion:

Responsibilities of the teacher accompanying the excursion team do not end with the return of the team. A follow up work in terms of the following points still needs to be done by:

- 1.The experiences gained by each student and difficulties encountered during the visit are needed to be discussed in the group. The queries and doubts of the students related to their educational experiences and extensive study of the subject should be properly satisfied at this stage.
- 2.The articles collected for the school museum should be deposited after labelling and classifying them under proper categories.
- 3.The students should be asked to write some appropriate essay concerning their experiences and knowledge gained during excursion. A few of these essays or writings may be published in the school magazine or science club bulletin. This helps all the school students besides those going on excursion, to derive useful educational advantages and also providing a good platform in the matter of self-expression.
- 4.The teacher should try to seek correlation and help from the concrete first hand experiences of the students gained during excursion at the time to formal classroom teaching and laboratory work as well as in the organisation of co-curricular activities related with science.

7.12.5 Science Museums

What is a Science Museum?

As already said, science is that type of subject, the knowledge and skill of which cannot be acquired only through telling or reading. It requires active experimentation, careful observation and demonstration of the scientific facts and

principles within their natural surroundings and occurrence for their proper assimilation and application. It means that what is to be learned in science can be properly learned through direct experiences with the available facts and processes doing on in the natural environment. However, it is not feasible always to take the students into the natural surroundings for observing and experimenting with the facts and principles of science. In this situation, the collection of the natural objects of scientific interest in the form of science museum may prove quite effective and beneficial for studying the related scientific facts and processes.

As a matter of definition by science museum we mean such a suitable place in the school campus where different objects and specimen collected from natural or physical environment or constructed and improvised by the students may be placed, preserved and displayed safely and systematically in such a way as to help the students to learn about the related scientific facts and processes through a simple process of observation.

Need and Importance of Science Museum:

Besides proving its worth as a valuable aid in the teaching learning process, the organisation of science museum in the school also acts as a great source of inspiration for the budding scientists. In brief, the advantages drawn through it may be summarized as below:

1. It helps the students to get properly acquainted with their physical environment.
2. The students come across some phenomena or object of scientific interest which are otherwise not seen in normal circumstances, moreover, they get change to observe and study those objects and phenomena whenever and wherever they want to do so.

3. The study of scientific facts and principles becomes quite interesting and easy by the close observation of specimen and models available in the museum. It helps in the creation of genuine interest and developing positive attitude towards the study of science.
4. It helps in developing love for nature study among the students. It gives opportunity to collect scientific objects and specimens according to their own interest and taste provided through the organisation of science museum. It also helps the students in the proper satisfaction of their hoarding instinct.
5. Science museum helps in the proper development of the observation faculties of the children. As a result of getting practice in the task of observation, their power of comprehension and drawing inference is properly developed.
6. The instinct of curiosity is properly satisfied by observing quite new and rare objects and phenomena. This also adds to their funds of knowledge and the atmosphere for the learning of science in the school is greatly improved.
7. Active participation of children in organising the activities of science museum helps them in developing their organisational abilities related to the systematic placing, preservation and proper as well as safe use of the various objects.
8. It helps in developing scientific attitude among the students and in creating a healthy spirit of learning and knowing new things.

Organisation of a Science Museum:

The following points should be taken into consideration while organising the science museum for the students of General Science.

1. Choice of proper accommodation: In the selection of suitable site and accommodation for the science museum one has to take care of the following things:
 - (a) The place should be at a reasonable distance from the classes and science laboratories.
 - (b) The accommodation should be big enough as to accommodate objects and materials related to the different branches of General Science.
 - (c) All the articles and objects collected should be in a position to be kept and demonstrated quite safe and sound without getting spoiled or damaged for a long period of time.
 - (d) The objects should be kept in such a way as to provide a full view from all angles and thus enabling the maximum number of viewers to view things jointly at a single occasion.
2. What is to be kept in science Museum? For keeping in the science museum, the different specimens, models and other things of scientific interests belonging to different branches of science may be collected and categorized properly by the students. These items kept in the museum may be of the following nature:

Life Science Section:

- (a) Different kinds of rocks e.g., igneous rocks, stratified rocks, metamorphic rocks etc.
- (b) Different kinds of soils
- (c) Different kinds of leaves: roots, stems and flowers
- (d) Different kinds of insects-both useful and harmful e.g., butterflies, beetles, white and (full life history) in all stages, housefly (life history) in all stages, mosquito (full life history) in all stages, etc.
- (e) Different kinds of cereals, fruits, vegetables, seeds, etc.

- (f) Different kinds of reptiles preserved in dilute formaldehyde.
- (g) Different kinds of birds properly stuffed and preserved.
- (h) Articulated skeletons of human beings and other mammals.
- (i) Models of digestive, respiratory and other systems.
- (j) Models of human eye, ear, heart, lungs, etc.

Chemistry Section:

- (a) Specimen of all types of metals and their ores
- (b) Samples of different chemicals with descriptive charts
- (c) Models of atoms showing their structure
- (d) Charts and models concerning manufacturing and laboratory preparation of different gases, acids and other chemical substances
- (e) Models of fire-extinguishers
- (f) Specimens of various types of fertilisers and their process of manufacturing shown with the help of charts, etc.
- (g) The process of refining petroleum shown with the help of model or good charts. Along with this the samples and specimen of all the bi-products should also be shown.
- (h) Process of destructive distillation of coal shown with the help of a model or some good chart. Along with it, the specimen and samples of all the bi-products should also be shown.
- (i) Metallurgy of various metal ores like iron, copper, zinc, etc., may be shown by suitable models or charts.
- (j) Manufacturing process of glass along with the types and varieties of glass can also be properly displayed through specimen, charts, and models.

Physics Section:

- (a) Actual objects, models, and charts showing all types of levers and their uses
- (b) Working models and charts of petrol, diesel and steam engines
- (c) Working models of telephones and telegraph
- (d) Working models with demonstration of the open circuits of radio, television set, etc.
- (e) Models of aeroplane and jet-plane
- (f) Models of Rocket-ordinary and space rocket
- (g) Actual models of photographic camera and the specimens of the ingredients and materials for the developing and printing of the pictures.
- (h) Models of microscope, binocular, terrestrial telescope, and astronomical telescope.
- (i) An X-ray apparatus.
- (j) Photo-electric cells and their functions-demonstration equipment model or chart.

From where to get Articles for Science museum?

- (a) The students may collect different objects belonging to the physical and social environment during the visits and excursions to the places of scientific interest.
- (b) Certain things can be borrowed from the state or district museums, botanical gardens or from the science museum of some neighbouring schools and institutions.
- (c) The charts, models, specimens and real objects, etc. They also can be purchased from the market, factories and other places dealing with the sale of such things.
- (d) The charts, models, and improvised apparatus etc. may be constructed with the help of students.

7.13.Methods of preservation and safe Display:

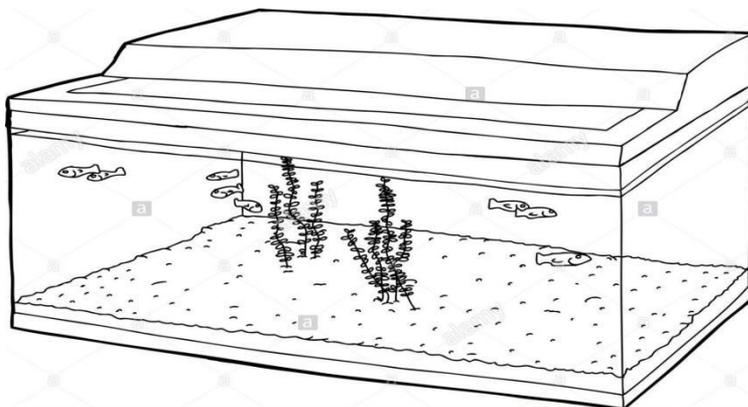
The proper establishment and organisation of the science museum demands that all the articles collected for the museum should be properly placed, preserved, and displayed for deriving maximum educational advantages. In general the following points should be carried for this purpose-

1. The materials collected for the science museum should be placed in a systematic way by putting it in some suitably classified sections either subject-wise like chemistry, physics, biology or botany sections or objects-wise like birds, animals, plants, objects, non-living objects, mineral sections, etc.
2. Every article placed in the museum should have its proper identification for being displayed effectively. For this purpose, we may attach a piece of thick paper or wooden piece by writing on it the following identifying data:
 - (a) Name of the object (b) Name of the student who have collected the objects (c) Date on which collected (d) A brief description of the object regarding its nature, characteristics, and the purpose served, etc.
3. All the zoological specimens should be kept in the show cases sealed properly, after properly disinfecting them with D.D.T. or spray of other strong disinfectants.
4. Specimens of different kinds of snakes, lizards, and fishes etc. can be kept preserved in the properly sealed jars filled with 30% formalin solution.
5. Life history of mosquitoes, housefly, white ant, etc. may be properly mounted on glass strips and kept in jars filled with 10% formaldehyde solution.

- Different birds should be stuffed and mounted properly for being kept safe in glass cases suited to their size.

7.13.1 Aquarium

For keeping living fish and other animals of water which are conditioned to live in the stagnant water, an aquarium may be constructed.



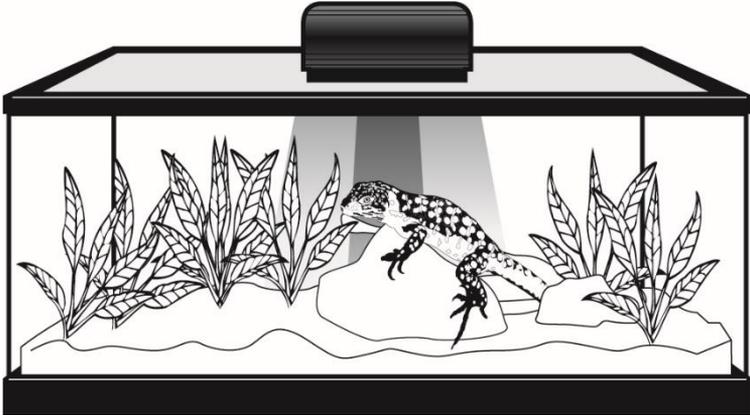
Aquarium is a sort of small pond made out of a glass box. For the construction of aquarium, we can have a small portable size glass box preferably of a rectangular shape, in the bottom of this box. We should first place some rich soil belonging to ponds, lakes or fertile fields and then cover it with a thin layer of sand, put some pieces of stones and pebbles and then root some water plants collected from the ponds for making the internal environment of this artificial pond as natural as possible. Afterwards, pond water is to be poured in these eggs, then the animals like snails and fishes with their eggs can be introduced in the water. For the safe preservation of the living animals in this aquarium, all precautions about their food and cleanliness of water are also to be followed quite strictly.

The specimens belonging to plants, leaves, flowers, stems of roots etc., should be kept in the proper glass jars by making use of appropriate chemicals.

Proper care should be taken for the safety of the objects like charts, pictures, and models etc. from the rats, white ants, and other harmful insects. For this purpose, the use of disinfectants like D.D.T., Gamaxine powers and naphthalene tablets and the spray of other strong disinfectants may prove quite beneficial.

7.13.2.Terrarium

The animals like earthworms, frogs etc., can be placed in the museum by keeping them safe in terrariums. Different types of terrariums can be constructed as to suit the living conditions and nature of the particular animals.



For keeping earthworm, a terrarium suiting to its requirements may be constructed in the following way:

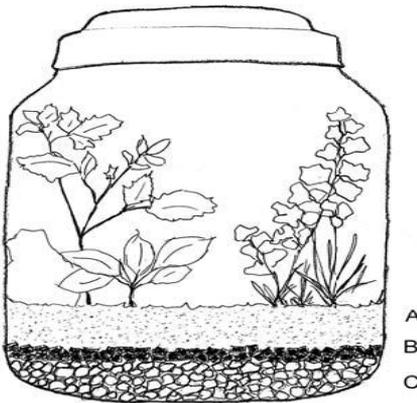
First of all, we have to take a rectangular glass box of portable size. The bottom of this box should be covered with a thick layer of the moist soil from the fertile fields. It is then covered

with the layers consisting of decayed vegetable matter, sands, and pebbles etc. Some earthworms along with their eggs are then laid down between these layers and some insects are also placed for being used as food by the earthworms.

In constructing terrarium for the frog, care is taken for partitioning it into two sections. In one section, there is an arrangement of water storage in the shape of a tank and in the other section, we have moist soil along with grass plants and the food material in the form of insects, flies etc.

7.13.3 Vivarium

A suitable open air caged accommodation may be provided in the museum to keep certain beautiful live animals like rabbits, hares, white rats, squirrels, etc. These animals should be given appropriate food at the proper time and proper cleanliness should be maintained in their cages. If possible, care should be taken that each of them gets the same natural living conditions for which they are most habituated.



Different type of caterpillars, silkworms, butterflies and other insects living in the air can be safely preserved and displayed with the help of vivarium. For the construction of

the vivarium, we take plant growing in an earthen pot and having the eggs of the Caterpillar or butterflies etc. on its leaves. It is covered with the help of a bell jar which is open from both the sides-top and bottom. The open top is closed with the help of a piece of thin cloth in order to keep the caterpillar or butterfly properly within the jar and also to allow the passage of air and light. The soil within the earthen pot containing plant is also kept quite moist for providing the plant all what is needed to its proper growth.

7.13.4 Science Museum:

Besides what is collected or preserved or displayed the most important thing in the organisation of science museum consists in one thing that all essential care is to be taken for maintaining proper cleanliness in the museum. The objects and materials that get damaged and become out of use should be immediately removed and replaced by the appropriate ones. In the end, it needs again to be emphasized that what is to be collected, and kept in the museum should always be arranged and placed in such a way as to allow its maximum possible use for deriving maximum advantages in terms of teaching and learning of the concepts, and principles of sciences.

7.14. Science Clubs:

Needs and Importance

The present age is the age of science and technology. The progress and development of the society is now closely linked with the progress and development in the field of sciences which in turn depends upon the quality of science education imparted to the youngsters in school. Consequently, it needs the inculcation of genuine interest towards the study of sciences, development of scientific attitude, and nurturing

of the creative and inventive faculties of the students. The formal classroom teaching or laboratory work alone can neither help in providing wider opportunities for the inculcation and development of such interest and attitudes, nor caters to the development and realization of the scientific talent. Therefore for serving the desired purpose there is a need of some other platform or means which may be helpful not only in supplementing the task of formal classroom science teaching but may also prove a source of constant inspiration and enthusiasm to the budding scientists for blossom out. The role of such a platform and means in this direction can effectively be played by the science club organised in our schools.

The significant contributions of the science clubs in comparison to formal classroom instructions have been beautifully summarized by Mckown in the following words:

“The club offers the pupil an opportunity for specialization which he does not have in the classroom. In the classroom his work is formal, in the club it is informal, in the classroom he is told what to do, in the club he chooses: in the classroom his method of dealing with topic is clearly outlined by teacher-imposed restrictions, in the club programme the method is of his own devising: in a classroom he tries to please the teacher, in the club he works for his own and his club’s interest and for the joy of doing his works: in the classroom he conforms to a system, in the club he suits his own convenience. In short, the club represents freedom and expression whereas the classroom represents conformity and repression.”

In this way, while being informal in its nature and operation, the activities of the science club offer valuable opportunity for the realization of the broader objectives of science education. The advantages drawn may be summarized as below:

- ❖ Science club provides opportunities for the self-realization and self-expression and thus proves a very good educational source for the release of pent-up emotions and channelizing the energies of the students towards desirable goals.
- ❖ It helps in generating genuine interest in the study of sciences besides inculcating scientific attitude among the students.
- ❖ It provides means and ways for the proper utilization of leisure time.
- ❖ It provides opportunities for the satisfaction of the instinctive urges like instinct of curiosity, constructiveness, inventiveness, hoarding, etc.
- ❖ It helps in linking the school studies more firmly with the outside world and brings the school very close to the society.
- ❖ The theoretical knowledge gained in the classroom and the practical skills acquired in the laboratory may take their applied shape fully through the activities of the science club.
- ❖ It helps in inspiring and energizing the students to work independently or jointly in a team spirit towards learning and using scientific facts and principles and thus proves a birth place for the future scientists.

With all these things on their credit side, the establishment of the science clubs in schools is now being thought as an essential requirement for enriching classroom teaching and making the teaching of science as interesting and useful as possible. The ministry of Education in the center and NCERT in particular are providing valuable incentives in terms of necessary guidance and financial help for the establishment and running of these clubs.

7.14.1 Types of Science Clubs:

In view of their nature and purpose served, the science clubs can be classified as General clubs and Special clubs.

The scope and field of General clubs in science is quite good and broad. These are not specially tied to a single purpose, branch or area of science. These are meant for meeting the requirement of the maximum number of students of varying scientific interests and aptitudes. Such types of clubs are usually named as Science club, Science Association, Biological Association, Physics or Chemistry Society, etc.

On the other hand, the special clubs of science are quite specific and special in the sense that they are meant for serving some specific purpose and specialized interest of their members. These clubs are usually named as Photographic club, Radio club, Nature Study club, Astronomical society, Wild life society, Botanical club, Aviation club, etc.

The decision to establish a particular type of club should be taken very cautiously by taking care of the special or general requirement of the institution and the students, resources available and competencies necessary for running the club. As a general consideration, however, in the case of secondary institutions, it is better to go for the establishment of a General type club as it may serve more useful purpose in terms of making the study of science more attractive, interesting, and useful from the view-points of maximum number of students and classes of the school and moreover it can suit well the resources and environment available on our schools.

Objectives of a Science Club:

The aims and objectives of a science club may be outlined as below:

1. To develop scientific attitude among the students.
2. To provide training in scientific method of problem solving.
3. To create interest in scientific facts and events related to one's surroundings.
4. To enable the students to select and actively participate in the scientific activities and hobbies suited to their special interest and aptitudes.
5. To develop students' interest and participation in the practical application of the knowledge related to different branches of science.
6. To create interest in the latest inventions and discoveries of science in various fields and to get acquainted with the life history and contributions of great scientists.
7. To make the students understand the value of time and to help them in the proper utilization of their leisure time.
8. To inculcate the feelings of fraternity and mutual co-operation and nourish the qualities of leadership.
9. To provide opportunity for the development of the constructive, explorative, and inventive faculties of the students.
10. To help the students in imbibing the habit of self-reliance, self-dependence, and love for manual work.
11. To develop among the students the spirit and attitude of healthy competition for the individual and social cause.
12. To help them in learning the habit of cleanliness and healthful living.
13. To help them in learning the art of organisation and taking initiatives for individual and collective work.

14. To acquaint them with the impact of the development in science and technological field in our day to day life and social progress.
15. To provide proper incentive and inspiration for the pursuit of scientific knowledge in vigorous way by broadening their scientific outlook.
16. To provide opportunities for bringing the school close to the society and acquaint the people with the services and contributions of the science to their life.

7.14.2.Organisation of Science Club:

The responsibility of taking initiative in the establishment of a science club in the school and then far in effective organisation essentially rests with the science teacher. Therefore, every science teacher must acquire the necessary ability for performing such responsibility by taking care of the things mentioned below:

A. Preliminary Organisation

1. The science teacher should try to create a suitable environment and persuade the students to feel a need for establishing science club in their school.
2. After getting appropriate response or initiative from students, s/he must try to contact the head of the institution and senior colleagues for their consent and advice on the issue of starting a science club.
3. With the active co-operation of the head of the institution, s/he should make efforts to arrange for the finances to establish the science club. While some amount may be taken from the finances of the institution and collected from the students in the form of membership fee etc., the department of NCERT, State Government or any voluntary agency may also be appropriate for providing assistance in this project.

4. After performing the above mentioned tasks, the teacher should call a formal meeting of the science students. In this meeting, the proposal and scheme concerning the organisation of science club in the school should be freely discussed. The aims and objectives of this club are to be placed before the students and constitution of the club is chalked out and the membership drive is launched.

