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MANGALAGANGOTHRI - 574 199,
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COURSE 8
Pedagogy of School Subject - II (c)

BIOLOGICAL SCIENCE
(Curriculum and Pedagogic Studies)
BLOCKS 3 & 4
(PART - 2)

B.Ed. DEGREE PROGRAMME
(OPEN AND DISTANCE LEARNING)

SECOND YEAR B.Ed.

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Dr. Suneetha C.N.   :   **Block - 3**   **Course Writers**

Dr. Arthy Shetty   :   **Block - 4**

Dr. Vishwanath H.N.   : **Block - 3**   **Course Scrutinizers**
Associate Professor(,
Sarada Vilas College of Education
Mysore

Dr. Suneetha C.N.   : **Block - 4**
Associate Professor(Rtd.),
Onkarmal College of Education,
Krishnamurthy Puram, Mysore-4

Dr. Chidananda A.L.   **Assistant Course Editor**

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Overview of the Course

The basic concerns of education-to enable children to make sense of life and develop their potential, to define and pursue a purpose and recognise the right of others to do the same-stand uncontested and valid even today (NCF 2005). With this context, it becomes very important that student-teachers should get acquainted with the pedagogical bases of their method-subject/school subject. Pedagogy is considered a fertile ground for the integration of knowledge about the learner, the subject, and the social context.

Biological Science as Course 8 Paper under ODL of B.Ed. Programme is constituted by three major areas, namely, The nature, scope, history, and importance of biological sciences, The aims and pedagogical approaches for teaching-learning of biological sciences at different stages of school, and Theoretical aspects regarding how children understand and construct the knowledge of biological concepts in their diverse social contexts (NCTE 2009). Learning Resources of Biology and Assessment Practices are the other two integral parts of this course-8 paper.

The framework of the pedagogy of Biological Science is designed using Four Blocks with Six Units each. All the four blocks head towards the objectives of the paper Course-8 in which developing scientific temper, scientific attitude, appreciation towards the dynamic and expanding body of knowledge, nurturing curiosity, bringing the relationship with every day's experience and concepts of biological sciences, constructing appropriate and meaningful inquiry episodes, problem-solving situations and investigatory projects based on biology curriculum, bringing/developing linkage of different concepts of biological sciences with life skills are the thrust areas.

In the First Block, the nature and objectives of teaching biological science, its scope, history of biological sciences, the significance of inquiry, observation, and experiments in biological science, its inter-disciplinary linkages, and social concerns are discussed. The Second Block focuses on the Approaches and strategies of learning biology. Observation, inquiry, experimentation, experiential learning, expository approach, investigation, project, and collaborations are discussed with a special reference on teaching-learning in Biology. The Third Block deals with Learning Resources in Biology. Use of ICT tools and online resources at various stages of school education, ICT based virtual experiments and simulations as learning resources in biology are introduced with examples and illustrations. Planning for teaching-learning of Biology and Assessment parts are focused in the Fourth Block. It explains the need, importance, and different avenues for the professional development of Biology Teachers.

Finally, it all depends upon the other end of the communication i.e., the Receiving End. Hence the way how you receive, perceive, and practice this academic pursuit is the most significant aspect. These course materials may not be all-in-all but it gives you a path with a clear destination. Further, it will become more functional by your inquisitiveness and enthusiasm. Wishing you all the very best for your academic journey for great success and positive professional transformation.

Block 3 : Curriculum and Learning Resources in Biology

Unit 1 : Selection and Organization of Contents in Biology

Unit Structure

3.1.1. Learning Objectives
After completing this Unit, the student teachers will be able to,
- Define curriculum;
- Explain the characteristic features of the biology curriculum;
- Establish the relationship between Curriculum, Syllabus and Textbook;
- Identify the learning resources that are relevant to the biology curriculum;
- Classify the learning resources into different types;
- Recall the criteria of content selection for The biology curriculum;
- Describe the principles that are useful in organizing the content of The biology curriculum; and
- Explain different patterns of content organizations in The biology curriculum.

3.1.2. Introduction
Dear Student Teachers,

The asset of any country is its resources. These resources are human, physical/environmental and economical. Among these human resources are very significant as the same can regulate the other two constructively for the wellbeing of the country. These human resources are nothing but its citizens and the quality of these citizens is determined by its Education system. Of course, education is a long run endeavour and its results are far-reaching. That is why the education system and its curriculum as a whole must be meticulously planned, designed and executed. For this very first thing to be fulfilled is the framing of clear and well-defined objectives. In this unit, you will come to know about the meaning, nature and importance of curriculum and learning resources.

3.1.3. Learning Points and Learning Activities

3.1.3.1. Meaning, Nature and Importance of Curriculum and Learning Resources in Biology

Activity-1:
To begin with, let us have a look at the following illustration (NCF 2005)

Janabai lives in a small village in the Sahyadri hills. She helps her parents in their seasonal work of Paddy and Turdal farming. She sometimes accompanies her brother in taking the goats to graze in the bush. She has helped in bringing up her younger sister. Nowadays she walks 8 km. every day to attend the nearest secondary school. Janabai maintains intimate links with her natural environment. She has used different plants as sources of food, medicine, fuel wood, dyes and building materials; she has observed parts of different plants used for household purposes, in religious rituals and in celebrating festivals. She recognizes minute differences among plants and trees and notices seasonal changes based on shape, size, distribution of leaves and flowers, smells and textures. She can identify about a hundred different types of plants around her - many times more than her Biology teacher who believes Janabai is a poor student. Can we help Janabai translate her rich understanding into formal concepts of Biology? Can we convince her that School Biology is not about some abstract world coded in long texts and difficult language? Rather it is about the farm she works on, the animals she knows and takes care of and the woods that she walks through every day. Only then will she truly learn science.

The word "Curriculum" has been originated from the Latin language-**'Currere'** meaning to run or to proceed. The implied meaning is 'a race' or 'the course of a race'. By the seventeenth century, the University of Glasgow referred to it as **"Course of study"**. And thus it was related to educational activities. By the nineteenth century, European universities referred to their complete course of study as Curriculum. By 1824, the word 'curriculum' got elaborated and defined as "a course, especially a fixed course of study at a college, university, or school".

In the present context, the term curriculum encompasses all the activities that are conducted inside as well as outside the school. It may be academic, non-academic, scholastic and non-scholastic. Most of the time the term curriculum refers to the lessons and academic content taught in school or in a specific course or programme. A curriculum is a framework that sets expectations for student learning. It serves as a guide for teachers, a roadmap that establishes standards for student performance and teacher accountability. Curriculum refers to an interactive system of instruction and learning with specific goals, contents, strategies, measurement, and resources. The desired outcome of the curriculum is the successful transfer and/or development of knowledge, skills, and attitudes among the students.

National Curriculum Framework 2005 (NCF2005) has very well narrated about how, why and what of science education. It says science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition. The advances in science and technology have transformed traditional fields of work such as agriculture and industry, and led to the emergence of wholly new fields of work.

People today are facing an increasingly fast-changing world where the most importantly needed skills are flexibility, innovation and creativity. These different imperatives have to be kept in mind in shaping science education. Good science education is true to the child, true to life and true to science itself. This simple observation leads to the following basic criteria of the validity of a science curriculum:

1. Cognitive Validity: Requires that the content, process, language and pedagogical practices of the curriculum are age-appropriate, and within the cognitive reach of the child.

2. Content Validity: Requires that the curriculum must convey significant and correct scientific content. Simplification of content which is necessary to adapt the curriculum to the cognitive level of the learner must not be so trivialized as to convey something flawed and/or meaningless.

3. Process Validity: Requires that the curriculum should engage the learner in acquiring the methods and processes that lead to the generation and validation of scientific knowledge and nurture the natural curiosity and creativity of the child in science. Process validity is an important criterion since it helps the student in 'Learning to Learn' Science.

4. Historical Validity: Requires that the science curriculum be informed by a historical perspective, enabling the learner to appreciate how the concepts of science evolve. It also helps the learner to view science as a social enterprise and to understand how social factors influence the development of science.

5. Environmental Validity: Requires that science be placed in the wider context of the learner's environment, local and global, enabling him/her to appreciate the issues at the interface of Science, Technology and Society, and equipping him/her with the requisite knowledge and skills to enter the world of work.

6. Ethical Validity: Requires that the curriculum promotes the values of honesty, objectivity, cooperation, and freedom from fear and prejudice, and inculcate in the learner a concern for life and preservation of the environment.

At the primary stage, the child should be engaged in joyfully exploring the world around and harmonizing with it. The objectives at this stage are to nurture the curiosity of the child about the world (natural environment, artefacts and people), to have the child engage in exploratory and hands-on activities for acquiring the basic cognitive and psychomotor skills through observation, classification, inference, etc.; to emphasize design and fabrication, estimation and measurement as a prelude to the development of technological and quantitative skills at later stages; and to develop basic language skills: speaking, reading and writing not only for science but also through science. Science and social science should be integrated as 'Environmental Studies' as at present, with health as an important component. Throughout the primary stage, there should be no formal periodic tests, no awarding of grades or marks, and no detention.

At the upper primary stage, the child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) and continuing to learn more about the environment and health, including reproductive and sexual health, through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activities, discussions with peers and teachers, surveys, organization of data and their display through exhibitions, etc. in schools and the neighbourhood should be important components of pedagogy. There should be continuous as well as periodic assessments (unit tests, term-end tests etc.). The system of 'direct' grades should be adopted. There should be no detention. Every child who attends eight years of school should be eligible to enter Class IX.

At the secondary stage, students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analyses on issues concerning the environment and health, including reproductive and sexual health. Systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology, are to be important parts of the curriculum at this stage.

Learning Resources in Biology
Learning is a complex process that takes multi-faceted dimensions. It is a process that occurs in a socio-emotional context. Teachers and students interacting formally and informally in different situations contribute to learning among students. Peer group interactions in the school grounds, free time chatting with friends during breaks, why, starting from the morning assembly to gathering together for any festive and significant occasions in the school, projects carried out in the classroom as well as outside the classroom, anxiously attending the tests and examinations, trips, excursions made with the classmates and teachers- all these are activities are coming under one big canopy that is "Curriculum" where learning will be there as by default. They all together form what is known as a "Learning Community" in which every activity leads to learning.

Learning resources, for the sake of our convenience and study purpose could be classified into three types, namely, (i) Material Resources (ii) Community Resources and (iii) Human Resources. Under material resources, printed resources, pictures, portraits, diagrams, charts, records, documents, reference books, textbooks, workbooks, encyclopedia, preserved specimen, herbaria, live preservations (potted plants, laboratory equipment, chemicals, preservatives and experiments) are categorised. In Community Resources, we come across, botanical garden, museums, zoo, hospitals, primary health centres, food processing units, milk dairy, parks, science exhibitions, science fairs, poultry forms, duck forms, mushroom culturing centres, sericulture centres, fisheries, prawn culturing centre and farm-houses, department of studies and research in life sciences etc. In Human Resources, the expertise, subject specialists, scientists, doctors with their respective specializations, experts in animal husbandry, apiculture, ornithologists, oncologists, entomologists, botanists, zoologists, bio technician, senior-most professors in the life science departments are included.

Apart from the above-said resources, one more type, the most significant resources, namely, digital resources are there. This has made the teaching-learning process more interesting, easy-going and effective for both and students and teachers. Online, offline, virtual class, virtual experiments, virtual teaching-learning experiences etc. are outstanding in their quality and effectiveness. Computers, internet and the multi-media approach are very predominant learning resources nowadays. These can even solve the problem of non-availability of resource persons or expert teachers to distant areas. That is why is called "Death of Distance" and "Death of Time" as the technology has overcome the constraints of time and space.

There is a very vivid linear relationship between, curriculum leading to the syllabus and in turn, syllabi are expressed in Textbooks. Textbooks are the common reference material for both the teacher and the students. Hence the textbook is considered the prime site for curriculum designing. Though curriculum planning is a much wider process, the expression of it inevitably depends upon textbooks. Improved textbooks that are carefully written and designed, professionally edited and tested, offering not merely factual information but also interactive spaces for children which are important from the point of nature of true science education with the constructivist learning approach. But curricular reform can go much farther if textbooks are accompanied by several other kinds of materials. Subject dictionaries, for instance, can relieve the main textbook from becoming encyclopedia, burdened by carrying definitions of technical terms and instead allow the teacher to focus on understanding concepts. Supplementary books, workbooks, and extra reading materials will follow next. There are fine examples of such materials produced for the study of the environment, introducing children to the observation of trees, birds and the natural habitat. Such resources need to become available to the teacher and for use in the classroom

Atlases have a similar role to play in enriching the child's understanding of the earth, both as a natural and as a human habitat. Atlases of flora and fauna, people and life patterns, history and culture, etc. can greatly enlarge the scope of the subjects. Such materials could be available in a resource library and at the cluster level to be borrowed by schools for use, or they could be placed in the school library, or made available by teachers. Manuals and resources like, Teachers Handbooks are just as important as textbooks. Apart from these, Audio and Video materials and Websites on the Internet are also important resources for learning biology.   These would provide tips for teachers, which they could use for lesson planning.

Check Your Progress - 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Process Validity of the content helps the students to
   a. Recall the content
   b. Recognize the content
   c. Classify the objects
   d. Learn to learn

2. Curriculum is,
   a. An academic plan
   b. Syllabus
   c. The framework that sets the students' learning outcomes
   d. The teaching-learning process

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. A textbook is a common resource for both teacher and the students
   b. Learning is a complex process that occurs in a socio-emotional context
   c. Atlases are of no use to the subject Biology
   d. Encyclopedia and herbaria both are material resources
   e. Laboratory manuals are exclusively meant for teachers
   f. Workbooks are just a repetition of textbooks, hence of no use.

3.1.3.2. Selection and Organization of Content in Biology

Activity-2

Ask the students to go through any topic or a selected topic like "Life Processes" in the textbook meant for different consecutive standards (8th, 9th and 10th std. Biology Textbooks). Let them try to find out some factors, like, the commonality of the topic and the hierarchical arrangement following the maxims of learning the content. It could be, simple to complex, easy to difficult, specific to general etc.

Activity 3

Ask the students to study the salient features of one particular Phylum or Family (Zoology and Botany) in general, typological study and followed by varieties of specific species/specimens. Based on this experience, let the students try to explain the arrangement of the content.

Contemporary research on students' features about their learning activity reveals certain facts that are worth discussing. Hence a glance at these characteristic features is given here.

- Students are naturally curious about all aspects of the biological world. Maybe it is identifying plants and animals, understanding biotechnology, or investigating ecological systems. Students will have an interest and curiosity in knowing in their world and seek explanations for how things work.
- Students already have explanations based on existing knowledge, attitudes, and skills when a biology lesson begins. Students' knowledge-based explanations, attitudes, and skills may well be inadequate, incomplete, or inappropriate and even sometimes incorrect. Contemporary educational researchers use such terms as "Misconceptions" to characterize the cognitive component of student understanding. Briefly, students interpret instructional activities in terms of what they already know; then they actively seek to relate new concepts, attitudes, or skills to their prior set of concepts, attitudes, or skills. The assimilation of new experiences is based on the students' prior experiences, and it may or may not get "learned" the way the teacher intended. Students' learning is

accurately viewed as the process of refining and reconstructing extant knowledge, attitudes, and skills, rather than the steady accumulation of new knowledge, attitudes, and skills.

- Students have different styles of learning. "Learning style" refers to the way individuals perceive, interact with, and respond to the learning environment. Learning styles have cognitive, affective, and physical components. Hence it has to be compatible with the proper strategies of teaching.
- Students pass through developmental stages which have a strong influence on learning. During the 1960s and 1970s, Jean Piaget's popular theory became significant and influenced the process of curriculum development across the world. Piaget's work focussed on cognitive development. Current research in the cognitive sciences is, in many respects, an extension of Piaget's work. Contemporary curriculum development holds a larger view of student development. In addition to cognitive development, we should also attend to the student's ethical, social, and psychomotor development. This broader view of development is important to the selection of instructional methods.

All the four said issues about students' learning are explained in the context of constructivism. In the constructivist model, students reorganize and reconstruct core concepts, or intellectual structures, through continuous interactions with their environment and other people. Applying the constructivist approach to teaching requires the teacher to recognize that students have prior conceptions of the natural world. They may be inadequate and need further development. Curriculum developers can design materials and teachers can use strategies so that students encounter objects or events that focus on the concepts, attitudes, or skills that are the intended learning outcomes. Then they can have students encounter problematic situations that are slightly beyond their current level of understanding or skill. The instructional approach then structures physical and psychological experiences that assist in the construction of more adequate explanations, attitudes, and skills. These new constructions are then applied to different situations and tested against other constructions used to explain and manipulate objects and events in the students' world. Briefly, the students' construction of knowledge can be assisted by using sequences of lessons designed to quest current conceptions and by providing time and opportunities for reconstruction to occur.

Curriculum designing involves the selection of contents that are in line with the aims and objectives of the education in general and specific subjects in particular. The selected contents will have to be arranged in a form that will help the teachers in choosing and organizing appropriate and suitable learning experiences for classroom teaching. Here, the focus of the curriculum is essentially based on the selection and organizing of content for learners and learning experiences in the form of activities. This phenomenon activity is grounded on certain sound theoretical knowledge and framework called Criteria.

Criteria for the Selection of Subject-Matter or Content of the Curriculum
According to Ornstein and Hunkins (1998), the selection of the subject matter for curriculum employs eight criteria/principles explained below:

1. Criterion of Self-Sufficiency: This explains about helping learners attain maximum self-sufficiency most economically. According to Scheffler (1970), the economy in attaining self-

sufficiency is the main guiding principle of content selection. It implies that less teaching effort and less use of educational resources and more gain/achievement from students. In a way, it advocates that students should be given a chance to experiment, observe and do the field exposures on their own. It is allowing students to learn independently.

2. Criterion of Significance: The chosen content must be significant enough in bringing the anticipated development, learning of activities, skill, processes and attitudes. It must be significant enough in bringing about learning in all the three domains of learning and dimensions of the personality, namely, cognitive, affective and psychomotor. Apart from this, the subject matter must be culture-sensitive.

3. Criterion of Validity: This refers to the authenticity of the content selected. Therefore while fixing content one must be sure enough that the topics are not obsolete. Modern curriculum experts are putting more thrust on the current trends, relevance and authenticity of the curriculum. Otherwise, the whole thing will become "outdated".

4. Criterion of Interest: This appears to be true to the learner-centered Curriculum. Students learn best if the subject matter is meaningful to them. It becomes meaningful if they are interested. If the chosen content has a direct application to day-to-day life situations, then automatically it creates meaning and this in turn creates interest and curiosity. These are the basic requirements for any learning.

5. Criterion of Utility / Application: Anything that is taught must have usefulness or applicability in required situations. Anything that is not useful definitely will not create interest among learners. As a result, they will not study the subject. Hence the content must be apt enough in giving a learning experience that helps the students in gaining a job, earning, and other domains for the flourishing the potentials in them.

6. Criterion of Learning ability: This principle explains that the chosen content must be well within the reach of the learning (Learn ability) by the students. In Piagetianterm it must be within the schema of the learners. The cognitive structure should be within the learning experiences of the students. Teachers are supposed to adapt the psychological principles of learning in sequencing, organizing the learning activities and transaction of the teaching-learning process of the subject.

7. Criterion of Feasibility: This is regarding the implementation of the subject matter. This is done by taking into consideration of the real situation of the school, available resources, and provision by the government and the society in general. Students must learn within the available time or the stipulated time. It should not be like, providing the subject matter which is impossible to complete learning. Feasibility also includes the availability of competent teachers and experts in that particular area of the subject.

8. Criterion of Individual Difference: Classroom will always have heterogeneous groups of students. No two individuals are alike or each individual is unique. Hence while selecting the content one has to consider the nature of the learners and mind their individual needs related to learning. The organization and design of the content must be appropriate to the nature of students.

Based on the aforesaid criteria the content part of the curriculum will be selected but the next part is about how to organize these topics or arrange them into meaningfully sequenced teaching-learning or transacting activities. The curriculum reflects 'what' of content to be taught and the teaching-learning phase needs guidance on 'how' to be taught. The teaching-learning phase being the major part of the curriculum will be embedded with the pedagogy of teaching, the scheme of evaluation and much more of this. Here, teaching helps in accessing achievement among the students. This is the strong and direct relationship between the curriculum content and the curriculum transaction. According to Olivia (1982), the relationship between the curriculum and the transaction of instructions is continuous, repeated and never-ending. The content to be organized in the curriculum must be per the general principles. The following principles, namely, scope, sequence, continuity, integration, articulation and balance have been proposed by several educationists and eminent scholars (Sowell, 2000; Ornstein & Hunkins, 1998).   Now let us discuss the process of organizing content in the curriculum- the phase which is governed by certain principles:

1. Scope of the Content:
The topic chosen and fixed under the curriculum must have both breadth and depth of knowledge. It could be in terms of coverage of the subject using topics, deeper level of the chosen content, learning experiences and making it an integrated whole. Hence scope includes cognitive domain, affective domain as well as the psychomotor domain also. Goodland & Zhixin Su (1992) believe that the scope of the content must include the spiritual aspects also. It speaks about how much knowledge a student should gain at the secondary school level. Ornstein & Hunkins (1998) advocate that the scope of the curriculum must be decided based on the usefulness of the content selected, students' abilities, amount of content and a smart balance in the content selected among cognitive, affective, psychomotor and spiritual outcomes.

2. Sequence of the Content:
This principle explains the arrangement of the content in terms of the sequence or the order of the presentation of the content. However, it must have a binding thread for the cumulative learning outcomes among the students. It should have opportunities for students to make connections and enrich their understanding of the content. It should lead to the cumulative development of intellectual and affective processes. It should have a compatible logic as the learners can learn. It should abide by the psychological laws of learning and developmental aspects of human beings. Ornstein & Hunkins (1998), Hilda Taba (1962), and Bruner, (1960) have identified certain principles based on which the content has to be organized and they are,

    I. **Simple to Complex:** Easier concepts/content arranged first and gradually the subsequent levels of complexity are increased with the respective content/topics. Simple concepts are presented first, followed by complex ones with interrelationships among them. This type of content arrangement facilitates optimum learning among students.

    II. **Spiral pattern/Spiral Curriculum:** Bruner (1960) advocates this pattern of content arrangement. Here, the concepts are introduced on a simple level in early grades and then the same concepts are revisited with more and more complexity and the same content is treated at the application level later on pre-requisites. It works on the assumption that any bit of information or learning must be grasped before the other bits of information can be understood. This is also referred to as a whole-to-part pattern. Content is better

understood if an overview (Whole) is first presented to show the connections among the parts.

III. **Chronological Order:** This pattern is very much suitable in certain subjects like history, literature studies and anthropology. In the case of historical studies in Science like the evolution of man, development of science as a discipline this pattern is adapted.

IV. **Vertical Organization:** Here the content and skills to be learnt are arranged so that they build on one another, they align with the general sequence of cognitive development. It will be simply like, what students have learned and what they will learn later.

V. **Horizontal Organization:** Here the content and skills taught during one level or one period of time-related to another. The knowledge to be developed will expand horizontally so that the area of the knowledge gets widened.

3. Integration of the Content

Integration of the content means bringing together the different concepts, facts, generalizations, rules and principles on the same knowledge platform so that they reinforce each other. For example, Darwin's theory of organic evolution and struggle for existence show complimentary connectivity with each other. Similarly, the adaptations, structural and functional modifications seen in organisms show inter-dependency. Otherwise, the content will be fragmented, disjointed and detached making useless learning by students. An integrated curriculum design will have different branches of life sciences and technology in an interwoven manner. This type of content arrangement will make the student fit enough for the present world. Issues on Science, Technology, Environment and Society are inter-connected in the curriculum. Pure Sciences are complimented with Social Sciences in attempting to solve day to day problems of society. The integrated and multi-disciplinary approaches take the student outside the laboratory and away from the textbook into the local community.

4. Perspectives of space, time and causal relations

Biology being a descriptive subject, as well needs laboratory experiences for meaningful learning. These laboratory experiences should expand students' perspectives of space, time and causal relations. This means to say that, over the school years, students should extend their ideas of space from local to regional to national to global perspectives. Their ideas of time should extend to the distant past and the future. Causal relations should extend from simple cause and effect to the complexities of interrelated and interdependent systems with multiple causal relations. In the end, students should come out with a global perspective that can recognize complex interdependences and consider the future of humanity.

The subject biology needs a balance between the topics to be taught, textbooks, technology and laboratory experiences. The constructivist approach advocates five phases in any teaching-learning process and they are, Engage, Explore, Explain, Elaborate and Evaluate. (5 E model of learning) Each of these phases can intervene at any stage of teaching in one particular period of classroom activity. It is because, all these are action verbs, so it need not be a watertight sequence as said above. For example, 'Engage' – this activity can be there at the beginning of the lesson, the middle of the lesson as well as at the evaluation stage also. However, a brief

explanation of each of these phases will help us to understand the selection and organization of the content in general and one classroom period in particular.

Engage: This is considered as the initiating phase of the learning task. Therefore, here the activities are expected to bring connections between the past and present learning experiences and also, focus students' thinking on the learning outcomes of the current activities. This phase expects a total engagement of a student mentally in the learning of the concept, processes, or skill to be explored.

Exploration: Here the students are supposed to experience and develop the concepts, processes and skills. For this, they have to actively explore the environment or manipulate the materials.

Explanation: This phase focuses on catching the attention of students on a particular aspect and provides opportunities to verbalize their conceptual understanding or demonstrate the skills for others / for their peer group. Here teachers also can explain the concepts, definitions, demonstrate the experiments and exhibit the skills.

Elaboration: This phase will take the teaching-learning process to the application level of understanding. Here the students are given plenty of opportunities to practice the desired skills and learned behaviours. This will help the students in acquiring a deeper and broader understanding of the subject and good quality in performing skills.

Evaluation: This phase helps both the teacher and students to check their level of achievement. For a teacher, it gives feedback about the teacher-effectiveness and for students, it will be feedback about their learning outcomes.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Misconception means
    a. Wrong conceptualization
    b. Students' inadequate/wrong understanding of the concept
    c. Misunderstanding
    d. Inconsistency in understandings

2. There must be scope for spiritual aspects in the curriculum- This is advocated by
    a. Goodland & Zhixin Su
    b. Bruner
    c. Ornstein & Hunkins
    d. Hilda Taba

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
    a. The content to be organized in a curriculum must be per the aims and objectives of education
    b. The usefulness of the content need not be considered at all in the curriculum
    c. The phase Evaluation is concerned with feedback to students only

d. Engage, Explore, Explain, Elaborate, Evaluate are the five phases of content organization in Constructivism
e. There must be a balance between theoretical aspects and laboratory experiences
f. Content fixation should be irrespective of individual differences

3.1.4. Let us Summarise

The word "Curriculum" is evolved from Latin language-'Currere' meaning to run or to proceed. The implied meaning is 'a race' or 'the course of a race'. By the seventeenth century, the University of Glasgow referred to it as "Course of study". A curriculum is a framework that sets expectations for student learning. It serves as a guide for teachers, a roadmap that establishes standards for student performance and teacher accountability. Curriculum refers to an interactive system of instruction and learning with specific goals, contents, strategies, measurement, and resources. The desired outcome of the curriculum is the successful transfer and/or development of knowledge, skills, and attitudes among the students.

At the secondary stage, students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analyses on issues concerning the environment and health, including reproductive and sexual health. Systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology, are to be important parts of the curriculum at this stage.

Learning resources, for the sake of our convenience and study purpose could be classified into three types, namely, (i) Material Resources (ii) Community Resources and (iii) Human Resources. Under material resources, printed resources, pictures, portraits, diagrams, charts, records, documents, reference books, textbooks, workbooks, encyclopedia, preserved specimen, Herbaria, live preservations (potted plants, laboratory equipment, chemicals, preservatives and experiments) are categorised. In Community Resources, we come across, botanical garden, museums, zoo, hospitals, primary health centres, food processing units, milk dairy, parks, science exhibitions, science fairs, poultry forms, duck forms, mushroom culturing centres, sericulture centres, fisheries, prawn culturing centre and farm-houses, department of studies and research in life sciences. In Human Resources, the expertise, subject specialists, scientists, doctors with their respective specializations, experts in animal husbandry, apiculture, ornithologists, oncologists, entomologists, botanists, zoologists, bio technician, senior-most professors in the life science departments are included.

Curriculum designing involves the selection of content that is in line with the Goals and Objectives of Education in a general and specific subject in particular. The selected content will have to be arranged in a form that will help the teachers in choosing and organizing appropriate and suitable learning experiences for classroom teaching. According to Ornstein and Hankins (1998), the selection of the subject matter should be based on certain criteria, namely, Self-Sufficiency, significance, validity, interest, utility, learn ability, feasibility and due weightage on the individual difference. While organizing or arranging the content into the curriculum the principles to be followed are, scope and sequence of the content, like, vertical, horizontal, and simple to complex, spiral, Perspectives of space, time and causal relations.

3.1.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1
1. d   2.c   3.a- √   b- √   c- X d- √   e- X   f- X

Check Your Progress - 2
1. b   2.a   3.a- √   b- X   c- X   d- √   e- √   f- X

3.1.6. Unit end Exercises

1. Define curriculum.
2. Explain the salient features of The biology curriculum.
3. How are Curriculum, Syllabus and Textbook related?
4. Give a list of learning resources that are relevant to The biology curriculum.
5. What are the criteria of content selection for The biology curriculum?
6. Describe the principles that help organize the content of **the biology curriculum**.
7. Explain different patterns of content arrangement in The biology curriculum.

3.1.7. References
1. https://www.ncbi.nlm.nih.gov/books/NBK218805/
2. http://egyankosh.ac.in/bitstream/123456789/46675/1/Unit-8.pdf
3. https://silo.tips/download/biology-introduction-rationale
4. https://www.academia.edu/35433764/selection and organization of Curriculum content
5. National Curriculum Framework 2005

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Block 3 : Curriculum and Learning Resources in Biology

Unit 2 : Approaches for Curriculum Construction in Biology

Unit Structure

3.2.1.   Learning Objectives
3.2.2.   Introduction
3.2.3.   Learning Points and Learning Activities
3.2.3.1. Traditional Approaches of Curriculum Construction in Biology
          Check Your Progress - 1
3.2.3.2. Modern Approaches of Curriculum Construction in Biology
          Check Your Progress - 2
3.2.4.   Let us Summarise
3.2.5.   Answers to 'Check Your Progress - 1 and 2'
3.2.6.   Unit end Exercises
3.2.7.   References

3.2.1. Learning Objectives

After completing this Unit, the student teachers will be able to,

- Explain the meaning and nature of approaches in curriculum construction in general;
- Recognize the two type of curriculum construction with the traditional approach and modern approach;
- Illustrate with examples, the traditional approaches of curriculum construction in Biology;
- Discriminate among the different types of traditional approaches of the curriculum - construction in Biology;
- Describe the modern approaches of curriculum construction;
- Distinguish between the traditional and modern approaches of curriculum design; and
- Explain the modern approaches of the curriculum with illustrations.

3.2.2. Introduction

Dear Student teachers,

The curriculum is considered the heart of the education system. It supports all the activities of the education system as a skeletal framework, by giving strength as well as scaffolding measures. You know that there must be a positive reciprocation between society and the education system. Any changes that a society undergoes must get reflected in the curriculum design also. Therefore, it is very common to see the curriculum reformation intermittently. While doing the curricular reformation or curriculum construction several approaches are followed. For the sake of our convenience of study, these approaches have been identified under two broader categories, namely, traditional approaches and modern approaches of curriculum construction in general and biology in particular. In this unit, you will come to know about the meaning, nature and salient features of traditional and modern approaches to curriculum construction with examples and illustrations.

3.2.3. Learning Points and Learning Activities

3.2.3.1. Traditional Approaches of Curriculum Construction in Biology

Activity-1

The following illustration helps us to understand the significance and impact of any curriculum on growing children. So let us go through the article followed by an analysis.

The History Learning Site

Education played a very important part in Nazi Germany in trying to cultivate a loyal following for Hitler and the Nazis. The Nazis were aware that education would create loyal Nazis by the time they reached adulthood. The Hitler Youth had been created for post-school activities and schools were to play a critical part in developing a loyal following for Hitler – indoctrination and the use of propaganda were to be a common practice in Nazi schools and the education system.

