ECOSYSTEM

Overview of the module-

Biology education: A bird's eye view

All societies in the world have come-up with pedagogical tools for ensuring the growth of their young members as socially accepted citizens and empowered to make the world a better place. Although the process of learning starts from home, schools provide exposure to various branches and dimensions of knowledge system and handhold the child to scientifically analyze and understand various natural and social phenomena happening in their surroundings. Amongst various subjects taught in the schools, science decorates an important position since the methodologies followed by this domain of knowledge, observation, experimentation, inference taking etc. can contribute significantly to the development of critical and creative thinking as well as the scientific temper amongst the students. Additionally, each science subject, physics, chemistry, mathematics etc. provides different kinds of intellectual challenge to the students. For instance, mathematics helps the development of abstract thinking and reasoning while physics and chemistry provides the tools for validating the concepts learned by doing experiments.

Biology, the division of science which discloses the world of both microscopic and macroscopic forms of life, structure and function of the body of various organisms including human beings and diverse components of the environment and relationship between them is very close to the human life. It deals with the topics that are directly linked to the days to day life of an individual, such as health, reproduction, environmental conservation, biodiversity, etc. However, learning

biology requires convergence of information from other branches of science such as physics, chemistry mathematics and even social science. Here learning cannot be restricted to the curriculum and the mother nature is the biggest laboratory and classroom available for a student. However, understanding the various concepts discussed in biology requires a lot of visualization and imagination. While going through the lessons of biology students have to deal with organisms which are not visible to the naked eye or even through the light microscope, one of the "sophisticated tool" available in their classroom' or the ones which they have never comes across in their life (marine or forest dwelling organisms). Additionally, grasping the topics such as biogeochemical cycle, evolution etc., the processes which takes place in a time span of centuries to millions of years also requires active imagination and visualization. Unfortunately, in most of the developing countries including India, the teaching aid available in biology classroom is blackboard and charts which compels the students to learn this vital subject by rot and fails them to connect it with their day to day life. For example, while learning the locomotion in a microorganism *Euglena,* which uses flagella to move, for most of the students the only source of information about this organism available is the figure given their textbook. Although India is undergoing tremendous reformation in the sector of science education, the Information Communication Technology (ICT) tools, which could help students in visualizing the concepts in biology and help in reducing the intellectual load and making biology education fun is getting popularity with a very slow pace. Additionally, installing facilities such as computers and smart classrooms and making ICT materials available in vernacular languages to the schools in rural India is also not expected in the near future. However, if we want to elevate the quality of biology education and provide training to our students to level with the

demands and challenges of 21st century we will have to restructure our science education keeping biology as the central point.

Ecology – where various subjects converge

Ecology or the environmental science constitutes one of the major limbs of biology. This subject introduces the vital message 'humans are only one among the countless species inhabiting the planet earth and each of these organisms are constantly interacting and dependent directly or indirectly with the living and non-living things present in their surroundings for their survival, to the learner. Additionally, learning ecology is expected to sensitize the growing minds towards the protection of their environment and expose them to the fact that our survival, health and wealth are dependent on various abiotic and biotic components present in the environment and non-judicious use of the natural resources or pollutants we are putting in to the environment can ultimately affect or own survival. Unfortunately, in India ecology is never given much emphasis in the school classrooms and the important concept of 'interconnectedness and interdependence' are seldom discussed in the classroom. However, in the current scenario of natural resource depletion, global warming and increased pollution and war for natural resources happening all over the world imparting the essence of ecology to the student is a need of the hour.

Objective of the CLIx Ecosystem Module-

The ecosystem module is developed considering the concerns and constrains faced by both students and teachers in the high school biology classrooms. The module presents basic concepts in ecology tightly bridging it with the concepts discussed in various 9th standard biology lessons and real-life situations experienced by the

students. The module starts with the exploration of the surrounding and understanding the biotic and abiotic factors present in the immediate surrounding of the students and helps them to understand the basic structure of an ecosystem as well to 'think globally by acting locally'. The module is built considering three major pillars of pedagogy, collaborative learning, learning from mistakes and relevance. Ecosystem module introduces important learning tools, observation, categorization, experimentation as well as the constructionism through various activities and helps to students think holistically and develop scientific temper and environmental awareness. The tools of ICT such as videos, simulations etc. has been used widely to help children in visualizing many concepts in ecology. Care was given to connect each lesson with the day to day life of the student that they could understand the importance of the subject ecology and make the information gained an integral part of their life.

The ecosystem module is designed and developed considering various chapters given in the 9th standard biology textbook of the states, Chhattisgarh Telangana, Mizoram and Rajasthan. The module has been divided into seven lessons covering different topic on ecosystem. The details of each lesson and its connection with the different sections of the text book are given below. Please refer the section 'for teachers' given in the online version of the module for further details.