B. Structural Organisation.

Structural organisation of the science club usually involves the following office bearers:

1. **Patron.** Mostly, head of the institution is opted for this assignment.
2. **Sponsor.** The teacher in-charge of the club usually acts as its sponsor.
3. The following office bearers of the science club should be nominated or elected democratically in the presence of the
 - (a) President
 - (b) Secretary
 - (c) Assistant of joint Secretary
 - (d) Treasurer
 - (e) Publicity Officer
 - (f) Class representatives

Duties of the Office Bearers:

The patron is required to perform the following responsibilities:

- (a) To advise the sponsor/teacher in-charge of the club in the matters related with the smooth running of the club.

- (b) To provide all facilities for conducting the activities of the club and to make himself available from time to time for participating in the important activities of the club.
- (c) To help in seeking assistance and co-operation from the State and Central Govt. NCERT, voluntary agencies and the department working in his own institution.

Duties of the Sponsor

- (a) To advise the students, President and Secretary in the proper organisation of the club and in farming appropriate programmes.
- (b) To participate in all the meetings and activities of the club and to have adequate supervision over the activities involving laboratory and scientific skills and especially over those involving risk and accidental factors.
- (c) To maintain the proper zeal and enthusiasm of the members for the effective running of the club.

Duties of the President

- (a) To organise the programmes and the activities under the guidance of the sponsor.
- (b) To preside over all the meetings of the club.
- (c) To help other office bearers and members in performing their duties and assignment.

Duties of the Secretary:

- (a) To frame the programmes of the meetings and keep a proper record of the proceedings of the meetings of the clubs.

- (b) To invite the outside experts and guests speakers etc. in the club and attend them properly.
- (c) To take charge of all the correspondence related to the club activities.
- (d) To take responsibility for conducting the programmes and activities of the club.

Duties of the Assistant Secretary:

- (a) To provide full co-operation and to help the secretary.
- (b) To take over the responsibility of conducting the meeting and the club activities in the absence of the secretary.

Duties of the Treasurer:

- (a) To collect subscriptions from the members.
- (b) To keep the proper account of the income and expenditure of the club.
- (c) To prepare budget of the club and present the statement of the account when asked.

Duties of the Publicity Officer:

- (a) To keep a record of all important scientific activities, achievements, and programmes of the club.
- (b) To publicise the activities of the club in the school and outside the school through posters and writing in the magazines, newspapers, and scientific journals.

Duties of the Representatives:

These are the students nominated or elected from the respective sections and classes of the science faculty of the school. Their duties are:

- (a) To actively participate in the meetings and programmes of the club.
- (b) To help in enlisting new members.
- (c) To seek co-operation of the fellow members of the society for the smooth running of the club.

C. Functional Organization

Every office bearer and member of the club should whole heartedly work in a team spirit for the smooth and effective running of the programmes and activities of the club. Usually the following types of activities may be understood in a science club:

1. Arranging talks and lectures of the distinguished speakers, subject experts, and outside guests on the subjects of scientific interests.
2. Arranging debates, group discussions, seminars and workshops, paper reading and quiz contests on the topics related to scientific interests.
3. Arranging excursions and short trips for the members to place of scientific interest.
4. Collecting objects and specimens of scientific interest like, rocks, leaves, seed, insects, butterflies, reptiles, etc. and to preserve them in the science museum for display.
5. Decorating the walls of the classrooms, library, and laboratory with scientific pictures and charts preferably by students themselves.
6. Improvising and preparing handmade apparatus.
7. Organizing science exhibitions and science fairs.
8. Keeping record of day to day weather conditions in the form to tables, charts, and graphs showing maximum and minimum temperature, percentage humidity, wind direction, rainfall, etc.

9. Celebrating the birthday of scientists and other dignitaries connected with scientific advancement.
10. Creating in the school a healthy environment for carrying out scientific studies and activities.
11. Organizing welfare activities for general public and society.
12. Arranging scientific film and shows.
13. Keeping the first aid kits and fire extinguishing services for emergency and period of distress.
14. Arranging cleanliness and health weeks in the institution.
15. Organising school services in the field of health and sanitation.
16. Preparing certain things of common use like soaps, writing inks, tooth powder, shoe polish, phenyl, varnish, etc.
17. Publishing science, magazine, and news bulletin of scientific events.
18. Looking after school garden and helping in the preparation of different kinds of manures and fertilizers.
19. Helping in the proper organization of a science library and laboratory in the school.
20. Helping the institution with its activities to come closer to the community and society and making the science popular among the people.

7.15 Science Fairs:

Science fairs are now becoming popular day by day. NCERT, SCERT and state departments of education are joining hands for the promotion and encouragement of science fairs at district, regional or state levels by providing essential financial aids, guidance, and all other official assistance. These fairs may prove a good platform. Forum and means for

the display of all the activities whether formal or informal in nature undergoing in the field of science education in different schools. These also provide healthy competition among the students with the improvements of science and prove a source of great inspiration and encouragement for making the science populate, interesting and useful among the people of community.

What is done in the Science Fairs?

Science fairs are the joint functions of the holders as well as of the participants. The department of science, belonging to different schools here, joins hands in displaying their formal and informal activities related to the teaching and learning of science by participating in the exhibition as well as competitions and other programmes organized by the host club or some other agency.

Exhibition Displayed in the Science Fairs

The exhibition in science fairs are ordinarily of the following nature:

1. Objects and specimens collected by the students.
2. Graphic material like charts, pictures, graphs and diagrams on various topics and events related to different branches of science.
3. Charts depicting the process and functioning of various inventions and discoveries related to science.
4. Scientific models prepared by students individually or collectively.
5. Apparatus or any other scientific instruments made by students themselves.
6. Scientific toys either electrical or mechanical or magnetic made by the students.

7. Improvised apparatus showing some innovation brought out in the existing cones.
8. Industrial and technological use of certain scientific principle demonstrated through the arrangement of some apparatus or innovative design of a process depicted through charts.
9. Articles of scientific use entirely and exclusively prepared by the students.
10. Display of several projects successfully completed by the students.
11. Good science text books, general and reference books, news bulleting and journal.
12. Good aids for the teaching of different topics in physical and life sciences.

Other activities Undertaken in the Science Fairs:

Apart from organizing exhibitions and displaying the objects, the following types of programmes and activities may also be under-taken in a science fair.

1. Holding debates, declamation, and paper reading contests on different topics of scientific interests.
2. Holding easy competition on the topics of scientific interest.
3. Holding group discussions, seminars, and workshops related with the study. Research and development of science.
4. Arranging lecture and talks of the science teachers and educators on useful scientific topics.
5. Holding science quiz contests.
6. Organising competition in the field of aids used for teaching science.

7. Organizing film shows and plays on the topics and themes related to the development, study and application of science.

Purposes and objectives of the organization of Science Fairs:

Science fairs are seen to serve some of the following purposes and objectives-

1. Science fairs prove a good media and means to the science students for trying out theory into practice.
2. Science fairs afford opportunity to the students as well as members of the community to understand the practical application and utility of science.
3. From these fairs, the students get opportunity to see the individual or collective performance of others students for being encouraged and inspired to work hard in the pursuit of science.
4. Science fairs create interest in the students for science and thus may help in making the study of science a joy in itself.
5. These fairs provide opportunity to the talented and creative talents.
6. Such forum helps in bringing out the future scientists into limelight and this may prove quite helpful in catching them young for being trained as a skilled and technical personals and inventors for the growth of the society, nation and mankind.
7. Science fairs help in providing satisfactory forum and opportunity for the healthy competition on the individual and the institutional level.
8. Science fairs bring the school quite close to community and the society. The guardians of the students derive pleasure and satisfaction on seeing the

performance of their wards. They are also acquainted with the utility and service of science in their day-to-day life.

9. Science fairs may help in knowing about the methods, techniques, and aid materials developed by the individual teacher. Students or institution and deriving benefit by coming into contact with each other.

7.15.1 Organization of Science Fairs:

Science fairs are organized by the individual intuitions not only for their own students but these may also be organized in the level of inter-schools, inter-district, and inter-state levels. For their effective organization at any level, the science teachers have to play a significant role in terms of the planning as well as execution. In general, the following things are to be kept in mind by them for the organization of these fairs. For their effective organization at any level, the science teachers have to play a significant role in terms of the planning as well as execution. In general, the following things are to be kept in mind by them for the organization of these fairs:

1. The science teacher (in-charge) should seek the co-operation of the head of the institution and also of his colleagues and the students before undertaking the task of organizing science fair in his/her school. Moreover, it is also necessary for him to ensure the active co-operation and help from the participating institutions and teams for the effective organization of science fair.
2. The major problem concerning the availability of the finance for the organization of science fair can be solved by seeking due co-operation from all corners. Besides the contribution from the host club and financial assistance from NCERT, SCERT and state

government, the participating teams should also contribute in the form of entrance fees and bearing expenses in setting up of their exhibits and participating in the competitive activities.

3. In the matter of the selection of site, proper spacious site is to be selected as to provide maximum facility for the successful organization of the fair.
4. Proper allocation of space should be provided to each participant team according to their needs and requirements.
5. Rules and regulations regarding participation, display and security of their own goods and equipments should be made clear to everyone of them.
6. All required amenities should be provided for each team. There should be connections of electricity, water, gas, etc. available to them.
7. Each team should arrange for their own guides to explain the functioning of their gadgets and exhibits to the public.
8. The exhibits should be easily visible and their working and principle should be demonstrated and explained by competent guides.
9. Different separate sections should be made for the display of gadgets and exhibits concerning different branches of science. E.g. Physics section, Chemistry section, Botany Section, Zoology section, etc.
10. Easy section branch of science may also have subdivisions concerning their own one or the other kinds of exhibits grouped together. E.g. Electronics divisions, hydrodynamics divisions, mechanical divisions, etc.
11. Time of opening and closing of the science fair should be notified beforehand.

12. Arrangement should be made in such a way as not allowing the visitors to make a crowd at one place. There should be proper flow of visitors in a queue, one behind the other as far as possible.
13. The programme of talks, lectures, and other items such as debates, declamations, discussions, seminars etc. should be chalked out properly well in time and due publicity should be given to it.
14. In case science film shows are to be arranged, the films, accessories etc. should be arranged beforehand to avoid any disappointment and inconvenience.
15. There should be proper arrangement of safety and security of the properly of each participating team and also of the total site of the fair.
16. Awards and prizes should be given to the deserving participants and teams for providing necessary incentives and encouragement.
17. The judgment and evaluation of the work and exhibits of the participating teams should be quite impartial and fair. The host institution should try to appoint quite capable, honest and impartial judges for this purpose.
18. There should be an environment of love, mutual trust, and co-operation among the participant teams. If competition is there, it should be a healthy one as to inspire and motivate the participants to learn and work more in the pursuit of science.

7.16 Classification of Educational Materials

The educational materials which can be developed from different materials can be classified in terms of:

- i) Freely (no cost) and easily available materials in the environment. These can be in the natural environment such as plant, animals, and minerals as well as scraps/waste from commercial and domestic use.

- ii) Easily accessible materials in the environment with very little cost such as masks, battery, bulbs, wire, cardboard, etc.
- iii) Materials available for large-scale distribution such as charts, models, etc.
- iv) Materials which need use of machines such as projectors, tape recorders, cameras, record players, etc. and
- v) Materials for mass media or distant learning systems such as radio, TV, etc.

7.16.1 Characteristics of Improvised Apparatus

The following are some characteristics of improvised apparatus:

- i) The raw materials are easily available either free of cost at low cost in the local environment.
- ii) The materials do not involve specialized skills and can be made by pupils, teachers or members of the community.
- iii) The materials can be easily and effectively used by the teachers and pupils in clarifying the set objectives.
- iv) The process involved in the production of the materials is simple and inexpensive.
- v) The material is simple, accurate, and appropriate to the age level of the users.
- vi) The material stimulates thinking, reacting, discussing, experimenting, or further study.
- vii) The material is free from distractions, conflicts or bias.
- viii) The production of the materials is not time-consuming.

Process of Developing Improvised Apparatus

The flow chart given on following page shows the process of developing improvised apparatus. The different steps involved in are:

- i) Definition of objectives: The objectives of the materials in terms of knowledge, skills, and attitudes to be developed are defined in the light of the needs of the users.

- ii) Preparation of a design: A design for the development of different materials is decided in terms of the type of the materials to be developed, its cost, relevance, and the resources available in the local environment.
- iii) Development of materials: After having decided the design, the materials are developed by students, teachers, specialists or community in cooperation with each other.
- iv) Pilot testing of the materials: The pilot testing of the materials is done by the teachers or researchers with selected sample users. On the basis of the results of pilot testing necessary improvements are made in the materials. This also provides a feedback for modifying objectives and design of the materials, if necessary.
- v) Finalization of materials: If the material is considered satisfactory after pilot testing, it is finalized for production.
- vi) Production and distribution: Adequate number of copies of the final materials are produced. It is distributed to different schools if it is considered valuable to users.

Problems in the Development and Effective Use of Improvised Apparatus

The development and effective utilization of improvised apparatus is sometimes affected by one or more of the following factors:

- i) Indifference or reluctance of teachers and administrators.
- ii) Inadequate skills of pupils and teachers in production or construction techniques.
- iii) Lack of sources, funds, and facilities.
- iv) Lack of time on the part of pupils and teachers.
- v) Lack of awareness of the resources available in the local community.
- vi) Lack of initiative and resourcefulness of teachers and administrators.
- vii) Administrative and other constraints.

Many of these problems can be solved if the teachers are provided appropriate training in the development, production, and utilization of low-cost educational materials. The administrative support is also essential for the effective development and utilization of low-cost material.

7.16.2.Improvised Apparatus

Self-improvised apparatus have a number of advantages out of which the main are:

1. Educational and Psychological Utility
2. Economic Utility
3. Social Utility
4. Recreational value
5. Scientific Utility
6. Practical Utility
7. Identification of Talented Students in Science

1. Educational and Psychological Utility – A child always learns by doing and is active by nature. In assembling of the apparatus, the children get some constructive work to do and creating something new gives them tremendous satisfaction. As a result of satisfaction, the students are motivated to make new discoveries and find psychologically more competent for themselves. A co-ordination between the mind and hands develop and s/he prepares the apparatus with his/her own hand and as such also attain knowledge of the theories and principles related to that apparatus. In this manner, the construction of improvised science apparatus develops a co-ordination of hands and mind, while gaining knowledge of the practical aspects of science his/her interest is created in scientific hobbies and interests.

2. Economic Utility – In the assembling of these apparatus those items which are used are considered to be waste and thrown or those items which have low cost or inexpensive. Thus, these items are prepared at nominal cost and a Biology Teacher, without burdening the school with

extra expenditure, prepares the apparatus for experiments and thus, makes his/her school laboratory more powerful and well equipped.

3. Social Utility – Self-improvised apparatus have a social utility because the construction of these material forms the habit of doing the work by own hands. Loyalty towards labour increases the habit to work together without any disparity and makes the child moulds himself/herself according to the needs of the society and moves towards the goal of socialism.

4. Recreational Utility – The students derive pleasure while working. Thus, when they start working on the construction of an apparatus, they do so happily. In this way, they keep themselves busy and think about creative and constructive activities. They keep themselves busy preparing such apparatus in their leisure and even on holidays and recreate themselves.

5. Scientific Utility – When the children work themselves, they develop interest in scientific activities and apparatus, as a result, they attain scientific knowledge and develop scientific outlook. The student's self-confidence is increased and they can prepare and use apparatus according to their requirements. This way, they try to relate science to their daily lives. It enhances the qualities of liking towards discovery and exploration, correct evaluation, etc. It enhances the concrete ability, interest, invention, and discoveries and the quality of correct evaluation of students.

6. Practical Utility – The construction of any apparatus inspires the students to work in an organized manner. They can discover new apparatus, produce them according to needs, repair old apparatus; they can also take interest of upkeep of the apparatus and decorating them.

7. Identification of Talented Students in science – Self improvised apparatus is prepared under the supervision of the teacher. Thus, the teacher can easily find out which students

have scientific potential/talent. The students having potential can be given proper opportunities and help them become capable scientists and thus, take constructive steps to help these talented students. By the construction of such improved apparatus, scientific talent can be tapped and care can be taken to promote and patronize them.

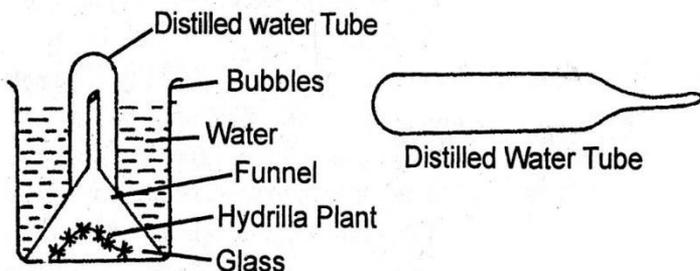
Some improvised apparatus

1. Apparatus to understand the respiratory system in plants – Material required

- a) A glass jar
- b) A glass funnel
- c) Empty tube of distilled water for injection
- d) Hydrilla plant
- e) Water

Procedure – Fill the glass with water. Place the hydrilla plant inside the glass. Invert the funnel over it. Then break the neck of the distilled water tube carefully so that it becomes a symmetrical tube (resembling a test tube). Fill water in the tube and convert it over the funnel end carefully and the whole assembly is kept in the sun.

After some time, we will see that some bubbles are arising and the level of water in the tube is decreasing. If a glowing splinter is brought near the collected gas, it kindles. This shows that the evolved gas is oxygen which is expelled by hydrilla plant as a result of respiration.



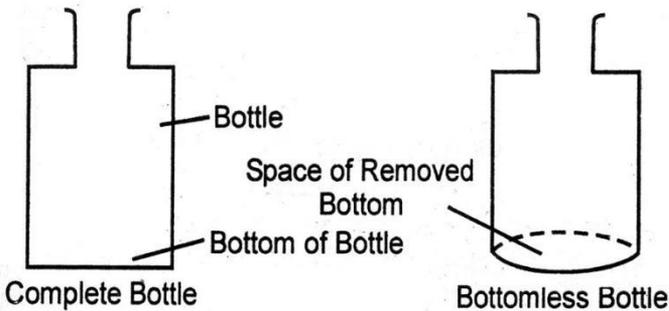
2. Apparatus to understand the functioning of the Lungs –

Materials required

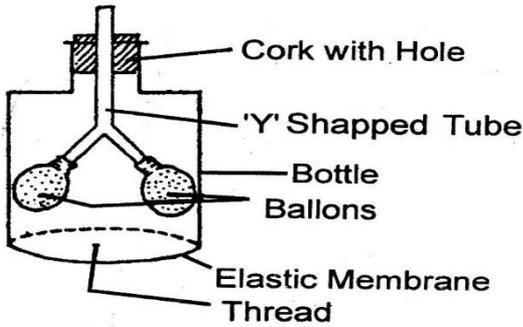
- | | |
|-------------------------|--------------------|
| a) A large sized bottle | b) 'Y' shaped tube |
| c) A elastic membrane | d) Two balloons |
| e) Rubber – cork | f) Sand |
| g) Blotting paper | h) Stove |

Method – First of all, the bottom of the bottle should be removed. For this, we mark the portion to be removed with the help of a file. Then, wet a blotting paper and stick it on both sides of the mark. Heat the bottle upon the mark. It cracks and in this way, the whole bottom is removed.

The 'Y' shaped tube is fixed into the bottle with the help of rubber cork having holes in it. The balloons are then tied to the inner arms of the 'Y' shaped tube. The bottom of the bottle is covered with an elastic membrane having a small hole in the center to allow a thread with a knot at one end so that the elastic membrane can be pulled.



Procedure – When the thread is pulled, the elastic membrane also is pulled and a vacuum is created in the bottle. The air enters the bottle through the 'Y' shaped tube and the balloons inflate. This process is similar to the functioning of lungs. The lungs inflate by which diaphragm is enlarged.