Enforcing a Nazi Curriculum in schools depended on the teachers delivering it. All teachers had to be vetted by local Nazi officials. Any teacher considered disloyal was sacked. Many attended classes during school holidays in which the Nazi Curriculum was spelled out and 97% of all teachers joined the Nazi Teachers' Association. All teachers had to be careful about what they said as children were encouraged to inform the authorities if a teacher said something that did not fit in with the Nazi's curriculum for schools.

Subjects underwent a major change in schools. Some of the most affected were History and Biology.

History was based on the glory of Germany – a nationalistic approach was compulsory. The German defeat in 1918 was explained as the work of Jewish and Marxist spies who had weakened the system from within; the Treaty of Versailles was the work of nations jealous of Germany's might and power; the hyperinflation of 1923 was the work of Jewish saboteurs; the national resurgence which started under the leadership of Hitler etc.

Biology became a study of the different races to 'prove' that the Nazi belief in racial superiority was a sound belief. "Racial Instruction" started at the age of 6. Hitler himself had decreed that "no boy or girl should leave school without complete knowledge of the necessity and meaning of blood purity." Pupils were taught about the problems of heredity. Older pupils were taught about the importance of selecting the right "mate" when marrying and producing children. The problems of inter-racial marriages were taught with an explanation that such marriages could only lead to a decline in racial purity.

Science had a military-slant to it. The curriculum required that the principles of shooting be studied; military aviation science; bridge building and the impact of poisonous gasses.

Girls had a different curriculum in some regards as they studied domestic science and eugenics – both of which were to prepare young girls to be the perfect mother and wife. In Eugenics, girls were taught about the characteristics to look out for in a perfect husband and father.

Indoctrination became rampant in all subjects. At every opportunity, teachers were expected to attack the lifestyle of the Jews. Exam questions even contained a blunt reference to the government's anti-Semitic stance: for Example, "A bomber aircraft on take-off carries 12 dozen bombs, each weighing 10 kilos. The aircraft takes off for Warsaw the international centre for Jewry. It bombs the town. On take-off with all bombs on board and a fuel tank containing 100 kilos of fuel, the aircraft weighed about 8 tons. When it returns from the crusade, there are still 230 kilos left. What is the weight of the aircraft when empty?"

Physical Education became a very important part of the curriculum. Hitler had stated that he wanted boys who could suffer pain………. "a young German must be as swift as a greyhound, as tough as leather, and as hard as Krupp's steel." Physical Education took up 15% of a school's weekly timetable. Boxing became compulsory for boys. Those who failed fitness tests could be expelled from their schools – and face humiliation from those who had passed such tests. For boys considered special, different schools were created. Those who were physically fitter and stronger than the rest went to Adolf Hitler schools where they were taught to be the future leaders of Germany. Six years of tough physical training took place and when the pupils from these schools left aged 18, they went to the army or university. The very best pupils went to Order Castles. These were schools that took pupils to the limits of physical endurance. War games used live ammunition (bullets) and pupils were killed at these schools. Those who graduated from the Order Castles could expect to attain a high position in the army.

From 1935 onwards, after the Nuremburg Laws, Jewish school children were not allowed to attend schools. The Nazi government claimed that a German pupil sitting next to a Jew could become contaminated by the experience.

The sole purpose of this educational structure was to create a future generation that was blindly loyal to Hitler and the Nazis.

It is the Curriculum through which the general aims and objectives of school education receive concrete expression. The traditional approaches of curriculum construction were either Subject-centred or Teacher centered, or both. The teaching methods, like, lecture method, lecture-cum-demonstration method and indoctrination of knowledge are categorized under traditional approaches of the curriculum. Most of the time the curriculum was designed based on behaviouristic school of thought or behaviouristic principles.

According to Walker (1990) curriculum is composed of three essential aspects, namely,
1. **Content**-includes knowledge in the form of facts, concepts, theories and topics,
2. **Purpose**-the purpose of the curriculum will be catering to the intellectual, social and personal aspects (expressed as Goals and Objectives) and
3. **Organization**-this includes the planning, scope and sequence of the subject. In total, the curriculum means it will be the result of conceptualization of thoughts and action in relation to the outcome of the activities and experiences.

Therefore it is said that curriculum is what the learner constructs by interacting with individuals, institutions and society. In short, it is the experiences that learners have in the course of living.

We have certain curriculum models in the past which are said to be the benchmark in curriculum development, for example, Biological Science Curriculum Study (BSCS), Mathematics Study Group (MSG), Social Science Curriculum Programme (SSCP) Physical Science Study Group (PSSG), Chemical Education Materials Study (CHEMS) and Nuffield Science. These are the curriculum models that have been assessed for their efficacy in different countries. They have also produced a large number of instructional support materials apart from textbooks, like, handbooks, workbooks, teachers' guides and curriculum guides for effective implementation.

Many countries in Asia during the 1960s showed a tendency to incorporating science curricula designed in Developing Countries. Apart from the acquisition of science knowledge, the development of scientific temper, attitude, interest, science process skills is of prime importance in those curricula. Irrespective of any approach the curriculum construction was governed by the following principles:

- The principle of child-centeredness: the curriculum was constructed based on the child's needs and interests.
- The principle of community-centeredness: the school and community must move hand-in-hand. There must be a correlation and interrelationship between society and individuals.
- The principle of Integration: curriculum should take care of integrating different disciplines, skills, needs of the individual as well as the needs of society. Science education must fulfil the demands of society.
- The principle of conservation: science curriculum should help in preserving and transmitting the knowledge with respect to nature and facilitate to adapt "live and let live" Principle in life.
- The principle of creativity: curriculum should make each student a miniature scientist, place each student as a discoverer and facilitate for their creative activities.
- The principle of activity centeredness: there must be ample scope for learners' activities. It could be short-term and long-term activities, do-it-yourself activities, and individual as well as group projects.
- The principle of flexibility: curriculum should not be so rigid, rather flexible so that there could be chances for modifications to suit the changing needs of the learners and society.
- The principle of Totality of Experiences: every subject taught in the school along with the science subject should result in a cohesive experience for the child so that the all-round development of the learner is assured.

The main features of the traditional approach to curriculum development are that its outcomes are predictable and it is based on the predetermined objectives. Here the activities are planned. Usually, teacher dominated in presenting the pre-fixed topics and repetition of the established knowledge was a common feature. Despite this, the year 1960 should be recognized as the era of reformations in science education. It is because during 1960 several science curriculum improvement projects were undertaken in several countries, with the collaboration and cooperation of UNICEF and UNESCO. The efforts put forth by different developing countries in Asia, the United Kingdom and the United States of America are noteworthy here.

United Kingdom

In United Kingdom, the concern for science education came out in the form of **"Nuffield Science Teaching Projects"** during 1960. Initially, the aim of the Nuffield Science Programme was the production of new materials for separate science subjects namely, Biology, Chemistry and Physics at the GCEO level (five-year course in three separate science subjects, for students of 11 to 16 years of age – Grades 7 to 11). Although the scheme was not widely accepted in British Schools, its philosophy has been incorporated in many new alternative syllabi. In 1967-68 Nuffield Scheme for Secondary Science for the average and the below-average students was also launched. Apart from this, an integrated science was initiated for the first two years of secondary education. This scheme was intended to provide a general science course for students at the secondary level and is known as the Nuffield Combined Science Project.

The Nuffield Programmes do not provide a tightly structured readymade curriculum with clearly defined behavioural objectives and an elaborate textbook. The main purpose of all the programmes was to develop materials that will help teachers to present science in a lively, exciting and intelligibly way. The students are expected to learn by inquiry. The teacher has greater freedom to translate and adapt the programme to meet students and school system requirements. The Teacher's Guide rather than the student's text represents the real heart of the programme.

United States of America

Quite a good number of projects were started during the 1960s in the United States of America. The curriculum was developed in different subjects with a unifying principle with each other. In the following discussion, you will come to know about the approaches of curriculum construction in the subject of Biology.

Biological Sciences Curriculum Study (BSCS)-William V. Mayer, University of Colorado – 1962-69

The BSCS programme was established based on the following nine unifying themes which have an interconnection with one another. For example, among the given nine themes below, the first five concern the contents of texts, the last two concern the logical structure of the texts and the remaining two (Themes 6 and 7) are an intermediate-they concern both structure and content.
1. Change of living things through time-Evolution
2. Diversity of Type and Unity of Pattern in Living Things
3. The Genetic Continuity of Life
4. The Complementarily of Organisms and Environment
5. The Biological Roots of Behaviour
6. The Complementarily of Structure and Function
7. Regulation and Homeostasis-Preservation of life in the face of change
8. Science as Inquiry
9. The History of Biological Conception

Based on the above themes three versions were produced, namely,
1. Biological Science-An Inquiry into Life (Yellow Version) - designed based on a Cellular-Biochemical-Evolutionary Approach. This version contained topics like Unity, Diversity, Interaction and Continuity of life.

2. Biological Science-Molecules to Man (Blue Version) – designed based on Molecular-Biochemical-Evolutionary Approach. The topics of this version were, Interaction, Evolution of Life Processes, New Life and Genetic Continuity, Life Processes-I Energy Utilization and Life Processes-II Regulation and Coordination
3. Biological Science-Ecology (Green Version)-designed based on –Ecological-Evolutionary Approach. The topics in this version are, The World of Life, Biosphere, Diversity among Living Things, and Patterns in the Biosphere, Within the Individual Organism, Continuity of the Biosphere and Man and the Biosphere.

For academically unsuccessful students the BSCS has prepared a set of materials under the title of Biological Science-Patterns and Processes. In addition to this, it has prepared a series of programmed material laboratory blocks, single topic inquiry films, and a special publication for teachers.

Approaches of Curriculum Construction in India
National Council of Educational Research and Training (NCERT) (1961) produced a national curriculum meant for secondary education during the tenure of the fourth Five Year Plan. By taking the help of many eminent subject experts, professionals, NCERT brought a book titled "A Textbook of Biology for Higher Secondary Schools" and "Biological Science an Inquiry into Life"-adapted from BSCS. Based on these two contributions, it has also brought Laboratory Manuals and Teachers' Guidelines. The Teachers' Guide helps the teachers to teach the subject of Biology in the Indian context. It focuses on major concepts, their interrelatedness with other subjects and concepts, and the holistic features of the subject. The components of the textbook are based on three parts, namely, Unity, Diversity and Continuity of life. It includes the project works, activities, the scheme of evaluation in a hierarchical manner with respect to the level of difficulty. It also provides the reference book list and a list of audio-visual materials.

Check Your Progress - 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. One of the features of the traditional approach to curriculum is
   a. Social Interaction
   b. Explorations and Experiments
   c. Teacher domination
   d. Pre-determined objectives and predictable outcomes

2. Nuffield Programmes were taken up by,
   a. United States of America
   b. United Kingdom
   c. NCERT
   d. India

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. Content, purpose and organization are the three essential parts of the curriculum.
   b. Any curriculum should be governed by the principle of flexibility also.
   c. Nuffield Programmes were designed with firm objectives and textbooks.

d. Green's version of BSCS deals with molecular biology.

e. Biological Science-Patterns and Processes (of BSCS) were meant for academically unsuccessful students.

f. Traditional approaches to the curriculum were based on constructivism.

3.2.3.2. Modern Approaches of Curriculum Construction in Biology

According to the Oxford dictionary, the term 'Modern' refers to 'the process of development as a new stage in a changing situation'. If it is applied to the field of education, it is by default says about the system of education as it exists now and its trend of development in the time to come/future. Anything that moved from the old to the new was modern and the processes for the emergence of modernity was development. Thus the changing needs of the society have influenced very much the curriculum pattern in India. To cope up with such a pivotal demand, there were various Educational Commissions since Independence and recommended the reformations to be done in the then running curricula. At present we have the curriculum as prescribed by **NCF-2005**. Now you know that New Education Policy 2020 has already arrived. But it needs some time for the implementation. The most emphasized approach for the modern curriculum is Constructivist Approach and Activity Based Curriculum.

The constructivist approach of the curriculum is concerned with uncovering the learner's thinking. Likewise, The Activity Based Child Centered Curriculum (ABCC) promotes the learners for an active role rather than a mere passive recipient. According to constructivism the knowledge is created through the learner's interaction with the social and physical environment. In turn, the main role of the teacher is to become a facilitator and create a conducive atmosphere for learning. Learners are encouraged to interact with others in solving problems and negotiating meanings. Thus each learner is supposed to construct the knowledge based on his experiences. This approach seeks the learner as an autonomous, independent and reflective individual.

The modern trend in curriculum design has brought quite a new type of approach like Integrated Approach, Inter-disciplinary/Multi-disciplinary Approach, Disciplinary Approach, Collaborative Learning Approach, Inquiry Based Approach, Reflective Approach and Pedagogical Approach. Let us have a look at these approaches with some illustrations.

Integrated Approach

The main feature of this approach is that there will be no fixed boundaries among the different subjects. Especially allied subjects are interlinked and intertwined so that students gain in knowledge will have more depth as well as breadth. It allows students to collect, process, refine, organize and present information about the topics of their interest which is free from subject barriers (Pigdon and Wolley-1992). Because of this curricular approach students are encouraged to see the inter-connections and inter-relationships among different curricular subjects. Instead of mastery over cognitive information, this curriculum focuses on skill development around a particular theme that is relevant to students and their life.

Peyser, Gerard and Roegiers-2006 have identified four major objectives that constitute an Integrated Approach to curriculum construction. They are,

1. Making sense of the learning process
2. Differentiating matters by relevance

3. Applying the learning to practical situations
4. Associating the learned elements

Integrated Approach provides learners with a learning environment that helps them make connections of their learning's across curricula. It focuses on connections rather than teaching isolated facts. The goal of such pedagogy is to enable the learner to master those situations he/she will have to deal with in his/her professional and/or private life.

Example:
Topic: Structure and Function of Human Eye- here the integration of the subjects, Biology and Physics is very obvious. To overcome the problems like Short-sightedness or Long-sightedness, knowledge of Lens, image formation on retina and usage of spectacles is needed from Biology and Physics. Thus, Integrated Approach will be learner-centered, flexible, and resulting in skill development and preferably open to new ideas and procedures. As a novel approach, this may create some confusion if not handled carefully. Of course, it is more time consuming, maybe un-economical also. Integrated Approach needs the expertise to select the theme and organize various disciplines together.

Inter-disciplinary/Multi-disciplinary/Disciplinary Approach:
Inter-disciplinary approach examines a topic from different perspectives, leading to a systematic effort to integrate alternative perspectives into a unified or coherent framework of analysis. These approaches are successful in making learners more aware of content-area connections, social needs and academic support and facilities available. It also helps in dissolving the boundaries among the disciplines and fostering stronger student-teacher relationships. In such support, teachers of different subjects could get collaborated, negotiated and co-operated to run the academic activities. Thus it will be a new opportunity for teachers to work together on a common platform.

In the disciplinary approach, each subject is separately taught, which may look exactly as in the traditional approach. For example, in Science, subjects like, physics, chemistry and biology were taught as different entities. One cannot completely eliminate this approach as it has its own positive points, but with a balanced usage, it will contribute tremendous results. Here the focus will be more on the subject and its content rather than the process. In our country, the disciplinary approach is very popular, mainly because of its feasibility. The teacher and the textbooks are the main sources of learning in this approach. This will be a very successful approach in the conditions of lack of facilities, non-availability of resource persons, material resources and more number/un-manageable strength of students. It is helpful in theory building, developing deductive reasoning, and abstract thinking and sharpens cognitive development. However, for science learning this approach may not encourage self-learning, do-it-yourself activities, exploration, experimentation and develop a scientific temper among the students.

Inquiry Based Approach
Science education includes explorations, inquiries and experiments. So Whitworth, Maeng and Bell (2013) opine that inquiry is an important pedagogical approach in teaching science. Pedaste et, all (2015) support the above viewpoint by another underlying reason that, its success can be significantly improved due to the recent technical developments that allow the

inquiry process to be supported by electronic learning environments. Inquiry requires more than simply answering questions or getting the right answer. It adapts investigation, exploration, search, research, quest, pursuit, perseverance and constant study. Educators play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable, moving children from a position of wondering to a position of enacted understanding and further questioning (Scardamalia, 2002).To achieve the desired outcomes using this approach, the following strategies can be adopted.

1. Simulation 2. Demonstration 3. Experiment 4. Field Study and 5. Project Work

For example:
- **Simulation:** Mendel's' Mono-hybrid and Di-hybrid ratio and process of pollination, transfer of genetic characters.
- **Demonstration:** Preparation of temporary and permanent slides for anatomical study and study of unicellular organisms, the study of microbes, including filamentous algae and fungi.
- **Experimentation:** Transpiration, water-transportation in plants, osmosis and experiment on the rate of respiration in plants, factors affecting transpiration and respiration in plants.
- **Field Study: S**tudying the pond-ecosystem, plant collection and herbarium preparation, visits to the zoo, natural history museum, milk-diary and bird sanctuaries.
- **Project Work:** Study of epidemic and pandemic diseases, pollution and controlling measures, mushroom culturing, visits to duck rearing, and sericulture centres.

Pedagogical approach

The pedagogical approach is learner-centered. In this approach, many innovative, as well as creative ways and means of teaching, are in practice. For example, constructivists, participatory, activity/Inquiry based– teaching-learning situations and here the teacher's role will be like that of a facilitator. The main thrust in such an approach will be on learners learning by their active participation. Therefore, students use their previous knowledge and new experiences to create/construct knowledge. Apart from being a facilitator teacher creates and structures the situations and conditions for meaningful learning by students.

Constructivist Approach

Today the most heard approach of curriculum construction is the Constructivist Approach. This is based on the central notion that learners construct their understanding of the world around them based on their own experience as they live and grow. According to Pritchard and Woollard (2010) learners select and transform information from past and current knowledge and experience into new personal knowledge and understanding. The constructivist Approach allows learners to be active in the process of constructing meaning and knowledge rather than passively receiving information. It fosters critical thinking and provides learners with a learning environment that helps them make connections with their learning.

The constructivist approach emphasizes more social interaction in learning. Hence it advocates certain innovative teaching-learning methods. Collaborating learning, cooperative learning, co-learning and coordination in learning are some of the noteworthy examples.

According to Laal and Laal (2012) Collaborative learning (CL) is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product. Further, they stated that collaborative learning is an umbrella for a variety of educational approaches involving a joint intellectual effort by students, teachers and both together. However, activities may vary but the main principle will be student-centeredness. It is always students' exploration or application of the course material and not simply the teacher's presentation or explication of it (Smith B.L and Mac Gregor-1992). According to Gerlach .J.M (1992), this approach assumes that learning is a naturally social act in which participants talk among themselves. It is through the talk that learning occurs. Social constructivist Vygotsky believes that students while interacting with two or more (may be interpreted as a pair), or a small group (three to five individuals) or a class (20 – 30 students) will learn a lot. Here learning also may be interpreted as performing learning activities such as problem-solving. Dillenbourg extends this further and says that interaction may be of different types including face-to-face or computer mediated.

To make the collaborative approach very successful teachers must be fully aware of and understand the learner's abilities, their preferred learning styles and competencies. Some of the strategies, like, Online-Collaborative Learning, Jigsaw Method, Think-Pair-Share, Integrated Process Approach and Peer Teaching help bring effectiveness in the collaborative approach.

To design and execute the curriculum for great success, achievement and development irrespective of any approach it is important to abide by some of the principles, like:
- The curriculum should be learner-centered, inclusive and developmentally appropriate.
- It should be relevant, responsive and research-based.
- It should be culture-sensitive.
- The curriculum should be contextualized and global.
- It should make use of pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative.
- It should be adhering to the principles and framework of Mother-Tongue-Based Multilingual Education (MTB-MLE).
- The curriculum should be a spiral progression.
- It should be flexible enough to enable and allow schools to localize, indigenize and enhance the same based on their respective educational and social contexts.

National Curriculum Framework (NCF-2005) has prescribed certain Principles regarding the approach to knowledge in the curriculum as follows:
- Acquiring a critical perspective on social reality and the natural environment through the lessons provided by the subject matter.
- Connecting with the knowledge from within the class to outside contexts to 'situate' knowledge and realizing its 'relevance' and 'meaningfulness'; to reaffirm one's experiences outside school; to draw one's learning from observing, interacting with, classifying, categorizing, questioning, reasoning and arguing about these experiences.
- Making connections across disciplines and bringing out the interrelatedness of knowledge.
- Realizing the 'fruitfulness' and 'openness' of enquiry, and the provisional nature of truth.

- Engaging with 'local knowledge'/indigenous practices in the local area, and relating these to school knowledge wherever possible.
- Encouraging questions and leaving space open for the pursuit of new questions.
- Being sensitive to the issues of 'equality' in classroom transactions as well as established stereotypes and discrimination regarding learn ability of the knowledge area by different groups (e.g. girls not being given field-based projects, the blind being excluded from the option of learning mathematics, etc.).
- Developing the imagination, and keeping imagination and fantasy alive.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Integrated Approach provides learners,
   a. Opportunity to learn across the different curricula
   b. Streamlined single subject
   c. Chances to learn more than languages
   d. Chances to learn science and social science together

2. According to Gerlach J.M. learning is,
   a. Memorizing the content
   b. Acquiring more vocabulary
   c. Learning certain skills
   d. A natural social act

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. Curriculum must be culture-sensitive
   b. To make the curriculum global and also contextualized is impossible
   c. Inquiry based approach mainly uses questions and explorations
   d. Collaborative learning happens only in large groups
   e. Because of its rigid nature, Disciplinary Approach should be completely avoided
   f. Integration includes connections across disciplines and bringing out the interrelatedness to knowledge

3.2.4. Let us Summarise
The curriculum is one of the best devices which helps in achieving the educational goals and objectives. A society inevitably undergoes several changes and obviously, these changes influence the education system. In turn, this will influence the curriculum and its pattern. The traditional approaches of curriculum construction were either Subject-centred or Teacher centred, or both. The teaching methods, like, lecture method, lecture-cum-demonstration method and indoctrination of knowledge are categorized under traditional approaches of the curriculum. Most of the time the curriculum was designed based on behaviouristic school of thought or behaviouristic principles.

Many countries in Asia during the 1960s showed a tendency to incorporating science curricula designed in Developing Countries. Apart from the acquisition of science knowledge, the development of scientific temper, attitude, interest, science process skills is of prime

importance in those curricula. In this direction, there are certain curricula in the past which are said to be the benchmark in curriculum development, for example, Biological Science Curriculum Study (BSCS), Mathematics Study Group (MSG), Social Science Curriculum Programme (SSCP) Physical Science Study Group (PSSG), Chemical Education Materials Study (CHEMS) and Nuffield Science. These are the curriculum models that have been assessed for their efficacy in different countries. They have also produced a large number of instructional support materials apart from textbooks, like, handbooks, workbooks, teachers' guides and curriculum guides for effective implementation.

National Council of Educational Research and Training (NCERT) central government autonomous committee (Established 1961) produced a national curriculum meant for secondary education during the tenure of the fourth Five Year Plan. By taking the help of many eminent subject experts, professionals, NCERT brought a book titled "A Textbook of Biology for Higher Secondary Schools" and "Biological Science an Inquiry into Life"-adapted from BSCS.

The modern trend in curriculum design has brought new types of approaches, namely, Integrated Approach, Inter-disciplinary/Multi-disciplinary Approach, Disciplinary Approach, Collaborative Learning Approach, Inquiry Based Approach, Reflective Approach and Pedagogical Approach. To design and execute the curriculum for great success, achievement and development irrespective of any approach it is important to abide by some of the principles, like The curriculum should be learner-centered, inclusive and developmentally appropriate, It should be relevant, responsive and research-based, It should be culture-sensitive, The curriculum should be contextualized and global, It should make use of pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative, It should be adhering to the principles and framework of Mother-Tongue-Based Multilingual Education (MTB-MLE), The curriculum should be a spiral progression, It should be flexible enough to enable and allow schools to localize, indigenize and enhance the same based on their respective educational and social contexts.

3.2.5. Answers to' Check Your Progress - 1and 2'

Check Your Progress - 1
1. d 2. b 3. a- √ b- √ c- X d- X e- √ f- X

Check Your Progress - 2
1. a 2. d 3. a- √ b- X c- √ d- X e- X f- √

3.2.6. Unit end Exercises
1. What is meant by approaches to curriculum construction?
2. Explain any two types of curriculum construction with the traditional approach.
3. Explain any two types of curriculum construction with the modern approach.
4. Illustrate with examples the traditional approaches of curriculum construction in Biology.
5. Distinguish between the traditional and modern approaches of curriculum design.
6. What is BSCS? What are its salient features? Explain.
7. Bring out the salient features of Nuffield Programmes.
8. What are the principles of curriculum construction?

9. What are the guiding principles for curriculum construction envisaged by NCF 2005?

3.2.7. References

1. http://www.biologyeducation.net/news-and-articles/a-new-approach-to-curriculum-design/
2. https://www.dlsud.edu.ph/coed/ncvre/docs/2019/DrChesterRelleve-PEDAGOGYGENZ.pdf
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/216679/10/10_chapter%202.pdf
4. https://shodhganga.inflibnet.ac.in/bitstream/10603/135991/9/09_chapter%202.pdf
5. https://www.historylearningsite.co.uk/nazi-germany/nazi-education/
6. National Curriculum Framework 2005

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Block 3 : Curriculum and Learning Resources in Biology

Unit 3 : Analysis of Print and Electronic Materials in the area of Biology

Unit Structure
3.3.1.   Learning Objectives
3.3.2.   Introduction
3.3.3.   Learning Points and Learning Activities
3.3.3.1. Analysis of Printed Resource Materials in the area of Biology
          Check Your Progress - 1
3.3.3.2. Analysis of Electronic Resource Materials in the area of Biology
          Check Your Progress - 2
3.3.4.   Let us Summarise
3.3.5.   Answers to 'Check Your Progress - 1and 2
3.3.6.   Unit end Exercises
3.3.7.   References

3.3.1. Learning Objectives
After completing this unit, the student teachers will be able to
- Define the printed and electronic resource materials in the subject Biology;
- Identify the resource materials that help in the teaching of the subject Biology;
- Explain the resource materials in the area of Biology;
- Classify the resource materials into Printed and Electronic types;
- Illustrate with examples, the printed resource materials in Biology;
- Illustrate with examples, the electronic resource materials in Biology; and
- Make use of printed and electronic resource materials for the teaching and learning process.

3.3.2. Introduction
Dear Student Teachers,

To teach the subject of Biology effectively, a teacher has to make use of several types of resources. These resources get classified into three major types, namely, Printed Resources, Electronic Resources and Community Resources. Some experts will add one more type, namely, Human Resources. In this unit, you will come to know particularly about what is printed and electronic resources in the area of teaching-learning Biology. Their availability, usage and application will give more confidence to the teacher. Some of them are exclusively meant for teachers and some are meant for both, teachers and students. Sometimes, the same resource materials may be used by both with different purposes, like the Textbook. Similarly, Work Book is exclusively meant for students. Apart from this, you know that modern education is immensely influenced by digital media and electronic materials. The nature and application of these resources have a strong impact on the system of education. You will be knowing some of the printed as well as electronic resource materials too in this unit.

3.3.3. Learning Points and Learning Activities

3.3.3.1. Analysis of Printed Resource Materials in the area of Biology

Activity-1

Ask the students to refer to certain printed resource materials and discuss about their utility in the group. It could be any resource, like, an encyclopedia on life science, biology dictionary or any printed documentary-like,

- Jeeva Jagattu - Encyclopaedia (Kannada)by Kannada University, Hampi.
- Welcome to Malnad-Kuvempu Memorial Bio-Park (2008): Published by Rastrakavi Kuvempu Pratisthana (Rgd) Trust, Kuppali.

As a common term, we all know that printed resources are nothing but information or the subject matter that has been published and accessible in printed format. Printed materials include books, government reports, academic journals, textbooks, workbooks, reference books, newspapers, journals, periodicals, teachers' guide, laboratory manuals, students' guide, self-instructional material, supplementary reading materials, encyclopedia, Special Issues and documentaries. One has to be very cautious while selecting the printed materials for reference.

It could be done based on three major principles, they are,

1. Appropriateness of the print material to the planned course.
2. Readability of the text and appropriateness of the vocabulary and content to the age/maturity level of the students to whom it is intended.
3. Should satisfy the criteria, like, content validity, cognitive validity, process validity, environmental validity and ethical validity.

Print materials are very popular because of several advantages. They are extremely portable, cost-effective, readily available and above all these, comfortable to use. Students do not need any special equipment to use it, and with adequate light, print materials can be used anywhere at any time. Students can review the material at their own pace thereby nurtures the individual difference.

Now let us try to understand some of the printed resource materials with illustrations and examples:

1. Textbook:

The textbook is the most used resource material irrespective of any subject and any teacher. It almost has become a synonym with the curriculum of the subject. According to Yoakum &Simpson, the textbook is "A Printed Material that is used for teaching-learning activities in the classroom".

Texts books are printed materials with good structure, design and contain the subject matter according to the predetermined objectives of a particular subject. They help in deciding the scope of the chosen topic. Apart from this textbooks clearly express the scope of a subject matter in context with the education system as a whole. They form a strong basis for the construction of lesson plans, designing the teaching-learning strategies and also for a

comprehensive evaluation. Many times the textbook acts as a self-learning material for the learners. However, a textbook should not and cannot be considered as the curriculum itself. Always the class should grow beyond the textbook. The quality of a textbook is decided by its external and internal criteria. Good external, as well as internal features of a textbook, will enhance the usage of it to the level of best. The external features of a text book are concerned with its physical output whereas the internal features are related to the quality of the content.

External Features (Mechanical Features)

The textbook should be good enough with long term durability. For that the paper used, the outer cover page and rapper must of a quality that can withstand the repeated usage. The print in the book should be clear with the optimum use of ink like, not too intense or dull. The ink should have uniform application so that throughout the book it looks similar. The font size of the words must be suitable for easy reading but it should not be too big unnecessarily. The print as well as the paper used and binding of the textbook should be attractive. As a biology textbook, it should have good illustrations with diagrams, pictures, sketches and photos to support the information. This makes the textbook more meaningful as well as attractive. The most important is that the pictures/diagrams should have a proper place and direct link with the topic presented. Each page should have some blank space on all four sides- left as margins. A textbook must be handy enough so that, it is easy to hold, carry, study and make reference out of it. The textbook should easily be available for students/parents to purchase with a reasonable amount.

Internal Features

The internal features of a textbook are of utmost importance as it contains the subject to be taught. It should have a suitable, feasible and flexible style of presentation. It should have a proper preface in such a way that it serves many significant purposes. For example, the preface of the textbook will intimate about the scope of the subject, the extent as well as limitations of the text, the target for whom the textbook is designed, ways and means of its usage. Usually, a preface will be followed by the list of content in which the topics are arranged according to the maxims of teaching. It also gives the number of pages devoted to each topic/unit/lesson. This makes a reader select the exact lesson within no time. Each lesson or unit will have a proper title, so that one can get a clear idea about the information which is there in the respective unit or lesson. At the end of the textbook, Index will help to access quickly the required picture and relevant information. It also gives the details regarding the authors, diagrams/pictures, units and sub-units etc. For example, the same information or the pictures could be used many times in different chapters, -this is indicated very clearly in the index list.

The subject matter should be developed based on the psychological principles of learning and compatible with the level of understanding, age and maturity of the students. There must be consistency in the matter printed. It should be in accordance with the objectives of the curriculum. There must be scope for individualized activities, self-learning, "Do It Yourself" Activities, Individual as well as Group Projects and a textbook must help in giving a better understanding of scientific principles and concepts. Each chapter should have an introduction, end with a summary and questions under exercises. It is better if the chapter-end exercises include:

- Opportunities that give the application of the acquired knowledge to life situations.
- Innovative ways and means for self-assessment.
- Suggestions for the individual as well as group/collective project work.
- Challenges and suggestions for further study.
- Opportunity to develop a learners' community.