Description of Lessons-

Lesson 1: Exploration of an ecosystem

This lesson introduces the basics building blocks of an ecosystem, biotic and abiotic factors to the students. Students get the chance to observe and collect data under the guidance of the teacher while conducting the field study. Teachers are

requested to show children various types of plants, animals and lifeless factors such as plastic, glass, different types of rocks etc. during the exploration of the surroundings. It is also advised to collect the vernacular names of plants and animals living in the focal area and gather local knowledge available with students about these organisms. Furthermore, the pollutants such as biodegradable or degradable wastes present in the field should be used for initiating discussion on pollution.

Video in lesson 1: shows different types of bacteria. By watching this video students get the chance to see the disease-causing bacteria such as *Salmonella typhi* (causing typhoid) or *Vibrio cholera* (cholera). Teacher can use this video to introduce the kingdom Monera,

Activity 1: Teachers should direct the students to make a table given in the activity1, before going to the field for observation. Students have to be guided to categorize the data collected by them into abiotic and biotic factors and a discussion should be conducted to make the relationship between them clear to the students.

Lesson 2: Understanding an ecosystem

This lesson opens world of diversity of ecosystems, both natural and manmade to the students. This lesson is the continuation of lesson 1 and teachers are required to discuss the biotic and abiotic components present in each ecosystem and the relationship between them. The aim of this lesson is to empower students to extend the basic concept of ecosystem which they have learned in lesson 1 to other ecosystems also as well as providing chance to understand the nature of various

ecosystems described in their textbook. This lesson could be used for enhancing the quality of teaching of the topics such as habitat, adaptation and biodiversity.

***Videos in lesson 2.1*:** illustrates the concept of aquatic ecosystem i.e., freshwater and marine ecosystem. Please request students to note the characteristics of underwater habitats in fresh and marine ecosystems.

Videos in lesson 2.2: demonstrates the terrestrial ecosystem i.e., forest, grassland and desert. Show adaptions acquired by different organisms to face the demand of various kinds of terrestrial ecosystems to the students and discuss its importance for survival in that ecosystem. E.g. How spots present on the body of cheetah helps to camouflage in the grassland ecosystem, how camel is adapted to the desert etc.

Videos in lesson 2.3: exemplify manmade ecosystem i.e., aquatic and urban ecosystem. Familiarizing children with the concepts that we human beings also creates ecosystem to satisfy our needs and such systems also follows the basic rules of the ecology, is essential for developing a holistic approach to the learning of any complex system including ecosystems, in a very young age itself. Discuss how biotic and abiotic factors are added while making an aquarium and how the relationships between them are maintained, how city works as an ecosystem and the role of human beings in maintaining the relationship between abiotic and biotic factors in a manmade ecosystem.

Lesson 2-activity 1: This activity also teaches the children the importance of the using the tool 'categorization' to understand and get control over large amount of data, a hallmark of any biological system.

Lesson 3: Let's make an ecosystem

Constructing something is considered to be one of the best strategy to gather knowledge about it, especially if it is a complex system like ecosystem. While making an ecosystem student get exposure to various elements constituting it and the connection and interaction between each of them. In this activity-based lesson students construct a man-made ecosystem i.e., artificial aquatic ecosystem, maintains it and observe the changes happening in it in the due course of time under the guidance of the teacher. This activity is expected to inculcate the habit of observations and continuous data collection for many days in students, a necessary skill required for studying any biological process.

Lesson 4: **Measuring an abiotic factor: Oxygen**

This lesson introduces one of the most important tool of pedagogy, experimentation. The aim of this lesson is to bring in the culture of doing experiments in to the classrooms and empower children to ask the fundamental question of science, "prove it". The experiment is designed in such way that students should do the activity in group, promoting the collective and collaborative learning. In addition to giving the experience with formulation of hypothesis and testing it empirically this lesson reminds teachers that many experiments could be done in the classroom using low-cost materials that could be purchased from the local market. Along with studying the protocol to test a hypothesis oxygen is dissolved in the water, student get exposure to the basic concept of 'volume' and measurement of liquid and as well as inexpensive, accurate and easily available tool for measuring volume, the syringe.

***Video in lesson 4*:** is a tutorial to perform dissolve oxygen test.

Lesson 5: **From where organisms get energy and nutrients**

The lesson 4 introduced the concept of abiotic factors and measurement of it, while the current lesson introduces the categorization of the biotic factors present in an ecosystem based on their role; some of them convert abiotic factors into biotic factors (producer), others consume the biotic materials produced by the producers (consumers) and third group converts the biotic factors into abiotic factors (decomposers), completing the cycle. Teachers are requested to introduce this linkage between various forms of life present in different ecosystem while introducing this lesson to the children.