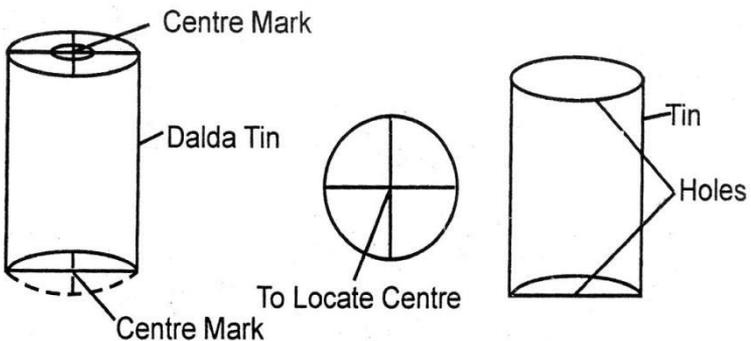


3. Apparatus to measure the growth of a plant – Material required

- (a) An empty Dalda tin of 4 ½ kg.
- (b) Two wooden bars of 3 ft. length, 2 ½ inch breadth and ½ inch thickness.
- (c) 02 mm thick two nails
- (d) Scale
- (e) Pencil
- (f) Nails and hammer

Method – Close the lid of the Dalda tin tightly. Locate the center of the tin on both sides as shown in the figure.

Then on both sides of the tin make two holes of a little more than 2mm diameter at the center point located.



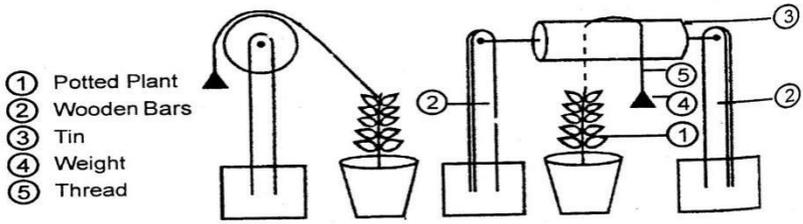
After drilling the holes, take the wooden bar and at equal height fix the 2 mm thick nails. Fix the tin in the nails in such a manner that it rotates freely. Then fix the bars in the ground or with the help of bricks ensuring that the tin rotates freely. Tie a thread to the upper most tip of the potted plant on one side and a weight on other side of the thread. Then place the plant near the wooden bars. Put the end of thread, having the weight over the tin. After assembling the apparatus, measure the height of the weight from the ground (base) a cm. Later on, after a number of days, re-measure the height from the ground (base) b cm. The difference in the reading (b-a) is the increase in height of the plant. Thus, by the observation of the difference in heights, the actual growth of the plant can be studied.

4. Apparatus to understand the functioning of the Muscles

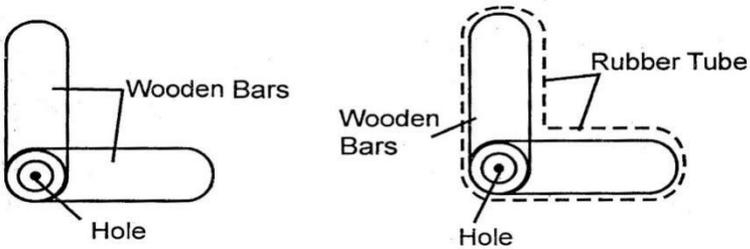
– Material required

- (a) An old cycle tube
- (b) Two wooden pieces/blocks
- (c) Thumb pins (drawing pins)
- (d) Screws
- (e) Nut socket

Method – Cut two pieces of rubber tubing equal to the size of the wooden pieces. Place the wooden pieces one on top of the other (as shown in the following diagram) and make a hole. Screw them together so that the joint is movable. Fix the pieces of rubber tubing on both the ends of the wooden pieces with the help of thumb pins (drawing pins). Now the tube fixed on the wooden bars is fixed on the other bar in the same sequence with drawing pins.



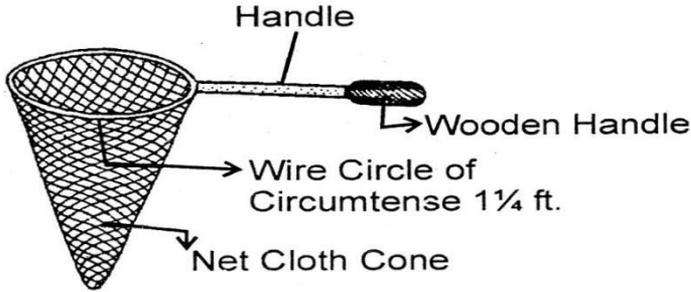
Procedure – When the wooden bar is raised up, the tube on that side contracts and the other side expands. If the wood is considered as bone and tube as muscles, then this apparatus helps in understanding the functioning of the muscles.



5. Butterfly Trap – Materials required

- (a) 4 ½ feet long iron wire (which can bend with pliers)
- (b) Pliers
- (c) Cloth used for mosquito nets
- (d) Needle and thread and wooden handle

Method – The wire is bent to make a circle of about 1 ¼ feet and the edges should be tightened with the help of pliers. Then double fold the rest of the wire about 8” long to make a handle. Then, the net cloth should be made into a cone of about 1 ½ feet height stitched along the wire circular frame. Then the wooden handle should be fixed on the wire handle and tied with a thread. The trap is ready.



List of some items which can be improvised

1. Auxonometer
2. Models of different plants and animals and their various organs osmometer.
3. Osmometer
4. Photometer
5. Slides of plants and insects
6. Construction of Aquarium, Terrarium and Vivarium and their decoration
7. Preservation of plants, animals and insects
8. Respirometer

REVIEW QUESTIONS

1. Write a short note on importance of practical work in teaching biology
2. How should the practical work in biology laboratory be organized
3. What is field trip? Mention its advantages.
4. Write notes on Aquarium, Terrarium and Vivarium
5. What are the uses of biology museum?

Chapter 8

EVALUATION

8.1 Concept and Process of Evaluation

Evaluation is a process through which the assessment, achievements and effectiveness of educational programs are determined. It serves as an assessment programme by which the strategies of education or the method of teaching can be put for reviewing. The feedback obtained could be considered for the implementation of the next educational programme. Sometimes evaluation is considered as an effective guidance programme. Evaluation of education is an important aspect of teaching-learning process. After deciding ‘what to teach’ (curriculum) and ‘how to teach’ (methods), the next step in teaching-learning process is ‘how to know that the students have understood/learned what has been taught’ (evaluation). It is mainly concerned with the determination of the pupil’s achievements during a given period of time and also to motivate them to put extra effort in their further studies. It is a means to determine the potentialities and interests of each and every student. The teacher should use the evaluation data as a diagnostic device to provide proper remedial measures to improve the students’ learning process. The process of evaluation is also meant to test the effectiveness of methods and instructions employed during the course of teaching and the extent of achievement of educational goals. Evaluation does not mean just the measurement of marks of the students in his/her subjects, but it is the overall assessment of students’ performance in his/her class.

Educational evaluation includes a series of activities, designed to measure the effectiveness of the teaching-

learning system as a whole. This system consists of three major elements - instructional objectives, learning experiences, and learner appraisal. It measures the quality of the learners' learning and any other outcomes, which need to be evaluated.

Educational evaluation is a systematic process, which determines:

- The extent to which the educational objectives are achieved.
- The effectiveness of the various learning experiences provided in the classroom.
- The change brought about in the total personality of the learner.

8.2 Meaning and Definition of Evaluation

Evaluation is defined as a process of gathering the data and analyzing it in such a way that the resulting information is used to determine whether the programme is effectively conducted according to the objectives achieved, activities planned, and arrived at the anticipated results. The word evaluation carries a number of synonyms like 'evaluating', 'measuring', 'assessing', 'appraising', 'examining', 'testing', 'marking', 'grading' and 'scoring'.

Evaluation is defined in different ways by different educationists. Some are:

According to Mary Thorpe: "Evaluation is the collection, analysis and interpretation of information about any aspect of a programme of education, as part of a recognized process of judging its effectiveness, its efficiency and any other outcomes it may have."

According to Bradfeild: "Evaluation is the assignment of symbols to phenomena in order to characterize the worth or value of a phenomenon usually with reference to some socio-cultural or scientific standard".

According to Dandekar: “Evaluation may be defined as a systematic process of determining the extent to which educational objectives are achieved by pupils”.

According to Kothari Commission: “Evaluation is a continuous process. It forms an integral part of the total system of education, and is intimately related to educational objectives. It exercises a great influence on the pupils study habits and the teachers methods of instruction and thus helps not only to measure educational achievement but also to improve it. The techniques of evaluation are means of collecting evidences about the students development in desirable directions.”

According to Remmers and Garge: “Evaluation assumes a purpose or an idea of what is good or desirable from the standpoint of the individual or society or both”

8.3 Need for Evaluation

Evaluation is an integral part of the teaching-learning process. It helps in understanding what the students have understood/learned from what is taught in the class. Evaluation is generally used to pass judgments regarding the students’ progress in a subject or field of action, but evaluation can also be used to assess students’ learning and make suggestions for his/her improvement. Therefore, the teacher should use the evaluation data as a diagnostic device to provide proper remedial measures to improve the students’ learning process.

Bloom states the importance of evaluation as:

9. To discover the extent of competence which the student has developed in initiating, organising, and improving his day- to-day work and to diagnose his/her strengths and weaknesses with a view to further guidance.
10. To predict the educational practices which a particular

student-teacher can participate in or organize.

11. To certify the students' degree of proficiency in a particular educational subject after completion of the course.

8.4 Importance of Evaluation

Education primarily aims at growth and development of the students. The process of evaluation helps in the improvement of education. Evaluation is a very dynamic process. Evaluation is not only a means for testing the academic achievements of the students but also helps in testing all the important dimensions of the students' personality and academic activities. It helps in recognizing the need of objectives and also helps in modifying them, if required, according to the needs of the individual and the society. It also helps in identifying the psychological requirements of the study material. It evaluates the curriculum and modifies it according to the needs of the changing objectives. It helps in testing the all round development of the student along with the skills in a particular field. Thus, it acts as a diagnostic and prognostic means and serves as a guide to the teacher and the student. It also helps in modification and improvisation of the evaluation tools and techniques. The process of evaluation does not end just with testing but continues to find the other aspects like limitations in the objectives, method, curriculum, evaluation tools, and techniques and then, forms the basis for bringing about the required changes. Thus, evaluation provides continuous improvement in the whole educational process.

In the Indian context, evaluation means examination which is used to determine the scholastic attainment of the student rather than evaluating the total growth of the student/child. In reality, examination is just a part of evaluation which in technical terms is called measurement.

8.5 Relation between Assessment, Measurement and Evaluation

Assessment:

Assessment is derived from the word, 'assess', which means 'to sit beside' or 'to assist'. Assessment in educational terms can be defined as, 'a process of gathering the data and fashioning the collected data into an interpretable form, from which the judgment can be made on the basis of set assessment rules.' The processes and instruments designed to measure the learner's achievements when the learner is engaged in the instructional programme is called as assessment. It is used to ascertain the extent to which the objectives of that particular instructional programme are fulfilled. Assessment precedes the final stage that is the evaluation.

Measurement:

The concept of measurement is often used while dealing with the tests or examination. Measurement is mainly concerned with gathering or collection of data that is scores of the students in various subjects. Measurement deals with only a part of the process of evaluation. It is concerned with a single aspect of the subject and does only quantitative assessment of the students' learning. For example, in an examination, a student obtains 20/25. It means that the teacher has measured the performance of that particular student in the examination. This process is considered as measurement. Measurement therefore can be defined as a process of assigning a number to the students' achievements. Measurement provides a quantitative description to the student's performance. Measurement emphasizes on the skills and abilities of the students. It measures the progress of the students and identifies the present status of the students.

Evaluation:

Evaluation is the process of finding out the extent to which the instructional objectives have been attained. Evaluation encompasses a wider terminology than the measurement. Conducting an examination and giving marks is measurement. Comparing the scores and judging their achievements is evaluation. For example, a student getting 65/100 marks is measurement. Based on the marks, if a student is considered as an average candidate in that particular subject, it is called evaluation. Evaluation is not only limited to the paper and pencil tests. Any valid evidence that helps a teacher to understand the pupils better so that the pupils can achieve an all-round development is called as evaluation. Techniques of evaluation are based on the principles of scientific and psychological observation, analysis and interpretation of the pupil's abilities.

Purpose of Evaluation:

Evaluation has two main purposes. They are:

- ❖ Administrative
- ❖ Educational

The educational purpose of evaluation is concerned with the maintenance of quality of education in the areas of

- Curriculum
- Teaching methodology
- Learning by the students

The administrative purpose deals with the

- Entire educational system
- The parents
- The society

8.6 Characteristics of Evaluation

Important characteristics of evaluation are:

- **Evaluation is a continuous process:** Evaluation of education is a continuous process, which is intimately

related to the educational objectives. It not only measures the educational achievements of the pupils but also improves the educational practices.

- **Evaluation is both academic and non-academic:** Academic evaluation by the way of examinations measures the knowledge gained by the students as part of their educational programme. The non-academic evaluation evaluates the attitudes, skills developed during their learning, and the changes observed in their behaviour with their friends and teachers in their school. The teacher takes up the responsibility of both the academic and non-academic evaluation of a student.
- **Evaluation improves the educational product:** Evaluation is a procedure on the basis of which plans are formulated to establish goals and decide what procedures should be followed to achieve these goals. That is to say, evaluation is a comprehensive procedure which plans for formulation of goals, conducts the process of teaching-learning to achieve these goals and judges to what extent these goals are achieved. Evaluation is a procedure used to improve the product of education.
- **Evaluation helps in creating need-based learning experiences:** The basic purpose of education is to provide objective based learning experiences, which suits the needs and abilities of the students. The programme of evaluation measures whether the students have achieved the required objectives or not by using different techniques like checklists, anecdotal records, and a battery of examinations. Based on these results, the various learning experiences are formulated.

- **Evaluation fulfills the overall purpose of education:** Evaluation encompasses the overall purposes of education. It evaluates the techniques of classroom instruction, determining whether the students are deriving the benefits from the system of learning and the changes that are required to improve the educational practices. It should also evaluate the personal and professional attitudes of the teacher as they have a direct effect on the teaching learning process.

8.7 The Concept of Evaluation

Evaluation is relatively a new term in the educational process. Concept of measurement was considered as evaluation while dealing with the tests or examination. Today, we consider measurement as a part of the process of evaluation. It is concerned with measuring only the quantitative aspect of teaching -learning that is carried out in the classroom. It only involves the assessment of the students' academic progress for a given period of time. The new concept of evaluation renders emphasis on developing and evaluating the broad aspects like attitudes, interests, abilities, skills, and the changes brought about in the behaviour and personality of the pupils. Thus evaluation has a wider meaning than the testing and measurement and provides a comprehensive outlook for the assessment of students' progress.

The new concept of Evaluation is not only quantitative but also qualitative in its assessment and is based on a number of factors like:

1. Pupil-centered approach to teaching
2. Emphasis on individualized instruction
3. Activity-centered curriculum
4. Limitations of traditional examination system

8.8 The Process of Evaluation

The process of evaluation is very complex and consists of various steps. They are enumerated below.

Formulating the objectives: The teacher has to identify the objectives of instruction before teaching a lesson. The specific learning outcomes of these objectives should be stated clearly.

Designing learning experiences: The teacher has to devise specific learning experiences to achieve the instructional objectives. It includes appropriate usage of teaching methods, teaching materials, and relevant teacher activities.

Selection of evaluation tools: The teacher has to use suitable evaluation tools to evaluate the students' performance regarding the academic achievements. The teacher may select the oral, written, or practical examinations as part of evaluation tools.

Collection of the data of students' progress: The teacher has to collect specific information about the knowledge gained by the students as a result of teaching-learning process.

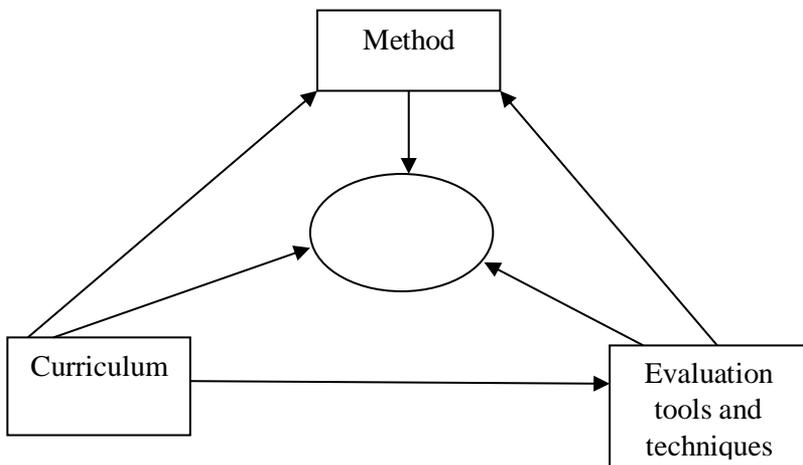
Analysis and interpretation of result: The teacher has to analyze the performance of the students. The evaluation should encompass not only the performance of the student in his/her academics, but also the achievement of instructional objectives, the teaching methods employed in the classroom, the activities conducted in the classroom, and overall behaviour modification observed in the students. The process of evaluation should indicate the level to which the student has performed rather than judging his/her performance.

8.9.1 Suggestions for improvement and remedial

measures: Based on the feedback obtained from the evaluation procedure, the teacher has to identify the weak points of the students and carry out remedial measures for their improvement. Similarly, the defects that are observed either in the teaching methods or materials used, teaching activities carried out, or the objectives formulated should be

rectified or modified. The new techniques of classroom instruction should be developed accordingly.

Triangular Process of Evaluation



Objectives

8.9.2 Advantages of the evaluation process

- Evaluation helps in improving the instructional strategies.
- Evaluation provides a basis for better teaching-learning procedures.
- Evaluation gives clarity to the educational objectives.
- Evaluation helps in the development of remedial programmes for poor achievers.
- Evaluation prepares the ground for bringing changes in the curriculum.

8.9.3 Functions of Evaluation

The important functions of evaluation are:

- Evaluation of the students' academic achievements
- Evaluation of behavior modification of the students as a result of classroom instruction
- Evaluation of the achievement of the instructional

objectives

- Evaluation of the methodology of teaching used by the teacher in the classroom
- Identification of problems of the students and providing the suggestions for remedial measures

8.10 Types of Evaluation

There are three types of evaluation

1. Diagnostic
2. Formative and
3. Summative

Diagnostic Evaluation: Diagnostic evaluation is a comprehensive mode of evaluation which helps in diagnosing the strengths and weaknesses of the students. It uses different techniques like specially prepared tests and observation tools. This type of evaluation is carried out at the beginning of the course at the individual or class level. It analyses the potentialities and also the needs of the students and helps in designing the curriculum and the courseware for the students of a particular class. It also helps for formative evaluation at the later stages. Serious problems of the students like the learning disabilities and psychological problems can be identified by diagnostic evaluation. Immediate remedial measures can be suggested for treating the students. Hence, diagnostic evaluation helps in identifying not only the level of the students but also the learning and psychological problems of the students and providing remedial measures for them.

Formative Evaluation: This type of evaluation deals with testing the knowledge gained by the teaching learning process. It evaluates the progress achieved by the students in their academics and the usefulness of the curriculum. The feedback taken from this type of evaluation helps in upgrading or modifying the curriculum to suit the needs and abilities of the students. It also helps in developing suitable teaching

techniques to aid in the improvisation of the system of education. Formative evaluation is conducted periodically. The teachers identify the discrepancies of learning in the students and carry out remedial measures for improving them by using the results of this evaluation. It also helps them to plan and modify their teaching strategies to suit the abilities of the students.

The main features of the formative evaluation are:

- To provide individualized instruction
- To observe the progress of every student
- To analyze the effectiveness of curriculum and the need for its upgradation.
- To assess the competencies of the teacher and the effective teaching strategies.
- To improve the overall learning environment of the student.