The chapters should have titles and sub-titles in bold fonts. This should be followed by the presentation of textual information with a varied, suitable and distinct form. The textual information must be in lucid, simple and precise scientific language. Standard terminology for scientific and technical terms should be used. It is better to give the English equivalents within the brackets wherever needed. It should have a glossary of technical terms used. There should not be any ambiguity in the given information. It should suggest some good methods and techniques for effective learning. Due importance must be given to methods and materials which draw upon the social community resources and school-society interaction. Each textbook must be accompanied by a laboratory manual and a teachers' guide.

Apart from these, UNESCO an international organization has advocated some principles which are ought to be bound by the textbooks. These principles are as follows:
- Before the preparation of a textbook, it should receive the requirements of the prescribed syllabus.
- The facts, concepts, generalizations and theories should be modern and within the comprehension level of the pupils.
- It should bring connectivity between science and life. Students must be equipped with 'Know-How,' utilizing knowledge in day-to-day life.
- The content should have not only the facts but the problems which are being researched and thereby arousing the interest among the students about these problems.
- The whole content of the textbook should aim at shaping the integrated modern scientific world outlook which ensures the success in mastering scientific knowledge and solutions of the problems of vital importance.
- The content should be simple, brief, exact, definite and accessible.

It is possible to get many textbooks for one particular subject. At that point, one has to select the best one. All the above said criteria will help the teachers in selecting the best textbook. Summing up we can say that the selection of a Science Textbook will depend upon the following points:
1. The author, his qualifications and experience.
2. External Features of the Textbook and
3. Internal Features of the Textbook – the subject matter, its nature, style of presentation and organization.

2. Work Books:
Workbooks exactly supplement the textbook. But it is exclusively meant for students' activity. It will be a source of learning activities. May be for collecting data, reporting observations, diagrams to be completed, labeling the pictures, identifying and naming activity, blank sheets, outline maps, blank spaces to write the answers and to draw diagrams. One workbook may have all these samples of activities or each activity may take one complete

workbook separately. The main feature of the workbook will be its help in self-learning and self-assessment. Therefore it is considered as a very apt learning aid for students. It will be fully economical in the usage of time and effort. However, workbooks are functional only with the support of the textbook. It cannot be a source of learning. And activities such as exploration, experimentation and problem solving are seldom addressed in workbooks.

3. Teachers' Manual / Teachers' Guide:

This is a resource material meant for the teachers. It helps the teachers to prepare well for classroom teaching. The teacher's manual is constructed mainly based on the curriculum and the textbook. The major difference between the textbook and the teachers' guide, is that textbook is a resource material for both the teachers and the students, (teaching as well as learning) whereas, the teachers' guide or teachers' manual is a resource material that could be used as guidance for teaching. This decides the design of the material.

Teachers' guide helps the teacher about how a unit has to be comprehended. It facilitates the teachers to analyze the facts, concepts, rules, principles, generalizations and theories. This in turn helps in the form of content analysis. The doubts and confusions regarding the content to be taught are cleared by the teachers' guide. It gives a list of Instructional Objectives also. Therefore a teacher can choose the suitable objectives for his class. And even by taking the reference of these objectives a teacher can construct a few more, new instructional objectives also.

Teachers' guide tells about the "How of Teaching". It guides a teacher about the sequence of the knowledge to be taught and also about how it has to be taught. It gives a complete network of the measures to be taken while teaching, like, the materials required to conduct a learning activity, time, suitable learning environment, and the teacher's as well as student's role. It also guides about the responsibilities, precautions to be taken by a teacher.

The manual will also give instructions regarding the evaluation. Tests, unit tests, monthly tests and a half-yearly exam and the respective pattern of questions are discussed here. It explains about the construction of a balanced question paper. It includes individual as well as group Project Activities meant for students which bring interest, curiosity in the subject.

4. Science Dictionaries:

Although dictionaries, in general, are plenty in number that which is meant for science or biology, in particular, are very rare rather handful only. Despite this, their usage is still rare, especially for students. To quote a few that available are:

  i. English-Kannada Medical Dictionary by Dr. D.S. Shivappa – this deals with medical terms with their Kannada meaning.
 ii. English-Kannada Science Dictionary-by J.R. Lakshmana Rao and Adyanadka Krishna Bhat. This includes English science words and their meaning in Kannada. It also includes certain newly coined terminologies as equivalent to English science words.
iii. Environment Dictionary- by T.S. Vivekananda and Sheshagiri Jodidar. This is pertaining to words, concepts that are related to the environment. This has been used by many people.

iv.   Science Dictionary English-English-Kannada with illustrations by Shashikumar. Published by P.C. Shabadimath Book Depot Gadag. Here one can find, anatomy, and other science concepts with graphics, pictures and illustrations. In the last part, namely, Appendices -the additional useful data and information regarding, a chronology of Astronomy, Physics, Chemistry and Biochemistry as well as Ecology, Earth Science is available.

v.   Dictionary of Biology-Michael Bull by Goodwill Publishing House New Delhi. This dictionary covers a wide variety of terms that have been carefully selected from all the major fields of pure and applied plant and animal science including classification, anatomy, cell biology, plant and animal pathology, genetics, ecology, cross-breeding, microbiology, and biotechnology. Many illustrations have been incorporated to acquaint the readers with the explained plant and animal species thoroughly. Labeling has been given wherever required to add to the reader's knowledge. Each term has been explained in a simple language and lucid manner. However, the technical correctness has not been tinkered with just to simplify the terms. Wherever the terms needed more than one connotation, they have been provided point wise for complete comprehension by readers.

5. Jeeva Jagattu-Encyclopaedia (Kannada) by Kannada University, Hampi: This resource has accumulated the relevant scientific knowledge from different sources and organized the information in a very systematic manner. This being an encyclopedia exclusively meant for life science is in the Kannada language.

6. Welcome to Malnad-Kuvempu Memorial Bio-Park (2008): Published by Rastrakavi Kuvempu Pratisthana (Regd.) Trust, Kuppali. Explanation regarding this printed resource reveals so many interesting facts. According to the editor of this, "Western-Ghats region of India is an enigmatic place. A hot-spot of biodiversity, this region abounds with an amazing variety of life, part of which is waiting to be explored. The region has evergreen and deciduous forests sheltering unique plants, animals, birds and insects some of which are on the verge of extinction. Rastrakavi Kuvempu has, through his indelible literature, immortalized this myriad variety of life.

This book is an effort targeted for a casual reader, who has an eagerness to know the complexity of the life of the region but does not possess either endurance or opportunity to pursue the same. Kuvempu in his literature used nature as ensembles and his entire work is liberally sprinkled with 'natural' anecdotes. This work is a small window to the natural world of Kuvempu. This park aims to preserve, without human interference, the natural environment that was the inspiration to our National Poet Kuvempu. Studies on bio-diversity and creating awareness among people are its other objectives. This book (Booklet) has been brought out to disseminate information on bio-diversity to create awareness among the people. This park is expected to be a source of inspiration to the future generations".

Science Journals, Periodicals and Magazines:
"Science Today", "Contemporary Education" and "Nature" are some of the journals or periodicals which deal with current issues in science. Apart from this the daily newspapers, weekly magazines and monthly periodicals will contain a few articles that belong to the field of science. There are science journals in Kannada published by Karnataka Vignana Parishat, like,

"Bala Vignana" and "Vignana Deepa". The University of Mysore is bringing out the three-monthly magazine, "Arogya Yoga". Periodicals that are relevant to medical science can also help in the Biological field.

Check Your Progress – 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. As Teacher's guide is meant for teachers, the one which is solely meant for students is,
    a. Laboratory Manual
    b. Teachers' Manual
    c. Work Book
    d. Textbook

2. The Internal criteria of a textbook includes,
    a. Strong outer coverage
    b. Content with consistently good quality
    c. Meaningful preface
    d. Epilogue

3. Below are given some statements, put √ mark for the correct ones and **X** for the wrong ones:
    a. Teachers' guide tells about 'How of Teaching'
    b. Usually, textbooks are referred to by students only
    c. Workbooks are not at all inevitable for textbooks
    d. Neat and labeled diagrams are one of the requirements of a good biology textbook
    e. Since many biological terms do not have Kannada translation, it is of no use in having English-Kannada Biology dictionary
    f. The workbook is a very good supplement for a textbook

3.3.3.2. Analysis of Electronic Resource Materials in the area of Biology

Activity-2
Ask the students to refer to certain electronic resource materials and discuss about their utility in the group. It could be any resource, like, an encyclopedia on life science, biology dictionary or any printed documentary. For example:
- Bio Onlinehttp://www.bio.com/resedue/educate.html/
- The Biology Projecthttp://www.biology-arizona.edu
- American Museum of Natural Historyhttp://www.amnh.org/

The materials that could be used by means of computers or other technological devices are generally considered as Electronic Resource Materials. In these days computers and related electronic resources have come to play a significant role in education. Electronic sources, whether on CD-ROM or the Web, can significantly open up the range of materials accessible to any subjects to be taught in the classroom. Using electronic materials in teaching is a great way to introduce and instruct students on these skills. The new curriculum also encourages educating children beyond subject borders and by working together as a community, promoting lifelong

learning. One of the aims nowadays seems to be to establish and view learning and studying as continuous processes that are part of our daily lives and not merely something that happens in schools. Showing students that learning happens beyond the classroom and that they are not studying just for the institution or to pass tests, is important.

The term electronic material usually covers e-books and e-journals, but it actually includes films, digital pictures, music etc. as well. Some e-books contain audio, such as short tracks or sound effects, for auditory learners. Physical activities can be integrated into electronic teaching materials as well, for example, by having tasks that require students to move around the interactive whiteboard (IWB) or SMART Board. To illustrate, electronic textbook materials include activities in a digital platform in the form of educational games to be played on the Interactive White Board such as SMART Boards. Other than e-textbooks, certain educational videos, applications on tablets such as iPads also come under electronic resources.

Electronic tools can make classes more efficient and effective. The classes become more interesting, and forum for discussions with more challenges. These multimodal materials provide content for the learners who learn by reading but they are often also quite visual, supporting the learning process of visual learners. The major advantage here is, electronic materials make it easier to take different learners into account and there by gives due importance to individual differences among the students.

The most extensive, if still not fully developed, the source for electronic resources is the World Wide Web. Many web sites can deliver primary documents, secondary literature, sound, and images from a wide variety of sources. Students who explore web sites related to a course can bring compelling evidence and arguments back to the class. Publishers are building companion websites around their textbooks, and large international projects have been launched to provide on-line sources for standard humanities and social science survey courses. Finally, libraries and scholars are making scanned materials accessible over the Web, although the copyright implications of this practice require close attention.

It is observed that usually when students write essays or answers for a course, they write for an audience of one: the instructor or the teacher. But teachers who have persuaded students that they are writing for a broader audience have found that students take the work more seriously and devote a great deal more effort to it. Thus creating a system of on-line publications for your class or for the subject Biology, can have a tremendous impact on student engagement with scholarly work. Online publishing also creates opportunities for student collaboration, and for students to take a more direct and responsible role in the learning process than they otherwise might. Another thing that makes electronic publishing valuable is that it exposes students to the stylistic constraints and opportunities of the new digital media. Already, it is so common to see that the personal communication occurs through e-mail, the World Wide Web (WWW), and private networks of computers. Some of the activities that could make use of electronic resources include the following:

- **Multimedia in-class presentations:** teacher using presentation technique with supplementary support of a standard spoken presentation with images, charts and graphs, or sound.

- **Essays in the form of WWW pages:** While even a traditional text essay might be posted for comment, the best web essays will make use of the Web's unique ability to incorporate multimedia elements.
- **Web teaching units for** Teachers / Students can share their experiences and analysis with the class or with an outside audience (including secondary and primary school classes).
- **Web exhibits:** By emulating the form and rigor of museum and library exhibits, students can produce a classroom and community resource on their topic.
- **Collaborative projects:** All of the above projects lend themselves to collaborative work by groups of students.
- **Classroom archive/library:** Over the years, a digitally savvy course might accumulate an excellent library of digital student essays, teaching units, exhibits, and dialogues.

The new technology with electronic resources will make a teacher's job much easier and effective also. At present, due to the COVID Pandemic situation, all most all educational institutions are advocating/using on-line courses, of course inevitable. Following are some of the strategies that teachers can adapt very well in their routine class works:

Administration: The routine administration of courses (advertising a class, providing copies of the syllabus, assigning discussion sections, and getting the assignment works done by the students) can be more efficiently handled with a course home page, electronic discussion groups, and e-mail lists. These tools can also dramatically improve the continuity and the community aspects of courses, helping students to engage with and learn from each other and even from people outside the course.

Readings/Sources: The Web and CD-ROMs provide a wider variety of secondary and primary sources (including visual and audio sources) than has previously been available. With proper guidance, students can now gain access to materials that were once accessible only to experts because they were too cumbersome to reproduce for classroom use or too expensive for students to purchase. By taking their own paths through these sources, students can bring their own evidence and arguments into classroom discussion sections, as well as write on a wider range of the chosen topics.

Teaching-Learning Session: A computer with presentation software can provide a single tool for support teaching with outlines, slides, statistical charts and tables, images, music, and even video clips. In addition to printing them as hand-outs, it could be saved in-class presentations in a web-compatible format for later review and discussion.

Discussion: Electronic discussion tools such as e-mail, conferencing software, and on-line chat services can seed discussion questions among the teachers handling the same subject for different sections of the class. And it could be done with the students also, before the class meets, so that it helps to draw out the shy students, and follow up on discussions or questions on the reading between classes. For courses without face-to-face discussion sections, these tools can bring the course to life over great distances (especially in the present situation) and help overcome scheduling difficulties.

Some of the electronic resource material that are useful for teachers as well as students are given below:

Science Reference Shelf
http://www.hypcc.astra
Science Fact Finder
http://www.accurate-eye.com.an/earth/html
The Biology Project
http://www.biology-arizona.edu
Internet Journal of Science-Biological Chemistry
http://www.netsi-journal.com
Endangered Species
http://eelink.net/endspp/
Bird Conservation Initiatives
http://www.audunon.org/bird/
Internet Resource Guide for Zoology -http://www/iyork.biosis.org/zrdoes/zoolifo/zoolinfo.httm
Bio Online
http://www.bio.com/resedue/educate.html/
American Museum of Natural History
http://www.amnh.org/

It becomes of utmost importance to look and take care before adapting any electronic resource into the classroom activity or any teaching-learning process. It will be better if the chosen electronic resource satisfies the following features/criteria:

- The scholarly quality of the resource must be up to the mark. For this, a teacher has to personally evaluate the scholarly quality of the electronic sources. Because, linking to electronic sources might be free, but the substandard source can lower the credibility of the course.
- Use of the appropriate medium. The language itself should not become a barrier. So displaying multimedia material, hyper linking to other sources, providing interactive experiences, very much depends upon good communication. As on-line archives begin providing access to recordings and radio and television programs, it is better to choose the resource that could be easily understood by the students.
- Using on-line information requires at least as much skill and discipline as using traditional sources. Because writing is not fundamentally different from that for a learning outcome that uses more traditional sources. Encourage students to take the same detailed notes and to follow the same strict citation procedures they use for conventional printed sources.

Computer technology is becoming both more useful and more cost-effective for many fields of teaching. But all will be dependent on the teacher, who can determine whether these methods will prove effective in the classroom. Finally, to make these technologies work in the classroom, teachers must make regular contributions to the electronic discussions just as they would to a face-to-face discussion. Online discussions have to be closely monitored to ensure their intellectual usefulness and to reinforce the importance of etiquette in this relatively unfamiliar context. Here teacher must be a participant to ensure that students take it seriously.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Electronic resources include
   a. Photos, pictures and practical records
   b. CDs and Websites
   c. OHPs and Microscopes
   d. Xerox Notes

2. Electronic resources include digital forms like
   a. White Board
   b. Green Board
   c. Black Board
   d. Smart Board

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. Electronic resources have shown that learning is beyond the classroom.
   b. On-line classes create disobedience among the students.
   c. E-books and E-journals are the part and parcel of electronic resources.
   d. Electronic tools can make classes more efficient and effective.
   e. Virtual classes can very well substitute real classes and give good results.
   f. The use of multimedia gives more clarity to the teaching-learning process.

3.3.4. Let us Summarise
    The fact that the 21st century is immensely influenced by digital media and electronic materials is very vivid and obvious. The nature and importance of these resource materials are having a strong impact on the system of education. However, we cannot deny the significance of Print materials. Print materials are very popular because of several advantages. They are extremely portable, cost-effective, readily available and more than all these, comfortable to use. Printed materials include books, government reports, academic journals, textbooks, workbooks, reference books, newspapers, journals, periodicals, teachers' guide, laboratory manuals, students' guide, self-instructional material, supplementary reading materials, encyclopedia, Special Issues and documentaries. The selection of these materials must be based on certain factors, like, appropriateness of the print material to the planned course, readability of the text and appropriateness of the vocabulary and content to the age/maturity level of the students to whom it is intended. And also, the printed resources have to satisfy the criteria, like, content validity, cognitive validity, process validity, environmental validity and ethical validity.

    The materials that could be used by means of computers or other technological devices are generally considered as Electronic Resource Materials. In these days computers and related electronic resources have come to play a central role in education. Electronic sources, whether on CD-ROM or the Web, can significantly open up the range of materials accessible to any subjects to be taught in the classroom. The term electronic material usually covers e-books and e-journals, but it actually includes film, digital pictures, music etc. as well. Some e-books contain audio, such as short tracks or sound effects, for auditory learners. Electronic tools can make classes more efficient and effective. The classes become more interesting, and forum for

discussions with more challenges. These multimodal materials provide content for the learners who learn by reading but they are often also quite visual, supporting the learning process of visual learners. The major advantage here is, electronic materials make it easier to take different learners into account and there by gives due importance to individual differences among the students. Both in the form of online and offline mode.

Some of the noteworthy web sites which are popular as electronic resource materials in Biology are:
http://www.bio.com/resedue/educate.html,
http://www.amnh.org/http://www.biology-arizona.edu

3.3.5. Answers to 'Check Your Progress - 1and 2'

Check Your Progress - 1
1. c2. b3. a-√   b-X   c-X   d-√   e-X   f-√

Check Your Progress - 2
1. b2. d   . a- √   b-X   c-√   d-√   e-X   f-√

3.3.6. Unit end Exercises
1. What are printed and electronic resource materials in Biology?
2. Explain any two Printed resource materials in the area of Biology.
3. Give examples for Electronic resource materials Biology.
4. What are the characteristic features of a good Biology Textbook?
5. Analyse any one Biology Textbook available now and comment on its quality.
6. Illustrate with examples, the electronic resource materials in Biology
7. Construct some printed and electronic resource materials for teaching concepts in Biology
8. What are the criteria for the selection of resource materials in Biology? Illustrate your answer.
9. List-out a few websites that are useful for teaching Biology.

3.3.7. References
1. https://depts.washington.edu/eproject/lesson1_3.
2. https://edtechnonprojectedmedia.wordpress.com/2015/07/16/printed-materials/
3. https://jyx.jyu.fi/bitstream/handle/123456789/57859/1/URN:NBN:fi:jyu-201805052470.pdf
4. Jeeva Jagattu-Kannada Vishwavidyalaya Vishwakosha Hampi University
5. Jeeva Shastra Bhodhane (2010) - H.S.Umesh Shruthi Loka Prakashana Mysore
6. Modern Science Teaching by R.C.Sharma Dhanpat Rai & Sons Publication
7. Welcome to Malnad Kuvempu Memorial Bio-Park (2008) Dr.Shiva Reddy (Executive Editor)

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Block 3 : Curriculum and Learning Resources in Biology

Unit 4 : Learning Resources in Biology

Unit Structure

3.4.1. Learning Objectives

After completing this Unit, the student teachers will be able to

- Explore and Identify learning resources that are relevant to the subject Biology;
- Classify the learning resources based on certain criteria;
- Explain the nature and uses of Audio learning aids in Biological Science;
- Describe the importance of visual aids with illustrations;
- Locate Audio-Visual Learning aids in the immediate environment;
- Select the learning resources based on the learning needs; and
- Justify Biology Laboratory as one of the best resources.

3.4.2. Introduction

Dear Student Teachers,

You know one Chinese Proverb that says, "I Hear- I Forget; I See-I Understand and I Do-I understand and never forget", which emphasizes the usage of Sensory Perception in learning. In hearing only one ear are active. So also in the case of seeing is the eyes, but if both seeing and hearing along with doing something is blended, definitely learning is going to be highly effective. As a teacher, you have come across certain concepts and theories which are quite abstract or difficult to understand. But it becomes the duty of a teacher to make students understand the concepts taught. Making use of learning equipments, audio-visual aids or any such Teaching-Learning Materials (TLMs) becomes very significant. Therefore, these TLMs are recognized as Learning Resources. In this unit, you will come to know about the learning resources excluding the print and electronic as the same are discussed already in the previous unit.

3.4.3. Learning Points and Learning Activities

3.4.3.1. Learning Resource in Biology - Meaning, Nature and Classification

Apart from the books, CDs and Online resources, the preserved organs or organisms (specimens) as a whole are very useful resources in Biology. For example, the collection and storage of Insects, certain parts of plants and shelled animals will allow the students to gain first-hand experience, interest along with the knowledge gain. The following activity may be conducted with the students:

Activity-1
The collection and preservation of insects involve the following stages.
(1) Collecting (2) Killing (3) Relaxing (4) Pinning and setting (5) Display

Insects such as bees, wasps, butterflies and dragonflies may be collected with the help of an insect net. After collecting the specimens, they are transferred into a Killer Jar. The killer jar is a wide-mouthed jar with an air-tight glass stopper. At the bottom of this jar place cotton balls soaked in chloroform with an air-tight lid. Two or three circular pieces of blotting paper cut to the size of the circumference of the jar are placed to absorb moisture. The killer jar should be handled with care.

Relaxing: The Relaxing Jar is prepared as follows: A few crystals of Para-dichlorobenzene may be put inside the jar and two circular pieces of blotting paper are placed on the chemical. Insects die in a few seconds when dropped into the killer jar. Then these specimens are transferred into the relaxing jar to render them sufficiently flexible.

After a few hours, when the wings and legs of the insects are soft, they are ready for-pinning. Then the insects are taken out and mounted on the mounting board.-The mounting board consists of two cork sheets which can be adjusted according to the size of the body of the insect. The specimen is placed on the mounting board and wings are spread out in the case of butterflies with the help of forceps. Entomological pins should be used for pinning the insects. One pin should be fixed through the thorax of the specimen so that it can be handled easily. Paper strips can be used to spread and mount the wings of butterflies. The mounting board with the insects pinned on them are placed in dry storage with some naphthalene and left to dry for about 5 days. At the end of this period, paper strips and pins except that passing through the body of the insect are removed. The insect can be handled by means of this pin. Moths and large, fleshy bodied grasshoppers are preserved in the same way, but in moths with hulky bodies, it is necessary to slit open the underside of the abdomen, remove the viscera, stuff the abdominal cavity with some cotton-wool soaked in 4% formalin, and then the two 5 ends of the abdominal wall are brought together and stitched or pasted with the help of quick-fix.

(Source: THE PRESERVATION OF ZOOLOGICAL SPECIMENS By P. JAWAHAR. B.Sc., M.A. Curator, (Zoology Section, Government Museum, Chennai. 600 OOB)

Learning resources are the support systems to the teachers as well as students which will not limit to just print and non-print materials, rather it includes, audio, visual, electronic, digital hardware/software resources and also human resources. According to the Department of

Education Canada "Learning Resources" refer to any material (whether acquired or locally produced) or any Persons with instructional content or function that is used for formal or informal teaching-learning purposes.

We do often say that learning should be based on first-hand experience or direct and purposeful experiences, but in practice, it will be very difficult to have this type of opportunity for all the concepts and contents prescribed in the syllabus. In such situations, teachers will make use of certain representatives or indirect experiences to cope up with the learning objectives. Usually, such elements are called Audio-Visual Aids. Sometimes learning resources are also referred to as Instructional Materials which include teaching-learning materials. These Teaching-Learning Materials are any collection of materials including animate and inanimate objects and human as well as non-human resources that a teacher may use in teaching and learning situations to help achieve desired learning objectives. These learning aids help students in concretizing the learning experiences to make learning more exciting, interesting and long-lasting.

Learning resources in the form of a support system will make the teaching-learning process effective. And there are several advantages in using these materials, for example: Evolution of Man, cell division, embryonic developments, and life processes and certain fossilized and extinct organisms-these may not be considered as direct experiences but could help understood in a much better way. These learning resources are classified based on the learning experiences they provide. Hence experience-based classification will be as follows:
- Resources that give direct experiences: for example, live Objects / Specimens.
- Resources that give Representative experiences: for example, Models of cells and tissues, Working Models-Human Heart, Kidney. Etc.
- Visual resources: for example, Charts, Pictures and Diagrams.
- Audio Resources: for example, Recorded sounds of birds and animals.
- Activity resources: for example, Plant Collection, Insect box preparation, Experiments and Observations, Field trips / Visits etc.

However, the learning resources could also be classified into the following types:
- Audio Learning Resources
- Visual Learning Resources
- Audio-Visual Learning Resources
- Community Learning Resources
- Human Resources

Audio Learning Resources:
These are learning resources which demand an attentive hearing or listening from the students. Here only one sense organ that is Ears and Hearing is involved. Radio Broadcast, Gramophone Records, Audio Discs/Tapes, Telephonic Conversation and Human Voice (Teacher / Resource Persons) are specific examples for Audio Learning Resources.

The teacher's voice could be a very good resource for learning provided it is assured with an effective medium of communication. For this, modulation of voice, expression of feelings, emphasis, stress, pause and silence at appropriate places are needed to be intermingled. Many

audio teaching-learning-material are available now. Audio CD/DVD recording is very popular now. NCERT, National Institute of Open Schooling (NIOS)and other institutions prepare Audio CD/DVD for children which are very effective teaching-learning materials.

Radio:

Radio is a very popular mass medium, the popularity of a radio is due to its easy access, speed and immediacy. In India, the first radio station was established in Mumbai in 1927. Later, All India Radio stations were started at Calcutta and Delhi in 1936. From 1937 and onwards Calcutta station has been broadcasting school programmes. Gyan Vani is a dedicated FM channel for educational broadcasts. It is used to broadcast educational programmes from Educational Media Production Centre (EPMC) of Indira Gandhi National Open University (IGNOU). Audio programmes developed by Central Institute of Educational Technology (CIET) of NCERT for school children are also broadcast by Gyan Vani.

Radio is used to broadcast lectures by eminent educationists, scientists, and also broadcast drama, stories, commentary, news, etc. Radio is popular all our country, urban as well as rural, settings. Sound, music, special effects are added to audio programmes to make them interesting and effective. Thus it helps in creating visual images through sound and enriches imagination in children. CIET, State Institute of Educational Technology (SIET) and educational technology divisions of SCERTs produce a topic and need-based audio programmes for school children. IGNOU also produces audio programmes for its student teachers enrolled in teacher education programmes. To overcome the limitations of the Radio, Tape recorder, podcast and audio CDs are used.

Visual Learning Resources:

These resources involve the use of the sense of sight only and hence they are called Visual Learning Resources. Under this category following are considered:

Charts, diagrams, sketches, models, motion pictures, film strips, slides, flannel graph and bulletin board, graphic materials, herbarium collections, working-models, Over-Head-Projector (OHP), microscopes with permanent as well as temporary slide mountings, preserved and live specimens, aquarium, terrarium, vivarium and practical records. Now excluding some very common learning resources, like, charts, blackboard work, we shall try to understand some other resources which need a fresh look.

1. Specimens:

Specimens are naturally occurring real or representative materials. In biological studies, we do come across certain specimens that play the role of typological study. For example, studying hibiscus flower to serve the purpose of studying all the flowers in general. In this case, the hibiscus flower plays the role of a representation. Likewise, specimens could be of three types, namely, (i) Live Specimen (ii) Dry-Specimen and (iii) Preserved Specimens.

Live Specimens: These are fresh and living or the specimens that are alive. For example, any potted plants, plants in the school garden, trees in the nearby park, insects, birds, pet animals, live microbes including algae and fungi.

Dry Specimens: These include the parts/organs or the whole dead organism but are chemically processed so that it could be used for the study purpose. For example, organs or the whole organism processed by Plastination-Technique, bones which are dried and processed, skull and skeletal system, insects, birds (stuffed scientifically) and herbarium sheets.

Preserved Specimens: These are preserved Bottle Specimens, organisms are preserved using Formaldehyde solution.

2. Models:

Model is an artificial representation of real objects. It may completely or partially represent the original thing as a replica. Model is a recognizable imitation of the real thing (for example human eye model). Usually, a model is similar to the original object in every aspect except the size. The size of an object may be reduced or enlarged. When the size is reduced, the object is simplified to show only the essential parts. On the other hand, when the size is enlarged, it shows the details of the object. For example, a model of the eye is enlarged to allow all the details to be seen easily and clearly. When the original organ is not possible for the study purpose then the models are used. For example, the human heart, brain, kidney, ear, skeleton, the structure of a cell and a variety of birds' nests.

Models can be of two types:

Stationary or Non-working Model- Stationary or non-working model is the type of model in which all the parts of the model are stationary, which means there will be no movement. It is easier to make and is widely used. For example model of the eye is a non-working model, human digestive system, brain and neuron.

Working Model - Working Model is a model in which either all or some parts are moving to show the process in the system. They appear interesting to learners. For example working model of lungs, circulation of blood and functions of the kidney.

3. Overhead Projector (OHP)

Overhead Projector (OHP) helps in displaying still visual material as a projection on a screen. It is a simple projector which is very easy to operate and therefore, popular among teachers. It is better than using a chalkboard as it helps the teacher to talk and show visuals at the same time. A teacher, can observe the reaction of students and interact with them. It also helps in saving time as these visuals/transparencies could be used again and again. OHP does not require a darkened room and is easy to handle and transport from one classroom to another. One has to use visual material either textual or pictorial by preparing transparencies. Transparencies need to be designed and developed for achieving the objectives of the teaching-learning.

There are two forms of OHP transparencies. (i) Single Transparency- If you want to use ten transparencies, then you may have to make ten single transparencies, and (ii) a Continuous Roll of OHP transparencies. As you proceed with your classroom teaching, you unroll and show it over the OHP platform. Single transparency – Thick transparent Acetate sheets are used to display visual or textual material while talking in class. They can be stored in boxes with blank sheets of paper in between two transparencies to ensure that they do not stick together.

Continuous roll – OHP has the provision of winding acetate rolls from one end to the other. You may start from one end to use it as you proceed through the class. Some may use it in place of the chalkboard. Some may use it for calculation, derivations, etc. The roll may also be used where visuals need to be shown in continuity for better comprehension.

4. Aquarium:

An aquarium is a small artificial pond ecosystem that could be placed in the corner of a classroom or school corridor. It will have all the possible biotic and a biotic components that a pond could have. So it is a live learning resource for students. It allows observing the locomotion of fish, and other small aquatic animals, algae and also aquatic microbes. Certain concepts like Aquatic ecosystem, energy flow, food chain, aquatic adaptation, vegetative propagation, features of hydrophytes and favourable conditions for the survival of organisms etc. could be studied using an aquarium.

5. Terrarium:

A terrarium is usually a sealed glass container containing soil and plants. It could be opened type so that maintenance and access to plants inside will be easy. But the terrarium could be quite large and open to the atmosphere also. Often terrariums are kept as decorative or ornamental items. Both open and closed terrariums are learning resources that create interest among students.

The closed container combined with the heat entering the terrarium allows for the process of small scale water cycle. It is because, the moisture from the soil and the plants, gets evaporated due to elevated temperature inside the terrarium. The water vapour then condenses on the walls of the glass container and eventually falls back on the plants and the soil below. This contributes to an ideal environment/ecosystem for the growing plants, as there will be a constant supply of water, the light that passes through the transparent glass, and Carbon-di-Oxide inside the container- thus making it favourable for photosynthesis.

(Source: https://en.wikipedia.org/wiki/Terrarium)
Closed Terraria

Tropical plant varieties such as mosses, orchids, ferns and air plants are generally kept within the closed terraria. However, the terrarium may be opened once a week to remove excess moisture from the air and walls of the container. This is done to prevent the growth of Mold or Algae which could damage the plants and discolour the sides of the terrarium. Terraria must also

be watered occasionally. For example, the absence of condensation on the walls of the terrarium or any wilting of the plants is an indicator that it requires water supply.

Closed terraria also require a special soil mix to ensure both good growing conditions and to reduce the risks of microbial damage. A common medium used is "Peat-Lite" a mixture of Peat Moss, Vermiculite and perlite. The mixture must be sterile to avoid introducing potentially harmful microbes.

Open Terrarium

(Source: https://en.wikipedia.org/wiki/Terrarium)

Open terraria are better suited to plants that prefer less humidity and soil moisture, such as temperate plants. Plants that require more direct sunlight will survive very well in an open terrarium. Note that succulent plants that are popular enough are the poor choice for a terrarium – open or closed.

6. Vivarium:

In Latin, vivarium means "Place of Life". So vivarium is an area usually enclosed for keeping and raising animals or plants for observation or research. Often a portion of the available ecosystem for a particular species is simulated on a smaller scale, with controls for environmental conditions. A vivarium may be small enough to sit on a desk or a table, such as a terrarium or an aquarium or maybe a very large structure, possibly outdoors. Large vivarium particularly those holding organisms capable of flight, typically include some sort of a dual-door mechanism such as a small port for entry and exit so that the outer door can be closed to prevent escape before the inner door is opened.

The vivarium is very apt for studying organisms like, birds and insects that dwell in air medium as well.   To understand the habitat of such organisms vivarium will a very good learning resource. Though it is an artificial environment, there will be sufficient natural factors that make it exactly similar to the original conditions.

7. Wormery:

Wormeries are designed to work as both an easy way to get rid of household waste and a cost-effective method of creating compost. Simply put, the worms will eat the organic matter you put into your wormery, such as fruit and vegetables, coffee grounds, and even paper - at warm temperatures. Wormeries are very much useful for studies dealing with worms and larvae. For example, earthworms are studied through wormery. A simple glass tube having both ends closed could be used for the preparation of a wormery. Inside the tube, the different layers of soil will be arranged. The movement of the earthworm will be seen clearly as the container is made up of transparent glass. Earthworms are called "Farmers' Friend". It is because these will loosen and

turmoil the different layers of the soil to make it more fertile. It also helps in maintaining the ventilation inside the soil.

8. School Garden:
The school garden is one of the best live and exciting learning resources. It allows using the schoolyard as a classroom and reconnect students with the natural world. Mahatma Gandhi's Basic System of Education advocated self-dependency, autonomy and self-reliance – all these values could be concretized with the help of a school garden. Here the students will come to know about the true sources of their food and learn through experience regarding gardening and agriculture concepts. And practice the skills that integrate with several subjects. It also allows them not only to achieve several educational goals, including personal and social responsibility but also to understand the dignity of labour. In a school garden, school children are set to work cultivating flower and vegetable gardens. The school garden is an outgrowth of regular school work. It is an effort to get children out of doors and away from books. It is a healthy realism putting more vigour and intensity into schoolwork.

Some of the activities conducted in the school garden are,
- Growing the saplings and studying them.
- Conducting grafting, layering and cutting activities for vegetative propagation.
- Growing certain succulent plants, like, cactus, opuntia plant, Aloe Vera and studying their morphological features, adaptations and benefits.
- Studying Lantana, amaranths, Chana and other fencing and decorative plants.
- Growing some vegetables, like, tomato, potato, onion and garlic plants.
- Growing certain creepers, like, pumpkin, cucumber and green pea.

The Benefits of School Gardens
J. Michael Murphy, an associate professor of psychology at Harvard Medical School, studied the Edible Schoolyard programme in Berkeley, California for two years. He discovered that school gardens are both 'shrinking students' waistlines and increasing their understanding of food and the environment. He observed that "when middle school students in large urban communities are allowed to learn about ecology in a real-world context, they are more enthusiastic about attending school, make better grades, eat healthier food due to wiser food choices, and become more knowledgeable about natural processes".

The benefit of having a school garden is very impressive and some of them could be noted as follows:
- Students learn focus and patience, cooperation, teamwork and social skills
- They gain self-confidence along with new skills and knowledge in food growing
- Garden-based teaching addresses different learning styles and intelligence
- Achievement scores improve because learning here is a more relevant and hands-on experience
- Students become more fit and healthy as they spend more time active in the outdoors and start choosing healthy foods over junk food
- The school campus will become more diversified and beautiful

1. Field Visits:

Field visits, study tours and educational excursions are an integral part of the curriculum and they are considered as one of the learning resources also. You will come to know more details regarding this in the next successive unit.

Audio-Visual Learning Resources

2. Television

Television has become most important in learning resources nowadays. Since it has a synchronized effect of sound and visuals, the impact will be deeper compared to any other learning resources. And you know that children are extremely fond of cartoon networks on Television. Similarly the subject matter in the form of Audio Visual Teaching-Learning-Material, undoubtedly then the learning will be interesting and effective. Gyan Darshan of IGNOU is a Channel dedicated to educational programmes. Educational programmes prepared by CIET for children are regularly broadcasted. SIETs produce programmes in local languages for children. UGC, DSERT and SCERT programmes are also available on Television. These educational programmes are useful to learners as a wide variety of information available in their local language. They can use it to learn about new things and then clarify the points they did not understand with their teacher. As a teacher, you should try to prepare students to watch the programme. You should ask questions related to the topic being telecast on TV. This will raise their curiosity level and they will be more alert and focused while watching the TV programme. After watching the programme, there should be a discussion. This will help in the retention of the points learned and helps in consolidating the learning. Both pre and post-screening discussions are important as they help in concept construction among learners.

3. Video CD/DVD

Video programmes are developed on specific topics to be used in classroom teaching. A script is prepared and the programme is developed using cameras. Professionals generally develop video programmes. Though as a teacher, you can prepare short films for your students and make them available through CD or DVD for them to watch in class or later at their home. Video programmes may be run on the DVD player as well as computer. CIET of NCERT has developed many Video CDs and DVDs for school children. National Institute of Open Schooling (NIOS) develops programme for children. Besides many private organizations also develop programmes but the cost is more and thus not all children can be benefited from these video programmes. Both online and offline mode of curriculum transaction is on-demand in the present pandemic situation due to Covid-19.

4. Computers

As a teaching-learning material, a computer is said to be of immense importance. Its potential is enormous. It supports the group as well as individualized learning and this increases its scope of use in a variety of situations and a variety of ways. A computer can record, analyze, interact with students, store and manipulate data on an extensive scale. It may be used as a teaching-learning material and thus can act as a learning resource in a variety of ways. One can use it for various purposes. For example,

- Teachers can provide a series of learning exercises, with the inbuilt feedback system. This satisfies the pace of learning of each student according to the respective individual difference.
- Provide the learning material in small units and gives immediate feedback and this reinforces further learning.
- Games are a great stimulator for learning. New concepts may be introduced through games.
- The animation is another feature possible on computers. Students are fascinated by animated programmes. Thus, the animation may be used to capture their interest to teach difficult topics by tapping the affective domain criteria.
- Simulate complex topics and help students to understand. Abstract concepts like Cell and Cell-Organelles, Photosynthesis and Structure and Function of DNA may be simulated on computers for better understanding.
- Interact with learners at each step for getting motivated to learn further. When computers are used for the teaching-learning process it is called Computer Assisted Learning (CAL) or Computer Monitored Learning (CMI). Here the computer interacts and communicates with the learner according to the predesigned programme.
- The students are guided through the new concepts in a predetermined manner. The computer interacts with the learner at every step and thus it is interactive learning and the learner is always active.

Use of computers, internet, online and offline mode of transaction – all these are considered under the multimedia approach. It is the synchronization of audio and video makes the impact deeper compared to either of the medium taken separately. Hence whether it is online or offline, computer-aided simply it is called multimedia approach.

Check Your Progress - 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. The term 'Teaching Aid' is meaningfully substituted by
   a. Charts and Models
   b. Specimens
   c. Learning Resources
   d. CDs and DVDs

2. A terrarium contains,
   a. Soil and trees
   b. Water and aquatic animals
   c. Phytoplanktons
   d. Zooplanktons

3. Below are given some statements, put √ mark for the correct ones and **X** for the wrong ones:
   a. A garden cannot become a learning resource
   b. The most effective sequence of having learning resource on the topic "Insect" could be Live insect, preserved insect, CDs and DVDs on insects, diagrams and charts
   c. As radio is a one-way communication medium, it cannot be a learning resource

d. Wormery deals with the rearing of earthworms
e. Expecting students to work in the school garden is not advisable
f. The aquarium is said to be a miniature of the pond ecosystem

3.4.3.2. Community Resources and Human Resources in Biology

Activity-2

Ask the students to make a list of community resources as well as experts in the field of life science in their surrounding area. Let them make a though study of any one of community resources, for example, pond ecosystem, primary health centre, horticulture department or zoo/bird sanctuary/reserve forest area.

Community Resources:

School and community should go hand-in-hand. Unfortunately, we see only school or classroom-based learning among students which is very rigid. An ample amount of resources can be drawn from the surrounding environment or the community to teach Biology. This will also help in developing certain social responsibilities and democratic values among students. Thus society or the community are the essential and integral parts of the education system. The subjects taught in the schools including biology are related to daily life and therefore the concepts that a child learns are not only inside the class but outside the class too.   There is a strong give and take the relationship between the school and the community.

In the real sense, the community resources have both direct and indirect influences on the learning resources. They give multifaceted learning opportunities to students. There is an ample opportunity for students to gain first-hand learning experience through interactions with the community. These interactions are vital learning experiences. For example, in villages children will get information about the crops from their elders. It will be easy for them to identify different types of crops and crop cycles. According to Vaidya, making use of the community resources is beneficial to the teachers as well as students, like,

- Facilitate to critically visualize the teaching-learning situations well in advance and to collect the learning resources.
- Encourages to construct learning situations and nurtures the skill of observation.
- Helps in developing scientific hobbies, like, bird watching, gardening and nature walk.
- Supports the classroom teaching with practical context.
- Makes the learning so natural and interesting as well as challenging.

It is better to list out community resources that are easily accessible. For example, the nearby agricultural fields, gardens, farm-houses, forest area, lands, ponds, streams, bird-sanctuaries, forest safaris, varieties of NGOs, health centres, horticultural centres, plant nurseries, poultry forms, zoo, museums, exhibitions and aquarium centres. This list has to be updated every year. This will make it easy to organize any community-based activities. Community resources could be utilized in two ways, like, either a teacher can all the students to the spot where the resources are available or bringing the resources to school and classroom. For example, to understand how the silk is produced, one has to take the students to the place where

silkworms are reared and silk is extracted is one type. Likewise, arranging a talk about healthy and hygienic habits for adolescents by an expert in the school itself is the second type.

Human Resources:

Man is considered a human resource. It is because of his fund of knowledge, expertise, rich experiences, skills, specializations, power of analysis, synthesis and skill of problem-solving and ability to judge and decision making. These are ought to be developed among the students. Hence all the individuals having the above-said qualities could be considered as human resources. Following are the characteristic features of human resource:

- This is a live, energetic, enthusiastic and ever occurring resource.
- It can create new concepts, methods and theories.
- It is flexible enough to update as the time and requirements change.
- Human resources are highly individual specific in nature.
- There will be no guarantee of getting help due to direct and indirect constraints.

The use of human resources in the teaching-learning of Biology will make it more effective and efficient. Collectively it influences good social changes also. Experienced teachers, naturalists, scientists, professionals, doctors, people who work in the different departments related to biological science, zoo authorities and staff – all these people could be considered as human resources.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Whatever students learn in a classroom must get,
   a. Evaluated through exams
   b. Recalled for a longer time
   c. Applications in day to day life
   d. Confined for scoring in exams

2. One of community resources for Biology is,
   a. Well maintained part
   b. Government offices
   c. Postal department
   d. Banks

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. A teacher cannot be considered as a resource
   b. There must be a good relationship between the school and community
   c. Zoo authorities and staff are one among the human resources
   d. Community is the one which Supports the classroom teaching with practical context
   e. In a Bird Sanctuary, only birds are studied
   f. Agricultural fields are of no use in learning Biology

3.4.3.3. Biology Laboratory as a Learning Resource

Activity-3

Science is incomplete without the usage of the laboratory. The laboratory is the place where theories will get a practical expression. According to **Joseph J. Schwab,** a laboratory is nothing but an exploring environment in which three essential tasks are found. They are,

- Gives a forum to find the solution to problematic situations.
- Provides a platform to conduct the discoveries and investigations in a miniature form.
- It helps in minimizing or completely removing the differences between thought and the processes/tasks.

The biology laboratory is a modern research infrastructure, providing a broad range of biological and biochemical techniques with in-depth practical training offered by experienced staff. Important routine work is on microbial and molecular analyses and biological sample preparation in general. Several special applications, such as respiration experiments, enzyme kinetics, sterile culturing of microalgae, morphological taxonomic determination of locally available species. In addition to the basic tasks such as providing bench space or experimental setups in the constant temperature room, the biological laboratories offer some specialized working areas. It gives a space for the observation of organisms like unicellular and multi cellular algae and fungi under microscopes.

A biology lab is a place where the students study detailed structures, morphological, histological and physiological aspects of plants and animals. Study of slides under the microscopes or studying the museum specimens kindles a natural curiosity towards Nature and in stills a joy of learning the flora & fauna around us. This is a place where the students could be given a chance to 'discover' before they are 'told'. In turn, this will help them in constructing knowledge on their own.

Characteristic Features of a Good Biology Laboratory
- Biology laboratory must be spacious enough so that each student will get sufficient place for working
- It should be loaded with a conducive environment and motivating factors
- It should be flexible in providing the opportunity for an individual as well as group activities, effective lecture-cum-demonstrations
- There must be proper seat arrangements so that a teacher can move around, observe and supervise students while they conduct experiments
- Every student should have access to sufficient resource materials, equipment and apparatus
- Biology lab should have sufficient storage place
- It should have good ventilation, the supply of water, electricity, gas and light

Essential Equipment/Apparatus/Materials
- Anaesthetic liquid/chloroform, Bovine serum, aqueous bovine serum, used for preserving organisms, formaldehyde solution, acetic acid, alcohol,
- Hydrochloric acid, sulphuric acid and nitric acid must be stores scientifically with all strict precautionary measures.

- Methylene blue, Congo red stain, Iodine solution, Safranin solution and other stains, Benedict solution, ringer solution, acetic glue, rubber cement glue
- Materials used for the collection of organisms like, nets, dip nets,
- Borosil glass wears, heating equipment, spring balance, physical balance
- Measuring jar, glass pipe, straw, pipette and burette, flasks, conical flasks, beakers of different size Dissection set, dissection tray and glass troughs of different capacity
- Models of organs of different animals and organisms including models of a human eye, heart, brain, kidney, skull and skeleton
- Bottle specimens of plants and animals of different family and phylum respectively
- Each laboratory must and should have laboratory manuals, and every student should get easy access to these manuals

However to get a comprehensive list of laboratory materials is not an easy job, and also it depends upon the extent of how much a teacher will make use of it. It also depends upon the curriculum prescribed for a particular standard. For some practical and common purpose, the following could be taken into consideration:
- Compound microscopes, Dissection microscopes, Micro Projectors, Refrigerators
- Equipment that could control light, temperature and moisture
- Perishable and Non-perishable materials and chemicals
- Learning aids, like, charts, models and preserved and stuffed animals
- Tools that are needed to repair the equipment if required

A biology lab must be equipped with a table along with the walls having glass-paned windows so that enough light is available for microscope study. These should have drawers and water fittings. There must be a big demonstration table, stools, sinks, wall blackboard, wall shelves for chemicals, Almirahs, space for aquarium, vivarium and for keeping other animals. There must be an inbuilt system for the disposal of wastes used unwanted materials. A continuous water supply and electricity is very essential for a biology laboratory.

Biology lab is inevitable for the study of structure and function of organisms, anatomical details, observation of morphological features and also for the study of the plant cell, animal cell, cell division, life cycle of unicellular organisms and parasites. H. Dowdeswell believes that there are certain advantages by giving practical work to students, like:
1. It inculcates the skill of keen observation, one of the science processes skills among the students
2. It enables the students to record meticulously their observations
3. Enables the students to learn many managerial skills
4. Sustains the interest and curiosity in the subject
5. Develops the skill of scientific method and scientific temperament
6. Develops the skill of analysis and synthesis
7. Develops the ability to test the concepts that already learnt
8. Enables the students to experiment with explorations as well as to illustrate
9. Inculcate the values like being unbiased and free form prejudices
10. Develops the ability to be careful, focused, patience, perseverance and alert while conducting experiments

Check Your Progress - 3

The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Biology laboratory will be,
   a. A place to apply the theory to practice
   b. A place for conducting experiments
   c. A place where lecture cum demonstrations are conducted
   d. A place where students are passive learners

2. Biology laboratory must have,
   a. Bottled specimens
   b. Certain acids and bases
   c. Equipments, resources, good ventilation, the supply of water, electricity, gas and light
   d. Microscopes and dissection set

3. Below are given some statements, put √ mark for the correct one and X for the wrong one:
   a. Laboratory experiences facilitate the development of scientific temperament
   b. For high schools, the classroom itself can be converted into a biology laboratory
   c. Practical classes in high school will be cumbersome and hence should be avoided
   d. It is possible to conduct simple explorations in a biology lab
   e. In Karnataka, there is a huge number of schools without a laboratory
   f. The natural environment gives plenty of opportunities to learn the subject of biology

3.4.4. Let us Summarise

Teachers will make use of certain representatives or indirect experiences to cope up with the learning objectives. Usually, such elements are called Audio-Visual Aids in turn these are learning resources only. Sometimes learning resources are also referred to as Instructional Materials which include teaching-learning materials. These Teaching-Learning Materials are any collection of materials including animate and inanimate objects and human as well as non-human resources that a teacher may use in teaching and learning situations to help achieve desired learning objectives.

Learning resources in the form of a support system will make the teaching-learning process run very smoothly. Learning resources are classified for the sake of our convenience as Audio Learning Resources, Visual Learning Resources, Audio-Visual Learning Resources, Community Learning Resources and Human Resources. Specimens (live, preserved both), models (still and working), Over Head Projects, Micro projectors, Aquarium, Terrarium, Vivarium and wormery, school garden, CDs, DVDs, Internet resources, online and offline resources, ponds, primary health centres, birds sanctuary and biology practical laboratory are the major resources for learning.

3.4.5. Answers to 'Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. c   2.a   3. a- X   b- √   c- X   d- √   e- X   f- √

Check Your Progress - 2
1 .c   2.a   3. a- Xb- √   c-√   d- √   e- X   f- X

Check Your Progress - 3
1. a   2.c   3. a- √   b- X   c- X   d- √   e- √ f- √

3.4.6. Unit end Exercises
1. What are the learning resources relevant to the subject 'Biology'?
2. How are the learning resources classified? Illustrate your answer.
3. Explain the nature and uses of Audio learning aids in Biological Science.
4. Describe the importance of visual aids with illustrations.
5. Give a list of Audio-Visual Learning aids in the immediate school environment.
6. What are the criteria for the selection of learning resources?
7. Justify Biology Laboratory as one of the best resources.
8. Explain the features of a good biology laboratory.

3.4.7. References
1. http://egyankosh.ac.in/bitstream/123456789/46675/1/Unit-8.pdf
2. http://egyankosh.ac.in/bitstream/123456789/8511/1/Unit-7.pdf
3. https://en.wikipedia.org/wiki/Terrarium
4. https://www.greenhearted.org/school-gardens.html
5. https://en.wikipedia.org/wiki/Biolab
6. http://www.e-books-chennaimuseum.tn.gov.in/preservation pdf
7. Jeevashastra Bodhane - H.S.Umesh (2010) Shruthiloka Prakashana, Mysore
8. Modern Science Teaching by R.C. Sharma, Dhanpat Rai & Sons Publication

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Block 3 : Curriculum and Learning Resources in Biology

Unit 5 : Field Visits and Excursion as Learning Resources in Biology- Planning, Organization and Observation

Unit Structure
3.5.1.   Learning Objectives
3.5.2.   Introduction
3.5.3.   Learning Points and Learning Activities
3.5.3.1. Learning Resource in Biology - Field Visits and Excursion
          Check Your Progress - 1
3.5.3.2. Planning, Organization and Observation in Field Visits and Excursion
          Check Your Progress - 2
3.5.4.   Let us Summarise
3.5.5.   Answers to 'Check Your Progress - 1and 2'
3.5.6.   Unit end Exercises
3.5.7.   References

3.5.1. Learning Objectives:
After completing this Unit, the student teachers will be able to,
- Explain the meaning and purpose of field visits and excursions;
- Differentiate between the field visit and excursions;
- Justify the importance of field visit and excursions as learning resources in Biology;
- Describe the procedure of organizing a field visit and excursions;
- Design different field visit with different objectives;
- Locate the areas/places for field visit according to the needs of teaching Biology;
- Mention the precautions to be taken while conducting a field visit;
- Identify the responsibilities of a teacher in conducting a field visit/excursion; and
- Recall the responsibilities of the students to be given during field visits/excursions.

3.5.2. Introduction
Dear Student Teachers,

Education need not happen only within the four walls of a classroom. Everyone knows that learning is beyond the school and the curriculum. Real education definitely cannot occur with the rigid regulations of a formal classroom.   Especially the subject Biology has a direct link with the environment, society day to day life. Therefore it becomes the duty of a teacher to enable the students to link the acquired knowledge to their life. For this, organizing the activities outside the class and school campus is one of the strategies. It could be, like, organizing the field visits, field trips, excursions, educational tours, conferences, science fairs, exhibitions etc. All such activities are usually conducted under the great canopy of Co-Curricular Activities (CCA). In some schools, a well-established Science Club will take care of all such activities. In this unit you will come to know about how the outdoor activities such as field visits, excursions and field trips are arranged, what are duties of a teacher, what precautions have to be taken, the objectives of such co-curricular programmes and also how to evaluate these programmes.

3.5.3. Learning Points and Learning Activities

3.5.3.1. Learning Resource in Biology - Field Visits and Excursion

Activity-1
Field visits to collect plants and animals could be of two types. For example
  1. Collecting whatever is available in a chosen area and studying them further.
  2. Collecting a particular plant/animal which is pre-determined before the execution of the visit.

For a given task one of my students was collecting a water sample wherever she comes across and observing it under the microscope. But many times she was unhappy because she did not get the one which she wanted. One day she was thrilled as she got that particular alga "Nostoc" in the water tank which was there in the school campus itself.

Field visits, excursions and educational tours will support the classroom teaching and many times they supplement, reciprocate and complement the main curricular activities. Field visits give a golden opportunity for understanding the mutual dependence of organisms. Reserve forest areas, hilly areas, sanctuaries, ponds, zoos, exhibitions, museums, food processing industries, milk diaries including agricultural fields and rural environment are the real resources where the subject biology get flourished naturally, but these cannot be brought to the classroom. So a visit to such areas has become an integral part of the regular curriculum. Similarly, educational tours will have both recreational and educational values. For this, places of tourist importance are included. Visit to such places also can bring opportunities to learn biology. Places like sewage water treatment plants, silkworm rearing and silk production, duck rearing, pig rearing, poultry farms and farmhouses meant for several purposes are some other places where a visit can be organized for biological studies.

Intermittently a biology teacher should plan for field visits. Because this is one of the key methods of supporting the work done in the classroom or the laboratory. No matter where you take the students, but it is damn sure that allowing first-hand information will prove more popular and interesting than just learning through a textbook.

Going on field visits/trips offers students a unique cultural learning experience. It allows students to be involved in new environments, the key to encouraging curiosity about a given subject (For example, exploring details regarding certain herbs only, plants with transparent stem, particular insects, larvae etc.). It is also valuable as an exercise in broadening a student's understanding of the world and Man's place in it.

Field trips and excursions are used as synonyms. Of course, both are meant for learning biology in the environmental context but still, there appears to be a thin line of difference. An excursion is a school journey, an organized trip made by the teachers and the students in which entertainment and educational purposes are merged. Whereas the field trips are organized visits by the teachers and students to immediate or distant places to enrich the learning experience and to bring a direct link to the classroom teaching with more scope for academic aspects. One thing that will be common is that a field visit/trip or excursion is a journey by a group of people to a

place away from their normal environment. The purpose of this could be usually observation, educational and non-experimental research or to provide students experiences outside their everyday routine pattern of activities. One of the major objectives is, observation of the plants and animals in their natural habitat, and possibly collecting samples.

Benefits of Field Visits and Excursions

- Students will get a concrete experience regarding certain abstract concepts. For example, the concept of Symbiosis, wherein a fantastic adaptation between fungi and an alga named as "Lichens" is observed
- Exposure through field visits and excursions will give first-hand information regarding the certain lifestyle of some plants, like the Sandalwood tree(a semi- parasite growing on the roots of the other trees).
- On a field visit, students are more likely to retain the information. The practical experiences help them to remember, learn and understand well the subject.
- Subjects taught in the classroom will get reinforced through the activities of field visits and excursions. Thus the lessons are brought to life.
- It allows the students to be involved in new environments, thus encouraging their social development and many new studying skills. It is observed that students appear to come out of their hindrances, feel to participate, become more creative and display leadership qualities.
- School trips, field visits provide every student with real-world experiences. Whether the visit is to a bakery, dairy, hospital, primary health centre, a garden or a museum, with each experience students can create a connection between what is happening at school and in the real world.
- Taking students outside the school campus will very exciting and a cause for enjoyment. The regular authoritative teacher dominated situations will be completely devoid here. This is the most impressive aspect for students. Field visits erase the boredom of the daily routine classroom teaching-learning situation.
- Students are more likely to understand the subject better through real-life connections and hands-on experience of the lessons they have already learnt in the classroom situation. This relevance of what they are learning helps them to perform better in school exams, tests and projects.
- School field trips allow children to open their eyes to new environments and new cultures. It positively shapes their perspective on a global level and triggers ideas and solutions that may not stem from their natural everyday behaviour and habits. Moreover, students who go on field trips become more empathetic, tolerant and respectful towards a different culture and the society as a whole.

Certain topics are very much suitable for a field study with some modifications, and a few are given below:
1. Collecting creatures from nearby ponds using sweep nets and pond nets, observing them under compound microscopes, and extending this to discover and identify predators and preys in an aquatic food chain.
2. Activities related to "Living things and their Habitats", "Classification of Organisms", "Plants and Seasons", "Special Inflorescence", "Plants and their Adaptations".

3. A field visit to Zoo can cater to the study of different phyla, like, reptiles, birds and mammals. The aquarium corner in the zoo will open up another opportunity. It could be a strong reference for bio-diversity also.
4. A visit to "Butter-Fly Park", "Shuka Vana" (Garden of Parrots), "Natural History Museum" and "Bird Sanctuary" will give an extended learning opportunity to students.
5. A visit to agricultural fields for studying seed germination (Both monocots and dicots).
6. A visit to Plant Nurseries will enhance the knowledge of decorative plants and indoor plants. It helps them to understand their economic importance also.

Check Your Progress - 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. The purpose of a field visit usually is,
    a. Observation, educational and non-experimental research
    b. Entertainment
    c. Recreations
    d. Jovial time-passing

2. Exposure through field visits and excursion will give
    a. Enjoyment /Recreation
    b. First-hand information
    c. Additional information
    d. Chance to understand each other

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
    a. Field visit and excursions are one and same with the same purpose
    b. On a field visit, students are more likely to retain the information.
    c. It is not sure that school trips and field visits provide every student with real-world experiences.
    d. Concepts taught in the classroom will get reinforced through the activities of field visits and excursions.
    e. Going on field visits/excursions offers students a unique cultural learning experience.
    f. Students get confused as the subject taught in the classroom and that which is learnt through field visit is different.

3.5.3.2. Planning, Organization and Observation in Field Visits and Excursion

Activity-2
Organize a structured discussion regarding conducting a field visit in one of the periods. Then ask the students to think freely, about how they will organize this activity. Let them plot a plan for this. To ease their work the following table is given. Let them refer to this and prepare an action plan for each of the items given in the table below:

Activities → Particulars ↓	Visit to Plant Nursery	Visit to Zoo	Visit to Food Processing Unit	Visit to Bird Sanctuary	Visit to Ponds in the Locality	Visit to Museum	Visit to Butterfly Park	Visit to Botanical Garden	Visit to Reserve Forest Area
1.Objectives									
2.Location									
3.Duration									
4.Permissios									
5.Directions									
6.Precautions									
7.Documentation									
8.Report writing									
9.Follow-Up									

A field visit or excursion from school needs planned arrangements and systematic phases. Usually conducting a field visit or excursion will have five sequential steps, namely, Planning, Preparation, Execution, Follow-up and Evaluation.

Planning:

A field visit or an excursion should have clearly defined objectives that are coherent with the objectives of the curriculum. The time preserved for the activity, the number of participants and associates, mode of transportation, obtaining the permission of the authorities who are in charge of the place to be visited, a route to be travelled, the expenditure and other administrative factors have to be decided in advance. A list of the articles, materials to be taken with them must be prepared. The distribution of responsibilities among students should be based on the interest, capacity and competence of the individual pupil. There must be a firm decision regarding collective responsibility and the nature of the task to be done by a group of students. For example, if the person who is good at preparing the report is given the responsibility of maintenance of discipline, the result will be an utter failure.

If the field visit is arranged for plant collection, the task needs to be distributed among the students, for example, some groups may do the collection of phytoplankton and some other groups may do the collection of terrestrial herbs and shrubs. This makes the work smooth going and also every student will be involved in the work. While going for outdoor activities, we have

to aim at multiple types of tasks. The teachers should often take some time to learn about the destination and subject before the visit. Thus planning and preparation apply to both the students and the teachers. An Action Plan regarding the activities at the time of execution should be prepared in advance and every student must be aware of this action plan. The Code of Conduct exclusively to be followed at the time filed visits and excursions should be constructed. For this involving students will be a better option. So that it will add up to the effectiveness. One thing must be borne in mind that all such outdoor activities should not disturb the on-going work of the school. Instead of having a small concept as the major agenda of learning it is better, to have more and diverse learning experiences during the visit.

Preparation:

Proper planning will lead to preparation. By the plan, both the teachers and students will get prepared for the programme according to the blueprint of their plan. Students must get know the purpose of the field visit or excursion, what they are supposed to observe, record, collect and report. They should also be given the directions for the proper execution of field visit or excursion programme. There should not be any half-done preparations rather it has to complete in all respect. Since field visits are socially conducted involving a group of people, everyone must know their limit and contribute to the total maintenance of the discipline. In that sense, self-discipline is very important in field visits. Everyone should follow the discipline and take care so that the totality of the group is not disturbed and the purpose of the field visit is not hampered. Here self-control by everyone guarantees success and self-control includes, following the group decisions and orders by the leaders, extending cooperation, coordination and having time-sense. If the students do not possess these qualities, then the field visits will be the source of bad experiences. The equipment, apparatus and materials which are to be used during the visit, have to be sufficient in number as well as in good working condition-this is very important. Field visits with different purposes will have different types of materials and equipment. These materials vary according to the nature and objectives of the field visits.

However, basically for a biology field visit, we need to take varieties of containers, jars, nets, boxes, old newspapers, binoculars, pen-torch, fine-knife, hand-lens, preservatives, a manual that help in identification and classification, First-Aid Box and simple medicines like, paracetamol tablets, pain-killers Dettol Tincture of Iodine etc., It is advised to get the permission from the parents and head of the institutions well in advance.

Execution:

During the visit, the teacher will have more responsibilities as well as need to be more alert. A good plan and preparation is very essential for the success of the execution. However much of it will depend upon the teacher's directions on the spot. During this time a teacher should act as a supervisor. He should take care of the students' performance and activities and make sure that they are getting all the desired information and simply not wasting the time. If at all novel and important things are seen the teacher should draw the attention of the students and make them note down about it. Better if the teacher doesn't poke his nose into every students' activities. Because students also need some freedom with their responsibilities. Even though he could give guidance, cooperation and help with enthusiasm it will be very informal. He must try to bring a link between the teachings in the class to the teaching in the field visits.

There are certain precautions relevant to the field visit and they are, the whole purpose of the field visit may go out of the track, students may form their group and start wandering as their whims and fancies. Similarly, regarding the finance and expenditure as well as time to be devoted there will be no standard norms. Therefore sometimes it will be expensive also. And about the major responsibility of a teacher, there is no need to tell it again. A field visit maybe sometimes dangerous also, and without the proper material and human resource (Local People) support it will highly impossible to conduct or execute.