Summative Evaluation: The summative evaluation is conducted at the end of academic year after completion of the entire curriculum. It helps in assessing the final product that has been developed through the process of evaluation. It evaluates the achievement of the objectives of education. It is designed in such a way as to determine the extent to which the behavior modification has been observed in the students. Various types of tests are used in summative evaluation. Achievement tests and annual examinations are good examples of summative evaluation.

8.11 Tools of Evaluation

“A tool of evaluation in education is a device or technique that will facilitate the process of measurement”. The main objective of the modern concept of evaluation is not only to evaluate the students’ academic achievements but also the overall personality of the individual. The various types of tests, observation, schedules, and rating scales that are used

to evaluate the overall behaviour modification in the students are called as the tools and techniques of evaluation. These techniques are qualitative as well as quantitative. The quantitative techniques provide a formal evaluation which is a numerical measurement. The qualitative techniques are non-formal; they conduct observation and provide a subjective evaluation of the individual.

The tools and techniques of evaluation can be classified under three main categories. They are

1. Observational techniques
2. Testing techniques
3. Self-reporting techniques

<i>Observational Techniques</i>	<i>Self-reporting Techniques</i>	<i>Testing Techniques</i>
Observation	Interviews	Achievement tests
Checklist	Questionnaire	Teacher-made tests
Rating scales	Interest inventory	Standardized tests
Anecdotal records		Diagnostic tests
Cumulative records		Intelligence tests
		Aptitude tests

Observational Techniques:

They are the techniques of evaluation where the behaviour of an individual is observed in different situations and noted by the observer and/or the researcher. The behaviour modification is denoted in a sequential and orderly manner. The observation technique, the checklists, the rating scales, and anecdotal records are some of the observational tools.

Observation:

Observation is one of the important techniques used by the teachers to understand the knowledge gained by the child. It also helps in identifying the child's abilities. The teacher observes the child's responses in various situations, his/her attitudes, interests, feelings and his/her relation with peers and elders. The data collected by observation helps in providing a realistic picture of the students and in diagnosing his/her abilities and weaknesses. It helps in developing a desirable blueprint of the child's future.

Observation is a subjective technique. The main drawback of this technique is the bias towards the individual. Observation may show the behaviour of the individual under a given situation only; it may not give an accurate picture of the general behaviour of the child and may be misleading.

8.12 Types of Observations

❖ **Natural observation:** This type of observation is carried out under natural conditions of the student. The teacher and the student do not face each other. The student does not have an idea of being observed. Hence, there is no chance of modifying his/her behaviour for the observer's sake. This type of observation is a realistic observation.

❖ **Participative observation:** In the participative observation, the teacher actively engages himself/herself along with the students in their activities and observes their behaviour. In this type of observation, the teacher collects the first hand information of the students' behaviour. The teacher has to take care of not being noticed while observing since some students may modify their behaviour.

❖ **Non-participant observation:** In non-participating observation, the teacher observes the students from a distance. The students are not aware of this observation. The collected data is accurate. Since the observation is from a distance, the teacher may

misunderstand some behaviour.

Advantages

The advantages of observation are:

- ❖ A simple tool of evaluation
- ❖ Constant observation of the students
- ❖ It is an economical method of evaluation
- ❖ Easy remedial action

Disadvantages

This technique has the following disadvantages:

- ❖ A subjective method of evaluation can lead to bias in judgment.
- ❖ Cannot account for the modification of the students' behaviour when the observation is noticed.
- ❖ It cannot be validated as one observation may differ from the other.

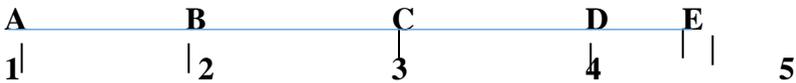
8.13 Rating scales

The term “Rating” expresses an opinion or an idea about a situation or an object. The rating scales provide a systematic procedure for obtaining and reporting the judgments of the observers. A rating scale consists of a set of characteristics or qualities to be judged. The rating scale indicates the degree to which each attribute is present in the individual. The rating scale is merely a reporting device. It is expressed by a scale of values. The person who rates the attributes does it by observation. It is also a subjective tool of evaluation. There are different types of rating scales. They are:

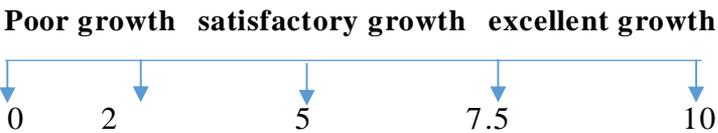
Descriptive Scale: The rating is descriptive. Usually the rating is done on a five-point scale.

A	B	C	D	E
Excellent	Good	Satisfactory	Average	Poor

Numerical Scale: In this type of rating, a number is the descriptive five point scale.



3. Graphic Scale: This scale is also straight line which has descriptive phrases. Few points denote each phrase. Putting a tick mark at the particular point of the phrase carries rating.



8.14. Checklists

The teachers identify certain traits in the students by using the checklists. It is a method of recording whether a characteristic is present or absent or whether an action was taken or not. Checklists are used as an overall guide to assess children's personality in general situations or they may be applied specifically to an individual child's behaviour. The specific points usually studied include the behaviour. Features indicate the presence or absence of the trait under study. The checklists are similar to rating scales in appearance and use. The basic difference between them is that a rating scale provides opportunity to indicate the degree to which a characteristic is present or the frequency with which behaviour occurs. On the other hand, the checklist calls for a simple "yes" or "no" decision. The data collected from the checklists provides good basis to the teacher to understand the progress as well as the personality of the students.

8.15 Anecdotal record

Anecdotal records provide a description of the behaviour of the students. It is a promising method of

evaluating the students' behaviour in different situations. The teacher observes the major events in the life of the students' and makes note of their behaviour in these situations. According to Randall, "the anecdote is a record of some significant items of conduct, a record of an episode in the life of the students, a word picture of the student in action, the teachers - best effort at taking events in which the student takes such a part as to reveal something which may be significant about his personality". The anecdotal records provide a documentary evidence of the changes in the behaviour which occurred as well as the changes that are in progress. The anecdotal records are made effective by noting down the time and date of the incidents along with the circumstances as well as the description of the incidents. The most valuable observational records are the descriptions of significant incidents in the life of the student. The anecdotal records provide evidences of students' interests, attitudes, social behaviours, and skills. The anecdotal record provides useful data about the pupil's behaviour in real life situations.

8.16. Cumulative records

The cumulative record maintains record of information about the students from a specific period till date. It incorporates all the relevant information of the students like their interests, hobbies, their intelligence, regularity, likes and dislikes, strengths and weaknesses, classroom behaviour, scholastic achievement etc., in totality. It includes all the scholastic and non-scholastic information which can be evaluated by the teacher through a number of activities carried out in the school. It also shows the improvement in all these aspects of behaviour in a child.

The data that is maintained in a cumulative record includes:

1. Personal data
2. Scholastic achievement
3. Physical data
4. Co-curricular activities
5. Interest and hobbies
6. Testing Techniques Test

A test is a device to obtain measurement in education. A test usually presents a uniform set of tasks to all members of a given group at a scheduled time with a due prior notice. Tests are meant only for checking the knowledge of the students.

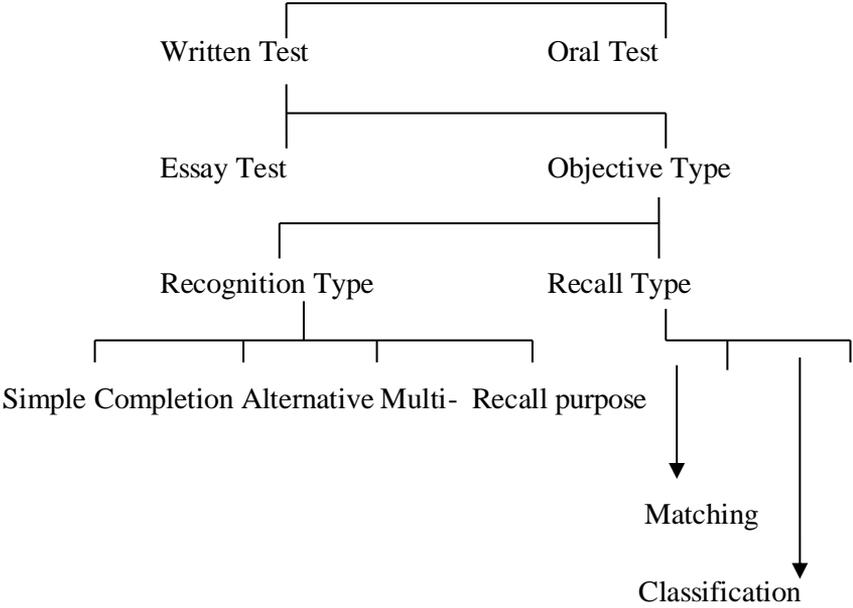
8.17 Types of Tests

Achievement tests: These tests are widely used in the classroom by a teacher for various purposes of testing. They are:

- To measure prerequisite skills needed for the course or unit
- To assess the achievement of objectives
- For assigning grades
- To monitor the students learning process
- To identify students learning difficulties

Achievement tests are generally classified as teacher made tests and standardized tests.

Schematic Representation of Achievement Test



8.17.1 Teacher-made tests

Teacher-made tests are those tests which test the assimilation of learning by the students as a result of classroom instruction. It helps in improving the classroom teaching. In classroom test the content matter and almost every outcome can be put to test. The emphasis in classroom testing is on the test at the end of a short period of instruction. The class test can take many forms. It shall consist of a short duration, objective type test, having the format of constant alternative or multiple choices or multiple facets or the combination of these.

8.17.2 Oral tests: Oral tests are usually used in the lower classes and sometimes in higher classes in science.

In science subjects, viva voce are usually conducted in the practical tests or at the end of the project work. In this test, the student answers the questions verbally in a face-to-face manner.

Advantages

- Wide range of topics and matter could be covered.
- Misconceptions and doubts among the students and teachers can be clarified by indulging in short discussions.
- A range of questions can be imposed regarding the same topic.

Disadvantages

- It is time consuming.
- The probability of bias is there.

8.17.3 Written test: Written tests are paper pencil tests. They are the cheap and widely used testing techniques in the educational field. They are used to test the ability of the child. Written tests may be long essay type, short essay type or objective type.

8.17.4 Essay type test: This type of test is framed to test the subjective knowledge in an elaborate way. The entire subject matter is covered in the questions given and choice is also provided.

Advantages of essay type test:

- They are easy to frame.
- They can be used to test the students' language, expression, and organizational ability besides the basic knowledge.
- Copying is avoidable.
- Guessing creates few problems.
- It encourages the habit of studying.

Disadvantages

- There is a chance of subject bias.
- This test is based on rote memory.
- Sampling is limited as a large body of subject matter

has to be covered in a set period of time.

- Different teachers rate differently.

8.17.5 Short answer type test

In this test, the questions are framed in such a way that the answers are written in two or three sentences. The answers to these questions are bigger than the questions in objective type test but are much smaller than the questions in essay type tests.

Advantages

- Answers are short and written in few sentences.
- Evaluation is easy.
- Students can score more marks.
- Questions can cover wider area.
- Less chance of subjectivity and more reliable.

8.17.6 Objective type tests

In this type of tests, the answer to the question is generally provided in the question paper itself. The student has to choose the correct answer.

Objective type of tests is of two types:

- Recognition type of tests
- Recall type of tests

Recognition type of objective tests: In This type of test, the questions are asked in such a way that the students have to choose or write only a word or a few words as an answer. This type of test further consists of alternative response type or true/false type of test, multiple choice test, classification type of test and matching type of test.

Recall type of objective questions: In this type of test, the students' power of recall is tested. The students have to answer the question that tests their power to recall. Recall type consists of simple recall type of questions and completion type of questions.

8.18 Standardized test

The informal classroom tests discussed so far are useful in measuring the achievements of the students. These teacher-made tests reflect the content and the objectives specific to each class. But when there is a need to compare the performance across the school, the teacher needs standardized tests, which have a wide coverage and measures and content common to a large number of schools.

8.19 Difference between Teachers-made Achievement Test and Standardized Achievement Test

<i>Teacher-made Test</i>	<i>Standardized Test</i>
Used to evaluate the content and outcomes of the school curriculum.	They are used to evaluate common content & outcomes of a number of
Quality of test items is unknown.	Quality of test items is known.
Unreliable.	Reliable. The values vary between 0.80- 0.95.
Flexible in administration	The administration procedure is standard-based on given instructions.
Scores can be compared only in the concerned school context.	Scores can be compared to norm-groups. The test manuals guide interpretation of results.

8.20 Diagnostic test

Generally it is observed that most of the students have difficulty in understanding and learning certain concepts. Finding out the different learning difficulties faced by the students is essential to make the teaching-learning process effectively. Diagnostic tests are found to be practical in

performing the above task.

The diagnostic test consists of items based on a detailed analysis of the specific skills involved in successful performance and the study of the most common errors made by the students. The test difficulty level is relatively low. The lower difficulty is necessary in order to provide adequate discrimination among those students with learning disabilities. A Diagnostic test is lengthy than a normal test because it should have many items for testing each learning point. It has to be based on a smaller subject area.

8.20.1 Intelligence tests

Intelligence tests differ from achievement test. The achievement tests attempt to measure specific skills whereas the intelligence tests attempt to measure the person's capacity to undertake difficult tasks, ability to perceive relationships, capacity to undertake activities that are complex and characterized by abstractions, solve problems, apply knowledge in a variety of contexts, etc. Many researches have been conducted to find the relationship between general intelligence and academic achievements and the results indicate a high correlation between them. This means intelligence and general scholastic achievement tests are good measures of each other.

8.20.2 Aptitude tests

Aptitude is defined as “a group of characteristics deemed to be symptomatic of an individual's ability to acquire proficiency in a given area. Examples might be a particular art, school subject or vocational area”. These tests serve a predictive function. They help the teacher to identify the potential talents by identifying the prerequisite characteristics which are essential for one to be competent to perform a given task. Presenting items on such sub-skills that may eventually be developed into expert complex skills, these tests identify those who can do well in a field of study or in a profession

and those who cannot. These tests are generally used while selecting people for special course/career. The aptitude tests are designed to predict the students' future performance in some activity. Aptitude tests are of various types. They are verbal, non-verbal, individual, and group tests.

8.20.3 Self-reporting Techniques

These are the tools of evaluation where the observer is given a chance to express his/her own feelings, interests, attitudes, and capabilities in a natural scenario. The questionnaires, interviews, and interest inventories are some examples of the self-reporting techniques.

1. Interviews: The interview is one of the most widely used assessment technique of evaluation. The important qualities of an interview are it is flexible; it is face-to-face with the interviewee. And it is easy to evaluate in a congenial atmosphere. Truthful information can be collected. Interviews are of two types:

- **Structured Interview.** This type of interview is a formal interview where the questions are predetermined and are asked in a sequence to all the students in a similar manner. This is a standardized approach where the answers can be logically analysed.
- **Unstructured Interview:** Unstructured interviews are informal interviews. The questions are not predetermined and the interviewer has the flexibility to question on different domains like the attitudes, beliefs, and values in addition to the regular content. The unstructured interviews are flexible and are usually planned to suit the abilities of the students.

ii) Questionnaires: A questionnaire is used as an evaluation tool to know the individual details, interests, abilities, attitudes, and opinions. The questionnaire consists of questions which the individual answers without any bias.

This technique is better than interview as it is inexpensive and less time consuming. The personal appearance, mood or conduct of the questioner does not affect the results of the questionnaire. In a questionnaire, written instructions are given to all students regarding the way the responses are to be recorded. The questionnaires are of two types. One is the structured or closed form and the other, unstructured or open form. A structured questionnaire contains the questions and the alternative answers to them. The unstructured questionnaire gives freedom to the students to reveal their opinions and attitudes. The disadvantage is that the information gathered through it cannot be easily analyzed.

iii) Interest inventory: “Interest” is a state of feeling in which one wishes to pay particular attention to a thing or person; it is a feeling of curiosity or concern. An individual develops interest from the adolescent period. The development of interest is based on the positive learning experiences of the child. The interest inventory is an evaluation tool which helps in measuring the interest of the child. This results in understanding the abilities of the child. A child may be interested in a particular subject but s/he may not possess the ability to master it. Usually, the interest inventories are used to identify the students’ interests in skill based subjects and professional subjects.

8.21 Preparation of Scholastic Achievement Test (SAT)

Achievement may be defined as a change in the behaviour in a desired direction. It is an important and essential constituent in the process of evaluation.

Assessment involves collecting information about students’ knowledge, skills, or abilities. An Achievement test is a formal assessment. The test helps the teacher to understand the level of comprehension of the students in a particular subject and allows them to know the capabilities of the students.

Achievement test helps in identifying:

- The capabilities of students in developing the required skills
- The ability of the teacher in developing the required skills
- The proficiency level of the individual students
- Comparison between the scores of individual students of the school

8.21.1 Meaning and Definition of Achievement Test

The International Dictionary of Education defines achievement test as a test designed to measure the effects of specific teaching or training in an area of the curriculum.

Good's dictionary defines it as “Achievement test is a test designed to measure a person’s knowledge, skills, understandings, etc., in a given field taught in school”

According to **Collin's** Dictionary “A test designed to measure the effects that learning and teaching have on individuals is called an achievement test”

According to **N.M. Dousine**, “Any test that measures the attainments or accomplishments of an individual after a period of training or learning is called an achievement test

According to **Thorndike and Hagen** “The type of ability test that describes what a person has learned to do is called an achievement test”

8.21.2 Important Features of Achievement Test

- Achievement tests measure the modification of behaviour brought about by learning behaviour of the students.
- It is a standardized test to suit the needs of the students.
- It is based on the difficulty level of the students and contains a number of test items.
- It contains various items on different domains of knowledge, skill and application.

- It provides equivalent and comparable items of the test.
- A test manual is provided for administering and scoring the test.

8.21.3 Functions of Achievement Tests

- To measure the knowledge gained by the students.
- To promote the students to the next higher class.
- To motivate the students for further learning.
- To place the students in different sections according to their performance level.
- To test the teaching efficiency of the teacher.
- To identify the strengths and weaknesses of the students and provide remedial measures.

8.22 Construction of Standard Objective based Test/Unit Test

Generally, the achievement tests that are conducted in a school are in the form of a standard test which are based on objectives of instruction. The unit tests are a form of achievement tests. A teacher prepares the unit test. It gives weightage to instructional objectives and content knowledge. For effective scoring, it is provided with a scoring key and marking scheme. They are conducted on completion of a unit after a stipulated period of instruction. The construction of objective-based test is a complex task and involves a complete understanding and practice of all the processes of teaching and learning.

Advantages of a Unit Test:

- Unit test helps in understanding the success of a teaching method.
- Identifying the strengths and weakness of the students
- Developing the remedial measures
- Application of knowledge gained

The construction of standard objective-based test has the following steps:

- Planning the test
- 6. Preparing the test
- 7. Administering the test
- 8. Scoring the test
- 9. Evaluating the test

8.23 Characteristics of a Good Test

A good test should be measured based on different criteria.

Validity: The test should perform the function that it is meant to. It should not measure the things, which are not required. For example, the test meant for testing the scientific knowledge should not measure the arithmetical or linguistic ability of the student.

Reliability: A good test should be reliable, that is it should be repeatable and work similarly with similar groups. A particular student should score same points even if examined by different examiners at different times. The difference in the score should be negligible.

Objectivity: The test should score the same or almost the same score, irrespective of the persons who are scoring it.

Practicable: The test should be practicable, that is the students should be provided with sufficient time to complete it. It should neither be too lengthy nor too short. Students should be busy all through the test and this is also good from disciplinary and administrative angle.

Easy scoring: The test should be made in such a way that the conventional type of scoring should be minimum. The test should be provided with keys for automatic evaluation. It should not be subjective.

Clarity: Instructions given in the test should be precise and concise. It should not mislead the student in any way. The

language used in the test should be simple and understandable.