Follow-up:

Every activity such as field visit or excursion should extend up to the follow-up phase inevitable, then only the fulfilment of the purpose is possible. After returning from the visits, students should be encouraged to write a report on that, prepare a model out of the collected materials, prepare herbaria sheets, preserving the plants by formalin solution and stuffing the organisms. Whatever they did during the field visit or excursions must get documented, this is very important. Follow-up activities could be in the form of discussions, debate, lecture, and lecture-cum-demonstration and the practical session also. Taking the help of the senior teachers, reference books from the library, internet and online access – all these will facilitate the preparation of a well-balanced field visit report.

Evaluation:

This phase is considered as very essential which comes after the execution. A field visit or excursion is conducted based on certain pre-determined objectives. So after the completion of the visit, one has to check whether their pre-determined objectives are achieved or not. If yes, how far and if no why not. Evaluation is done from the students' as well as the teacher's point of view. Students should exchange their experiences through discussion, questioning, opinions and explanations. They should find out the discrepancies in their activity and should consider it while organizing another visit or excursion. They have discussed the troubles and disturbances they faced during the visit and find out the root cause of it. And further should develop certain precautionary measures for such disturbances in their new visits to be arranged in the future.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Conducting field visit or excursion will have sequential steps,
       a. Planning, Execution and Evaluation
       b. Planning, Execution and Follow-up
       c. Execution, Evaluation and Follow-up
       d. Planning, Preparation, Execution, Follow-up and Evaluation

2. For conducting a field visit,
       a. Teachers need to plan meticulously
       b. Students need to plan properly
       c. Both students and teachers need to have Planning and Preparation
       d. Either the teacher or the students need to plan properly

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
    a. The field visit after completion can have either follow-up or evaluation as both mean the same
    b. The first-aid box is a must during the field visits/excursions
    c. Follow-up activities could be in the form of discussions and reflections
    d. A field visit/trip cannot be dangerous but always will be amusing rather
    e. A separate code of conduct must be there while conducting a field visit
    f. A field visit or excursions are not enough to cover the syllabus so they are unnecessary

3.5.4. Let us Summarise

The nature of the subject biology very significantly needs the intervention of experiences that are outside the school also. For example observation of the natural habitat of plants, animals and microbes inevitably involves field experiences. For this, a teacher has to arrange and organize out of school activities such as field visits and excursions. Field visits, excursions and educational tours will support the classroom teaching and many times they supplement, reciprocate and complement the main curricular activities. Field visits give a golden opportunity for understanding the one to one interdependence of organisms. Reserve forest area, hilly areas, sanctuaries, ponds, zoo, exhibitions, museums, food processing centres, milk diaries including agricultural fields and rural environment are the real resources where the subject biology get flourished naturally, but these cannot be brought to the classroom so a visit to such areas has become an integral part of the regular curriculum.

Field visits and excursions have many note-worthy benefits as far as learning outcomes from students are concerned. For example, they give the first-hand experience, direct learning experiences that last for a longer period. Apart from academic benefit certain social values like cooperation, coordination and withstanding nature- are very well learnt in such activities. They could feel a sense of exploration in reality. School field trips allow children to open their eyes to new environments and new cultures. It positively shapes their perspective on a global level and triggers ideas and solutions that may not stem from their natural everyday behaviour and habits. Moreover, students who go on field trips become more empathetic, tolerant and respectful towards a different culture and the society as a whole.

A field visit or excursion from school needs some meticulous arrangements and systematic phases. Usually conducting a field visit or excursion will have five sequential steps, namely, Planning, Preparation, Execution, Follow-up and Evaluation. It will be still better if the students are also involved in the preparation of the plan for a field visit or excursion. An Action Plan well in advance will much better for the effective and efficient execution of the programme. However, it is very important to keep in mind that the objectives of field visits or excursions must be in accordance with the objectives of the subject and the curriculum.

3.5.5. Answers to 'Check Your Progress - 1and 2'

Check Your Progress - 1
1. a   2.b   3.a- X   b- √   c- X   d- √   e- √   f- X

Check Your Progress - 2
1. d   2.c   3.a- X   b- √   c- √   d- X   e- √   f- X

3.5.6. Unit end Exercises
1. Explain the meaning and purpose of field visits and excursions
2. Differentiate between the field visit and excursions
3. What is the importance of field visits and excursions?
4. Describe the procedure of organizing a field visit and excursions
5. Illustrate two field visits with different objectives
6. Mention the precautions to be taken while conducting a field visit
7. What are the responsibilities of a teacher in conducting a field visit/excursion?
8. What responsibilities could be given to students during field visits/excursions?
9. What isthe code of conduct to be adapted during field visits and excursions?

3.5.7. References
1. https://www.planmyschooltrip.co.uk/science-biology.php
2. https://sixthform.stephenperse.com/blog/?pid=458&nid=45&storyid=4734
3. https://hanumantrbk.org/blog/5-benefits-of-field-trips-in-education.html
4. Jeevashastra Bodhane - H.S.Umesh (2010) Shruthiloka Prakashana, Mysore
5. Modern Science Teaching by R.C.Sharma Dhanpat Rai & Sons Publication

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Block 3 : Curriculum and Learning Resources in Biology

Unit 6 : Use of ICT Tools and Online Resources at Various Stages of School Education; ICT based Virtual Experiments and Simulations as Learning Resources in Biology

Unit Structure

3.6.1. Learning Objectives

After completing this unit, the student teachers will be able to,

- Explain the meaning of ICT and its applications;
- Identify the components of ICT tools and their importance;
- Describe the uses of ICT in education;
- Recognize different ICT tools that are commonly used in the teaching-learning process;
- Recall certain educational blogs and their uses;
- Locate the educational uses of email and social networking;
- Explain animation and simulation techniques in biology teaching;
- Justify the use of animation and simulation as teaching strategies;
- Critically review the virtual lab experiments that are available; and
- Cite certain digital products that are helpful for biology teaching.

3.6.2. Introduction

Dear Student Teachers,

There is no single field that is not influenced by Information and Communication Technology (ICT) today. Whether it is an industry, agriculture, textile, banking or Education, software and hardware are sure to interfere. Now learning is not confined only to the classroom or beyond the school activities. E-learning is extensively used. Learning that takes place using the internet is called E-learning which utilizes several sources to collect data or information on the required content areas or learning fields. Email, E-Journals, E-Books and any digital resource, in general, have been developed and used to enrich knowledge exploration and extension. There are abundant resources in terms of Websites in E-learning. Virtual-Lab, Virtual-Classroom, Virtual-Experiences, Virtual-Libraries and Virtual-Field Visits are very popular now. As it is rightly said in NCF 2005, interactive net-enabled computers rather than only CD-based

computer usage would facilitate a meaningful integration of computers, and enhance school curriculum in rural and remote areas by increasing connectivity and access to ideas, and information. It is such two-way interactivity rather than one-way reception that would make education technology-based. So in this unit, you will come to know about the recent developments in the field of Educational Technology in terms of ICT and online resources for learning Biology.

3.6.3. Learning Points and Learning Activities

3.6.3.1. Use of ICT tools and online resources at various stages of school education

Activity-1
- Give an exposure regarding video-conference just by making use of smart-phones to your students. While the network becomes very clear, let them discuss a topic and construct one interactive circle for a small stipulated time.

- Encourage students to attend certain "Webinars" on Biological Concepts which are conducted by authentic organizations.

In the mid-1970s the world got a new era started by the intervention of Satellite Communication in the field of education. Educational technology is regarded as an important means of universalization of education in India. As it is rightly expressed in the NCERT documents, computers, the internet along with the convergence of various technologies has given rise to the more reachable, easily accessible and ever occurring Information and Communication Technology (ICT). Consequently, this has opened up new avenues, opportunities and challenges in the field of education. Although the vast potential of ICT in the field of science education has been well recognized, it still has a long way to run through.

In the 1980s a beginning for introducing computers in schools was made through the Computer Literacy and Studies in Schools (CLASS) Project. But appropriate multimedia software both in English and other Indian languages suited for various age groups in schools is still a rare commodity. However, in terms of content, the Focus Group on Habitat and Learning has made a good beginning by proposing a 22 country-wide open, transparent and publicly accessible information system on different facets of India's environment. One can easily get data regarding biodiversity, agriculture and healthcare. Similarly, EDUSAT an interactive satellite-based distance education system launched on 20th September 2004 uses audio-visual medium and employed Direct-To-Home (DTH) facilitated quality broadcast. The programmes included an interactive channel for students with experts and could include talks, lectures or demonstrations, discussions, question-answer sessions etc. Talk-back terminals and receive-only terminals could be set up at selected schools and that could also be utilized for other schools in the neighbourhood.

Of late, Satellite Radio has opened up the possibility of countrywide digital audio science channels. It could cover the most interior and remotest parts of a vast country like India with the help of a specially designed satellite radio receiver. This digital satellite communication radio system uses geo-synchronous communication satellites dedicated to radio broadcasts and is

essentially a direct-to-home radio. (currently under the name World Space Radio). Access to news, educational broadcasts, and entertainment from all around the world through its unique global relay capability are the remarkable features of this system. Since the broadcast is digital, it is possible to download data files (sound as well as picture files) into a personal computer. It is hence possible to transmit and receive slides/visuals, store them in a personal computer, and synchronize with the audio broadcast for a full-fledged lecture-cum-demonstration which can be projected onto a large screen to an entire class.

Two-way interactivity is possible through telephone lines. In particular, the production of software is relatively easy and cheaper to produce. Satellite Radio can prove to be an important tool for science communication/education in India. ICT as a tool should be used carefully so that it serves to bridge the social gaps and equalize opportunity; inappropriate and insensitive use may as easily widen the gaps. Efforts are initiated to utilize ICT at the school level to prepare children to face the challenges of a society that is fast transforming into an information-driven society.

Kofi Annan, the former UN secretary-general, points out that to attain the goal of Universal Primary Education by the year 2005 we must ensure that Information and Communication Technologies unlock the door of education systems. But introduction and integration of ICTs at different levels and various types of education in a developing country like India is the most challenging undertaking.

Meaning of ICT:
ICT has three parts, namely, Information, Communication and Technology. Information is the summarization of data. Technically data are raw facts and figures that are processed into Information. Communication is a process that disseminates information and knowledge, and Technology is a mode or media through which information can be disseminated. So ICT is the technology required for information processing and dissemination. ICTs may involve technologies like radio, computers, satellites, mobile phones and the internet. To be specific we can say that *ICTs are devices used in the electronic collection, editing, storage, distribution and presentation of information*. ICT is how people interact with their colleagues around the world, exchange their ideas, information, messages and co-ordinate with each other through a variety of technological means.

Components of ICT:
ICT includes communication devices and applications like the computer, hardware networks, software, mobile technology, satellite communication, video conferencing, RFID(Radio Frequency Identification) - is the wireless non-contact use of radio frequency waves to transfer data. Tagging items with RFID tags allows users to automatically and uniquely identify and track inventory and assets. RFID takes auto-ID technology to the next level by allowing tags to be read without a line of sight and, depending on the type of RFID, having a read range between a few centimetres to over 20+ meters)Technology, WI-FI zone, pen drives, Internet, www, Web2.0 and Social media etc.

Satellite Communication:

The age of satellite communication dawned in 1962 with the launching of Early Bird, the first communication satellite. The two big international satellite systems Intelsat and Intersputnik began operating in 1965 and 1971.India launched a satellite for communication called INSAT and for Education purposes, EDUSAT was launched in the year2004.INSAT-4CR was launched on 2 September 2007 by GSLVF04. It is a replacement satellite for INSAT -4C which was lost and destroyed.

Video Conferencing:

It is a two-way communication system. It is also called teleconferencing, which is the use of television video and sound technology as well as computers to enable people in different locations to see, hear and talk with one another. It can still consist of people meeting in separate conference rooms or booths with specially equipped television.

World Wide Web (www):

The World Wide Web, known as www, w3 or simply the web, is one of the several internet resources developed to help, publish, organize and provide access to information on the Internet. The web was first developed by Tim Berners Lee in 1989 while working at CERN, European Particle Physics Laboratory in Switzerland.

Role of ICT in Education:

Information Technology can provide a medium for teaching and learning and contribute flexibility to course provision. The valid uses of information Communication Technologies are:

- Distance learning via electronic networks.
- Open learning through students controlled learning pathways.
- The process of changing teaching and learning styles by using a narrow range of Information Technology based facilities.

According to Sampath(2011), the four major areas of education are, Teaching, Learning, Curriculum, Educational Programme and the fifth one is ICT. According to the revised Draft on National Policy Information Communication Technology in school education (prepared by the Department of School education literacy, MHRD in 2011) ICTs encompasses all devices, tools, contents, resources, forums, and services, digital and those that can be converted into or delivered through digital modes, which can be deployed for realizing the goals of teaching-learning, enhancing access to and reach resources, building capacities, as well as management of the educational system. This will not only include hardware devices connected to computers and software applications but also interactive digital content, Internet and other satellite communication devices, teleconferencing, video conferencing, web-based content repositories, interactive forums, learning management system and management information system.

ICT has also played a vital role in providing distance education very effectively. IT provides online delivery of courses, online assessment and online design courses to a large number of students at a time. The ICT–based system like digital libraries; online courses, audio and video conferencing contribute significantly to the area of E-Learning and have opened a new era in the area of E-Learning.

In the 12th five year plan, special stress is given on enhancing facilities in schools, especially on ICT. The stress laid on implementing ICT at the elementary level by replacing the Application of ICTs in the Teaching-Learning Process. Computer-aided learning has a provision under the SSA programme also which included, provision of networked computers, accessories and an Internet connection in a phased manner. Development of Pedagogically appropriate e-content in the local language and a variety of software tools to serve the school curriculum have also been given special emphasis. This will focus to enable students and teachers to access a wide variety of resources indispensable integrated into the classroom available in the digital format, store over, efforts to make to the cost-effective and efficient ICT solution have also given special emphasis.

Uses of ICT in Education:
- ICT increases access to education.
- It improves the quality of education by developing new ways of interaction and also makes the teaching-learning process more interesting.
- It provides equal opportunities to a large number of learners to obtain education and information.
- It provides specialized tools for learners with visual, hearing or mental impairment so that they learn and acquire knowledge at their own pace.
- It provides support to every school in sharing educational / learning experiences with the different schools throughout the country.
- It enables the distance education system to be more effective.
- It helps in promoting technology literacy to every citizen and especially to young stars.
- It provides opportunities for lifelong education.
- It enhances the teacher's quality both in terms of teaching and research.
- The systematic use of ICT tools in classroom instruction makes the teaching-learning process more effective and highly interactive.
- It has shifted the teaching-learning process from teacher-centered learning to student-centered learning.

The effective and efficient use of ICT depends on technically competent teachers. They should be able to appreciate the potentiality of ICT and have a positive attitude towards ICT.   In turn, this demands:(i) ICT literacy of Teachers (ii) Effective use of ICT hardware and software for teaching-learning activities (iii) ICT – based pedagogy, online support, networking and management.

A teacher can make use of ICT in several ways, like, Computer Assisted Learning (CAL), Computer Aided Instruction (CAI), use of LCD projector, PowerPoint Presentation (PPP), use of Smart Board, Email, Discussion Forum, Webinars, Wikis, Blogs, Social Media, YouTube, CCTV, Video-Conferencing, Tele-conferencing, Google Meet, Google Earth and Online Teaching.

Smart Board is an interactive White Board that accepts Touch Input from a finer, pen or any other solid object. It operates as a part of a system that includes the interactive whiteboard, a computer, a projector and white boarding software or smart notebook. The components are

connected wirelessly or via USB or serial cables. A projector connected to the computer displays the desktop images on the whiteboard.

E-mail is the most popular and excellent web-based media. Teachers can use E-mail for various purposes especially for delivering some web-based services. The easiest and convenient method to access the web sources is E-mail. Some faculty use E-mail and discussion lists to cover basic issues so that classroom time can be devoted to the discussion and highly contentious issues.

Discussion forum/News Group: They are on-line discussion groups on many topics of varied interest. Discussion allows the open exchange of messages on a topic of common interest. Electronic – based discussion groups can alter the classroom structure and dynamics. The absence of face to face interaction can make students alienated, and hostile. Through computers, the images can be display data from external sources. It can access data quickly to reach the desired segment. It makes the classroom transaction more interesting and also removes the monotonousness of the traditional classroom situation.

Blogs and Wikis: Blogs and wikis are based on web2.0 technology. These are asynchronous modes of communication. Authoring a blog, maintaining a blog or adding an article to an existing blog is called blogging. Individual articles on a blog are called blog posts, posts or entries. Wiki is an online collaborative writing tool. Wikis are designed to help groups collaborate, share and build online content and are especially useful for learners who are separated by time and place. Some Educational use of Blog and Wikis are:

Blogs can be used to inform students of classroom requirements, post hand-outs, notices homework and assignments or act as a question and answer board. It provides conversation between batch mates in larger classes. It provides new channels of information and knowledge from anywhere anytime.

Wikis enable and promote group collaboration, editing and revising the information or the articles. It maintains and builds a repository of content and material. It Empowers learners through a more democratic, open philosophy of learning and sharing. Help students experience the messiness of group collaboration, problem-solving and critical thinking. A wiki can be used as a presentation tool in place of conventional software, and students can directly comment on and revise the presentation content. Wikis can be used to map concepts. They are useful for brainstorming, and editing a given wiki topic can produce a linked network of resources. The teacher can use wikis as a knowledge base, enabling them to share reflections and thoughts regarding teaching practices.

Social Networks: Social Networks are an interactive medium, which is based on Web2.0 technology. Among all the social media, Face book is the most popular media. People can share information, upload photos/videos post comments etc. on social media. It is an asynchronous way of communication. People can instantly communicate with each other. Students can use social media to discuss class-related topics with their peer-mates and with their teachers. It helps students experience the messiness of group collaboration, problem-solving and critical thinking. Teachers can use this media to inform students about various class-related topics, post hand-outs,

notices etc. It provides Synchronous communication between learners and teachers and provides new channels of information and knowledge from anywhere anytime.

Google Earth: Google Earth makes Google Maps in 3D visual, 3D Globe for your computer that includes traditional mapping, layered terrain, cultural landmarks etc. Teachers in all content areas can use Google Earth for numerous interactive lessons. Maps and explorations can be built, shared, saved and exported into movies and other presentations.

Mobile Learning (M-Learning): The term M- Learning stands for mobile learning which means learning with the help of handheld technology such as Mobile Phones, laptops and other portable devices. M-learning is convenient as it is accessible virtually from anywhere. M-Learning means the acquisition of any knowledge and skill through using mobile technology anytime, anywhere that result s in alteration of behaviour (Tejwani & Silviya Thomas, 2013). Nowadays, Smart Phones are available in the market and they have the most common features like that of laptops and computers, and they are relatively less expensive than Laptop and Computer. M-Learning also brings strong portability by replacing books and a note with a small RAM filled with tailored learning contents. It can download a PDF File or E-books with the help of Android or Windows Phone and store it in its RAM.

In the current situation where the system of education is severely affected by Covid-19, Mobile Learning is bringing a ray of hope. Now let us see the advantages of M-Learning:

- The teacher can record their lecture/teaching points and upload it as a podcast and can share the link with their students. Students can use this link while studying or for references.
- Through text messaging with teachers, students can clarify their doubts related to classroom lessons while reviewing the lesson, and the teacher can answer them instantly or in the next class or can direct them to the reference sources where they can meet their query.
- The teacher can create a shortlist of salient features, exam hints, short summaries etc. which can be shared with students through messaging.
- The mobile dictionary can be used by the students to build vocabulary.
- The mobile phone makes it easy for students to discuss class-related topics with their peer group and their teachers in social media/social networks.
- Mobile learning allows group learning of students when they are working on the same projects.
- The teacher can ask a new question related to the subject taught in the class and let the students find out the answer from internet sources by using Mobile phones and to see how quickly they find out the answer.
- Mobile devices are cheaper than desktops or laptops.
- M-learning can be used anywhere anytime including schools, colleges, offices, homes etc.
- Fast & easy accessing of information
- Motivates the students with multimedia facilities.
- Enhances and compliments traditional teaching styles.

Disadvantages:
- Devices may become outdated quickly and students have to keep combating obsolescence.
- Mobile Network has limited bandwidth.
- With the help of a Mobile Network, people can download the file but cannot print out the material.
- Mobile learning can create vision problems also.
- Loss of Data may occur due to discharged batteries, the low storage capacity of devices.

Smart class and Blended learning also make classroom transactions highly interactive. Blended learning can be thought of as a new pedagogical approach that blends the effectiveness and socialization opportunities of the classroom with the technologically advanced active learning possibilities of the online environment. Whereas Smart classrooms are technology-enhanced classrooms that foster opportunities for teaching and learning technology, such as computer specialized software, audience response technology, networking, and audio/visual capabilities. The smart classrooms demand learning initiative that assists educators to make ICT integral to learning.

Following are the General ICT tools for teaching and learning:
Desktop and laptops, Projector, Digital cameras, Printer, Photocopier, tablets, Pen Drive, iPod, Web-boards, Scanners, Microphones, interactive whiteboard, DVDs and CDs, Flash discs and Video Games.

The most commonly associated term for ICT use is E-Learning. This includes learning at all levels, both formal and non-formal, that uses an information network-the Internet, an Intranet (LAN) or Extranet (WAN). Generally, these are used for course delivery, interaction, evaluation and/or facilitation. Nowadays the term 'online learning' is used instead of e-learning. Web-based learning is a subset of e-learning and refers to learning using the internet mainly using a browser (such as Chrome or Firefox or Internet Explorer).

Blended Learning is another popular term that is gaining currency. These are referred to as learning models that combine traditional classroom practice with E-learning solutions. Like, for example, having online mentoring sessions along with the traditional classroom teaching, maybe through chat, and are subscribed to a class email list. A web-based training course can be enhanced by periodic face-to-face instructions. In blended learning, the factors like consideration of nature and difficulty level of the subject matter, the learning objectives, learning outcomes, characteristic features of learners and learning context to arrive at the optimum mix of instructional and delivery methods are assured.

ICT in Education Curriculum for Teachers
The teachers' curriculum is considered a significant vehicle for the realization of the goals of the National Curriculum Framework (NCF) and consequently is designed to provide an enhanced exposure to information and resources for ongoing professional support, improved teaching-learning-evaluation-tracking, and increased productivity. The National Policy on ICT in School Education organizes the competencies for ICT Literacy into three broad levels, namely,

(i) Basic, (ii) Intermediate and (iii) Advanced, and the curriculum subsumes them. These are consecutive stages.

Stage 1- Basic:
        Basics of computers and basic use of tools and techniques – operate a computer, store, retrieve and manage data, use a computer to achieve basic word and data processing tasks; connect, disconnect and troubleshoot basic storage, input and output devices. Connect to the internet, use e-mail and web surfing, use search engines; keep the computer updated and secure; operate and manage content from external devices (sound recorders, digital cameras, scanners etc.); connect, disconnect, operate and troubleshoot digital devices.

Stage 2- Intermediate:
        Create and manage content using a variety of software applications and digital devices; using websites and search engines to locate, retrieve and manage content, tools and resources; install, uninstall and troubleshoot simple software applications.

Stage 3 - Advanced:
        Use different software applications to enhance one's learning – database applications, analysis of data and problem solving, computing, design, graphical and audio-visual communication; undertake research and carry out projects using web resources; use ICT for documentation and presentation; create and participate in web-based networks for cooperative and collaborative learning; become aware of issues of cyber security, copyright and safe use of ICT and take necessary steps to protect oneself and ICT resources.

        The content of the curriculum involves activities that simultaneously draw upon competencies from different levels, such that completion of all levels is ensured. The ICT in Education curriculum broadly attempts to equip teachers with ICT competencies to strengthen their professional capacities and to effectively use ICT tools and devices in their teaching-learning. The teacher will also be trained to manage the ICT environment in the school and function as a local coordinator for organizing capacity-building programmes.

        The curriculum, therefore, is rolled out as a series of short courses, spanning the six strands and ensuring together with the basic, intermediate and advanced levels of competence. Three induction and twenty refresher courses leading to a diploma in ICT in Education are proposed. Induction courses are to be conducted in face to face mode whereas State (SCERTs/ SIEs) may choose to conduct the refreshers in face to face or online mode.

Check Your Progress - 1
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. The challenge yet to be solved in ICT is
        a. Illiteracy
        b. Unemployment
        c. Lack of educational packages in Indian languages
        d. Inadequate Internet connections in rural areas

2. Combination of traditional classroom practice with E-learning is called
   a. Traditional learning
   b. Student-centered learning
   c. Computer learning
   d. Blended learning

3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
   a. Web-based learning is a subset of E-learning mainly by browsing through the internet
   b. Chrome, Firefox or Internet Explorer commonly used browsers
   c. Web-boards, Scanners and Microphones are not ICT tools
   d. Intranet and Extranet are called WAN and LAN respectively
   e. M-learning means learning while moving
   f. ICT Enhances and complements traditional teaching styles.

3.6.3.2. ICT Based Virtual Experiments and Simulations as Learning Resources in Biology

Activity-2

- Ask the students to search through the internet about different websites meant for teaching and learning biology. And also let them find some animated and simulated concepts, for example, Cell division, Circulation and Locomotion in Animals.

- Topics like, Inflorescences, Pollination, Mendel's Mono-hybrid and Di-hybrid - Experiment and Life-Process are very interesting and clear if studied through Animation and Simulations. So let the students find the difference between the effectiveness of conventional teaching and ICT-Based teaching.

Learning must be a joyful activity. Learning biology can be made easier by adapting ICT tools as instructional strategies in the teaching of biology. It is because ICT has the potential of changing the traditional classroom into a smart classroom and improve the teaching-learning process more effectively and efficiently.

One of the debates with biology teaching is the appropriate use of animals and plants to enhance the learning experience. In particular, a significant amount of time is often set aside within curricula for relevant practical experiences, including dissections, drawings, microscopy, experimentation and discussions with peers and staff. An increasing number, though a minority of students are, for many reasons, disinclined to handle biological materials, while financial cutbacks are making the provision of them more difficult. This makes teaching the discipline using practical activities increasingly difficult.

To some extent, the above problem is solved by the intervention of computers and ICT mainly in the form of Virtual Experiments and Simulations in Biology. In the most general terms, a Virtual Laboratory is a computer-based activity where students interact with an experimental apparatus or other activity via a computer interface. Here there will be no physical reality behind whatever the activity they conduct. In this manner, there are virtual labs, virtual classes, virtual experiments and virtual experiences. However, these virtual modes of

transactions have proved quite effective and efficient. For example, a virtual learning experience of a Human Tooth will give a very clear, effective and efficient understanding of the concept. Simulations and Animations will make it more interesting and possible to look at the sides of the object (Human Tooth) which otherwise would be quite impossible.   A learner can understand very clearly the structure and function of Incisors/Molars (Human Teeth) if the teacher uses an animated programme on the human tooth. Likewise, multimedia applications allow video and digital simulations of laboratory activities realistically but without the risks and costs associated with laboratory experiments.

What Are Simulations?
Doing a live experiment for getting first-hand information has no match or substitute for it. But what if you need to explore the space-related information? Similarly what about the movements of millions of molecules, moving haphazardly in a container, or how safe a car is during a crash without hurting anyone? All these are practically impossible but possible in virtual and simulated activities. That is why simulations are considered a significant endeavour.

A simulation is the re-creation of a real-world process in a controlled environment. It uses something called "Modelling" to figure out the result of the simulation. A model is a representation of an object or process (original) that describes and explains the phenomenon when it cannot be experienced directly. The simulation technique uses a probability experiment to mimic a real-life situation. Instead of studying the actual situation, which might be toll costly, too dangerous, or too time-consuming, scientists and researchers create a similar situation but one that is less expensive, less dangerous or less time-consuming.

Simulations are used in many ways. For example, the "Micro-Teaching" activity conducted in the teacher training programme, is a very good example of a simulation of teaching practice. In scientific discoveries simulations are used to test designs for safety, to save money and even to create graphics for movies and video games. One can put the laws of gravitation into a computer, and used it to create a 3D simulation of the planets and the solar system. Simulations are also used in meteorology to study weather and climate change but this is an area where modeling is difficult. Predicting the motions of every particle in the earth's atmosphere is incredibly hard and that is why Weather forecasts can go wrong sometimes.

Biology simulations help students to learn about biology and practice the skills, like, observation, dissection, microscopy, preservative activities, namely, herbarium preparation, formalin preservation, live-specimen maintenance (potted-plants, honey-bee keeping), preparation of permanent slides and experimentation even much more than this. These simulations allow students to experiment with concepts that may take too much time or too many resources to complete in a traditional science lab setting. While simulations cannot replace real-world experiences, they are a useful tool in both scientific research and education. These simulations can be run quickly and each has random components allowing students to easily gather data from multiple trials. Some simulations are guided Virtual Labs while others can be used for a science inquiry approach by allowing the user to make decisions and control multiple variables.

Simulation is also explained as a technique of studying and analyzing the behaviour of a real-world system or process by mimicking it on a computer application. For this, we can take an example by Johnson Labs Simulations on Mitosis (a link from Online Labs in Biology) that explores how a person's cells decide if and when they will divide. In the simulation, the user investigates how different cells make the decision to divide by first selecting a particular tissue and then alters the conditions to which that tissue is exposed. The user then monitors the intracellular chain of events that leads to cell division. Apart from this, numerous simulations and animations can be found on the internet to illustrate key principles. The easiest way to locate these resources is just inter the word of the concept and the term "Animation" and search. For example, Mitosis and Animation.

Virtual Labs makes use of computer graphics technology to simulate the science experiments from the NCERT laboratory manual. The science experiments cover all the aspects including performing the experiment as per procedure, taking readings, observations, tables, graphs and conclusions of the experiments (Lab In App –Virtual Labs).

The following are the concepts/topics simulated in the App for Class 8th Science and are referred from the latest NCERT books:

Crop Production and Management:
- Preparation of soil-Plough, Cultivator
- Sowing, Modern methods of Irrigation-Sprinkler system, Drip Irrigation and
- Traditional methods of irrigation.

Microorganisms:
- Different types of microorganisms-Bacteria, Fungi, Protozoa and Algae
- Nitrogen Fixation in Leguminous Plants

Cell-Structure and Functions:
- Structure of different types of cells
- Comparison of Plant and Animal Cells

Reproduction in Animals:
- Human Reproductive Organs-Male and Sperm
- Human Reproductive Organs-Female and Ovum
- The life-cycle of Frog
- Development of Embryo
- Reaching the Age of Adolescence
- Endocrine Glands

The following are the concepts/topics simulated in the app for class 9 science and are referred from the latest NCERT Books:

The Fundamental Unit of Life
- Observing various cells from the human body
- Plasma membrane or cell membrane: Osmosis with an egg

- Structure of a plant cell
- Structure of an animal cell

Tissues
- Meristematic tissue
- Simple permanent tissue
- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue

Diversity in Living Organisms
- Monera
- Protista
- Fungi
- Plantae: Thallophyta
- Plantae: Bryophyta
- Plantae: Pteridophyta
- Plantae: Gymnosperms
- Plantae: Angiosperms
- Animalia invertebrates- Porifera
- Animalia invertebrates-Coelenterata
- Animalia invertebrates -Plathehelminthes
- Animalia invertebrates -Aschelminthes
- Animalia invertebrates -Annelida
- Animalia invertebrates -Arthropoda
- Animalia invertebrates -Mollusca
- Animalia invertebrates -Echinodermata
- Animalia vertebrates-Pisces
- Animalia vertebrates-Amphibia
- Animalia vertebrates-Reptilia
- Animalia vertebrates -Aves
- Animalia vertebrates -Mammalia

The following are the concepts/topics simulated in the app for class 10 science and are referred from the latest NCERT books:

Life Processes
- Autotrophic nutrition
- Human alimentary canal
- Human respiratory system
- Human heart
- Human excretory system

Control and coordination
- Neuron
- Reflex arc
- Human brain
- Phototropism
- Geotropism
- Endocrine system

How do Organisms Reproduce?
- Male reproductive system
- Female reproductive system
- Vegetative propagation
- Human sperm

Heredity and Evolution
- Tracing evolutionary relationships
- Fossils

The following are the experiments simulated for class 11 biology and are referred from the latest NCERT laboratory manual.
- **Compound Microscope**: To study parts of a compound microscope.
- **Morphology**: To identify and study the morphology of 8 representative types of bacteria, fungi, and different plant groups
- **Study of Animals**: To study some selected animals based on external features.
- **Plant Tissues**: Study of tissues and diversity in shapes and sizes of plant cells.
- **Animal Tissues**: Preparation of temporary slide of animal tissues and their study.
- **Modification of Root**: To study modifications of the root.
- **Modification of Stem**: To study modifications of the stem.
- **Modification of Leaf**: To study Modification of leaf.
- **Inflorescences**: To study and identify different types of inflorescences.
- **Flowering Plant Study**: Study and describe flowering plants of families Solanaceae, Fabaceae, and Liliaceae.
- **Anatomy of Stem and Roots**: To study the anatomy of stem and root of monocot and dicots.
- **Herbarium Sheets**: Preparation of herbarium sheets of flowering plants
- **External morphology of Animals**: Study of the external morphology of animals.
- **Osmometer**: To demonstrate osmosis by potato osmometer.
- **Imbibition**: Study of imbibition in raisins or seeds
- **Distribution of Stomata**: To study the distribution of stomata on the upper and lower surfaces of leaves and experimentation on transpiration.