Comprehensive: The test should cover the whole syllabus. Care should be taken to cover each topic in the syllabus.

8.24 Preparation for a Unit Test

The construction of an achievement test can be divided into the following steps:

- Planning the test
- Building the blueprint
- Framing the questions and editing the question paper
- Administering the test
- Scoring the test
- Evaluating the test

Planning the Test

At present, unit test plays an important role as an achievement test, in most of the schools has to administer after the completion of each unit in the syllabus. To make the unit test an effective instrument of evaluation, it has to be planned in a systematic pattern well in advance. The first step in planning is the setting of clear objectives. It should test those objectives, which come under the domains of knowledge, understanding, application, and skills. Specifications about the portion of syllabus, which has to be tested, should be clearly pointed out.

While planning the test, the teacher has to consider important points like:

- Purpose of the test
- Test specifications
- Weightage to the instructional objectives
- Weightage to the content prescribed.
- Weightage to various questions like essay type, objective type or short answers
- Weightage to difficulty level

- System of options
- Division of test paper into various sections

The purpose of the test: The teacher has to identify the exact purpose of conducting the test, whether the test is diagnostic, formative, or summative. Once the purpose of the test is decided, the type of the test to be administered has to be properly planned.

Developing Tests Specifications: This comprises the following:

- A list of instructional objectives
- An outline of the course content
- A two-way chart depicting the weightage distribution to different areas of the content

Distribution of weightage: After determining the objectives, content, and the number of the test items, it is important to give due weightage to the above aspects by making sure that all the aspects are covered. Objectives should be defined in terms of the behaviour change and each behaviour change in turn should be given due weightage.

A two dimensional chart should be prepared to facilitate the distribution of test items under particular behaviour and content. This chart will serve as a blueprint for the reference while constructing the test. The chart guides how many test items should be designed under each topic and the respective behaviour change. The chart ensures the proper coverage of the content as well as the objectives.

Weightage specified to different objectives: The important objectives of the teaching are knowledge, understanding, application, and skills. Due weightage should be given to each and every objective included in the unit plan.

Weightage to the objectives

<i>Objectives</i>	<i>Marks</i>	<i>Percentage</i>
Knowledge		
Understanding		
Application		
Skill		
Total	25	100%

Weightage Given to the Content:

A teacher has to identify the important points in the lessons of the content while giving due weightage to the content. Due importance should be given to all sub-units of the content taught in that unit.

<i>Subject</i>	<i>Marks</i>	<i>Percentage</i>
Topic-1		
Topic-2		
Total		100%

Weightage to Different Types of Questions

Different types of questions are used to test the achievement of different objectives. A single type of questions may not be able to test all the objectives. Hence, a combination of essay type, short answer type and objectives should be judiciously framed.

Weightage to Difficulty Level

<i>Type of the question</i>	<i>Marks</i>	<i>Percentage</i>
Essay		
Short answer		
Objective		
Total	25	100%

A class consists of students whose level would be above average, below average, and average. Depending upon the individual capabilities of the students, a teacher has to set the question paper with average, easy and difficult questions in right proportions. The questions set in the examination should be neither too tough nor too easy for the students to attempt. A test should contain about 25% difficult questions, 25% easy questions and about 50% average questions.

<i>Difficulty level</i>	<i>Marks</i>	<i>Percentage</i>
Easy		
Average		
Difficult		
Total	25	100%

8.25 Preparing the test: Once the total number of test items and weightage to the objectives and content are decided, the preparation for the test should then start.

While preparing for the test, the following points should be kept in mind:

- ❖ Different types of test items should be given.
- ❖ The different questions should be categorized into different groups. E.g. essay type, short answer type etc.
- ❖ The test items should be given at a 50% difficulty level.
- ❖ The test items should be clear and properly structured. It should be easily understandable and should determine the entire answer.
- ❖ Appropriate directions for answering the question paper should be provided. They should be clear, precise, and complete.

Building the Blueprint

The blueprint is a plan, which provides the details of the design of the question paper in concrete terms. It gives in concrete terms an assurance that the achievement test being

conducted will be a measure of learning outcomes and the content knowledge of the students in a balanced manner. The blueprint is prepared in the form of a three dimensional table with appropriate specifications. The blueprint is a three-sided grid, with the content spread along the vertical axis and the objectives to be tested along the horizontal axis. The three dimensional chart covers the following:

- Instructional objectives
- Topics to be covered
- The type of questions given

The blueprint depicts the weightage given to the above areas in terms of marks or points. There are many advantages of the blueprint. Some of them are given below:

- It helps in improving the validity of the content of teacher- made tests.
- It clearly defines the scope and value of the tests.
- It relates the objectives to the content.
- It presents a clear picture that the test will measure the learning outcomes and the course content in a balanced manner.
- Blueprint increases the objectivity of the test.

A Typical Blue print

Content/ Objectives	Knowledge	Understanding	Application	Skills	Total Marks
Topics	E SA O	E SA O	E SA O	E SA O	
1.					
2.					
3.					

Total Marks					
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E = Essay type questions

SA = Short Answer type questions

O = Objective type Questions

Framing the Questions Paper

The question paper is set only after the finalization of the blueprint. Questions should be based on the requirements given in the blueprint by giving utmost importance to the objectives and the content.

Two options are given to the students, internal and external. In the external type of option, students are given choice. E.g. they may select some six questions out of ten given in the test. But in the case of internal option, students have an option within the question. For example: there would be a) and b) for the same question 1. The students may choose either a or b.

Following criteria should be taken into consideration while framing the questions:

- It should have the specific objectives.
- It should relate to the specific content.
- It should be designed according to the requirements of the blueprint.
- It should stimulate the process of thinking.
- It should maintain the desired difficulty level.
- It should be very clear in its scope and the length of the answer.

Administering the test: The success of any achievement test is based on the proper administration and conduct of the test. Poor planning of the administration process may lead to poor results. Therefore, it is important to see all the aspects beforehand for the conduct of the test like the time of the test, period of the test, place of test, mode of instructions, etc.

The following suggestions should be followed while administering the test:

- The required instructions may be given orally or in written form before the commencement of examination.
- The basic physical facilities like light and ventilation should be provided.
- Appropriate seating should be provided.
- Sufficient time should be provided to the examinees for completing the answers.
- The invigilator should take into account the general problems of the examinees and not to concentrate on some group or individual examinee.
- The test should be conducted in a peaceful environment.

8.26.1. Meaning and Definition of Action Research

The concept of action research is very old but Stephen M. Corey has applied this concept first in the field of education. He has defined the term Action Research.

“The process by which practitioners attempt to study their problems scientifically in order to guide, correct and evaluate their decision and action is what a number of people have called Action Research”.

“Action research is a process for studying problems by practitioners scientifically to take decision for improving their current practices” Stephen M. Corey.

“Research concerned with school problems carried on by school personal to improve schools practice is action research” Sara Blackwell.

According to Mc. Thre: “Action Research is organized, investigative activity, aimed towards to study and constructive change of given endeavour by individual or group concerned with change and improvement”

8.26.2.Characteristics of Action Research:

On the basis of these definitions of action research, the following characteristics may be enumerated:

1. It is a process for studying practical problems of education.
2. It is a scientific procedure for finding out a practical solution of current problem.
3. The practitioner can only study his/her problem.
4. It is personal research for clinical research work.
5. The focus is to improve and modify the current practices.
6. The individual and group problems studied by action research.
7. It does not contribute to the fund of knowledge.
8. Research is directly associated with the problem.

Origin of Action Research

The concept of action research is based on the ‘Modern Human Organization Theory’. This organization theory is task and relationship centred. It assumes that worker of the organization has the capacity to solve the problem and take decision. S/He brings certain values, interest, and attitudes in the organization. Therefore, the opportunities should be given to the workers of the organization to study and solve the current problems of their practices so that they can improve and modify their practices.

The effectiveness of an organization depends on the abilities and skills of the workers. They have to encounter some problems and can realize the gravity of the problems. The practitioner can only study and solve his/her problems of the current practices. The workers will be efficient when they will be given freedom for improving and modifying their practices.

The origin of action research is also considered from the field of psychology or social psychology. Kurt Lewin

explains life space in terms of person and goal. It depends on the abilities of a person to achieve the goal. The person's activities are governed by the goal. The practitioner has to face this type situation.

The concept of action research is being used in education since (1926). Backingham has mentioned this concept first in his book 'Research for Teachers'. But Stephen M. Corey used this concept for solving the problems of education for the first time.

8.26.3.Steps of Action Research

The research work is done by reflective thinking and not by traditional thinking. The reflective thinking functions systematically. The steps of research are drawn from reflective thinking.

The following are the six steps of research:

1. Selection of the problem
2. Formulation of Hypotheses
3. Design of Research
4. Collection of Data
5. Analysis of Data and
6. Formation of conclusion

First step: The problem is selected and defined. The feasibility of the problem depends on its delimitations. Hence, the problem is also delimited in this step.

Second Step: Some tentative solutions are given for the problem. When these solutions are based on certain rationale, they are termed as hypotheses which are formulated.

Third Step – These hypothesis are subjected to verification. A design of research is developed for collection of data or evidences for testing the hypotheses. It involves method, sample, and techniques of research. The appropriate method and techniques are selected for this purpose.

Fourth Steps – The observations and research tools are administered on the subjects and their responses are scored out. Thus, the obtained data are organized in tabular form.

Fifth Step – The appropriate statistical techniques are used to analyse the data so that some decisions may be taken about the hypotheses, the results are used to draw some conclusions.

Sixth Step – The results are discussed and some conclusions are drawn in the form of new information, theory, facts, and solution for the practical problems.

These steps are followed in both types of research - fundamental and action research, but there is significant difference between the two. The comparison of fundamental and action research has been approved in the tabular form in the next pages.

Objectives of Actions Research:

The action research projects are conducted for achieving the following objectives:

1. To improve the working conditions of school plant.
2. To develop the scientific attitude among teachers and principals for studying their problems.
3. To develop the scientific attitude among students and teachers for understanding and solving their problems.
4. To bring excellence in school workers.
5. To develop the ability and understanding among the administrators to improve and modify the school conditions and make it more conducive to learn.
6. To root out the traditional and mechanical environment of the school.
7. To make the school system effective for generating healthy environment for student learning.
8. To raise the level of performance and the level of aspiration of the students.

8.26.4.Fields of Action Research

The action research projects may be designed in the following field of education.

1. In improving and modifying the classroom teaching strategies, tactics, and teaching aids.
2. In developing interests, attitudes, and values of the students towards their studies.
3. In dealing the classroom problem relating to discipline and code of conduct.
4. In assigning the homework so that the students should take interest in completing them.
5. In improving the spelling errors and wrong pronunciation.
6. In dealing with the problems of poor attendance in class as well as in school and coming late to school.
7. In developing the habit of completing class notes and active participation.
8. In removing the practical problems of students relating to school situations or poor adjustment.
9. In solving the personal problems of students relating to school situations or poor adjustment.
10. In dealing with the problems of school administration organization.

Characteristics of an investigator:

A good research worker should possess the following qualities:

1. S/He should have the full understanding about the functions and activities of his/her job.
2. S/He should have the reflective thinking about various dimensions of his/her job activities.
3. S/He should be sensitive towards his/her job. A sensitive person can perceive the problem. Most of the teachers are blind to problems because they are not sensitive towards the job.

4. S/He should be creative and imaginative. These abilities are essential in formulating the action hypothesis for his/her problem.
5. S/He should have the knowledge and training of action research.
6. S/He should have insightful into his/her area. During his/her teaching experience s/he can identify the real problem on the basis of his/her insight.
7. S/He should have the scientific attitude for studying and observing things.
8. There should be objectivity in his/her thinking.
9. His/her behaviour should be democratic. The action research design should not intervene the activities of other teachers of school activities.
10. The most important characteristics is the patience and pursuant of the investigator.
11. S/He should have knowledge and skill of measuring instruments and elementary statisticians.
12. S/He should have an open mind so that s/he can discuss his/her problems with his/her colleagues and experts in the field to have a correct picture of the problem.
13. S/He should have an urge to bring about excellence in job economic performance.
14. S/He should be economical in designing the project from time. Energy and money point of view.

Steps of Action Research

In designing and conducting action research project, the following steps are followed-

1. **Identification of problem** – A teacher should be sensitive towards job activities. The problem is isolated from the broad field. The investigator must realise the seriousness of the problem.
2. **Defining and Delimiting the Problem** – After identifying the problem, it should be defined so that the

action and the goal may be specified. The delimitation means to localize the problem in terms of class, subject, group, and period in which a teacher perceives the problem.

3. **Analysing Causes of the problem** – The causes of the problem are analyzed with the help of some evidences. The nature of the causes is also analysed whether it is under the control or beyond the control of the investigator. This helps in formulating the action hypothesis.

4. **Formulating the Action Hypothesis** – The basis for the formulation action-hypotheses are the causes of the problem which are under the approach of the investigator. The statement of action hypothesis consists of the two aspects: action and goal. It indicates that the action should be taken for achieving the goal.

5. **Design for testing the action Hypotheses** – A design is developed for testing the most important action – hypothesis. Some actions may be taken and their results are observed. If the hypothesis is not accepted, second design is developed for testing another hypothesis. In action-research, one hypothesis is tested at a time. The design of action-research is flexible and can be changed at any time according to the researcher.

6. **Conclusion of Action Research Project** – The accepting or rejecting the action – hypothesis leads to draw some conclusions. The statement of conclusion indicates some proscription for the practical problem of school or classroom. The conclusions are useful in modifying and improving the current practices of school and classroom teaching.

The National Council of Educational Research and Training has been taken interest in the action research projects. The extension department of NCERT have been conducting seminars and workshops for in-service teachers for imparting knowledge and skills of action research

projects. It has developed its own paradigm of action research projects.

8.26.5.A paradigm of Action Research Projects

The steps and sub-steps are proposed by NCERT for conducting action research projects.

1. Topic of the project
2. Objectives of the project
3. The system of the project work
4. Evaluation of the project
5. Estimation of expenditure for the project
6. Name of the institution number of students enrolled in sections
7. Number of teachers in different subjects
8. The available facilities in school for the project work
 - a) Background for the project work
 - b) The importance of the project for the school
 - c) Identification of problem
 - d) Defining and delimiting problems
 - e) Formulation of action-hypotheses
 - f) Testing the action-hypothesis
 - g) Conclusions of the project work
 - h) Remarks by the investigator.

On these lines, the teacher plans an experimental project, after conducting the experiment he writes a report of the project work.

Experimental project of Action Research:

The experimental project is designed for solving the problem of English teaching.

- 1. Topic of the project** – A study for improving the spelling errors in English.
- 2. Investigator** – An experienced teacher of English
- 3. Background for the project work** – The English teacher has observed and experienced that students commit more errors in English spellings. S/He has noted several types of

spelling errors in student's home assignments, compositions, translation, and their written work.

Analysis of causes of the problem

Causes	Evidences	Nature	Control
The students do not complete their written work attentively and seriously.	By observing the written work of students of English language	Fact	Under the approach of the teacher.
They do not give due attention on spelling during their student.	By administering recognition or recall type test	May be fact or conjecture	Under the approach of the teacher
The teachers do not give due importance to spellings during their teaching.	Enquiring from the students and supervising their written work	May fact or conjecture	Under the approach of the teacher
The students are lacking in the prerequisite they do not have clear under-standing.	Oral questions may be asked in English language grammar and based upon their previous knowledge.	Fact	May be or may not be under the approach of the teacher.

4. Objectives of the Project – This project is designed and conducted for achieving the following objectives-

- To make the students sensitive to their spelling errors in English.

- To improve the English spellings of the students.
- To promote the level of achievements in English.
- To realize the need and importance of correct spellings in English language.

This project is directly conditioned by these objectives.

5. The importance of the project for the school – English is the second language but it is the international language. Even in our country, we can exchange the ideas with the persons living in every corner. It is only the media of communication in our country as well as abroad. It is an important language. Therefore, students must learn English correctly.

6. Field of the problem – The field of problem is the spelling errors in English language.

7. Specification of the problem – The problem is located in class IX A, period second, at D.A.V. Inter College Dehradun. The students of this class commit several types of spelling errors in English.

8. Analysing causes of the problem – The causes of the problem are identified objectively so that tentative solutions may be developed for the problem. The causes are analysed with the help of following table.

The analysis of the causes of the problem provides the basis for the formulation of action hypothesis.

9. Formulation of Action Hypotheses – The following two action hypotheses have been developed by considering the causes which are under the approach of the English teacher.

- **First action Hypothesis:** The modification and improvement may be done in English spelling errors by proper correction of English written work. The first part of Action Hypothesis indicates goal and the later part is the action to be taken for achieving the goal.

- **Second Action Hypothesis:** The spelling of words and their meanings should be emphasized in the goal. The

first part of action hypothesis is rested by using separate designs of the project.

10. Design for testing action Hypothesis: The first action hypothesis is tested by employing the above design of the project.

8.26.6 Types of Action Research

Action research design is an educational research involving collecting information regarding current educational programs and outcomes, analyzing the information, developing a plan to improve it, collecting changes after a new plan is implemented, and developing conclusions regarding the improvements. The main purpose of action research is to improve educational programs within schools. The four main types of action research design are individual research, collaborative research, school-wide research and district-wide research.

- **Individual Research:** Individual action research is research conducted by one teacher or staff member. This type of research is conducted to analyse a specific task. A teacher may wonder if implementing group activities within an English class will help improve learning. The teacher alone performs research by implementing a group activity for a certain length of time. After the action is performed, the teacher analyzes the results, implements changes, or discards the program if not found to be helpful.
- **Collaborative Research:** Collaborative research involves a group of people researching a specified topic. With collaborative research, more than one person is involved in the implementation of the new

program. Typically, a group of students, larger than just one class are tested, and the results are analyzed. Many times collaborative research involves both teachers and the principal of the school. This type of research offers the collaboration of many people working jointly on one subject. The joint collaboration often offers more benefits than an individual action research approach.

- **School-Wide Research:** Action research programs are generally created from a problem found within an entire school. When a program is researched for an entire school, it is called school-wide action research. For this type of action research, a school may have concerns about a school-wide problem. This can be a lack of parental involvement or research to increase students' performance in a certain subject. The entire staff works together through this research to study the problem, implement changes, and correct the problem or increase performance.
- **District-Wide Research:** District-wide research is used for an entire school district. This type of action research is usually more community-based than the other types. This type may also be used to address organizational problems within the entire district. For district-wide research, staff from each school in the district collaborates in correcting the problem or finding ways to improve the situation.

Action research is a systematic multi-staged cyclical process which seeks to improve practice through the implementation of informed and incremental change. Action research is not done in isolation but seeks out

the opportunities for collaboration and the participation of other agents.

8.27.1. Remedial Teaching

Remedial education is meant for the students who are in need of it, in order to overcome their learning difficulties. The students termed slow learners, backward or who by one or the other reasons shows poor performance in learning are provided such education. For an instance, there is a student who repeatedly shows poor performance in the achievement tests, is unable to answer the questions put to him/her in the class, neglects his/her home task, demonstrates inability to perform certain experiments or drawing appropriate inferences from the collected data, etc. The observations of such behaviour of the student in the teaching and learning of biology may label him/her as poor and weak in the study of the subject biology. After spotting out such a student, the teacher is bound to go deep in diagnosing the extent, nature and cause of his/her weaknesses and difficulties. Such diagnosis may help for thinking about some remedial measures that can be taken for removing the weakness and difficulties of the student.