The following are the experiments simulated for class 12 biology and are referred from the latest NCERT laboratory manual.
- **Androecium:** To study the reproductive parts of commonly available plants.
- **Gynoecium:** To study the reproductive parts of commonly available plants.

- **Blastula:** To study the blastula stage of embryonic developments in mammals, with the help of permanent slides, charts, and models.
- **Mendel's Law Segregation:** To verify Mendel's law of segregation.
- **Water Holding Capacity of Soils:** To determine the water holding capacity of soils.
- **Adaption of Plants in Xeric and Hydric Condition:** To study the ecological adaptations in plants and living in xeric and hydric conditions.
- **Adaption of Animals in Xeric and Hydric Condition:** To study the adaptions in animals living in xeric and hydric conditions.
- **Homologous and Analogous Organs:** To study the homologous and analogous organs in plants and animals.
- **Pollen Germination:** To calculate the percentage of pollen germination.
- **Pollen Tube Growth:** To study pollen tube growth on stigma
- **Staining Nucleic Acid:** Staining of nucleic acid by acetocarmine.
- **pH of water and soil:**
- **Gametogenesis:** To study the discrete stages of gametogenesis in mammalian testis and ovary.
- **Mitosis:** Preparation and study of mitosis in onion root tips.
- **Meiosis:** Study of stages of meiosis using permanent slides.

To perform the above experiments Download the Class 11 Biology Practical App from the Google Play Store.

Check Your Progress - 2
The questions given below are followed by multiple answers, put √ mark for the correct answer:

1. Simulation means,
    a. Imitation
    b. Copying
    c. A re-creation of a real-world process
    d. Original situations

2. Virtual learning will make use of,
    a. Computer graphics technology
    b. Word document
    c. Print medium
    d. Voice document
3. Below are given some statements, put √ mark for the correct one and **X** for the wrong one:
    a. Virtual learning is similar to original experiences in all respects.
    b. The skill of dissection is taught through virtual lab activities.
    c. Animation and Simulation are the same.
    d. Virtual experiments are computer-based activities.
    e. Simulations are representations of reality.
    f. Since ICT is too expensive we cannot expect it as a solution to educational problems.

3.6.4. Let us Summarise

Information and Communication Technology – ICT has three parts, namely, Information, Communication and Technology. Information is the summarization of data.CT includes communication devices and applications like a computer, hardware networks, software, mobile technology, satellite communication, video conferencing, RFID Technology, WI-FI zone, pen drives, Internet, www, Web2.0 and Social media etc. Information Technology can provide a medium for teaching and learning and contribute flexibility to course provision. The valid uses of information Communication Technologies are - Distance learning via electronic networks, Open learning through students controlled learning pathways and the process of changing teaching and learning styles by using a narrow range of Information Technology based facilities.

A teacher can make use of ICT in several ways, like, Computer Assisted Learning, Computer Aided Instruction, use of LCD projector, Poser Point Presentation, use of Smart Board, Email, Discussion Forum, Webinars, Wikis, Blogs, Social Media, YouTube, CCTV, Video-Conferencing, Tele-conferencing, Google Meet, Google Earth and Online Teaching. Smart Board is an interactive White Board that accepts Touch Input from a finer, pen or any other solid object. Learning biology can be made easier by adapting ICT tools as instructional strategies in the teaching of biology. It is because ICT has the potential of changing the traditional classroom into a smart classroom and improve the teaching-learning process more effectively and efficiently.

In the most general terms, a Virtual Laboratory is a computer-based activity where students interact with an experimental apparatus or other activity via a computer interface. Here there will be no physical reality behind whatever the activity they conduct. In this manner, there are a virtual lab, virtual class, virtual experiments and virtual experiences. However, these virtual modes of transactions have proved quite effective and efficient. Animation and simulation-based educational packages are very helpful not only for the teaching of biology but also for giving practical knowledge of the subject. However, ICT as a tool should be used with care so that it serves to bridge the social divide and equalize opportunity; inappropriate and insensitive use may as easily widen the divide. Efforts are initiated to utilize ICT at the school level to prepare children to face the challenges of a society that is fast transforming into an information-driven society.

3.6.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1
1. c   2.d   3.a- √   b- √   c- X   d- X   e- X   f- √

Check Your Progress - 2
1. c   2.a   3.a- X   b- √   c- X   d- √   e- √   f- X

3.6.6 .Unit end Exercises
1. Explain the importance of ICT and its applications in teaching Biology.
2. What are the components of ICT tools?
3. Describe the uses of ICT in the field of education.
4. Give examples for educational Blogs and their uses

5. What are the educational uses of email and social networking?
6. Explain animation and simulation techniques in biology teaching
7. Justify the use of animation and simulation as teaching strategies

3.6.7. Reference

1. https://ictcurriculum.gov.in/mod/page/view.php?id=309
2. http://www.teachingexpertise.com/articles/teaching-primary-literacy-ict-6996
3. https://www.open.edu/openlearncreate/pluginfile.php/5902/mod_resource/content/1/How_ICT_resources_can_support_learning_at_primary_level.pdf
4. http://oaji.net/articles/2015/1707-1442037069.pdf
5. https://ncert.nic.in/pdf/focus-group/science.pdf
6. https://www.biologysimulations.com/
7. https://labinapp.com/resources/class-8-science/
8. https://labinapp.com/resources/class-9-science/
9. https://labinapp.com/resources/class-10-science/
10. https://labinapp.com/resources/class-11-biology/
11. https://labinapp.com/resources/class-12-biology/
12. http://www.irjims.com
13. Application of ICTs in Teaching-Learning Process - Sudipta Deb Roy Librarian, Vivekananda College of Education, Karimganj, Assam, India

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 1 : Planning of Teaching in Biology

Unit Structure

4.1.1. Learning Objectives

After completing this Unit, the student teachers will be able to,

- Recall the meaning and definition of Lesson Planning;
- Recognize the need for a lesson plan;
- Explain the steps involved in making a lesson plan;
- Describe the characteristics of a good Lesson Plan;
- Identify the different teaching-learning strategies in the organization of a lesson plan; and
- Mention the advantages of a lesson plan.

4.1.2. Introduction

Dear Student Teachers,

Teaching is the art and science of helping others to grow in their knowledge and understanding. For carrying out any activity it is important to know its purpose. If one knows clearly what is to be achieved, the planning will be done accordingly and the work will be carried out properly. You know that teaching is a social-emotional activity in which a teacher deals with real human beings that is- students. Hence proper planning definitely will help a teacher in achieving the predetermined objectives. One of the most important principles of teaching is the need for planning. Planning is a mental activity which could be having a specific time-bound, like, annual planning, monthly planning, unit plan, planning for unit test, half-yearly exam and annual exam, as well as planning for a daily lesson of 40 to 45 minutes. Planning is needed for laboratory work, field visits, project work, bridge courses and educational tours and excursions. Far from compromising spontaneity, planning provides a structure and context for teachers and students, as well as a framework for reflection and evaluation (Spencer 2003 p.25).

Spencer notes that there are four fundamental questions a teacher should ask themselves when planning a teaching session.

- To whom am I teaching? The number of learners and their study level or stage in learning.
- What am I teaching? The topic or subject, the type of expected learning.
- How will I teach? Teaching-learning methods, length of time available, location of the teaching session.
- How will I evaluate the student's understanding? Informal and formal assessments, questioning techniques, feedback from learners.

4.1.3. Learning Points and Learning Activities

4.1.3.1. Concept of Lesson Plan

Planning is the best antidote for the nerves that many people feel when **teaching** a subject for the first time or meeting a new group of students. It is also the only way to ensure that your educational objectives are achieved.

A lesson plan is a teacher's own guide to control the teaching-learning process under the conditions he finds himself in. Lesson plan differs from teacher to teacher but the teachers should be able to frame lesson plans which provoke productive thought and action among the students.

Points to be kept in mind for planning a lesson:
- Define your aims and learning outcomes or objectives.
- Think about the structure of the session and the timing of the activities.
- Decide on the best teaching and learning methods to achieve the learning outcome.
- The listing content and key topics, and research more if needed.
- Refine the lesson plan.

How to make a Teaching Plan
- Know the objective. At the beginning of every lesson, write thelesson plan goal at the top.
- Write the overview. Use broad strokes to outline the big ideas for the class.
- Plan the timeline.
- Get to know the students.
- Use multiple student interaction patterns.
- Address a variety of learning styles.

Check Your Progress - 1
1. Why is planning for teaching is essential?
2. Mention the important points to be followed while planning to teach.

4.1.3.2. Importance of Lesson Plan
Lesson planning is a significant element of the teaching-learning system. A lesson plan is a step-by-step guide that provides a structure for essential learning. It is important because it helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.

- Makes it a valuable teaching worth over time.
- To meet the instructional programme that is to meet the goals and direction of the course.
- Proper planning keeps the teacher organized and on track while teaching thus allowing them to teach more and manage less.
- It helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.
- Helps the teacher to teach with confidence.

Check Your Progress - 2
1. Why is Lesson Planning essential for a teacher?
2. Give the importance of a Lesson Planning.

4.1.3.3. Designing a Lesson Plan

Making an effective lesson plan takes time, diligence, and an understanding of the students' goals and abilities. The goal, as with all teaching, is to motivate the students to take in what you are teaching and to retain as much as possible. This will provide some ideas that will help you get the most out of your class.

Know your objective:

At the beginning of every lesson, write the main purpose of your teaching of that particular class. These are nothing but **Instructional Objectives.** It should be incredibly simple. For example:

Students will be able to

Identify different animal body structures that enable eating, breathing, moving, and thriving. It's what your students can do after you're done with them! If you want to do a bit extra, add *how* they might do this (through video, games, flashcards, etc.).

Plan your timeline:

If there's a lot to cover in a fixed amount of time, break your plan into sections that you can speed up or slow down to accommodate changes as they happen. We'll use a 1-hour class as an example.

Get to know your students:

Identify clearly who you are going to educate. What is their learning style (visual, auditory, tactile or a combination)? What might they already know, and where might they be deficient? Focus your plan to fit the overall group of students you have in class, and then make modifications as necessary to account for students with disabilities, those who are struggling or unmotivated, and those who are gifted.

- Odds are you'll be working with a pile of extroverts *and* introverts. Some students will benefit more from working alone while others will thrive in pair work or groups. Knowing this will help you format activities to different interaction preferences.

- You'll also wind up having a few students that know just about as much as you do on the topic (unfortunately!) and some that, while smart, look at you like you're speaking

Neptunian. If you know who these kids are, you'll know how to pair them up and divide them (to conquer!).

Use multiple student interaction patterns.

Some students do well on their own, others in pairs, and yet others in big groups. So long as you're letting them interact and build off each other, you're doing your job. But since each student is different, try to allow opportunities for all types of interactions. Your students (and the cohesion of the class) will be better for it!

Address a variety of learning styles:

You're bound to have some students that can't sit through a 25-minute video and others who can't be bothered to read a two-page excerpt from a book. Neither is dumber than the other, so do them a service by switching up your activities to utilize every student's abilities. Every student learns differently. Some need to see the information, some need to hear it, and others need to get their hands on it. If you've spent a great while talking, stop and let them talk about it. If they've been reading, come up with a hands-on activity to put their knowledge to use. They'll get less bored, too!

Creating a Good Lesson Plan Structure and Organization:

A lesson plan is a step by step guide that provides a structure for essential learning. A lesson is the instructors' road map of what students need to learn and how it will be done effectively during class time. A successful lesson plan addresses and integrates three key components- Learning Objectives, Learning Activities and Assessments to check for student understanding. A productive lesson is not in which everything goes as planned, but one in which both students and instructor learn from each other. A good lesson plan is simple yet powerful is based on behavioural research that characterizes well-structured lessons. Points to be remembered for frame a lesson plan are:

- Start lessons by reviewing prerequisite learning. This can include a type of formative assessment.
- Provide a short statement of goals.
- Present new material in small steps, with student practice after each step. Simple student exercises after the presentation are formative assessments used to determine student level of mastery and to show how a teacher will modify instruction if needed.
- Give clear and detailed instructions and explanations.
- Provide a high level of active practice for all students.
- Ask a large number of questions, check for understanding, and obtain responses from all students. Thus using formative assessments to determine student mastery. Grading student responses are not necessary as this step is used to assist the teacher just as much as to assist the student.
- Guide students during initial practice.
- Provide systematic feedback and corrections. This phase requires that the teacher provide detailed information to the student. Simply telling the student the answer is incorrect is not enough.

Steps Followed in the Lesson Plan

- **Introduction:** The introduction of a new topic of Biology depends upon the assumption of linking the previous knowledge with the new knowledge which is to be imported. An introduction serves as a bridge between what students knew and what they are going to learn. The introduction topic should be brief and touch point. A few questions should be put on previous knowledge. If there is a new topic it can be introduced with the help of storytelling, events, pictorials, small discussions, etc. It depends on the lesson.

- **Statement of Aim:** After the introduction teacher must state the topic which is going to be taught. It must be stated soon after the introduction in clear and specific terms and reveal the importance of the lesson. The topic can be stated in question form or statement form.

- **Development of Lesson:** It is the most important and critical stage in suitable lesson planning. It values the creation of the teaching-learning process. The new knowledge is imported by the students in this stage while presenting the matter. The teacher explains, narrates, gives examples, illustrations shows pictures, and explains with maps, sketches, models and other sources.

- **Recapitulation:** Recapitulation means asking the pupils to reproduce what they have learnt. It is nothing but feedback. This can be done by putting one or two recapitulation questions and the teacher can clarify the doubts of students. This is a valuable exercise that makes the students more efficient in the subject matter.

- **Evaluation and Home assignment:** After the lesson, the teacher can give a small test or ask questions to evaluate the way he organizes and presents the subject matter to the class but this does not essentially make a part of the lesson plan. The home task should be assigned as essay type questions, objective type, activity-based or short answer type questions. Assignments must be corrected and evaluated by the teacher the very next day. It makes the student academically active even at home.

A Model Lesson Plan

Name of the Student-Teacher: Class: IX   Practicing School: Govt. High School

Unit/Topic: Ecosystem

Instructional Objectives

Students will be able to

- Recall the characters of our environment
- Define ecosystem
- Recognize different types of ecosystem
- List the uses of decomposers in the ecosystem.
- Classify the Bio-degradable and non-degradable substances.

Teaching Aids: Charts, Various activities using natural items
Reference: Books of X STD Part-I Science Textbook

Content	Facilitators Activity	Pupils Activity	Evaluation
1. Introduction: The chart is shown and the topic is explored	The facilitator presents a chart before the students and asks a few questions- Students, please do observe the chart carefully.	Observes	
	What do you see in this picture?	Fish, duck, Birds	
	What else can you see? How Can we classify it as?		
	List the non-living components in this chart?	Algae, Sunlight, water, trees Living &Non-living Sunlight, water, soil, air	
	List out the living components.		
	Very good	Fish, Birds, Algae, Animals	
	What is living and nonliving components present in the environment called as?	Ecosystem	
	Very good It is the Ecosystem		

2. Statement of Aim: So in today's class let us learn about the ecosystem and its components.

Explanation: All the living & Non-living components present in our environment is called an ecosystem.	The facilitator explains the definition by writing it on the board.	Students listen and note the points in their book	Define ecosystem
Types of Ecosystem There are mainly two types of ecosystems.	The teacher explains the concept of types of the ecosystem by using a chart and also by conducting an activity	Students observe the chart carefully and answer the questions	What are the types of the ecosystem?

1. Natural ecosystem 2. Man-made or artificial ecosystem. 1. Natural ecosystem is a community of living and non-living organisms where each component interacts together. Eg: Soil, Plants, air, and sunlight.	The teacher shows the natural items present in the ecosystem.	Students understand the concept.	What is the natural ecosystem? Give an example
2.Artificial ecosystems are the ecosystem that is created by man. Eg: crop field, Aquarium etc.	The teacher asks the students to construct an artificial ecosystem by using the chart	Students select the man-made items to construct an artificial ecosystem.	What is an artificial ecosystem? Give an example
Components of Ecosystem Abiotic components include sunlight, air, water etc.	The teacher shows the chart of components of the ecosystem and explains the concept.	Students list all the Abiotic components	What are the components of the ecosystem
Biotic components are divided into producers, consumers and decomposers Consumers can be further classified as herbivorous, carnivores and Omnivores.	Components of ecosystem Biotic Abiotic i. Producer a. Air ii. Consumer b. water iii. Decomposer c. Sunlight	Students try to classify the consumers	How are the consumers further classified?

Concluding Statement: In today's class, we have learnt about the ecosystem and its various components.

Recapitulation: The microorganisms are the decomposers as they break-down	The facilitator explains the concept or role of micro-organisms in the decomposition of	Students understand the concept of decomposition by using micro-organisms.	

the complex organic substance into simple organic substances. What will happen to the garbage and dead animals and plants in their absence?	substances. Conducts an activity to explain the concept of biodegradable and non-biodegradable substances. The teacher asks the students to separate the degradable and non-degradable substances.	Students separate degradable and non - degradable substances. They understand that wastes should be put in separate bins.	

Evaluation

The teacher conducts the Passing the Ball game and asks Questions:

 ➢ Define an ecosystem
 ➢ Name the different types of ecosystems.
 ➢ Give an example of an artificial ecosystem
 ➢ Name any two components of an ecosystem.
 ➢ List the biotic and Abiotic components.
 ➢ What is the role of bacteria in decomposition?
 ➢ Explain with an example the biodegradable and non-biodegradable substances.

Check Your Progress - 3
 1. What are the points to be noted for planning a Lesson?
 2. Why is planning important?
 3. In brief, write the structure of a good lesson plan.

4.1.4. Let us Summarise
 One of the most important principles of teaching is the need for planning. Far from compromising spontaneity, planning provides a structure and context for teachers and students, as well as a framework for reflection and evaluation. Planning is the best antidote for the nerves that many people feel when teaching a subject for the first time or meeting a new group of students. It is also the only way to ensure that your educational objectives are achieved.

Points to be kept in mind for planning a lesson:
 ➢ Define your aims and learning outcomes or objectives.
 ➢ Think about the structure of the session and the timing of the activities.
 ➢ Decide on the best teaching and learning methods to achieve the learning outcome.
 ➢ List content and key topics, and research more if needed.
 ➢ Refine the lesson plan.

A lesson plan is a step by step guide that provides a structure for essential learning. A lesson is the instructors' road map of what students need to learn and how it will be done effectively during class time. A successful lesson plan addresses and integrates three key components- Learning Objectives, Learning Activities and Assessments to check for student understanding. A productive lesson is not in which everything goes as planned, but one in which both students and instructor learn from each other. .A good lesson plan is simple yet powerful is based on behavioural research that characterizes well-structured lessons.

4.1.5. Answer to 'Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. A lesson plan is a teacher's own guide to control the teaching-learning process, it is also the only way to ensure that the educational objectives are achieved.
2. Know the objective. At the beginning of every lesson, write the lesson plan goal at the top.
   - Write the overview.
   - Plan the timeline.
   - Get to know the students. ...
   - Use multiple student interaction patterns.
   - Address a variety of learning styles.

Check Your Progress - 2
1. Lesson planning is a significant element of the teaching-learning system. A lesson plan is a step-by-step guide that provides a structure for essential learning. ... It is important because it helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.

2. Makes it a valuable teaching worth over time.
   To meet the instructional programmethat is to meet the goals and direction of the course.
   Proper planning keeps the teacher organized and on track while teaching, thus allowing to teach more and manage less.
   It helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.
   Helps the teacher to teach with confidence.

Check Your Progress - 3
1. The points to be noted while framing a lesson plan are:
   - Start lessons by reviewing prerequisite learning.
   - Provide a short statement of goals.
   - Present new material in small steps.
   - Give clear and detailed instructions and explanations.
   - Provide a high level of active practice for all students.
   - Guide students during initial practice.
   - Provide systematic feedback and corrections.

2. One of the most important principles of teaching is the need for planning. Far from compromising spontaneity, planning provides a structure and context for teacher and students, as well as a framework for reflection and evaluation. Planning is the best antidote for the nerves that many people feel when teaching a subject for the first time or meeting a new group of students. It is also the only way to ensure that your educational objectives are achieved.

4.1.6. Unit end Exercises
1. Why is planning important?
2. What is the concept of planning?
3. Write the steps involved in creating a structured Lesson Plan.

4.1.7. References
1. www.jsor.org/stable/4449372, www.bdu.ac.in/cdc/docs/ebook.
2. Pedagogy of School subjects-Biology -Dr. Malini-Vismaya Prakashana
3. Dr. Vijayalatha R.R., Dr. D. Sumitha- Pedagogy of Biological Sciences(2019)-Neelkamal Publications.
4. Chikara & Sharma Teaching of Biology- Tandon Publications Ludhiana

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 2 : Planning for Exposure to Various Learning Resources through Projects (Both Inside and Outside the School)

Unit Structure

4.2.1. Learning Objectives

After completing this Unit, the student teachers will be able to,

- Identify the learning resources;
- Analyze the nature of the project method;
- Recall the approaches to the project method;
- Explain the steps followed in the Project method; and
- Illustrated the project method with examples from biology subjects.

4.2.2. Introduction

Dear Student Teachers,

The pluralistic and diverse nature of Indian society makes a strong case for preparing not only a variety of textbooks but also other materials that children can use, enjoy and learn. Teachers with her experience and planning may use many learning materials, Community Resources and laboratories for designing effective learning experiences in the transaction of concepts applying various approaches and strategies. You may find a variety of methodologies for teaching the biological subject, in which project method is one among them.

According to J.A. Stevenson, "A project is a problematic act carried to completion in its natural setting." Students feel a sense of ownership of their learning when it is related to their own experiences. Moreover, a simulated environment of learning biological science demands many resources of learning. All these materials may not be available in the school. In such a situation the teacher may have to fall back upon resources available outside the school or in the community.

Many community resources can be used for facilitating the learners in the construction of knowledge of biological science and to find the relevance and meaningfulness of this knowledge in the context of the world beyond the four walls of the classroom. Community resources can be physical or human. These resources can be utilized in two ways - either community can be brought to the class or class can be taken to the community. Teachers, students, administrators and the community can collaboratively work to utilize various community resources. Integrating classroom learning with learners' own experiences outside the classroom contextualize their learning. This promotes learners' creativity, participation and interest in the biological science classroom, which helps them to shift away from the rote memorization and have a feel of science.

Limited resources and geographical factors should not be a barrier to meaningful learning. Their expertise can be utilized for the enrichment of teaching-learning experiences. For this, the teacher would need to have information and an idea of the available resources, and the person who is to be contacted. Teachers can take the help of students also to identify the local resources. Using community resources has added advantage of strengthening linkages between the schools and the community. The teachers' ability to plan learners' experiences in a manner that permits imaginative use of such resources directly affects the quality of education schools.

Usually, children of this age hesitate or feel shy while giving an oral presentation of their project reports. Science teacher can provide extensive practice in oral presentations.The teacher can set aside time at the beginning or end of periods for oral presentations. Students should always be ready to answer questions asked by teachers and other members of the class.By facing their audience, students can develop self-confidence and communication skills. The teacher should also encourage students to use as many visual materials as possible while presenting orally. Visual materials give a sense of confidence to the speaker and also hold the attention of the class.

4.2.3. Learning Points and Learning Activities

4.2.3.1. Project and Types of Project Method
A project method is a planned and formulated piece of study involving a Pedagogy of Biological Science. Projects are organized or planned activities in which students are allowed to investigate or research on their own. The problem is taken up by the learner either individually or in a group, to supplement and apply classroom and laboratory learning. It follows the approach of **Learning by Doing** and **Learning by Living**. Project work attempts to promote problem solving, creativity and a spirit of inquiry in science. Project work is a more or less open-ended activity and its type depends on the nature of the task.

Students may choose a project depending on their abilities, enthusiasm and interests. However, the complexity of the project, availability of the material resources, and time available to finish the project shall always influence the selection of a task. Situations that can raise suitable questions amongst the students are identified. Such situations may be arrived at through libraries, laboratories, magazines, discussions, field trips, print and electronic media, internet, science journals, etc. The working on a chosen project must first include the tentative objectives that might be attained.

The execution of the task must be properly planned. It is advised that the project team keeps a complete record of work including the choice of project, planning, discussions held, distribution of work assigned to different team members, references and books consulted observations, difficulties faced, guidance sought. According to Kilpatrick, "A project is a wholehearted purposeful activity proceeding in a social environment".

Types of Project method
1. **Constructive:** when students have to construct something related to social life. For example, the construction of charts, maps, models, etc. that could help in teaching-learning sessions of a classroom. Working model of heart, 3D model of DNA and Human Kidney are constructed either by individual or group project work.
2. **Artistic:** these projects are generally allotted in the aesthetic field of life. For example Music, drawing, painting, art and culture. In the subject of biology, there is plenty of opportunities to develop the artistic quality among students, like, pot culture, planting indoor plants and decorative plants.
3. **Problem Solving:** these projects are given to solve problems related to any life situation or related to any subjects. For example, how to preserve food grains and vegetables for a longer time, how to prepare the food without losing its nutritional value and recycling of wastes and debris.
4. **Group work:** a team of students is assigned with some work to be performed. For example, beautifying the school campus, or developing a school garden.

Check Your Progress - 1
1. Define the project method.
2. List out the types of project methods.

4.2.3.2. Approaches adopted and steps followed in Project work
- building apparatus/model
- performing experiments
- carrying out a survey
- observing nature
- using and interpreting available data
- doing fieldwork
- engagement in exploration
- Generation of information, etc.

Steps generally involved in a project work
1. **Providing situation:** Here the teacher should provide a situation that confronts students with some problem which the students feel responsible to solve.
2. **Selection of the project:** The teacher should work as a latent force to channelize the interest of the students but after all students should have the feeling that the project is of their own choice and it is not imposed on them by the teacher.
3. **Planning:** This is an important step as the success of the project is largely determined by planning. In this students are assigned duties, sources of material are listed, the procedure is visualized in detail, place time and duration etc. are decided.

4. **Execution:** The project now comes in its process and practical form. The students work according to the duties allotted. The teacher acts as a guide and co-worker and sees that the project runs smoothly and is completed within the time.
5. **Evaluation:** Students review the project, find out mistakes committed and correct wherever necessary. Self-criticism should not be avoided. If some phenomenon is setup, students can take down reading and where material products, they can evaluate the quality and quantity. The teacher here sees that the objectives of the projects have been achieved.
6. **Recording:** Preferably recording of the projects should be simultaneous but wherever it is not possible it should be done just after the completion of the project. Date regarding the choice of the project, discussions held, planning and duties assigned, execution and the entire procedure, material production or readings taken and mistakes reviewed should be recorded in detail.

Advantages and disadvantages of the Project method

Advantages:
- It helps in developing social norms and social values among the learners.
- It provides innumerable opportunities for the correlation of various elements of the subject matter and transfer of training or learning.
- It helps in growing knowledge very effectively as a result of their close co-operation on social participation in the spirit of democracy.
- It helps to solve the problems of individual differences since each student can carry out their work at his or her own pace.
- The emphasis on the project is "doing" so students are allowed to develop their initiative.
- Motivation to work is usually very high since it is based on students' interests particularly for students with special talents.
- Group projects afford opportunities for developing leadership qualities.
- The project helps students to have an in-depth study of the topic under investigation.
- This method is interesting and joyful for the learner.
- It proceeds from the concrete to abstract and learning by doing method.
- Students feel a sense of responsibility for finishing their assignments by the due dateso they become self-reliant.
- It develops interaction between teacher and pupil.
- There is freedom of work, the teacher is here a friend and a guide.
- It develops the scientific attitude and training in the scientific method.

Disadvantages
- The project cannot be planned for all subjects and the whole subject matter cannot be taught by this strategy.
- It is not economical from the point of time and cost.
- It is very difficult for a teacher to plan or execute the projects for the learner and supervise them.
- The project method is time-consuming since it will surely be more than a day.

- Project methods are most beneficial to students who have the potential for independent work.
- It is also very difficult to ascertain the extent to which a particular student has gone with the work since they may invite other people to do the work for them.
- It is difficult to get a topic that will interest all the students.

Check Your Progress - 2
1. Mention the different approaches in the Project method.
2. What are the different steps involved in a project method?
3. Write any four advantages and disadvantages of a project method.

Activity 11.12 Give an example of each of the above approach of taking up a project using a textbook at the upper primary/secondary/higher secondary stage

4.2.3.3. A general format for writing the project report
- Title of the project reflecting objectives
- Principles used for investigation
- Apparatus and materials required.
- Improvisation, if any
- Procedure
- Observations and calculations
- Conclusion
- Precautions
- Result and discussion
- Suggestions for further investigations
- References

To illustrate the format outlined above, sample project reports are presented for upper primary, secondary and higher secondary stages.

Example: A Project at Secondary Stage

Objective: To identify biodegradable and non-biodegradable materials (wastes) in the environment.

Theory:
It is important to recognize that the terms like biodegradable and non-biodegradable materials referred herein pertain to 'wastes' produced by human activities. These 'wastes' if not disposed of efficiently will cause excessive accumulation and pollute water, land and soil. The wastes range from human and farm excreta, industrial sewage, pesticides and herbicides, empty cans, bottles and jars, metal and plastic cups, polythene bags and jars, paper, discarded machinery parts, etc. Wastes also accumulate in the form of refuse from kitchen and vegetable markets, gardens, agricultural and farmlands, etc. The list is very long, but for the sake of convenience and from an ecosystem point of view, wastes are categorized into biodegradable and non-biodegradable. In an ecosystem apart from producers and consumers, there is another group

of heterotrophic organisms collectively referred to as decomposers that consist chiefly of bacteria and fungi which degrade and digest dead plants and animal material. All such materials which are degraded and decomposed by decomposers are called biodegradable wastes. Such wastes are easily manageable by a natural process or in waste treatment plants and can be turned into useful resources (for example, biogas plants, etc.). A large variety of waste materials produced by man and industry, either, do not degrade (polythene, plastic, glass etc.) or degrade very slowly only by decomposers (for example, DDT). Such wastes are called non-biodegradable materials. Their constant accumulation especially in highly populated urban areas is proving to be a great health hazard and the biggest obstacle for clean living.

Materials required:

   Sample of waste materials available in the garden, kitchen market, cowshed, etc. A spring balance, a pair of hand gloves, two plastic bags (10" x 6") and nylon thread.

Procedure:

1. Collect a handful of following samples from your nearby surroundings. Use a pair of gloves while handling the samples to prevent injury or infection. The samples could be vegetable matter, animal and fish remnants, bamboo pieces, cardboard pieces, straw, paper, leaves, pieces of glass, cow dung, pieces of cloth, food leftovers, twigs, bark, thermoplastic wastes, fruit peelings, pieces of plastic plates, rubber and plastic tubing, small pieces of a ceramic pot, DDT powder, etc. Sort out small samples (5g each) of waste from plant and animal sources (for example, vegetable matter, leaves, twigs, cardboard pieces, paper, cow dung, etc.).