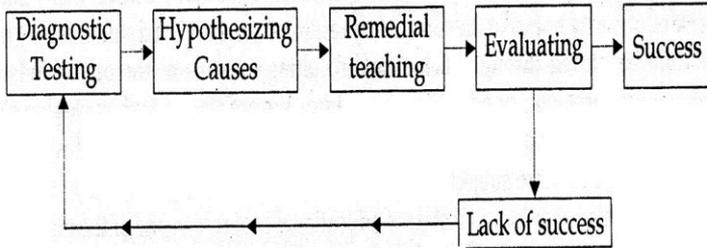
Educational efforts are aimed to bring desirable behavioural changes for an all-round development in the personality of an educand. However, many times these efforts may not yield the satisfactory results or the individual students may not be duly benefitted through such efforts resulting into one or the other kinds of behavioural problems or educationally failure. We are alarmed when we find a student turning into a problematic child or observe him/her lagging behind in his/her studies related to one or more subjects of the school curriculum. Here comes the need of diagnosing his/her behaviour and state of educational progress in one or the other subject of the school curriculum

Looking in this way, diagnosing testing in biology may be defined as a testing or evaluation programme carried out by a biology teacher for diagnosing the nature and extent of the learning difficulties and behavioural problems of an individual or group of students along with the inherent causes for chalking out suitable remedial programmes aimed to help them in getting rid of their difficulties and problems.

It can be easily concluded from the above discussion that diagnostic testing and remedial teaching are inter-related and complementary to each other. Each is based on and results into the other. Diagnostic testing in biological sciences should necessarily be followed by the suitable remedial teaching. In fact, neither diagnostic testing nor remedial teaching should ever be considered in isolation. They should form a part of a cycle known as diagnostic testing and Remedial teaching cycle which may be considered to involve the following processes for its complete execution.

15. Diagnostic testing for knowing the child's weaknesses and learning difficulties in biological sciences.
16. Hypothesizing the probable causes for these weaknesses and difficulties.
17. Applying remedial teaching for removing these weaknesses and difficulties.
18. Evaluating the outcome of the remedial teaching.

19. Continuing to repeat the above four processes to achieve desired success in removing the diagnosed difficulties and weaknesses.



8.27.2.Purposes of Diagnostic Test in Biological Sciences

1. To identify the weak areas of pupil's learning in the specific contents or subject areas of biological sciences.
2. To have an early diagnosis of the problems and learning difficulties of the pupils.
3. To help the teachers to detect the defects in the learning points and instructional programme for the desired remediation.

8.27.3.Preparation of a Diagnostic Test

Diagnostic test needs careful planning and efforts by their designers. Usually, the following steps are needed to be followed in the construction of a diagnostic test –

- Identification of the major concepts to be developed through the instruction of a particular unit, lesson or content material.
- Analysis of the concepts in terms of the specific learning outcomes and behavioural changes.
- To become definite about the minimum expected level of performance with regard to the behavioural changes in the acquisition of knowledge and understanding,

skill, application, interests, appreciations etc.

- To prepare properly graded objective type test items suiting to the concept and expected level to performance and the anticipated weaknesses, deficiencies and difficulties of the students.
- Try out of the test.
- Preparation of the final draft of the test.

Remedial measures or education involving corrective measures are to be undertaken for removing weaknesses, deficiencies, and difficulties of the learner in order to obtain desired mastery level or optimum educational growth in terms of the specified learning objectives. Its aim is not confined to remove the learning difficulties and overcoming the deficiencies but to provide such congenial environment, facilities, and opportunities to the learners as to develop their potentialities to the maximum.

Remedy depends upon the diagnosis. Therefore, one has to seek answer for the question like following before planning about any remedial education.

- What is the nature, extent, and level of the weaknesses, deficiencies, and difficulties of the learner?
- To which area and aspects of the subject matter, learning experiences and activities does it belong?
- What is the cause or causes of such weakness or deficiency?

Diagnosis about the above is thus first carried out through the diagnostic measures and then subsequent remedial programme is chalked out in the light of the result of such diagnosis.

What is Remedial teaching?

The term remedial teaching, as the name suggests, stands for the teaching or instructional work carried out to provide remedial measures for helping the students (or

individual students) in getting rid of their common or specific weaknesses or learning difficulties diagnosed through diagnostic testing or some other measures carried out for such diagnosis.

Remedial teaching in the subject biological and scientific sciences can take various forms like below:

1. Class teaching
2. Group tutorial teaching
3. Individual tutorial teaching
4. Supervised tutorial teaching
5. Auto-instructional teaching
6. Information teaching

Let us discuss now all these forms and aspects of remedial teaching.

1. Class Teaching – In this system or schedule of remedial teaching, the usual composition and structure of the class is not disturbed. The teacher here teaches a particular less/unit, emphasizes a point again and again, repeats the experiments or uses some specific teaching aid in order to remove the difficulties and deficiencies of the learners.

2. Group Tutorial teaching – Here the students of the class are divided into some homogeneous groups called tutorial groups on the basis of their common learning difficulties and identical weaknesses or deficiencies in the acquisition of the learning experiences in some or the other areas or aspects of the subject. The tutor in-charge of a tutorial group then tries to solve the difficulties of the learners. It results in making the task of the teaching more convenient, and effective for providing a better coaching and practice in terms of the needed remedial education.

3. Individual Tutorial Teaching – It is a one to one coaching, help, and guidance that is rendered by the teacher to the learner as and when needed by him/her in order to actualize

his/her potentialities to the maximum. Therefore, in this type of remedial teaching, maximum consideration may be provided to the principle of individual difference in the direction of the best results in the task of teaching and learning. Here, the students may progress according to their own pace, abilities, and capacities and get adequate help, individual attention, and reinforcement for coping up with their deficiencies and difficulties on the path of learning.

4. Supervised tutorial teaching – In this schedule of remedial teaching, the responsibility of overcoming the learning difficulties and removing deficiencies in some learning areas is handed over to the learners themselves. They have to work at their own for removing their difficulties and deficiencies. The role of the teacher is confined to observe and supervise the learning activities and provide as much help as necessary to carry on them on their path of self-learning and self-correction.

5. Auto-Instructional Teaching – This type of remedial teaching consists of auto-instructional programmes and activities. Here, the learner is provided with basic auto-instructional and self-learning material and equipments like programmed learning text books and packages, auto-learning modules, teaching machines, and computer assisted programmed instructions etc.

6. Informal teaching – The activities connected with such informal education in the form of excursions or trips, collecting material for the science museum, improvising science apparatus, working on useful scientific projects, engaging in the scientific hobbies, establishing aquarium, vivarium, terrarium, botanical garden, zoo, and nature study corner in the school campus and participating in the science club activities, etc. make the study of biosciences a joyful event. The learning difficulties arise out of the lack of interest,

non-availability of direct and first hand learning experiences, deficiencies in the methodology of teaching, psychological needs and problems of the learners and host of other reasons may be easily overcome through the organization of useful non-formal activities of scientific interest in the schools.

REVIEW QUESTIONS

1. What is an achievement test?
2. Explain the nature of “objective type tests “ and its demerits
3. Discuss how prognostic test differentiate from diagnostic test
4. Explain the important of remedial teaching
5. Mention the various type of tests employed in assessing achievement in biology.

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Chapter 9

PROFESSIONAL DEVELOPMENT

9.1 The Biology Teacher

The quality, competence, and character of teachers are undoubtedly the most significant in the different factors which influence the quality of education and its contribution to the national development. Nothing is more important than securing a sufficient supply of high quality recruits to the teaching of science, providing them with the best possible professional preparation, and creating satisfactory conditions of work in which they can be fully effective.

9.2 Who as a Good Biology Teacher?

- Being a good citizen, a science teacher fulfils all his/her duties. S/He is related to all the aspects of society. S/He should have knowledge of Biology related problems, needs of society, and should solve them in a democratic manner.
- As a teacher of science in college and community, s/he imparts knowledge of Biology according to the educational principles and needs of the community. His/her knowledge should be correct, complete, and novel. This teacher works towards fulfilling the objectives of education and special objectives of Biology teaching.
- A good Biology teacher teaches the theoretical, experimental, and practical aspects of every subject/topic.
- A good Biology teacher uses the best 'knowledge acquisition process' in the class-room and laboratory.
- A good Biology teacher makes use of Instructional Materials and other Audio-Visual Aids and also prepares them.

- S/He pays more attention to new, noble, and latest knowledge rather than only bookish knowledge.
 - A good Biology teacher selects important principles and facts from the entire syllabus and presents it in front of his/her students in a collective manner using appropriate method.
 - A good Biology teacher is familiar with the techniques of evaluation to evaluate his/her students correctly.
 - A good Biology teacher makes his/her teaching successful by knowledge acquisition process by obtaining complete knowledge of the personal needs, understanding capacity and problems of the students.
 - A good Biology teacher is fully competent in selecting ‘Biology Appartus’ and making proper use of it.
 - A good Biology teacher provides systematic instructions to his/her students. S/He takes part in all instructional activities.
- i) A good Biology teacher is an expert in organizing exhibitions, science fairs, and other activities for the people of school and community.
 - ii) A good Biology teacher gives introduction of his/her capabilities in laboratory, work sphere and school community and helps others.
 - iii) A good Biology teacher is proud to be a teacher. In order to improve his/her teaching skills, s/he takes part in various conventions, clubs, scientific group activities, in-service teaching experiments/research. In this way s/he is always aware about his/her responsibilities.

9.3 Traits of a Biology Teacher

1. Complete command over the subject
2. Zeal for the subject
3. Proper preparation
4. Special preparation for teaching each topic
5. Sufficient self-control

6. Practical skill and resourcefulness
7. Detailed knowledge of the child
- 8., Knowledge of parental behaviour
- 9, Affectionate and sympathetic behaviour
10. Practical and investigative attitude
11. Sincerity and honesty
12. Patience and endurance
13. Sweet, soft, courteous, inspiring and authoritative voice modulation
14. Easy and interesting language
15. Sharp intellect

9.4 Creed of Biology Teacher

The magazine of National Association of Agriculture teachers have prepared the following manner Indian version on the basis of Mr. Lowell E. Hedges (consultant in Agriculture), “My Creed as a Teacher”.

1. I am a teacher by choice and not by chance.
2. I believe in India.
3. I dedicate my life to its development and advancement of its people.
4. I will strive to set before my students by my deeds and actions, the highest standards of citizenship for the community, state and nation.
5. I will endeavour to develop professionally through study, travel and exploration.
6. I will not knowingly wrong my fellow teacher.
7. I will defend him as far as honesty will permit.
8. I will work for the advancement of my subject.
9. I will defend it in my community, state and nation.
10. I realize that, I am a part of the school system.
11. I will work in harmony with school authorities and other teachers of the school.

12. My love for the youth will spur me on to impart something from my life that will help make for each of students a full and happy future.

Some 'Must' For a Biology Teacher

8. S/He must change according to the need of community, level of students, problems of community, the availability of time and examinations. In this reconstructing, the co-operation of students should also be taken.
9. S/He must plan his/her teaching for the year according to the importance of topics of syllabus keeping in mind all holidays, examination, etc. Drawing a balance between theoretical, experimental, and practical knowledge and taken into consideration the entire syllabus, the teacher should preplan excursions, Science Day Projects, etc.
10. S/He must select proper audio-visual aids, all apparatus and make use of them correctly and completely.
11. S/He must select appropriate teaching methods to make teaching lively and activity-oriented.
12. S/He must have clear and novel knowledge of the subject.
13. S/He must have a positive attitude towards school management, teaching, and students.

9.5 Professional Ability of Biology Teacher:

1. Participating in community workshops, in-service training course, workshops, meetings, conferences, etc.
2. Having information of various new research developments.
3. Subscribing to good books, magazines, bulletins, and newspapers for the library and study them.
4. Listening to and watching various programmes based on science on the radio and T.V.
5. Participating in the activities of occupational organizations of science teaching.
6. Having good knowledge of other schools, colleges, universities, research institutes and regional laboratories

and acquire knowledge.

7. Taking part in the local, regional, and national meetings.
8. Acquiring knowledge of good teaching methods of science of national level.
9. Participating in meetings of committee preparing Instructional Material.
10. Aware of the new facts/happenings and the latest information, which s/he will be able to impart to the students.

9.6 Questionnaire for Self Evaluation

1. As a teacher of the school, how well are you fulfilling your duty?
2. In teaching your subject, how far are you imparting the latest knowledge by appropriate methods?
3. What is your contribution in National Extension Services and Community Development?
4. Are you a nucleus of activities for students, parents and local leaders in rural and urban areas?
5. Do you organize the curriculum at the appropriate time, according to the needs for the student community?
6. Are you imparting theoretical knowledge along with practical knowledge in a correct manner with full capability?
7. Are you making efforts to increase your professional qualification?
8. What opinion do the students, other teachers and the principal have of you?

9.7 Biology Teacher's Attitude

- Open-minded person in his/her approach.
- A burning desire for acquisition of knowledge, which is verifiable.
- Experiment-minded
- Systematic in his/her deeds

- Confidence in him/her
- Looks for the natural causes for the things that happen
- Becomes very curious
- Does not believe in any superstition
- Believes that truth never changes
- Listens, observes, or reads evidences supporting ideas contrary to his/her personal opinions
- Sticks to the facts and avoid exaggeration
- Draws conclusions based on adequate and sufficient evidences
- Believes that problems may be solved easily through scientific observation and experimentation
- Believes in cause and effect relationship.
- Objective and systematic in his/her work
- Adopts scientific method for solving problems
- Power of concrete and accurate observation and interpretation
- Intellectual honesty
- Never hasty in giving final results and judgments
- Impartial and unprejudiced

9.8 Requisite to Bio-Data of Biology Teacher

❖ **Basic academic qualifications**—These are laid down by the education departments or the employer but in all cases, the science teachers in high schools should be at least B.Sc. and in higher secondary school M.Sc. They should preferably be trained.

❖ **Trained in Modern Methods and Techniques**—New methods and techniques are being employed in the teaching of science. Science club, improvisation of apparatus, programmed instruction, teaching Machines and many other new concepts are coming in.

❖ **Contents of Training**—The science teacher should be trained in the following—

- The class-teaching methods and planning of lessons
- Laboratory organization
- Museum arts and techniques necessary for vitalizing science teaching programmes in schools. S/He should have knowledge of preserving specimens of plants and animals arranging science aquaria, vivarium, etc.
- He should be able to improvise the care and repair certain apparatus.
- The organization of instructional material
- Preparation of instructional material, etc.

❖ **Practical Knowledge of Child Psychology and of the Process of Learning**—The teacher should have a knowledge of child psychology so that, s/he may guide the students according to their interests, capabilities, and help in educational, vocational, and personal problems. S/He should also know the different laws of learning which can be applied to the teaching of science.

Suggestions for Betterment

1. A Biology teacher should have a thorough grasp of the subject-matter that s/he has to teach. Preferably, s/he should plan his/her lesson beforehand.
2. A Biology teacher should not expect that, s/he knows the answer to all the questions that the children ask him/her.
3. It is a bad policy to dodge pupils, at least in science which is so exact and accurate that the teacher can be caught sooner or later.
4. His/her teaching should be pupil-centred rather than subject or teacher-centred. The approach should be inductive.
5. A Biology teacher should provide adequate opportunities for the individual laboratory work by the students.
6. A Biology teacher should keep himself/herself in touch with the latest developments in science.

7. Teaching-learning process should be a co-operative endeavour of the teacher and the pupils. S/He should give knowledge to the students and at the same time learn with them.
8. A Biology teacher should make good use of teacher's manuals and laboratory guides, if available.

According to **Dean Potter**, the good teacher is, "enthusiastic, kind agreeable, accommodating, co-operative, patient, optimistic, inspiring, tactful, clear thinker, courteous, sympathetic, knows his subject, willing to accept his responsibilities, punctual, honest, courageous". Besides possessing these personal qualities, s/he should also possess academic qualifications.

9.9 Academic Qualifications

- ❖ S/He should be a master of his/her subject. For teaching higher secondary classes, s/he should be M.Sc. and for lower classes even B.Sc. can work.
- ❖ Along with academic qualifications, s/he should be trained in modern methods of teaching. S/He should have taken training courses like B.Ed. or B.T.
- ❖ S/He should always keep his/heer knowledge fresh. Changes that are always going on in the field of science mean that what a teacher teaches is going to be obsolete very soon like Air-craft man who coped with engines and then in a few years later with supersonic air-craft.
- ❖ According to LalaHardyal, "It is our duty to acquaint ourselves with the latest knowledge and develop our minds. Knowledge is like a deep well fed by perennial springs and your mind is like a bucket that you can drop into it."
- ❖ Pre-service training once gained is not sufficient enough. The mastery over professional skill in teaching can be acquired by attending short courses like seminars, workshops, conferences, refresher courses, etc. These will acquaint the teacher with the latest techniques of teaching,

modern aids, co- curricular activities and other developments in the field of science.

- ❖ Besides academic and in-service qualifications, the teacher should be familiar with child psychology. S/He should know that, every child is an individual and that s/he travels by his/her own tailor-made time schedule. The teacher should direct the students according to their taste, talent, and capabilities. S/He should not thrust anything on the child which does not favour his/her attitude.

9.10 Inspection of Biology Department

Importance of Inspection

Inspection is indispensable for improvement of instruction. “But the educational profession seems not to be staffed with pioneer, instead it merely reflects national dilemma.” In many places, there is too much teaching but not good teaching. So with the extension of education, it is a preventive measure to check its standard. It is the concern of society as a whole. The failure of teacher in self-development and formation goes to a large extent on the failure in providing proper inspection. For proper and better science teaching, supervision and inspection is provided by the state.

The inspector should supervise that the science work is properly perceived, carefully planned, and nicely executed.

Indian Education Commission remarks, “The inspectors are the key figures in any reform of class-room practice. They are authority. They should be consulted from the very beginning”.

Supervision of Biology department should be done at least once a year. It should encourage the teacher to work more efficiently, keeping in view the dignity and status of teacher.

Subjects of Supervision

- **The teacher’s time table, diary, etc.**—The inspector should see that the teacher is fully qualified, his/her personality is charming, his/her behaviour towards students

is proper, how many periods s/he takes, whether his/her diary is properly maintained or not.

- **Laboratory and Equipment**—The supervisor should also see that, the laboratory is fully equipped with apparatus and materials required for the students and the material is properly maintained.
- **Notebooks**—Notebooks of students should also be checked. The inspector should see that they are regularly signed and neatly kept and whether practical notebooks are complete or not.
- **Text-book**—The inspector should see whether the text-book caters to the needs of students or not.
- **Science Museums and Science Clubs**—The inspector should see if there is a Biology Club, what its aims are and to which extent they are executed, whether Biology Museum exists or not, if there is museum, its materials should be checked whether they are properly arranged and maintained. If Biology Museum does not exist in the school, the inspector should emphasize its need and importance to the Headmaster and Science teacher in the school.
- **Stock Registers**—The supervisor should see, the entries and try to know whether, they are up-to-date and kept in order or not.

9.11 Qualifications of a Science Teacher

Besides possessing the personal qualities that every teacher should possess, the science teacher should fulfil the following broad requirements:

1. Basic academic qualifications
2. Trained in the modern methods and techniques
3. Practical knowledge of child psychology and of the learning process

1. **Basic academic qualifications:** The basic academic qualifications are laid down by the Education departments or the employer but in all cases the science teachers in high schools should be at least a graduate of B.Sc. and in higher secondary schools a graduate of M.Sc. They should preferably be trained.
2. **Trained in modern methods and techniques:** New methods and techniques are being employed in the teaching of science. Science club, improvisation of apparatus, programmed instruction, teaching machines, and many other new concepts are coming in. It is, therefore, essential that the science teacher should be trained in ;
 - i) The class-teaching methods and planning of lessons
 - ii) Laboratory organisation
 - iii) Museum arts and techniques necessary for vitalizing science teaching programme in schools.
 - iv) S/He should have knowledge of preserving specimens of plants and animals arranging science aquaria, vivaria, etc.
 - v) The care and repair of apparatus. S/He should be able to improvise certain apparatus.
 - vi) The organisation of instructional material, etc.
 - vii) Preparation of instructional material, etc.

3. **Practical knowledge of child psychology and of the process of the learning process:** The teacher should have knowledge of child psychology so that s/he may guide the students according to their interests, capabilities, and help in educational, vocational, and personal problems. S/He should also know the different laws of learning which can be applied to the teaching of science.

Some suggestions to science teachers:

1. The first requisite for the science teacher is that s/he should have a thorough grasp of the subject-matter that s/he has to teach. Preferably, s/he should plan his/her lesson before-hand.

2. S/He should not expect that s/he knows the answer to all the questions that the children ask him/her. It is a bad policy to dodge pupils, at least in science which is so exact and accurate that the teacher can be caught sooner or later.
3. The teaching should be pupil-centred rather than subject or teacher-centred. The approach should be inductive.
4. Adequate opportunities should be provided for the individual laboratory work by students.
5. S/He should keep himself in touch with the latest developments in science.
6. Teaching-learning process should be a co-operative endeavour of the teacher and the pupils. S/He should give knowledge to the students and at the same time learn with them.
7. S/He should make good use of teacher's manuals and laboratory guides, available.

9.12 Professional Growth of Science Teachers

A teacher can never truly teach unless s/he is still learning. If the lamp can never light another lamp, it continues to burn its own flame. The teacher who has come to the end of his/her subjects, who has living traffic with his/her knowledge, but merely repeats his/her lessons, students can only load their minds, s/he cannot quicken them. "The greater part of our learning in the schools has been a waste because for most of our teachers, their subjects are like dead specimens of once living things".-Tagore

In order that the teachers are kept alive to the new developments, concepts, problems in their areas, a number of opportunities are provided by the Government in the form of:

- i) Seminars, Workshops, Conferences
- ii) Refresher Courses
- iii) Summer Institutes, etc.

The teachers can also add to their professional growth by participating inteachers organizations like the All India

Science Teachers Association, Indian Association of Teacher Educators (I.A.T.E), All India Federation of Educational Associations (A.I.F.E.A), Seminar Readings, celebration of teachers' day, National Foundation for Teachers' Welfare, etc.

9.12.1 Summer Institutes for Science Teachers

Various kinds of summer institutes have been started in India in order to refresh and up-to-date the knowledge of teachers of science and mathematics in secondary schools as well as for teacher educators in teacher training colleges. The different types of summer institutes are:

- 1. Unitary Institutes:** A number of summer institutes are organized every year in sciences. The purpose of these institutes is to orient the teachers in the developments in different fields of science as well as in the newer approaches to teaching science.
- 2. Sequential Institutes:** The sequential summer institutes reorganized on an all India basis for the best five participants (teachers) of the unitary type of institutes. The purpose is to prepare a team of pioneer resource persons for state level summer in states as well as to develop in them professional leadership qualities. The emphasis in these institutes is both on the understanding of modern concepts in content as well as of the new techniques of effective teaching. The programme includes lectures, group discussions, individual discussions, laboratory work, use of audio-visual material and project work.
- 3. Special Institutes:** These institutes are organized on all levels for method masters from teacher training colleges and institutes of education. The main emphasis at these institutes is on the development of improved textual material for the use of training colleges in the areas of science and mathematics and on the development of improved techniques of teaching and educational technology.

4. Project Technology Institutes. These are special types of summer institutes for secondary school teachers organized on regional basis. The programme includes intensive laboratory work, workshop practice, individual and group discussions. Emphasis is laid on the development of indigenous resource materials and audiovisual materials, which could be used by them in teaching when they go back to their respective schools. Thousands of teachers of different subjects have been trained through the summer institutes.

9.12.2 Summer Institutes

The importance of summer institutes for science teachers cannot be denied, especially when scientific knowledge is expanding at an enormous speed. The rate with which the knowledge is increasing, it is doubtful whether it will be at all possible for all school teachers to catch up with the new advances in the near future. It is, therefore, very essential that such institutes are organised on a much larger scale through the year. Though the summer institutes have made their own impact on the teachers who have attended them, yet much has to be done to make them a successful enterprise. Some doubts have been expressed by a number of teachers and other educators. Some of them are given here:

The materials presently used in the summer institutes for high school teachers are far too advanced unrelated to the real Indian classroom situation for science teachers in most of the States. It is, therefore, of great importance to develop new and integrated course materials embodying the modern approach. - U. G. C. Report, 1966.

Our frustration also arises from the conjunction of a number of factors: inadequate planning, language barriers, poor facilities, shortcomings of the staff and psychological hazards germane to the teacher participants themselves. Had one or two of these problems been recognized in advance, the

session might never have been convened and much effort would have been spared for better things. -'Physics Today', June 1967

Other limitations and difficulties pointed out are:

(i) There is no follow-up programme to keep alive the knowledge and attitudes stimulated during the summer institutes.

(ii) Much of the value of the summer courses is lost because of the dichotomy between what the teachers learn in the summer institutes and what they have to teach in the class. This obviously leads to frustration of enthusiastic teachers who want to make use of the concepts taught in summer institutes. The courses are prescribed by the Board or University and they have to be strictly followed.

(iii) The necessary books are not available.

(iv) One of the biggest hurdles is the system of examination which leaves little scope for the teacher to deviate from the routine syllabus and the way of teaching. As a result, the teachers are liable to forget most of the things which they learn at summer institutes, in a year or two.

The Review Committee on Summer Science Institutes (July 1971-November 1971) made the following observations:

1. There was hardly any coordination between the Summer Institute programme and other programmes of science improvement of the NCERT.
2. There was no effective attempt to involve the State Education Departments on any level in the organization of the Summer Institutes.
3. There was rigidity in the course content and also the overbearing influence on the external examination system.
4. There is lack of incentive for the participants of the Summer Institutes and this has led to the lack of interest because there is hardly any motivation in any form available for those who attended the summer

Institutes in the past.

Some Suggestions

- (i) There should be a vigorous follow-up programmes with a view to help the teacher to continuously apply the new knowledge in the classroom.
- ii) A journal should be started which includes the latest knowledge and reprint of important articles of merit for the use of teachers.
- iii) The material to be used in summer institutes should be designed to meet the needs of teachers in schools under the present conditions.
- iv) The book and other necessary material should be made available in Indian languages. The PSSC, BSCS, CHEM study and such other books should be translated. A programme for the production of indigenous kits should also be launched.
- v) There should be some agency to act as a clearing house for all new information and development in science and mathematics, which should be treated as a follow-up programme of the summer institutes.
- vi) There should be establishment of State-wise co-ordinating committees.
- vii) Unitary institutes should be organized on state-wise basis and should be related to state curricula.
- viii) Some kind of incentives should be given to teachers who attend sequential and project technology summer institutes by way of promotions, increments or privilege in admission in B.Ed, or M.Ed. courses.
- ix) The teachers should be encouraged by the administration to use innovations of teaching that they learn in the summer institutes.

9.13 Science Teacher's Diary

Every teacher should have a diary in which s/he should note down:

- i) The whole syllabus of the class or classes s/he has to teach.
- ii) The time-table of the class.
- iii) The schemes of his/her work during the session i.e. how much portion of the syllabus s/he will finish in each month. These monthly assignments can be divided into weekly assignments. S/He should also note the number of demonstrations that s/he will perform and the number of experiments that the student will do. This will also help him/her to find out the apparatus or chemicals that s/he will require during the session which s/he can get in time without any hindrance in his/her scheme of work that might be caused due to the lack of certain apparatus or chemicals.
- iv) S/He should write down the daily programme for a week, what topic s/he will teach on what day and with what method. S/He should in a way prepare hints on lesson plan for the whole week, after s/he has delivered his/her lesson according to the plan, s/he should assess his/her own work and write down on the notebook whether the lesson was a success or a failure. If failure, what the reasons were for that and how to overcome or eradicate those.
- v) The assignments given to each student and the comments on his/her work in the class and in the laboratory.
- vi) The record of each student in the field of studies, games, and other activities.
- vii) The whole programme of the Science Club i.e. the names of executive and the number of the members of the club, the lectures to be delivered, the excursions, visits, exhibitions, etc. to be arranged and other activities of the club. S/He should also note down a

brief description along with his/her comments on every deliberation of the club.

- viii) The difficulties that the students feel during the experiments.

9.14 Time Table

The time allotted for the teaching of science High and Higher Secondary classes in the school time-table is quite sufficient for class-room teaching. Out of six periods per week allotted for teaching of science, almost all of them are utilized in lecture work by teacher. No provision is made in the school timetable for the practical work by the pupils (for excursions, projects and other activities). As a result of this ill-distribution of time, the teaching of science becomes lopsided and the aims of teaching science are defeated. It is, therefore, suggested that,

i) The head of the institution should make provision of double periods in the school time-table for science practicals, at least twice a week.

(ii) These double periods for practical work should, as far as possible, be arranged in the periods preceding or following recess or in the last periods so that the teacher may be able to utilise a few minutes of recess if the need be.

(iii) The time spent on the preparation of a demonstration by the teacher should be counted in his/her daily load of work and for this the science teacher should be free from any type of work in the period preceding the science period.

(iv) The science teacher should chalk out his/her own programme in the time allotted to him/her for teaching science. It has been recommended in the Taradevi Report on the Teaching of Science that out of 100 hours per year, say, available for the teaching of science, 20 hours should be spent on excursions and visits etc., 30 hours for projects-and other allied activities and 30 hours for classroom teaching, demonstrations, discussion etc.

(v) The head of the Institution should also see that the science teacher is not given any other subject to teach, if possible.

The Ishwarbhai Patel Committee report recommended that for classes 1-IV/V, there is need for more creative and joyful activities than formal instruction. Children in these classes should not be required to remain in school for more than 2 ½ to 3 hours a day. In view of the fact that more than 80% of primary schools are in rural areas, no academic year should be prescribed. The school session should be scheduled according to local needs.

For classes VI-VIII, the time table should also be flexible although at this stage it will be necessary to introduce formal time table for proper teaching of the different subjects.

9.15 Home-Work

Home-work is important for

- The preparatory part of the assignment
- Description of an individual laboratory work of demonstration
- Writing a concise note on the subject referred to by the teacher for some extra study
- Write answer to the questions given by the teacher on the topic already dealt in the class

It is also important that the teacher corrects the pupils' homework and keep a record of it. This will avoid all type of undesirable temptation on the part of the pupils and they will be encouraged to write correct and to the point. In this way, the pupils find an opportunity to develop their expression and style of writing. The teacher should, however, check the students from copying the answer from the text-books. They should be encouraged to write in their own language and in their own style.

9.16 Supervision of Science Department

Supervision of science department is essential at least once in a year, for providing democratic leadership and proper guidance to teacher, for evaluating the instructional work and other co-curricular activities and, thereby, to improve the whole process of education through constructive criticism and desirable appreciation. The aims of the supervision should be to enthuse and instill in the teachers the spirit of working more efficiently. It should never be imposed and authoritarian and teachers should not feel it as a burden on them. The supervisor should always keep in view that the dignity of the teacher is maintained. S/He should be quite sympathetic to the teachers and should listen to the difficulties of the teachers. S/He should discuss with the science teachers about certain problems of limitations and should welcome suggestions from the teacher and then give his/her own view-point on the subject. The supervision should be scientific and without any bias or prejudice. The supervisor should take along with him/her an expert in science in order to get the real picture of the teaching of science in school. The supervisor should look to the following points:

(i) The teacher—his/her record, time-table, diary, the scheme of work: The supervisor should see that the science teacher is fulfilling the basic qualifications, his/her personality and behaviour with other members of the staff, his/her method of teaching science, the distribution of the time allotted for teaching science *i.e.*, for the theory work and practical work and other activities. S/He should also see that the teacher has kept a daily record of his/her teaching and activities and has drawn out the scheme of work for the whole session.

(ii) Notebooks of students: Whether the students have kept a regular record of the practical work and classroom

work and whether it has been regularly checked by the teacher.

(iii) Laboratory and Equipment: This is an important thing which should be given due importance during inspection. The inspector should see that the accommodation and equipment is adequate and the teacher has arranged and maintained the material in proper order.

(iv) Science club: If the school has already a science club, what its activities are and how far has it succeeded in achieving its objectives. In case the school has no science club, the inspector should emphasise its importance and the establishment of one.

v) Stock registers: Whether all the entries have been made and the registers are in order.

(vi) Science Museum The inspector should also inspect the Science Museum and emphasize its importance if the school has not maintained it.

vii) Science library: Whether the books are sufficient and kept in order.

viii) The Text-book: The inspector should note in the text-book that the students are following and find out whether this is upto the mark or not.

9.17 Professional Growth of Biology Teacher

1. Pivotal Importance of teachers—It is now universally acknowledged that teachers occupy a place of pivotal importance in our educative process. All other factors—building, equipment, instructional materials, organization, and finances are to no avail unless there are teachers of right type, proper academic, and professional background and strong traits of characters.

2. Irreplaceability of the teacher—Motivated by such an important role of teacher, education planners and administrators all over the world have started giving special attention to the improvement of teacher education with all

the latest researches. Even the most advanced countries have not been able to replace teachers. This has naturally produced considerable stirring in the theory and practice of teacher's professional preparation in the past few years.

- 3. Hectic activity of educational reform**—Awakened from the centuries of old slumber of political and cultural domination, free India is now trying to engage itself in hectic activity of educational reform in the field of professional training of teachers who are corner-stone of the arch of education. Youth, who are like flexible wood, ready to be moulded in any shape and are the future exponents of country, have their fate in the hands of teachers. So, it is a teacher who has to play potent role in educational field.

9.18. Need of Training of Biology Teachers:

Professional growth of teacher requires that, he or she should continue to learn throughout his/her profession. Pre-service education of teachers taken some years back is not enough for them. S/He should always be in need of continuity of education. S/He should have thirst for knowledge. Unless teachers are well trained, everything will fall like house of cards. So, before providing the other physical facilities, government should provide facilities for training of teachers. The teachers who have been teaching for ten years, go on teaching with their old worn out methods, ignorant of good methods of teaching. Their knowledge is rotten. Though the hall work of a good teacher is that, s/he is always learning and developing his/her knowledge and understanding of his/her children. The teacher never does justice to his/her profession unless, s/he is himself a learner. Only a burning lamp can light another. And every educational authority prefers that, "their children should drink from running stream rather than from stagnant pool".

9.18.1 Advantages of Training

- ❖ S/He can acquaint himself/herself with the latest researches

in the field of Science. Only then, s/he can train children to adjust themselves with the complex society.

- ❖ S/He can discuss his/her classroom problems with experts on the subject and other fellow participants or workers.
- ❖ Kothari Commission truly comments, “The need of professional training is most urgent in teaching due to rapid advances in the field of knowledge.”
- ❖ S/He can learn the use of newly developed aids and their preparation also.
- ❖ S/He may develop the ability for organizing various co-curricular activities in Science teaching for changing needs of society.
- ❖ S/He may develop ability in teacher for new methods of evaluation.
- ❖ S/He may develop an understanding of nature of child and the process of learning and teaching different stages of growth.

9.19 Means of In-Service Training

Secondary Education Commission (SEC) advocated provision for in-service training for professional growth of teacher through the following—

- ❖ **Seminars**—Teachers can attend seminars in science and other subjects, may be on the subject or some particular topic. It can be arranged on various problems. A working paper is prepared before-hand. It is circulated among the participants. Various committees are formed for various aspects of problem. The report is then read before General Assembly. It can be held on co-curricular activities, new techniques for teaching, Science curriculum improvement, etc. It largely broadens the professional outlook of science teacher.
- ❖ **Workshops**—Workshops are a bit different from seminars in their more practical approach. Workshops can be easily arranged on lesson planning, curriculum, test construction,

etc. The work is distributed among the various groups of participants and these groups discuss it intensively.

- ❖ **Refresher Courses**—Refresher courses acquaint the Biology teachers with the latest developments and researches in the field of particular subject. The experts on the subject offer their services.
- ❖ **Study of Professional Writings**—Biology teachers can study various publications by NCERT. Extension Service Departments of Colleges of Education can keep their knowledge refreshed.
- ❖ **School Programmes**—Club meetings, exhibitions, experimental projects, demonstration lesson, and extension lectures also add to the knowledge of Biology teachers.
- ❖ **Biology Teacher’s Study Group**—Science teachers from various schools of districts can have a monthly meeting where they can discuss various problems and share their experiences on method, hobbies, and other activities relevant to the subject. These are also invaluable to the teachers. Some problems of common interest can be discussed. But discussion should lead to practical action.
- ❖ **Other Means**—Educational tours to foreign cities, correspondence with other teachers of different states, conferences, various professional organizations like ‘Science Teachers’ Associations, which contribute Magazines, Round Table Conferences, Paper Discussions, Demonstrations, and Individual Research Work by the teacher are also various sources from which teacher can get much of professional knowledge.

No equipment in laboratory or library, no changes in timetable or curriculum can be of any importance if the teacher is not well prepared. Secondary Education Commission comments, “We are, however, convinced that, the most important factor in contemplated educational reconstruction is teacher, his personal and academic and

professional training and the place, he occupies in the community. But we are painfully impressed by the fact that social status, salaries and general service conditions of teachers are far from satisfactory and they are the factors, which have to contribute to national development of country.” Professor Whitehead says, “The waste in teacher’s workshop is lives of men.” This is the price that, any country will have to pay if it does not pay attention to attract the best brains to teaching profession by creating satisfactory conditions of work.” Swami Vivekananda remarked, “The task of spreading scientific knowledge and building up habits of thought and action in young generation mainly depends upon teacher more than any one.” So, teachers, the nation builders, should professionally grow well.

Organizations for Professional Growth

- All India Federation of Education and Association (Kanpur).
- All India Science Teachers Association (Delhi) founded under the presidentship of Dr. A.C. Joshi in 1956. The membership is open to all science teachers of schools, and college lecturers.
- All India Private College Teacher’s Associations (Kerala).
- National Association of Teacher Education (Delhi).
- All India Secondary Teacher’s Association (Delhi).
- Delhi State Science Teacher’s Association (Delhi).
- Punjab Science Teacher’s Association, Abohar (Punjab) founded in 1975.

REVIEW QUESTIONS

1. Discuss the requisites of a good biology teacher.
2. Write a short note on In-service –Training for biology teachers.
3. State the importance of Science Teacher’s Diary.

4. Explain the role Summer Institutes in the professional development of science teachers
5. Write the short note on the following
 - a) Time Table
 - b) Home-Work

Chapter 10

PROVISION FOR INCLUSION

10.1 Creativity

Creativity is the most important instinct of a child. It is like an ever flowing river which if not given the right direction can sublimate in the wrong path destroying the fields of society. Science is nothing but “creative thinking” and “creative doing”. If science is to be developed as creative subject, it becomes the responsibility of a science teacher to provide facilities for the development of creative spirit of children.

10.2 Definition

According to **Drevidahl**, “creativity is the capacity of a person to produce compositions, products or ideas which are essentially new or novel and previously unknown to the producer”. So, creativity is a unique mental process which results in an original and Novel product. It is accompanied by a number of mental abilities and personality characteristics. Researchers have agreed that there are five creative abilities namely,

1. Fluency (the ability to produce large ideas)
2. Flexibility (the ability to produce a variety of approaches)
3. Originality (the ability to produce uncommon response)
4. Redefinition (the ability to define in a way different from the usual) and
5. Sensitivity (the ability to evaluate implications).

10.3 Characteristics of Creative Persons:

Some of the specific characteristics of creative persons are

as follows:

1. Courageous
2. Desire to excel
3. Determination
4. Full of curiosity
5. Intuitive
6. Non-conforming
7. Sincere
8. Visionary
9. Willing to take risk
10. Receptive

The above list of traits can clearly discriminate creative talent from the normal. Creativity is a hidden seed. It can just be grown by providing suitable environment.

10.4 Methods of Developing Creativity:

Creativity can be developed in the classroom by providing suitable conditions.

1. Providing democratic atmosphere:

An atmosphere of democracy alone can give birth to creative spark. Dictatorship always tends to suppress this instinct. Where the teacher acts as a friend, there flourishes creativity. We should allow the children to work freely in a relaxed atmosphere and encourage their original ideas even when they are in crude forms. We should give ample time to them.