2. Likewise sort out small samples (5g each) of waste materials from other than plant and animal sources (for example, plastic caps, pieces of plastic tubes, polythene, glass, metal can, ceramic pieces, etc.).

3. With the help of a sharp knife, cut all the samples into very small fragments and mix them thoroughly into separate heaps 'A' (of samples in step 2) and 'B' (of samples in step 3).

4. Mark the polythene bags 'A' and 'B' with waterproof ink.

5. With the help of a nail, pierce several small holes in each polythene bag. Fill the two samples 'A' and 'B' in their respective bags marked 'A' and 'B'. Tie their mouths firmly with nylon thread.

6. Using a spring balance, weigh each bag separately and note their initial weight.

7. Now bury the two sample bags in a shallow pit of appropriate size dug out in the corner of a garden. Fill the pit with soil.

8. After three or four weeks, remove the bags intact from the pit, clean them thoroughly to remove any soil from the surface of the bags (don't use water for cleaning).

9. Dry the bags in open sunlight.

10. Weigh the two bags again and find the difference between their initial and final weight.

Recording:
Weights of the Samples -Initial weight, Final weight, Loss of weight Sample A Sample B 12.

Open the bags and transfer the contents separately on two sheets of paper and observe the physical changes in the samples that have occurred during the period of their burial in the pit.

Observations:
At the end of the study determine
1. Which sample has a substantial loss of weight?
2. Can various components in bags containing samples 'A' and 'B' be easily identified?
3. Has the color and texture of the components of samples 'A' and 'B' changed?

Discussion:
Sample 'A' contained waste materials of plant and animal origin. When buried they were subjected to decomposition by soil microorganisms. The complex organic matter was decomposed to simpler compounds some of which leaked out through the pores into the soil. Some material was partially decomposed (like twigs, bark, petioles and veins) while the soft tissues of leaves and dead animals were completely decomposed. It is because of this reason that a substantial loss of weight had occurred in sample 'A.'

The weight of the sample 'B' remains unchanged because no component in the sample could be decomposed by the microorganisms.

Conclusion: It is concluded that all the different types of material in bag 'A' were biodegradable while in bag 'B' the samples were non-biodegradable.

It may be noted that sample reports given above serve merely as guidelines while writing the projects. By no means, it is exhaustive and is open to further improvements. Recognition of the projects after completing the project, usually students want a few words of praise from the teacher. Recognition means enhanced status in the eyes of classmates, parents, other teachers and society.

The report of this project can be displayed in the class using a chart. Projects which are of general interest can be displayed during a school assembly where parents can also be invited. Sometimes radio and television reporters visit schools to record the activities of the students.

They also invite students to bring their projects to the stations for interviews. Superior or outstanding or innovative projects should get a chance to enter regional, state and national competitions, where they talk to experts who point out the strengths and weaknesses of their work. Students should be encouraged to publish the write-up of their project in the school newspaper/newsletter/journal.

Assessing the project work:
Each project should be evaluated on its own merits and not in competition with other projects. The ability, interest and background of the student should be given full consideration

while evaluating the project. The teacher should write comments and suggestions about each project while evaluating it. It encourages students to further improve the quality of their projects. So the project-based learning approach creates a "constructivist" learning environment in which students construct their knowledge. Whereas in the "old school" model the

The teacher was the taskmaster, and in the "new school" model the teacher becomes the facilitator

Check Your Progress - 3
List out some examples of project topics in Biological science.

4.2.4. Let us Summarise
According to J.A. Stevenson, "A project is a problematic act carried to completion in its natural setting."Students feel a sense of ownership of their learning when it is related to their own experiences. Moreover, a stimulated environment of learning biological science demands many resources of learning. All these materials may not be available in the school. In such a situation the teacher may have to fall back upon resources available outside the school or in the community.

- Projects are organized or planned activities in which students are allowed to investigate or research on their own. The problem is taken up by the learner either individually or in a group, to supplement and apply classroom and laboratory learning.

- Types of Project method are:
  Constructive
  Artistic
  Problem-solving
  Group work

- Approaches of Project method:
  Building apparatus/model;
  Performing experiments;
  Carrying out the survey;
  Observing nature;
  Using and interpreting available data;
  Doing fieldwork
  Engagement in exploration;
  Generation of information, etc.

- Steps in Project method:
  Providing a situation
  Selection of the project
  Planning
  Execution
  Evaluation
  Recording.

- Advantages and Disadvantages of the project method.

- General format for writing the project report.

4.2.5. Answer to 'Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. According to J.A. Stevenson, "A project is a problematic act carried to completion in its natural setting."A project method is a planned and formulated piece of study involving a Pedagogy of Biological Science.

2. Types of Project method are:
   Constructive
   Artistic
   Problem-solving
   Group work

Check Your Progress - 2
1. The different approaches in the Project method are
   Building apparatus/model;
   Performing experiments;
   Carrying out the survey;
   Observing nature;
   Using and interpreting available data;
   Doing fieldwork
   Engagement in exploration;
   Generation of information, etc.

2. The different steps involved in a project method are:
   Providing a situation
   Selection of the project
   Planning
   Execution
   Evaluation
   Recording.

3. Any four advantages and disadvantages of a project method.

Advantages:
- It helps in developing social norms and social values among the learners.
- It provides invaluable opportunities for the correlation of various elements of the subject matter and for transfer of training or learning.
- It helps in growing knowledge very effectively as a result of their close co-operation on social participation in the spirit of democracy.
- It helps to solve the problems of individual differences since each student can carry out their work at his or her own pace.

Disadvantages:
- The project cannot be planned for all subjects and the whole subject matter cannot be taught by a strategy.
- It is not economical from the point of time and cost.
- It is very difficult for a teacher to plan or execute the projects for the learner and supervise them.
- The project method is time-consuming since it will surely be more than a day.

Check Your Progress - 3
Some examples of project topic in Biological science are:
        Setting up an aquarium
        Planting School garden
        Studying the ecology of a pond
        Collection and preservation of insects.

4.2.6. Unit end Exercises
1. Explain different types of project work
2. What are the approaches adopted in taking up a project?
3. Describe the steps involved in a project method.
4. Explain a general format for writing the project report
5. Explain with an example for Biology project work
6. State the advantages and disadvantages of the project method.

4.2.7. References
2. www.fsmilitary.org/pdf/Project_Based_Learning.pdf1.
3. Pedagogy of School subjects-Biology -Dr.Malini-VismayaPrakashana
4. Dr. Vijayalatha R.R., Dr. D. Sumitha- Pedagogy of Biological Sciences(2019)-Neelkamal Publications.
5. Chikara & Sharma Teaching of Biology- Tandon Publications Ludhiana

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 3 : Learners Record in Biological Sciences

Unit Structure

4.3.1. Learning Objectives

After completing this Unit, the student teachers will be able to,

- Explain the need for a biology laboratory;
- List the requirements for a biological science laboratory;
- Design biological science laboratory;
- Recognize the importance of field visits and project work;
- Write a report of field visit and project work; and
- Find loopholes and overcome the error in Portfolio.

4.3.2. Introduction

Dear Student Teachers,

The practices of inquiry, data gathering and selection, observation, summary, analysis and evaluation used in learners record, cultivate habits of mind that are central to all disciplines. The recording allows students to reflect on their development as readers, writers and thinkers in the discipline as they enter the class, also engages students in first-hand research on a subject of great personal interest to them where they practice interviewing skills and strategies of gathering field notes and making a summary, interpretations which become part of the record. The observational records though brief, help students learn about and reflect on the relationship between direct perception and interpretation or evaluation. Because these observations must present positive, rather than negative representations of activity, students are confronted with the powerful role of language in shaping perceptions of reality.

4.3.3. Learning Points and Learning Activities

4.3.3.1. Designs and Requirements of a Biological Science Laboratory

For teaching biological sciences effectively and efficiently, a laboratory with the necessary equipment and material is essential. For developing application abilities, skills of

experimentation, construction, improvisation and scientific attitude, interests and power of appreciation laboratory work are essential.

At the planning stage following are the factors to be taken into consideration:
   a. Number of students working at a time.
   b. Minimum space required for each student for comfortable working.
   c. Number of biological science teachers available in the school.
   d. Space required for ancillary accommodation, storage and repairs.
   e. Amount of money required for setting up the laboratory.

Design and requirements of Biological science laboratory for school purposes.
   1. **Workspace:** workspace in which students are to work, a good source of light, water supply and flexible arrangements of tables and chairs. Electric supply, gas supply, a demonstration table with all supplies.

   2. **Aspect:** Consideration should be given to the amount of light reaching various areas. One long wall of the laboratory facing north gives suitable conditions for aquaria and working with microscopes. The opposite south-facing wall is suitable for plant growth and setting up a greenhouse or warden screen. The aspect of biological sciences laboratory depends upon the geographical position and climate of the school location.

   3. **Ancillary Accommodation:** The preparation room, has access from both inside and outside of the laboratory. An animal room, not communicating with the laboratory is useful for keeping small mammals, insects breeding cages and cultures, space for setting up an aquarium, display some illustrative material and for keeping chemical reagents and stains, the greenhouse is essential for growing plants.

   4. **Safety:**
       * Chemical fire extinguisher should be provided in the laboratory.
       * Laboratory should have more than one exits.
       * Electric supplies should be of low voltage and fitting to the tables away from the water source.
       * Poisonous, highly inflammable liquids should be labeled.
       * The first aid kit should be readily available.

   5. **Furniture and Fittings:** Modern laboratories have fixed working tables, fitted with gas and electric supplies and provided with sinks at each working station. Moveable chairs or stools etc. occupy the rest of the room and can be used according to the need. As some time is devoted to working with microscopes, the tables in biological science laboratories are generally lower than those in other laboratories. However, the main consideration is that the height of the table and chairs correspond so that there is leg and knee room.

       Individual work stations should have water, gas and electric supplies. There should be a sink with a high swan neck tap, for working purposes. Adequate cupboards and display cases, some lockable should be provided in laboratory and preparation rooms.

The Bulletin board should be fitted and shaded from direct light. A demonstration table is generally recommended at the front of the room.

6. **Lighting:** The laboratory should be well lit as special lighting is needed for microscopes and the growing of plants.

7. **Blackout:** a good blackout arrangement is necessary if work is done with projected materials. In Hot climates, an extractor or exhaust fan will be needed as any form of blackout reduces ventilation in the laboratory.

8. **Flooring:** Acids-proof plastics either as tiles or self-hardening liquid can be used. In warm climates, cement or concrete is cheap and easy to maintain. The floor should properly be fitted with water supply, water disposable pipes or channels.

9. **Wastes:** The end products of dissections, micro-organism cultures and other wastes become both unpleasant and health hazards and should be disposed off as soon as possible. Bacterial cultures must be sterilized before disposal.

General Requirements for Biological Science Laboratory and their use:
- The type of apparatus needed for experiments and demonstrations.
- The quality and quantity of the apparatus, considering the number of students working at a time.
- The quality of consumable material needed, taking into consideration the time devoted to laboratory work.
- Finance at the disposal of the teacher.
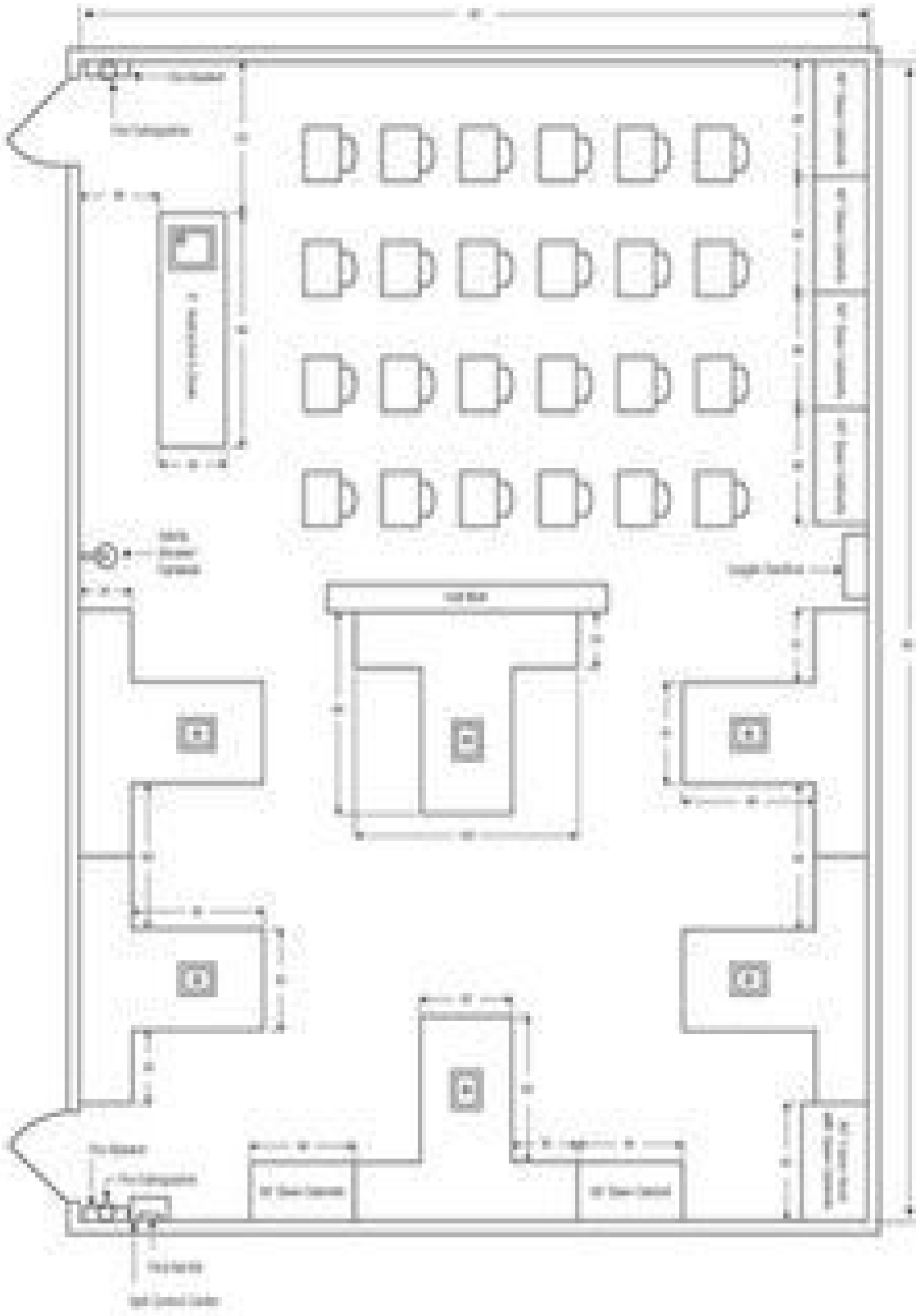
General Plan for Biological Science Laboratory

Check Your Progress - 1
1. What are the factors to be considered while planning a biological laboratory?
2. Write the requirements of the biological laboratory.
3. What are the safety measures to be considered while designing a biological laboratory?

4.3.3.2. Report writing of Project work, Excursion and Field visits

Project work is a planned and formulated piece of study involving a Pedagogy of Biological Science. Problem taken up by the learner either individually or in a group, to supplement and apply classroom and laboratory learning. It follows the approach of Learning by Doing and Learning by Living. Project work attempts to promote problem solving, creativity and a spirit of inquiry in science. Project work is a more or less open-ended activity and its type depends on the nature of the task.

A field trip or excursion is a journey by a group of people to a place away from their normal environment. When done for students it is also known as school trips. The purpose of the trip is usually observation for education, to provide students with experiences outside their everyday activities such as going camping with teachers and their peers. "Field trip means a biological excursion or a natural study trip", these are purposeful visits to places of scientific interest and provide valuable experience in the process of science learning.

Types of Field trip/Excursion
- Local school trips like factories, museums garden
- Community trips
- Tour or journey
- Imaginary tours (Motion pictures, slides, photographs)
- Inter-school visits.
- Individual trips

Importance of Field trips/Excursion
- It makes students more acquainted with new adventure process, products and their appreciation in society.
- It overcomes the boredom of classroom teaching and makes the students feel a free environment to learn themselves.
- It widens the knowledge about subject-related and other fields of knowledge.
- It develops a scientific attitude among the students.
- It develops observations and manipulation skills.
- It develops sociability and co-operation both among teachers and students.
- It develops a spirit of investigation by visiting the new scientific important places.
- It gives direct and first-hand experience to the students, eg. Farm, poultry, sericulture, fishery, nursery etc.
- It correlates school life with the outside world and community.
- They create a situation that helps to develop a spirit of scientific enquiry.
- It cultivates the power of critical thinking.

Organization of Field Trips/Excursion

- **Planning:** The visit or field trips should be prepared in advance with the active cooperation of both teacher and pupil with the light of purpose.

- **Preparation:** After planning the students should be prepared for the trip- they should know the purpose of the visit. The things they should look for, the type of information the students should gather.

- **Execution:** During the visit, the teacher should act as a supervisor. The success of the visit depends upon good planning and preparation and it depends upon the direction teacher.

- **Follow up:** Every visit should provide a basis for some activity as follow-up work. The pupil should exchange their experience through discussion, opinions, questioning, and explanation. Writing of an essay, talk on the visit, general discussion, making models and writing report.

Field trip/Excursion/project reports should include a compelling introduction, a well-structured body and a strong conclusion.

A general format for writing the project Work / Field trip / Excursion Report
- Objectives
- Principles used for investigation
- Apparatus and materials required.
- Procedure
- Observations and calculations
- Conclusion
- Suggestions for further investigations

What makes a good report?
Two of the reasons why reports are used as forms of written assessment are
- To find out what you have learned from your reading or experience.
- To give you an experience of an important skill that is widely used in the workplace.

An effective report presents and analysis fact and evidence that are relevant to the specific topic or issues of the report in brief. All sources used should be acknowledged and referenced throughout per the department requirements. The style of writing in a report is usually less discursive than in an essay, with the more direct and economic use of language. A well-written report will demonstrate your ability to:
- Understand the purpose of the report and adhere to its specification.
- Gather, evaluate and analyze relevant information.
- Structure material in a logical and coherent order.
- Consistently present your report according to the instruction of the report in brief.
- Make the appropriate conclusion that is supported by the evidence and analysis of the report.
- Make thoughtful and practical recommendations where required.

Check Your Progress - 2
1. Name the different types of field trips / Excursions.
2. Mention the importance of Field trips / Excursions.
3. What makes a good report?

4.3.3.3. Oral Presentation of Learners work in Biology and Portfolio

An oral presentation is generally a speech or vocal performance, occasionally accompanied by visually based presentations such as slide shows. It is where you show your knowledge on a particular subject. An oral presentation will consist of a talk of up to 25 minutes followed by a 30 minute oral question period by the faculty committee. Your talk should not be used to repeat the exact order and content of your submitted synopsis. Instead, pursue some aspects of your topic in greater depth than is allowed by the synopsis alone.

The presentation should follow a structured format but should be presented without reading a prepared script verbatim. At least one hour before you make your presentation, submit your presentation file on the model for use by the faculty committee as part of its evaluation.

During the question period, committee members may ask questions on a variety of topics related to either your paper or your oral presentation. In preparing for the questions, be sure to pay particular attention to the key references you choose in your bibliography. You should be able to defend your choices of each key reference within the context of the question, as well as demonstrate an understanding of details such as experimental methods, figures and tables etc. You should bring a copy of each of your key references, and you are free to refer to these during the question period. If you are well prepared and interested in the subject, the discussion should be stimulating and even enjoyable to all.

Importance of the Oral Presentation
- The study of presentation techniques is a chance for the students to gain insight into knowledge and skills that make a good teacher.
- The mastery of the subject topic and the goodwill to interact with others will allow them to enjoy sharing their knowledge in a constructive way both for their audience and themselves with structured planning and organization.
- It helps in gathering, analyzing and distributing scientific & technical information efficiently and accurately.
- Teaching students to design effective presentations implies developing their insightful and well-trained thinking strategies that can produce clarity in communication.

A general format Portfolio

A portfolio is a tool that one uses throughout one's college career to assess one's mastery of the subject. Portfolios can be a physical collection of student work that includes, materials such as written assignments, journals, entries, completed tests, artwork, lab reports, physical projects and other material evidences of learning progress and academic accomplishment, including awards, honours, certifications, recommendations, written evaluation by teachers or peers and self-reflection written by students. Portfolios may also be digital archives, presentations, blogs or websites. Online portfolios are often called digital portfolios.

Uses of Portfolios in the Classroom
- Student portfolios are most effective when they are used to evaluate student learning progress and achievement.
- Portfolios can help teachers monitor and evaluate learning progress overtime.
- Portfolios help teachers determine whether students can apply what they have learned to new problems and difficult subject areas.
- Portfolios can encourage students to take more ownership and responsibility for the learning process.
- Portfolios can improve communication between teachers and parents.

Check Your Progress- 3
1. Write in brief the importance of Oral presentation.
2. Mention any four uses portfolio in classrooms.

4.3.4. Let us Summarise
The practices of inquiry, data gathering and selection, observation, summary, analysis and evaluation used in learners record, cultivate habits of mind that are central to all disciplines. The recording allows students to reflect on their development as readers, writers and thinkers in a discipline as they enter the class also engages students in first-hand research on a subject of great personal interest to them where they practice interviewing skills and strategies, gathering field notes and making a summary, interpretations which become part of the record. The observational records though brief, help students learn about and reflect on the relationship between direct perception and interpretation or evaluation.

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Project work is a planned and formulated piece of study involving a Pedagogy of Biological Science. Project work attempts to promote problem solving, creativity and a spirit of inquiry in science. Project work is a more or less open-ended activity and its type depends on the nature of the task.

A field trip or excursion is a journey by a group of people to a place away from their normal environment. When done for students it is also known as school trips

Importance of Field trips/Excursion
- It makes students more acquainted with new adventure process, products and their appreciation in society.
- It overcomes the boredom of classroom teaching and makes the students feel a free environment to learn themselves.
- It widens the knowledge about subject-related and other fields of knowledge.

A general format for writing the project Work/ Field trip/ Excursion Report
- Objectives
- Principles used for investigation
- Apparatus and materials required.
- Procedure
- Observations and calculations
- Conclusion
- Suggestions for further investigations

An oral presentation is generally a speech or vocal performance, occasionally accompanied by visually based presentations such as slide shows. It is where you show your knowledge on a particular subject.

Importance of the Oral Presentation
- The study of presentation techniques is a chance for the students to gain insight into knowledge and skills that make a good teacher.
- The mastery of the subject topic and the goodwill to interact with others will allow them to enjoy sharing their knowledge in a constructive way both for their audience and themselves with structured planning and organization.
- It helps in gathering, analyzing and distributing scientific & technical information efficiently and accurately.

A general format Portfolio
A portfolio is a tool that one uses throughout one's college career to assess one's mastery of the subject. Portfolios can be a physical collection of student work that includes, materials such as written assignments, journals, entries, completed tests, artwork, lab reports, physical projects and other material evidences of learning progress and academic accomplishment, including awards, honours, certifications, recommendations, written evaluation by teachers or peers and self-reflection written by students.

Uses of Portfolios in the Classroom
- Student portfolios are most effective when they are used to evaluate student learning progress and achievement.
- Portfolios can help teachers monitor and evaluate learning progress overtime.
- Portfolios help teachers determine whether students can apply what they have learned to new problems and difficult subject areas.

4.3.5. Answer to 'Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. At the planning stage following are the factors to be taken into consideration:
   a. Number of students working at a time.
   b. Minimum space required for each student for comfortable working.
   c. Number of biological science teachers available in the school.
   d. Space required for ancillary accommodation, storage and repairs.
   e. Amount of money required for setting up the laboratory.

2. Requirements for Biological Science Laboratory are:
   a. The type of apparatus needed for experiments and demonstrations.
   b. The quality and quantity of the apparatus, considering the number of students working at a time.
   c. The quality of consumable material needed, taking into consideration the time devoted to laboratory work.
   d. Finance at the disposal of the teacher.
   3. The safety measures to be considered while designing a biological laboratory are:-
      - Chemical fire extinguisher should be provided in the laboratory.
      - Laboratory should have more than one exit.
      - Electric supplies should be of low voltage and it's fitting to the tables away from the water source.
      - Poisonous, highly inflammable liquids should be labeled.
      - The first aid kit should be readily available.

Check Your Progress - 2

1. The types of Field trips/excursion are-
   - Local school trips like factories, museums garden
   - Community trips
   - Tour or journey
   - Imaginary tours(Motion pictures, slides, photographs)
   - Inter-school visits.
   - Individual trips

2. The importance of Field Trip/Excursion are-
   - It makes students more acquainted with new adventure process, products and their appreciation in society.
   - It overcomes the boredom of classroom teaching and makes the students feel a free environment to learn themselves.
   - It widens the knowledge about subject-related and other fields of knowledge.
   - It develops a scientific attitude among the students.
   - It develops observations and manipulation skills.
   - It develops sociability and co-operation both among teachers and students.

3. An effective report presents and analysis fact and evidence that are relevant to the specific topic or issues of the report in brief.

Check Your Progress - 3

1. Oral presentation is generally a speech or vocal performance, occasionally accompanied by visually based presentations such as slide shows.
   - The study of presentation techniques is a chance for the students to gain insight into knowledge and skills that make a good teacher.
   - The mastery of the subject topic and the goodwill to interact with others will allow them to enjoy sharing their knowledge in a constructive way both for their audience and themselves with structured planning and organization.

- It helps in gathering, analyzing and distributing scientific & technical information efficiently and accurately.

2. Uses of Portfolio in the Classroom-
   - Student portfolios are most effective when they are used to evaluate student learning progress and achievement.
   - Portfolios can help teachers monitor and evaluate learning progress overtime.
   - Portfolios help teachers determine whether students can apply what they have learned to new problems and difficult subject areas.

4.3.6. Unit end Exercises
1. Briefly write the requirements of a Biological science Laboratory
2. Give a general format for writing the Field Trip & Project work.
3. What are the uses of Oral Presentation in Biological Science?
4. What makes a good report?

4.3.7. References

1. www.ncbi.nm.nih.gov/pmc/articles,
2. https://www.teachthought.com › Teaching
3. Modern Methods of teaching Biology-Richa Bhatt-APH Publishing corporation

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 4 : Development of Test -Items (Open-ended and Structured) in Biological Sciences

Unit Structure
4.4.1.   Learning Objectives
4.4.2.   Introduction
4.4.3.   Learning Points and Learning Activities
4.4.3.1. Concept and   Development of open-ended Test- items
          Check Your Progress - 1
4.4.3.2. Concept and Forms of Structured Questions
          Check Your Progress - 2
4.4.3.3. Assessment and Evaluation in Biological Science Assessment
          Check Your Progress - 3
4.4.4.   Let us Summarise
4.4.5.   Answer to 'Check Your Progress - 1, 2 and 3'
4.4.6.   Unit end Exercises
4.4.7.   References

4.4.1. Learning Objectives
After completing this Unit, the student teachers will be able to,
- Define the concept of open-ended and structured test items;
- Will administer the test-items;
- Explain the need for assessment and evaluation; and
- Identify the types of evaluation.

4.4.2. Introduction
Dear Student Teachers,
        Developing and validating reliable test items is a long process involving the investigation of student's difficulties, designing questions that can reliably uncover these difficulties. Behind every exam that measures a student's understanding, skills and achievement of objectives, a rigorous test development process is used. There are no short cuts to creating tests that are valid, reliable and fair. And that is the process of test development. Test development is done to meet the needs of a special group of students and to revise the test items. An item is the basic unit of interaction on a test. What we often call a test question is more properly known as 'item'. Items can be written in various formats including multiple-choice, matching, true or false, short answers and essays.

4.4.3. Learning Points and Learning Activities

4.4.3.1. Concept and Development of open-ended Test- items
        Open-ended questions are defined as free-form survey questions that allow the respondent to answer in open text format such that they can answer based on their complete knowledge, feeling and understanding. This means that response to this question is not limited to a set of options.

An open-ended question is designed to encourage a full, meaningful answer using the subject's knowledge or feelings. Open-ended questions also tend to be more objective and less leading than close-ended questions. Open-ended questions allow the respondents to express their opinions in a free-flowing manner. These questions don't have a predetermined set of responses and the respondent is free to answer whatever he/she feels right. Qualitative questions fall under this category. Open-ended questions typically begin with words such as 'Why' and 'How' or phrases such as 'Tell me about'.

The beauty of the open-ended question is that they can never be one word or closed answers. They will be either in the form of lists, some sentences or something longer like speech or paragraph. For example:

- Describe the functions of the respiratory system in man.
- How do you deal with stress and anxiety?

Developing open-ended Questions

Regardless of the specific type of question or scale selected all questions must satisfy a core set of requirements as:

1. Explicitly state the respondents' task in simple language. The question should clearly state what respondents must do to adequately answer the question.
2. Use simple active sentences and common language.
3. Avoid bias. Biased or leading questions implicitly communicate your point of view as part of the question.
4. Avoid multiple informational requests in a single question. Each question should have a single-minded focus.
5. Avoid ambiguity- Ambiguous words are words that are open to multiple interpretations must be avoided.
6. Avoid assumptions. Well-written questions do not presume or assume a particular respondent's state of mind.
7. Justify request for personal information.
8. Provide a reasonable time frame for behavioral questions.

Importance of Open-ended questions

- Open-ended questions cut down on two types of response error; respondents are not likely to forget the answers they have to choose from if they are given the chance to respond freely, and open-ended questions simply do not allow respondents to disregard reading the questions and just "fill in".
- Critical thinking isn't the only skill that can be developed through the use of open-ended questions. Open-ended questions require more than one-word responses, and these students develop their language and vocabulary skills. Students also learn to think creatively and solve problems by themselves.
- No limits on the answer- As answer options for open-ended questions aren't provided, the respondent has the liberty to include details about feelings, attitudes and opinions that they usually wouldn't get to submit in close-ended questions.
- Medium for students to answer creatively- students may stun the teachers with the vision and creativity in their answers.
- Expect unexpected answers from the students.

Check Your Progress - 1
1. What is an open-ended question?
2. What is the importance of Open-ended questions?

4.4.3.2 Concept and Forms of Structured Questions

A **closed-ended question** refers to any **question** for which a teacher provides the students with options from which to choose a response. **Closed-ended questions** are sometimes phrased as a statement that requires a response. Structured questions are questions that can be answered only in a specific way, such as true, or false; yes, no, or don't know; not good, good, fair, or very good, etc. structured questions are the questions that consist of a set of standardized questions with a fixed scheme, which specifies the exact wording and order of the question for gathering information from the students. For example;   Is Carbon dioxide released during photosynthesis.   Here the student can either answer by saying yes or No. there is no scope for elaboration.

Characteristic of Structured questions:
- They are our workhorses. They require a lower cognitive load on the students.
- They reduce the amount of thinking that a student needs to undertake to complete the task. This generally leads to higher response and more accurate data.
- They are easier for the teacher to code and analyze.
- It is easier and quicker for the students to answer.
- The answers of different students are easier to compare.

Forms of Structured Questions

Structured questions take many forms.
- Single response with nominal or ordinal categories (for example from the following list select the right category).
- Multiple responses (for example: From the following list select any one or more than one or all responses).
- Scaled questions- are questions that have a predefined answer list with options that are incrementally related to each other to measure the intensity to which a respondent feels toward or about something.
- Numerous variations on these primary types.

Advantages of Close Ended /Structured Questions
- They are easy to understand hence the respondents don't need to spend much time reading the questions time and again. Close-ended questions are quick to respond to.
- When the data is obtained and needs to be compared closed-ended questions provide better insight.
- Since close-ended questions are quantifiable, the statistical analysis of the same becomes much easier.
- Since the response to the questions is straightforward it is much likely that the respondents will answer sensitive or even personal questions.

Administration of Test-Items

Test administration is concerned with the physical and psychological setting in which students take the test, for the students to do their best(Airsian-1994). This means the students have to know in advance that they will be given a test.

Test administration procedures are developed for an exam programme to help reduce measurement error and to increase the likelihood of fair, valid and reliable assessment, specifically appropriate standardized procedures improve measurement by increasing consistency and integrity of the score scale for all examiners.

Consistency: Standardised tests are designed to be administered under consistent procedures so that the test-taking experience is as similar as possible across examinees.

Test Security: Test security consists of methods designed to prevent cheating, as well as to protect the test items and content from being exposed to future test -takers.

In particular, administration procedures designed to promote consistent conditions for all examinees increase the exam program's fairness. Test administration procedures related to security protect the integrity of the test items.

Different Aspects of Standardized Test Administration
- Light level
- Temperature
- Ambient noise level
- Ventilation
- Minimal distraction

Check Your Progress - 2
1. Give the characteristic features of structured questions.
2. Mention any two advantages of closed-ended or structured questions.
3. What are the different aspects of standardized test administration?

4.4.3.3. Assessment and Evaluation in Biological Science Assessment

Assessment pays attention to learning, teaching as well as the outcomes, but evaluation focuses only on the final outcome. According to the American Heritage dictionary Assessment means appraisal, then according to the same dictionary evaluation is the estimation or determining the value of something.

Assessment is more towards gauging performance to improve teaching, learning and outcomes. It is ongoing and process-oriented which can also be diagnostic but not graded. Information is mostly learner-centered and course-based. The main focus on evaluation will be the grades. Evaluation is summative and product-oriented.

Classroom assessment is an integral part of science instruction. Assessment is the "systematic process of gathering information about what a student knows, can do, and is learning to do". Classroom assessment is generally divided into three types:-

Assessment for learning, Assessment of learning and assessment as learning.

There are four principles of Assessment- Reliability, Fairness, Flexibility and Validity. Assessment is classroom research to provide useful feedback for the improvement of teaching and learning. Assessment is feedback from the students to the instructor about the students learning. Classroom assessment is the observation of students in the process of learning, the collection of frequent feedback on students learning. The purpose of classroom assessment is to improve student-teachers learning.

Assessment Techniques:
- Administering a pencil and paper test.
- Analyzing work products (for example, Collections).
- Oral Assessment.
- Observing formally and informally the student's attitude and behaviors.
- Performance-based Assessment in biological science.
- Conducting personal interviews and small group conferences.
- Portfolio Assessment.

Evaluation

Evaluation is a continuous process and a periodic exercise. It helps in forming the values of judgement, educational status or achievement of the student. In education how much a child has succeeded in his aims, can only be determined through evaluation. Thus there is a close relationship between aims and evaluation. Evaluation in one form or the other is inevitable in teaching-learning, as in all fields of activity of education judgements need to be made. In learning, it contributes to the formulation of objectives, designing learning experiences and assessment of learner's performances. Besides this, it is very useful to bring improvement in teaching and curriculum. It provides accountability to society, parents and the education system.

The evaluation has the following functions:
- Placement function-It helps to select pupils for higher studies, for different vocations and specialized courses.
- Instructional function- Helps to improve instruction and to plan appropriate & adequate techniques of instruction.
- Diagnostic function; - Evaluation has to diagnose the weak points in the school programme as well as weaknesses of the students.
- Predictive function: To predict the future success of the children.
- Guidance and motivation function Helps teacher to know the children and to provide necessary educational, vocational and personal guidance. To direct, to inspire, to involve and to reward the students in their learning thus to motivate them towards study.
- Development & Research function: -Helps in the achievement of educational objectives and goals and clears the doubts for further studies and researches.
- Communication function: To communicate the result of progress to students, to intimate the result of progress to parents and to circulate the result of progress to other schools.

Check Your Progress - 3
1. Define Assessment?
2. What are the functions of Evaluation?
3. Quote different assessment techniques.

4.4.4. Let us Summarise

Developing and validating reliable test items is a long process involving the investigation of student's difficulties, designing questions that can reliably uncover these difficulties. Behind every exam that measures a student's understanding, skills and achievement of objectives a rigorous test development process is used. There are no short cuts to creating tests that are valid, reliable and fair. And that is the process of test development. Test development is done to meet the needs of a special group of students and to revise the test items.

An open-ended question is designed to encourage a full, meaningful answer using the subject's knowledge or feelings. Open-ended questions also tend to be more objective and less leading than closed-ended questions.

Test administration procedures are developed for an exam programme to help reduce measurement error and to increase the likelihood of fair, valid and reliable assessment, specifically appropriate standardized procedures improve measurement by increasing consistency and integrity of the score scale for all examiners.

Classroom assessment is an integral part of science instruction. Assessment is the "systematic process of gathering information about what a student knows, can do, and is learning to do". Classroom assessment is generally divided into three types:

Assessment for learning, Assessment of learning and assessment as learning.

There are four principles of Assessment- Reliability, fairness, flexibility and validity. Assessment is classroom research to provide useful feedback for the improvement of teaching and learning. Assessment is feedback from the students to the instructor about the students learning.

Assessment Techniques:
- Administering a pencil and paper test.
- Analyzing work products (for example Collections)
- Oral Assessment
- Observing formally and informally the students' attitudes and behaviors.
- Performance-based Assessment in biological science
- Conducting personal interviews and small group conferences.
- Portfolio Assessment.

4.4.5. Answer to Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. Open-ended questions are defined as free-form survey questions that allow the respondent to answer in open text format such that they can answer based on their complete knowledge, feeling and understanding. This means that response to this question is not limited to a set of options.

2. The importance of Open-ended questions are:
   - Open-ended questions cut down on two types of response error; respondents are not likely to forget the answers they have to choose from if they aregiven the chance to respond freely, and open-ended questions simply do not allow respondents to disregard reading the questions and just "fill in".
   - Critical thinking isn't the only skill that can be developed through the use of open-ended questions. Open-ended questions require more than one-word responses, students develop their language and vocabulary skills. Students also learn to think creatively and solve problems by themselves.
   - No limits on the answer- AS answer options for open-ended questions aren't provided, the respondent ha the liberty to include details about feelings, attitude and opinions that they usually wouldn't get to submit in close-ended questions.

Check Your Progress - 2
1. The characteristic features of structured questions are
   - They are our workhorses. They require a lower cognitive load on the students.
   - They reduce the amount of thinking that a student needs to undertake to complete the task. This generally leads to higher response and more accurate data.
   - They are easier for the teacher to code and analyze.
   - It is easier and quicker for the students to answer.
   - The answers of different students are easier to compare.

2. The advantages of closed-ended or structured questions are:
   - They are easy to understand hence the respondents don't need to spend much time reading the questions time and again. Close-ended questions are quick to respond to.
   - When the data is obtained and needs to be compared closed-ended questions provide better insight.

3. The different aspects of standardized test administration-
   - Light level
   - Temperature
   - Ambient noise level
   - Ventilation
   - Minimal distraction

Check Your Progress - 3
1. Assessment pays attention to learning, teaching as well as the outcomes, but evaluation focuses only on the final outcome. According to the American Heritage dictionary Assessment

means appraisal. Assessment is more towards gauging performance to improve teaching, learning and outcomes. It is ongoing and process-oriented, can also be diagnostic in nature but not graded. Information is mostly learner-centered and course-based.

2. The important functions of Evaluation are

- **Placement function:** It helps to select pupils for higher studies, for different vocations and specialized courses.
- **Instructional function:** Helps to improve instruction and to plan appropriate & adequate techniques of instruction.
- **Diagnostic function:** Evaluation has to diagnose the weak points in the school programme as well as the weakness of the students.
- **Predictive function:** To predict the future success of the children.
- **Guidance and motivation function:** Helps teacher to know the children and to provide necessary educational, vocational and personal guidance. To direct, to inspire, to involve and to reward the students in their learning thus to motivate them towards study.

3. The different assessment techniques are –

- Administering a pencil and paper test.
- Analyzing work products (for example Collections)
- Oral Assessment
- Observing formally and informally the student's attitudes and behaviours.
- Performance-based Assessment in biological science
- Conducting personal interviews and small group conferences.
- Portfolio Assessment.

4.4.6. Unit end Exercises
1. What are the essential points to be noted for the administration of test-items?
2. Distinguish between structured and unstructured questions.
3. Define evaluation. Describe the different functions of evaluation.

4.4.7. References
1. www.sgktc.org/courses.phg.
2. G. Bhuvaneshwara Lakshmi,K.Subba Rao, Digumarti Bhaskara Rao- Discovery Publishing House.- Methods of Teaching Biology
3. Haladyna T M & Downing S.M (1989) The validity of a taxonomy of multiple-choice item-writing rules, Applied Measurement in Education.
4. Haladyna T M & Rodrigues M R (2013) Developing and Validating Test Items.
5. Saraswathi C B- Learning Teaching and Assessment
6. Malini L Educational Evaluation.

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 5 : Recording and Reporting of Learning Evidences/ Outcome

Unit Structure

4.5.1. Learning Objectives

After completing this Unit, the student teachers will be able to,

- Explain the concept of recording and reporting of learning evidences;
- Justify the importance of recording and reporting of learner's achievement;
- Explain the process of measurement of students' learning outcomes;
- Develop the skill of measurement of students' achievement through marks and grading;
- Recall the process of assessment of students' achievement;
- Recognize the assessment as reflecting process with respect to students' achievement; and
- Differentiate Assessment as reflected and reflecting process.

4.5.2. Introduction

Dear Student Teachers,

The recording process is the responsibility of the teachers and the departments. The statutory requirements for assessment and reporting demand reliable and valid records to enable judgements to be made about pupils' performance, progress and achievement. Teachers should record attainment in all assessments, oral, written or practical. In their mark books, together with any other key progress indicators or weakness. Departments must have an agreed standard for assessing work, particularly project or course work and should have a common recording system to enable smooth transfer of pupils.

Reporting is the process used to communicate knowledge gained from assessing student learning. The purpose of reporting is to provide relevant information about a students' progress to the student, parents, support staff and other teachers.

4.5.3. Learning Points and Learning Activities

4.5.3.1. Recording and reporting of learning evidences / outcome

      Recording provides the platform from which teachers can base their reporting on others and is a mechanism for evaluating learning and teaching. Recording will enable teachers to share with pupils' successful learning and identify development needs and next steps. Recording of evidence is also available in teachers' weekly plans. Teachers should only note significant strengths and weaknesses in the formal record sheet and indicate the need for longer-term action such as extension and reinforcement. Their strengths and weaknesses and areas for development will be reported to parents through school reports.

Ways of Recording
- In folios of pupil's work.
- Brief notes in teachers' jotters
- In the teacher's forward plans.
- Checklists, worksheets.
- National Tests
- Pupils report.
- Self/peer assessment sheets.

What to Record:

      Teachers should record for each student only what is useful and relevant for planning the next steps in learning and for reporting progress. This should include brief comments on progress about specific teaching aims, particular strengths and development needs.

When to Record:

      We should record at the end of a planned block of learning and teaching for example, in our planning evaluation section or as is required within the day-to-day running of the class. The recording should also take place prior to planned parental consultation or reports to parents.

Kinds of Evidence we can use:
- Conversation with pupils/parents/teachers
- Written evidence (pupil's work)
- Comments within or pupils work
- Observation
- Oral questioning
- Assessment/progress work built into schemes.
- Extension work
- Co-operation in the project.
- Self/peer assessment
- Ability to carry out practical activities.

Reporting

Reporting and compilation of pupil reports serve many purposes. They provide feedback to pupils, inform parents of their child's progress and provide agenda for parent meetings and they pass information from one teacher to another from one school to another.

Reporting to Pupils:

This can be in the form of discussion, written comments or work, identifying areas of strengths and setting targets for areas that need to be worked on encouraging any improvement or task well done, at the end of a topic/task.

Reporting to Parents:

It is School policy to issue two written reports per year. One in the half term and the other at the end of the term. The reports include marks and the teachers' comments, next steps and comments on how parents can help their child at home.

Reporting to Teachers:
This will take the form of passed on record sheets, pupil reports and informal discussions.

Check Your Progress - 1
1. Why is recording important?
2. Mentions the various evidences used for Recording.

4.5.3.2. Measurement of students' achievement

The students' achievement measure provides a comprehensive picture of student progress on their path to earning a college degree or certificate. An achievement test is a test of developed skill or knowledge. The most common type of achievement test is a standardized test developed to measure skills and knowledge learned in a given grade level, usually through planned instruction, such as training or classroom instruction.

Marks and Grading

Marks are awarded for individual assessment items, grades are awarded for courses. More specifically, a mark is the level of achievement against specified criteria for an assessment item. A grade is an overall level of achievement for a course, usually determined by combining the marks of the individual assessment items that makeup the course.

Grading System:

A grading system in education is a system that is used to assess the educational performance of a child which is entirely based upon points alone. There are seven grading systems:
- Percentage grading – From 0 to 100
- Letter grading – A to F
- Norm-referenced grading – Comparing students to each other usually letter grades.
- Mastery grading --Grading students as 'Masters' or 'Passes'
- Pass/Fail
- Standard Grading –Comparing students' performance.
- Narrative Grading – Writing comments about students.

Advantages of the grading system:
- Takes the pressure off from the students at certain levels.
- Grading pattern description- studious children are discriminated from the average and below-average types of students.
- Gives the students an obvious idea about their weakness and strengths.
- Make class work easier.
- Leads to a better rendezvous of ideas.

Disadvantages of the grading system:
- It doesn't instil a sense of competition.
- Not an accurate representation of the performance and the knowledge gained.
- It is not an exact scoring system.
- Lack of incentives.

Marking:
It is the process of awarding a number to represent the level of student learning achievement. As a rule, marking applies to students' level of performance in individual assessment tasks, not to overall achievement in a course.

Teacher marking should be something that students use to understand and try to improve; effective marking aims to get students to engage with feedback and then take action to improve learning.

Whether you are marking exam answers or student's assignments, the time spent making a good marking scheme can save you hours when it comes to marking a pile of scripts. It can also help you to know that you are doing everything possible to be uniformly fair to all students.

Designing Marking Schemes:
- Write a model answer for each question, if the subject matter permits.
- Make each decision as straight forward as possible.
- Aim to make your marking scheme usable by a non-expert in the subject.
- Aim to make it so that anyone can mark given answers, and agree on the scores within a mark or two.
- Allow for 'consequential' marks, for example, when a candidate makes an early mistake, but then proceeds correctly thereafter, allow for some marks to be given.
- Plot your marking scheme by showing it to others.
- Look what others have done in the past.
- Learn from your own mistakes.

Check Your Progress - 2
1. Define the grading system in Education? Isit entirely based upon points alone?
2. Write any three Advantages and Disadvantages of the Grading system.
3. What is marking?

4.5.2.3. Assessment as reflected process and as a reflecting process

Assessment is the process of identifying, gathering and interpreting information about students learning. Planning for assessment will allow teachers to incorporate the ability to plan for learning using a range of formal, informal or self-reflection assessments. Assessment for learning should occur as a regular part of teaching and learning and this information should be gained from assessment activities to further develop students' knowledge and ability to learn.

A collection of information from a variety of sources will indicate a good assessment. As a new teacher, it is important to know your student's interests and prior knowledge to engage the students in the task. Therefore, this will encourage learning to be significant and meaningful. Teachers should reflect on their teaching practice and allow for discussions or feedback to further improve lifelong learning skills. Teachers who are reflective educators will be able to take note of their teaching practice and reconstruct events, emotions and accomplishments of a teaching experience.

Reflecting on your assessment/ teaching will allow you to acknowledge your fears, better understand your strengths and weakness and identify any areas of improvement.

Check Your Progress - 3
1. How is Assessment useful as a reflected and reflecting process?
2. Mention the kinds of evidences that can be used for recording?
3. What is an achievement test?
4. What are the advantages & disadvantages of the grading system?

4.5.4. Let us Summarise

The recording process is the responsibility of the teachers and the departments. The statutory requirements for assessment and reporting demand reliable and valid records to enable judgements to be made about pupils' performance, progress and achievement. Teachers should record attainment in all assessments, oral, written or practical. In their mark books, together with any other key progress indicators or weakness. Departments must have an agreed standard for assessing work, particularly project or course work and should have a common recording system to enable smooth transfer of pupils.

Recording provides the platform from which teachers can base their reporting on others and is a mechanism for evaluating learning and teaching. Recording will enable teachers to share with pupils' successful learning and identify development needs and next steps. Recording of evidence is also available in teachers' weekly plans.

Reporting and compilation of pupil reports serve many purposes. They provide feedback to pupils; they inform parents of their child's progress and provide agenda for parent's meetings and they pass information from one teacher to another from one school to another.

The student's achievement measure provides a comprehensive picture of student progress on their path to earning a college degree or certificate. An achievement test is a test of developed skill or knowledge. The most common type of achievement test is a standardized test developed to measure skills and knowledge learned in a given grade level, usually through planned instruction, such as training or classroom instruction.

Marks are awarded for individual assessment items, grades are awarded for courses. More specifically, a mark is the level of achievement against specified criteria for an assessment item. A grade is an overall level of achievement for a course, usually determined by combining the marks of the individual assessment items that makeup the course.

A collection of information from a variety of sources will indicate a good assessment. As a new teacher, it is important to know your student's interests and prior knowledge to engage the students in the task. Therefore, this will encourage learning to be significant and meaningful. Teachers should reflect on their teaching practice and allow for discussions or feedback to further improve lifelong learning skills.

Reflecting on your assessment/ teaching will allow you to acknowledge your fears, better understand your strengths and weakness and identify any areas of improvement.

4.5.5. Answer to 'Check Your Progress-1, 2 and 3'

Check Your Progress - 1
1. Recording provides the platform from which teachers can base their reporting on others and is a mechanism for evaluating learning and teaching. Recording will enable teachers to share with pupils' successful learning and identify development needs and next steps.

2. The various evidences used for Recording-
- Conversation with pupils/parents/teachers
- Written evidence (pupil's work)
- Comments within or pupils work
- Observation
- Oral questioning
- Assessment/progress work built into schemes.
- Extension work
- Co-operation in the project.
- Self/peer assessment
- Ability to carry out practical activities.

Check Your Progress - 2
1. A grading system in education is a system that is used to assess the educational performance of a child which is entirely based upon points alone.

2. Advantages of the grading system
- Takes the pressure off from the students at certain levels.
- Grading pattern description- studious children are discriminated from the average and below-average types of students.
- Gives the students an obvious idea about their weakness and strengths.
- Make class work easier.
- Leads to a better rendezvous of ideas.

Disadvantages of the grading system:
- It doesn't instill a sense of competition.
- Not an accurate representation of the performance and the knowledge gained.
- It is not an exact scoring system.
- Lack of incentives.

3. Marking is the process of awarding a number to represent the level of student learning achievement. As a rule, marking applies to students' level of performance in individual assessment tasks, not to overall achievement in a course.

Check Your Progress - 3
The Assessment is useful as reflected and reflecting process as -

A collection of information from a variety of sources will indicate a good assessment. As a new teacher, it is important to know your student's interests and prior knowledge to engage the students in the task. Therefore, this will encourage learning to be significant and meaningful. Teachers should reflect on their teaching practice and allow for discussions or feedback to further improve lifelong learning skills.

Teachers who are reflective educators will be able to take note of their teaching practice and reconstruct events, emotions and accomplishments of a teaching experience.

2.5.6. Unit and Exercises
1. What is marking?
2. Describe the merits of marking in brief.
3. How does assessment as a reflecting process beneficial?

2.5.7. References
1. Teaching of Biology (life sciences) by Chikara and Sharma- Tandon Publications,
2. G.Bhuvaneshwara Lakshmi,K.Subba Rao, Digumarti Bhaskara Rao- Discovery Publishing House.- Methods of Teaching Biology
3. Haladyna T M & Downing S.M (1989) The validity of a taxonomy of multiple-choice item-writing rules, Applied Measurement in Education.
4. Haladyna T M & Rodrigues M R (2013) Developing and Validating Test Items.
5. Saraswathi C B- Learning Teaching and Assessment
6. Malini L Educational Evaluation.
7. www.oecd.org/berlin/43541636.pdf

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Block 4 : Planning of Teaching-Learning and Assessment of Biological Science

Unit 6 : Professional Development of Biology Teachers

Unit Structure
4.6.1.   Learning Objectives
4.6.2.   Introduction
4.6.3.   Learning Points and Learning Activities
4.6.3.1. Aims of professional development in Biology Teachers
        Check Your Progress - 1
4.6.3.2. Need for professional development in teachers
        Check Your Progress - 2
4.6.2.3. Programmes for professional development
        Check Your Progress - 3
4.6.4.   Let us Summarise
4.6.5.   Answer to Check Your Progress - 1, 2 and 3'
4.6.6.   Unit end Exercises
4.6.7.   References

4.6.1. Learning Objectives
After completing this Unit, the student teachers will be able to,
- Explain the term professional development of Biology Teachers;
- Justify the need for the professional development of teachers for teaching Biological Sciences;
- Identify the measures of professional development of a biology teacher;
- Develop a network for professional development with others; and
- Adopt new methods of teaching Biological science in the class.

4.6.2. Introduction
Dear Student Teachers,

        In education, the term professional development maybe used for a wide variety of specialized training, formal education or advanced professional learning intended to help administrators, teachers and other educators improve their professional knowledge, competence, skill and effectiveness.

        Professional Development of Teachers is need and Significant in this period of drastic changes that occur day by day in all walks of life. Teachers should go on updating their knowledge as well as skills related to the teaching of their subject. Professional development is the enrichment training provided to teachers over a period of time to promote their development in all aspects of content and pedagogy.

        Professional development for teachers should be analogous to the professional development of other professionals. Becoming an effective teacher is a continuous process that stretches from pre-service experiences to the end of a professional career. It is conceptually divided into pre-service and in-service teacher training.

It is not simply a time-bound activity or series of events, but a continuous process. From this perspective, the conventionally divided in-service and pre-service activities should be viewed as seamless components of the same process.

Professional development for teachers is more than training or classes as it functions as an agent for change in their classroom practices. The growth of a teacher's skill and understanding is developed through personal reflection, interactions with colleagues and mentoring which gives confidence by engaging with their practices and reaffirming their experiences. It could have a positive impact on teachers' pedagogical content knowledge as many teachers feel challenged with the teaching of curricular subjects due to lack of previous experience with hands-on activities, lack of content knowledge, lack of interest to acquire the resources needed to create an appropriate learning environment and lack of confidence.

In the last few years, major in-service professional development programs have been conceptualized and implemented. DPEP and subsequently SSA have brought in the possibility of continuous capacity building exercise for teachers.

4.6.3. Learning Points and Learning Activities

4.6.3.1. Aims of Professional Development in Biology Teachers
Science knowledge is constantly changing and expanding its relevance to societal issues therefore science teachers need constant opportunities to build their understanding and abilities in the same direction. In the vision of NSES (National science educational Standard) science teachers are professionally responsible for their development and the maintenance of their teaching profession.

The aims of professional development are to:
1. Enrich and update teachers' knowledge in their discipline, pedagogy and other areas of school curriculum continuously. For example: Learning new scientific theories, expanding knowledge of subject area contents and concepts more effectively.
2. Develop a culture of shared learning and accountability such that teachers are not mere recipients of training conceptualized in a top-down manner but is engaged with the task to develop their own and the group's knowledge.
3. Evolve a mechanism by which effective programmes of teacher professional development can be initiated for a large number of teachers in vastly different areas and to deal with a range of diverse learners for inclusive education.
4. Research and reflect on the gaps in students' learning and their progress
5. Understand and update their knowledge on social issues
6. Apply Information Communication Technology (ICT) in their classrooms for better student learning.
7. Motivate and regenerate the enthusiasm of teachers to inculcate interest in innovations.
8. Training and mentoring in specialized teaching techniques that can be used in many different subject areas.
9. Earning a certification in a particular educational approach or program.
10. Developing technical, quantitative and analytical skills that can be used to analyze student performance data and then use the findings to modify.

11. Learning new technical skills such as the use of interactive whiteboards or course management systems.
12. Working with colleagues such as in professional learning communities to develop teaching skills collaboratively.
13. Acquiring leadership skills.
14. Conducting Action Research to gain a better understanding of what is working or not.

Check Your Progress - 1
1. What is Professional development?
2. Write any two aims of professional development in teachers.

Activity – attend summer camps and prepare a detailed report

4.6.3.2. Need for professional development in teachers

1. Changes in the Child Psychology

A teacher who is not capable of reading the mind of a student will be a poor teacher. So he should update his knowledge related to child growth and development, adolescent characteristics etc.

2. Change in the Attitude of Students

Today's students are entirely different from students of the olden days, and tomorrow's will show a higher degree of difference. If the teacher is not able to catch the changes in the attitude of the students of different eras, he will be thrown out of the stream.

3. Change in the Taste of Students

The teacher should be able to catch the interest area of the students of different periods and should use examples related to such areas for elaborating and illustrating the learning materials.

4. Knowledge Explosion in the World

There is a phenomenon called knowledge explosion in every field of our life that unbelievable facts and theories are born every day, and the specialized areas of minute aspects of different departments of knowledge go on increasing. So teachers should keep basic knowledge of each genre of knowledge.

5. Development in the Field of Modern Science

New scientific inventions are made frequently. If the teacher does not keep an eye on the new theories and inventions, he may have to give misinformation to the students which may ultimately create some black moles on the image of the teacher.

6. Development in the Field of Information Technology

New information technology has made so many changes in the field of education. Those who are not able to use technology in classrooms are labeled illiterate at present. Even the small

children have become expert users of technology, which demands the teacher to become a better use of technology.

7. Changed Curriculum and Learning Experience
The curriculum setters have accepted a dynamic and flexible approach for the same, which demands the teachers go on updating their idea on the aims and objectives of the latest curriculum and syllabus. The teacher should be able to make use of the latest methodologies for the transaction of the learning materials. He should know how to manage group activities and brainstorming sessions effectively. Latest Trends in the Teaching-Learning Process

Importance OF Professional Development
- Will be better able to recognize the opportunity.
- Will be more aware of trends and direction in technology and society.
- Become increasingly effective in the workplace.
- Able to help, influence and lead others by your example.
- Will be confident of the future employability.
- Have a fulfilling and rewarding career.

Check Your Progress - 2
1. What is Knowledge explosion? Explain in brief
2. Write the needs for professional development in teachers.
3. State the importance of professional development.

4.6.3.3. Programmes for professional development
Professional development is a training that is completed by current professionals to continue development as a teacher. Excellent teachers never feel that they have completely 'arrived' at the pinnacle of education and they realize that there is room for improvement. The best teachers never stop growing as professionals.

There are many different types of professional development programs available for science teachers from free to costly and from quick to time-consuming. While any experience that helps teachers grow in their teaching skills can be considered professional development. Some examples of professional development for biological science teachers are as follows:
1. Professional activities within the school
2. Activities sponsored by the professional organization
3. In-service programmes like workshops, seminars, conferences, refresher courses, summer camps etc.
4. Providing opportunities for higher education
5. Exchange of teaching
6. Visits to other schools, exhibitions, museums, research organizations etc
7. Reading and publishing professional literature
8. Participating in radio/ TV programmes
9. Usage of self-rating scales and self-evaluation
10. Affiliation with other school and teachers
11. Communicating with other teachers
12. Active engagement with research work

13. Evolving a model for continuous professional development for building the capacity of individuals who plan, implement and are engaged in this effort.
14. Ensuring that teachers who are involved in developing their professional capacities are motivated to contribute and to learn from these programmes so that they can implement these in their classrooms.
15. Identifying and developing appropriate themes, and interaction mechanisms, procedures, norms and logistics and acquiring appropriate learning resources.
16. Reviewing and analyzing the systems for large scale professional development activities.
17. Identifying and evolving the possibility of the extent to use ICT in the training through the cascade and other models.
18. Open Lessons: In which, teachers develop lessons and invite colleagues to observe the lesson and provide feedback in a post-observation session.
19. Study Groups: Within 'Study Groups' teachers collaborate as a single large group or in smaller teams, to solve a common problem or create and implement a plan to attain a common goal.
20. Inquiry/action research approach
21. Mentoring by older or more experienced teachers guide and assist younger or novice teachers in all areas of teaching.
22. Induction Programmes for the newly recruited teachers
23. Deputing Untrained Teachers for procuring a professional degree
24. Programme evaluation studies may be taken up by states/UTs to know the implementation of In-service Teacher Professional Development programmes.
25. Impact Studies- States and Union Territories can take up impact studies for assessing the In-service Teacher Professional Development (ITPD) programmes in the classrooms and on the learning achievement of children of classes IX and X.

The teachers can also add to their professional development by participating in teachers organizations like -The All India Science Teachers Association (AISIA), Indian Association Of Teacher Educators (IATE), All India Federation Of Educational Associations (AIFEA), Seminar reading, the celebration of teachers day, National foundation for teachers Welfare etc.

Check Your Progress - 3
1. Name the different types of professional development programs for teachers.
2. Who is an excellent teacher?

4.6.4. Let us Summarise
Professional development is the enrichment training provided to teachers over a period of time to promote their development in all aspects of content and pedagogy. Professional development for teachers is more than training or classes as it functions as an agent for change in their classroom practices.

Aims of professional development are to:
- Enrich and update teachers' knowledge in their discipline, pedagogy and other areas of school curriculum continuously.
- Develop a culture of shared learning and accountability to enrich the knowledge, the motivation of children and research, etc.

- Evolve a mechanism by which effective programmes of teacher professional development can be initiated
- Apply Information Communication Technology (ICT) in the classrooms for better student learning.
- Motivate and regenerate the enthusiasm of teachers to inculcate interest in innovations.

So there is a strong need for professional development in teachers mainly to understand:
- The changes in the Child Psychology
- Change in the Attitude of Students
- Knowledge Explosion in the World
- Development in the Field of Modern Science
- Development in the Field of Information Technology
- Changed Curriculum and Learning Experience.

There are different types of programmes like workshops seminars, conferences, refresher courses, summer camps etc for the professional development of biology teachers.

The teachers can also add to their professional development by participating in teachers organizations like -The All India Science Teachers Association (AISIA), Indian Association Of Teacher Educators (IATE), All India Federation Of Educational Associations (AIFEA), Seminar reading, the celebration of teachers day, National foundation for teachers Welfare etc.

4.6.5. Answer to 'Check Your Progress - 1, 2 and 3'

Check Your Progress - 1
1. Professional development is the enrichment training provided to teachers over a period of time to promote their development in all aspects of content and pedagogy.

2. Aims of professional development in teachers are:
- Enrich and update teachers' knowledge in their discipline, pedagogy and other areas of school curriculum continuously.
- Develop a culture of shared learning and accountability such that teachers are not mere recipients of training conceptualized in a top-down manner but is engaged with the task to develop their own and the group's knowledge.

Check Your Progress - 2
1. There is a phenomenon called knowledge explosion in every field of our life that unbelievable facts and theories are born every day, and the specialized areas of minute aspects of different departments of knowledge go on increasing. So teachers should keep basic knowledge of each genre of knowledge.

2. The need for professional development in teachers is mainly to understand
- The changes in the Child Psychology
- Change in the Attitude of Students
- Knowledge Explosion in the World
- Development in the Field of Modern Science

- Development in the Field of Information Technology
- Changed Curriculum and Learning Experience.

3. Importance OF Professional Development are:
- Will be better able to recognize the opportunity.
- Will be more aware of trends and direction in technology and society.
- Become increasingly effective in the workplace.
- Able to help, influence and lead others by your example.
- Will be confident of the future employability.
- Have a fulfilling and rewarding career.

Check Your Progress - 3
1. The different types of programmes like workshops seminars, conferences, refresher courses, summer camps etc for the professional development of biology teachers.
2. Excellent teachers never feel that they have completely 'arrived' at the pinnacle of education and they realize that there is room for improvement. The best teachers never stop growing as professionals.

4.6.6. Unit end Exercises
1. Write any four aims of professional development in Biology.
2. Explain the need for the professional development of teachers in the modern era.
3. What are the different programmes for teacher's professional development?

4.6.7. Reference
1. Chikkara & Sharma -Teaching of Biology, Tandon Publication Ludhiana
2. R.C. Sharma, Modern Science Teaching, Dhanpat Rai Publishing company-pg 248-257
3. Malini L- Techniques Methods and Approaches of Pedagogy
4. Siddique & Siddique- Teaching of Science
5. Vijayalatha R & Sunita D- Pedagogy of Biological Science
6. www.ncert.nic.in/departments/nie/dse/deptt/activities/pdfs/chapter.pdf

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