2. Proper physical environment:

It is also indispensable for development of creative spirit. Open lawns, gardens, spacious laboratories, and aquarium kindle creative spirit of children. Students should be provided with a simple workshop where they can improvise, mend, and repair apparatus and think of original ideas.

Examples of great scientists who laboured hard due to lack of facilities and gave origin to new and exciting investigations should also be cited before the students.

3. Science Clubs, Hobbies, Excursion:

These also aid in developing creative spirit in children. In club meetings, students can make new models, apparatus, etc. and as hobbies they can prepare chemicals etc. Excursions to places of scientific interest arouse their

curiosity. They are inspired and tend to be creative. Field work should be preferred to mere lecturing within the four walls of classroom. Project work should be encouraged. Problem solving attitude should be inculcated among the students. Thought-provoking questions should be asked in the classroom to stimulate thinking among the students. Students should be encouraged to practice risk taking abilities and independent judgment.

10.5.1 Gifted Children

School children with superior learning aptitudes are frequently referred to as gifted children. The gifted child is both an asset and a responsibility. There is a limited pool of ability and special talent in every country. This must be identified and developed to save it from total loss.

10.5.1 Meaning of the Gifted and the Creative: In simple language, a gifted child is one who can make outstanding contribution in any area of national life. Giftedness, generally speaking, includes actual or potential qualities of creativity, emotional stability, and social adaptability. Following are the important definitions of gifted children:

James Drever is of the view that, "children possessing high intellectual ability, generally or in a particular field are gifted children."

Terman and Oden state, "Gifted children are far above the average in physique, social adjustment, personality traits, school achievement, play, information and versatility of interests."

In the words of Hillingworth, "By a gifted child we mean one who is far more educable than the generality of children are. The greater educability may lie along the lines of one of the arts, as in music or drawing, it may lie in the sphere of mechanical aptitude, or it may consist in surpassing power to achieve literacy and abstract knowledge."

Paul Witty slates, "Those whose performance in a worthwhile human endeavor is constantly remarkable as well as those who are academically superior."

R. J. Havighurst observes, "Gifted children are those individuals from kindergarten to high school age who show unusual promise in some socially useful area and whose talent might be stimulated."

Broadly speaking, 'gifted children' should include all those children who give promise of creativity of a high order in any worthwhile line of human endeavor. They have superior ability that can make them contribute to the quality of living in society. Therefore, we include not only the intellectually gifted but also those who show promise in music, the graphic arts, creative writing, dramatics, mechanical skills, and social leadership. Nevertheless, here we are dealing with children having gifted intellectual ability.

While discussing the education of the gifted, the creative, and the intellectually superior, it may be observed that, in essence, all these three types of children may be placed in the same category. In practice, it is very difficult to formulate separate policies. These categories differ in degrees only and not in kind.

In the words of Hollingworth, "By a gifted child we mean one who is far more educable than the generality of children are. The greater educability may lie along the lines of one of the arts, as in music or drawing, it may lie in the sphere of mechanical aptitude, or it may consist in surpassing power to achieve literacy and abstract knowledge." Paul Witty, Ruth Strang, Havighurst and many others think that the term gifted children should include all those children who give promise of creativity of a high order in any worthwhile line of human endeavor. They have superior ability that can make them contribute to the quality of living in society.

Therefore, we include not only the intellectually gifted but also those who show promise in music, the graphic arts, creative writing, dramatics, mechanical skills and social leadership.

10.5.2 Main Characteristics of gifted in Biology

1. Very high I.Q
2. Ability to apply knowledge to unfamiliar situations
3. Ability for abstract and symbolic thinking
4. Annoyance with details
5. Attention span long for age
6. Curiosity indicated by asking serious questions
7. Dislike of rigid time schedule
8. Energy level (physical and intellectual) very high
9. Exposure needed limited and fewer repetitions to learn
10. Intense interest in one area
11. Knowing a lot about things of which other students are unaware
12. Learning commensurate with that expected of older students, often start of reading at an earlier than average age
13. Very extraordinary memory
14. Often thinking faster than they write (can result in sloppy work)
15. Spontaneous and diverse interests
16. Standards and goals unusually high
17. Very high vocabulary and mature expressive ability enormous.

Those students who show some or several of the characteristics mentioned above are referred to by many adjectives such as 'genius', 'gifted' and 'talented' etc.

Categories of Gifted Children: Usually following are considered as the categories of the gifted on the basis of Intelligence Quotient (I.Q). (Stanford Revision-USA).

IQ	Percent of Population
160-169	0.3%
150-159	0.2%
140-149	1.1%
130-139	3.1%
120-129	8.2%

On the basis of Dr. V.V. Kamat's classification, 120 I.Q. may be considered as the lower limit of giftedness.

Usually, it is said that nearly 2 to 3 percent of the population may be placed under the category of the gifted children.

Special Attention on the Education: It is of great importance to bring out the hidden 'gem-like' potentialities in pupils not only for the interest of such students but for the interest of the humanity as a whole. The following lines fully illustrate this:

"For many a gem of purest ray serene. The dark unfathomed caves of the ocean bear. Full many a flower is born to flourish unseen. And waste its sweetness on the desert air."

We are interested in the gifted on account of the following considerations:

1. There is a limited pool of ability and special talent in every country. This must be identified and developed to save it from loss.
2. The gifted individuals have played an important role in the preservation and advancement of civilization.'
3. Values of democracy will be realized in the fullest

sense when we recognize the full range of ability within our total population.

4. Many gifted children languish in educational institutions simply because they are not aware of their 'gifts' and the school programmes do not provide them enough motivation and challenge.
5. We need leaders for our business, education, research, government etc. These leaders are provided by this class of gifted children.

10.5.3 Adjustment Problems: A gifted child may become a problem for the parents and the teacher if s/he is not handled properly. Following problems may arise:

- ❖ When s/he is not properly guided, s/he utilises his/her superior intelligence in mischief, indiscipline, gang-formation and revolts against his/her elders thus becomes a nuisance.
- ❖ Because of lack-of opportunities and lack of recognition, s/he sometimes develops inferiority complex.
- ❖ Too much of recognition or applauses by the parent or teacher also develop in him boastful conceit.
- ❖ There is a lack of stimulation for him/her in the subjects of his/her interests when s/he does not get opportunities of progressing according to his/her own pace.
- ❖ S/He revolts against the parents and teachers when they do not recognise him/her, and sometimes creates mischief in order to catch their attention or to show his/her superiority.

10.5.4 Identification of the Gifted:

For identifying the gifted children, following techniques are employed:

2. Intelligence Tests (Individual)
3. Intelligence Tests (Group)

4. Achievements Tests and Batteries
5. Observations by Teachers and others

It may be observed that reliance should not be made only on one technique.

The search for talent must be a continuous process and has to be taken up at all stages. The secondary stage, however, is the most crucial.

The identification process should involve the entire range of school personnel. The science teacher should have an integral part in the identification of all kinds of exceptionalities.

Laycock suggested the following 20 items which may be used to identify a gifted child.

1. Possesses superior power of reasoning, of dealing with abstractions in order to generalize from specific facts, of understanding meanings, and of perceiving relationships.
2. Has great intellectual curiosity.
3. Learns easily and readily.
4. Has a wide range of interests.
5. Has a broad attention span that enables him/her to concentrate on and to persevere in solving problems and pursuing interests
6. Is superior in quantity and quality of vocabulary as compared with other children of his/her own age.
7. Has the ability to do effective work independently.
8. Has learned to read early, often well before school
9. Shows initiative and originality in intellectual work.
10. Shows alertness and quick response to new ideas.
11. Is able to memorize quickly.
12. Has great interest in nature of man and the universe problems of origin and density, and the like.
13. Possesses an unusual imagination.
14. Follows complex directions easily.

15. Is a rapid reader.
16. Has several hobbies.
17. Has reading interests which cover a wide range of subjects.
18. Makes frequent and effective use of the library.
19. Is superior in arithmetic, particularly in problem solving.
20. Where is the 20th point?

No one method of identifying gifted children is sufficient in itself. Therefore, a combination of methods and personnel must be employed. The process of identification includes teacher observation, individual intelligence tests, group intelligence tests, achievement test batteries and creativity tests.

10.5.5 Enrichment Programmes for Gifted:

Enrichment consists in giving the gifted child the opportunity to go deeper or to range more widely than the average child in his/her intellectual, social, and artistic experience. Such a programme may be characterized by (1) emphasis upon the creative or the experimental; (2) emphasis on the skill of investigation and learning; (3) independent work, stressing initiative, and originality; (4) high standard of accomplishment; (5) co-operative planning and activity that provides opportunity for leadership training and experiences in social adjustment; (6) individual attention given by teacher to student; (7) first-hand experiences; (8) flexibility of organization and procedure; (9) extensive reading; and (10) concern with community responsibility.

- **The Triple Track Plan:** In this type of learning plan, there are three tracks:
 1. The first is for the dull children who may cover it in a longer duration of time.

2. The second one is for the average children who cover it in an average period of time.
3. The third is for the children of superior intelligence. S/He covers the entire work in a shorter period of time due to his/her intelligence, efforts and initiative.

Such a system has been adopted in most of the schools in the United States.

- **Rapid Promotion:** Gifted children should be promoted to the next higher grade as soon as they achieve the target of a particular grade.
- **Special Schools:** In some countries, special schools are organised for gifted children. Some educationists have pointed out some limitations in organising such schools.
- **Acceleration:** Acceleration offers opportunity for a gifted pupil to move at a pace appropriate to his/her ability and maturity and to complete an educational programme in less than the ordinary amount of time. It involves advancing the gifted child rapidly from grade to grade in school so that s/he enters college earlier than the others.
- **Segregation or Ability Grouping:** The gifted pupils may be placed in special groups for all or part of the school day. The purpose of ability grouping is usually to provide for enrichment of children's experiences in both depth and breadth, and to permit the children to stimulate one another.
- **Summer Programmes:** Special cultural and educational programmes may be organised for gifted children during the summer season. This approach is being tried in U.S.A. and in a limited measure in our country as well.
- **Scholarships:** Gifted children should be given special scholarships for pursuing their studies. This will lead the gifted child in the right direction.

- **Special Visits:** Groups of gifted children may formally visit places of historical, industrial, geographical, and economic interest. This would enable them to understand and appreciate the important places of social value also.
- **Contact with Eminent Persons:** Gifted children may show interest in any special field of activities. Their meetings may be fixed up with the persons of eminence of that particular field.
- **Vocational and Personal Guidance and counseling's:** The gifted children should receive proper guidance in all areas of life so that their total development is of an optimum level.

10.6.1 Backward Child

“All the students, who, in the middle of their school career would be unable to do the work of the class next below that which is normal for their age, are technically speaking backward students”.

Under this definition, we can include all those children who are unable to complete the work of the class next below them i.e. their junior class and those who attain very low marks in Biology.

10.6.2 Identification of Backward Child

The weak and backward children in Biology can be identified by the following tests—

1. By direct observation in the class and laboratory.
2. Determining Academic Age/Mental Age
3. Various Examination conducted in class
4. Record of previous examination
5. Intelligence testing
6. Evaluation of other teachers and parents

The teacher should identify such students with the help of above mentioned tests and make special arrangement for their studies. These students can also be identified by the following characteristics.

10.6.3 Characteristics of Backward Child in Biology

- ❖ They sit quietly and inactively in class.
- ❖ They answer quickly in the class but invariably answer wrongly or they do not answer at all. Their behaviour becomes neurotic.
- ❖ They are unable to do symbolic and unpersonified work.
- ❖ They cannot understand the complicated instructions for practical work easily.
- ❖ They are unable to understand the different processes and principles of Biology.
- ❖ In 'Identification' and 'Spotting', they work very slowly.
- ❖ They have interest in practical work but their level of work is very poor.
- ❖ They find themselves mal-adjusted in class.
- ❖ They get very few marks in Biology though they may get good marks in other subjects.
- ❖ They have failed in a single class for 1 to 4 years.
- ❖ In the sociometric test, they come in the category of neglected or small clique.
- ❖ They come to the class late and tend to run away fast.

10.6.4 Teacher's Duty towards Backward Child

A) Adjustment of Syllabus

1. With the help of students, the syllabus should be prepared in a suitable manner in the form of 'annual-teaching-plan' to meet the needs of all the students, with the help of 'Teacher-student-plan' method.
2. Each topic of Biology should be explained with the help of very easy examples.
3. The entire syllabus should be divided into small portions.
4. The principles should be taught after the completion of theoretical and practical activities.
5. To encourage them to get better marks, they should be

given 'Open Book System Tests' in the classroom. Their confidence should be boosted by giving them consolation prizes.

B) Teaching Process-Methods

1. Mostly, Problem-solving-supervised study method and demonstration method should be used. Special materials should be provided to them for self-study.
2. They should be taught using the formula personified to unpersonified, known to unknown, and concrete to abstract.
3. 'High time effective method' should be used.
4. To encourage them, special apparatus and audio-visual aids should be used.
5. Their previous knowledge should be kept in mind.
6. Activity method, tutorial and personal work plans should be prepared for them.
7. They should be rewarded for good work.
8. The late comers should be provided materials for 'supervised study'.
9. Special classes should be conducted as per the requirement.
10. For practical activity/work, the laboratory assistant should be given special instructions to help them.
11. Verbal and written instructions should be given for every activity.

C) Case Studies

To help such students, the teachers should do case studies of such students and take the help of other teachers also. After detailed study, they should organize them according to the results obtained.

D) Examination, Class and Home Work

1. While examining the students, the teacher should clearly tell the students that s/he is testing the

knowledge of the students.

2. Proper corrections should be done by the teachers in the class work, homework and examination notebooks.
3. They should be given a chance to correct their mistakes.
4. The weak students should be given extra time for practice.
5. While giving them class work and homework, its volume should be kept in mind.

E) Parent-Teacher Co-Operation

The teacher should talk in detail regarding these students, to their parents and give them proper instructions.

F) Curricular Activities

1. The backward students should be encouraged to participate in curricular activities according to their capabilities.
2. For them, simple competition should be organized.
3. While putting up questions in the class, they should be asked easy questions.

By adopting such measures, the Biology teacher can arrange proper study means for backward students of his/her subject.

REVIEW QUESTIONS

1. Define 'Creativity'.
2. What are the characteristics of creative person?
3. Who is a gifted child?
4. Explain the methods of educating the gifted children in science.
5. Who are backward children? How to identify and educate them?

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INDEX

A	
Achievement test,	512
Activity approach,	289,290
Activity-centered	336,489
Aesthetic	18,24,25
Affective domain,	55,56
Aims,	64,71,100
Analysis,	75,76,126
Applications,	269,300
Assessment,	296,297,302
Assignment,	368,377,456
Assumption,	237,239
B	
Behavior	277,278,279
Bell jar apparatus,	448
Biological laboratory,	382,383,407
Biological Science Curriculum study Project,	315
Biological science	7,9
branches,	333,413
curriculum,	480,484
improvised apparatus,	472,473
instructional objectives	516
knowledge,	540,541,544
lab,	558,559
meaning,	57,68,61
methods,	480,381
specifications,	138,512
subjects,	7,30,32
teaching,	25,32,67
values,	523,507,504
Biology,	
Benjamin Bloom,	51,59,60,64
Blooms taxonomy,	
Blue version,	
Blue print,	

Breakage registers,	
C	
Calculation,	
Cause and effect,	
Classroom management,	
Clubs, science,	
Cognitive domain,	
Cognitive objectives,	
Comprehension,	
Computers, library,	
Concentric approach,	
Conceptual approach,	
Consumable stock registers,	
Content,	
Correlation,	
Criticism sheets,	
Cultural value,	
Cumulative records,	
Curriculum,	
aims,	
approaches,	
bases,	
characteristics,	
concept,	
construction principles,	
cycle,	
defects,	
definition,	
determinants,	
development process	
drawbacks	
dynamic,	
evaluation,	
functions,	
improvement,	
indian scenario	
load,	

meaning	
national framework,	
objectives,	
organization,	
organization approaches,	
organization principles	
process	
project	
qualities	
recommendations	
reforms	
styles	
syllabus,	
urgency steps,	
Deductive approach	
Demonstration kits	
Diagnostic tests	
Digital library,	
Dignostic evaluation,	
Disciplinary value,	
Discipline,	
Disciplines,	
Discrimination,	
E	
Education,	
Educational importance,	
Educational objectives,	
Educational programme,	
Einstein, Albert,	
Evaluation,	
assessment,	
characteristics,	
cognitive domain,	
concept,	
curriculum,	
definition	
functions,	

importance,	
lesson plan,	
meaning,	
measurement	
need,	
process	
purpose,	
science club,	
tools,	
triangular process,	
types	
unit planning	
Experimentation	
Experiments,	
Eye accidents,	
F	
Facts,	
Fairs, science,	
Fermentation,	
Films,	
Fire,	
First aid,	
Formative evaluation,	
G	
Germinalization,	
Guidance program	
H	
Herbartian lesson plan,	
Heuristic method,	
High school science kits,	
Home assignment,	
Homework	
Hunter's score card,	
I	
Inductive approach,	
Innovations,	
Instruction cards,	

Instructional materials,	
Instructional objectives,	
Intelligence tests,	
Interactive curriculum	
Interviews,	
L	
Laboratory,	
administration	
apparatus,	
books/records,	
characteristics,	
chemistry,	
discipline,	
factors,	
guidelines,	
hazards,	
indent form,	
instruction cards,	
kits,	
maintenance,	
manuals,	
method,	
mishaps	
mobile	
organization	
physics	
planning,	
preparations,	
procurement,	
recommendations,	
requirement	
requirements,	
requisition	
safety management,	
secondary schools	
stock registers,	
storage,	

timetable,	
types,	
whitehouse plan,	
work,	
Learning experiences,	
Learning organization,	
Lecture method	
Lecture method,	
Lecture-cum-laboratory plan,	
Lesson plan,	
Librarian,	
Logical approach,	
M	
Methods,	
Mobile science laboratory	
Model value	
Motivation	
N	
National Council of Educational Research and Training (NCERT)	
Nuffield Foundations,	
O	
Objective based test,	
Objective type tests,	
Observation,	
Oral tests,	
Order register,	
P	
Practical work,	
Presentation,	
Project method,	
Project work,	
Psychomotor domain	
Psychomotor objectives	
Pupil-centered approach,	
Q	
Question types,	

Questionnaires,	
R	
Rating scales,	
Rating scales,	
Records,	
Respiratory apparatus,	
S	
Scholastic Achievement Test,	
club,	
correlation with in,	
curriculum defects,	
curriculum project,	
curriculum,	
definition,	
kits,	
laboratory,	
Subject-centered approach,	
T	
Teacher-centered approach,	
Teaching-made tests,	
administering,	
evaluation,	
preparation	
sample	
techniques	
types	
Textbook,	
analysis,	
author	
characteristics	
curriculum,	
evaluation	
features,	
functions	
position	
subject organization	
writing principles	

U	
Unit plan,	
Unit test,	
Unitary approach	
V	
Visual aids,	
Vogel's spot check evaluation scale,	
W	
Whitehouse plan,	
Written test,	
Year plan,	
Z	
Zoology	

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About the Book

This book Teaching of Biological Science primarily designed to fulfill the need of biological science students of B.Ed. Greater care has been taken to ensure that this book provides a complete reference to the examination needs of the students as well as a useful hand book on imparting sound teaching-instruction in biological science. Extensive use of flow charts has been made throughout the book to help the reader to understand the key concepts at a glance.

This book divided into ten parts; efforts have been made towards presenting the book in a simple and effective language. The contents of this book are arranged in a coherent manner. The book enables the student teachers to acquire knowledge of aims and objectives of teaching Biological Science, Science laboratories organization and register maintenance. Safety procedures in a Biology Laboratory, besides mastery over the lesson plan, unit plan. The student–teachers can also understand the curriculum development in science. All attempts have been made to include the latest trends and current educational practices, evaluation, technology in teaching biological science and provision for inclusion.

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