***Videos in lesson 5*:** There are three videos in lesson 5, the first one titled 'algae' shows various filamentous and single cellular forms of algae, which are the producers of aquatic ecosystem to the students. Along with introducing the role of this microorganisms in maintaining the oxygen level and food availability in the aquatic habitats the same video can be used while teaching the kingdom Protista. The second video on *Euglena* could be exhibited while discussing the portion on this organism given in the textbook. Video 3 (Plants) is connected with the lesson on biodiversity; students could see various kinds of thallophytes, gymnosperms and angiosperms. Additionally, a segment of video 3 is dedicated for describing adaptations shown by various plants which could be used to communicate the topic adaptation more effectively.

***Videos in lesson 5.1*:** show different types of microscopic and macroscopic animals (consumers) living in aquatic habitats. These videos could be used also for providing introduction to the animals belonging to various 'groups of taxonomy

(classification)' described in the chapter on biodiversity and classification in the text book.

***Video in lesson 5.2*:** shows various types of fungi which plays the role of decomposers in ecosystems. Please show this video while teaching the Kingdom Fungi also.

***Lesson 5-activity*:** 1 Functions as a platform for the students to learn the categorization of living things present in their surroundings into producers, consumers and decomposers and to know how they are connected and dependent on each other. Teachers are requested to guide students to extend this activity to different kinds of ecosystems they know as well as to the ecosystem they have constructed in the classroom.

Lesson 6: **Human and ecosystems**

Like any other organism we humans are also dependent on our environment for the fulfillment of our various needs. Meanwhile such activities can impact various biotic and abiotic components present in our environment as well as the relationship between them. However, though children gather theoretical knowledge of ecology they rarely get the chance to know how their day to day life is connected with various biotic and abiotic components present in the environment. The present lesson is aiming to make students aware of our dependency on the environment and the need for conserving natural resources and avoiding pollution.

***Lesson 6-activity 1*:** Although the topic biodiversity is taught in detail in India classrooms, students often fail to appreciate the value of diverse kinds of organisms living in their surroundings. In this context, the present activity aims to make

students aware of our dependency on diverse kinds of plants and animals to fulfill one of our primary need, the food. Teachers are requested to select different kinds of food items prepared locally and list the ingredients of each item by discussing with students. Additionally, the direction of the discussion could be extended to the cultivation of each ingredient and linking it with the lessons on agriculture. For instance, if mustard is added to a food item, teachers could ask students to collect information such as in which states it is cultivated? what are the processes it goes through before it reaches your kitchen? etc. Additionally, making a list of the items students uses from morning till they sleep (start from toothpaste and brush or neem twig, coffee/ tea……to the bed they sleep), the processes through which it obtained (cultivated / process of preparation in the case of abiotic factors) could also be conducted to provide the broad picture of our dependency on the environment.

Lesson 6-activity 2**:** This activity is meant to show children the direct and indirect services provided by different ecosystems. Teachers are requested to use this activity while teaching habitat, natural resources, water, pollution etc. While making children familiar with the services we are getting from different ecosystems, the message of judicious use of natural resources, avoiding pollution and sustainable development should also be discussed. In the place of video of aquatic ecosystem given in the lesson teachers are encouraged to use local ecosystems, known to the students, also for this activity.

Lesson 7: **Agriculture and Ecosystems**

In many contexts children ask their teachers to tell them the fields where the knowledge of ecology is applied for the benefit of human beings. Agriculture is one

of the best answer for this question. This lesson presents a detailed analysis of how basic knowledge of ecology, 'biotic factors abiotic factors and the interaction between them' is applied in agriculture. For instance, in paddy/wheat cultivation when manure is added to the fields actually the farmer is increasing the availability of abiotic factors (nutrients) that are required for the growth of paddy / wheat. Similarly, when pest insects are removed, consumers eating the paddy / wheat plant (producer) and hence reducing its growth are eliminated. Teachers can link this lesson to concept of man-made habitats as well as lessons on agriculture given in the text book.

***Video1 in Lesson 7*:** demonstrates steps of developing a paddy field ecosystem. Using this video as a model, teachers could discuss the various steps involved in the cultivation of various crops and direct children to think how productivity from a crop field can be increased by applying the knowledge of ecology they have.

***Lesson 7-activity 1*:** It is a well-known fact that many of the ecological process take long duration to complete and for many student, visualization of such processes is not an easy task. Hence many of them learn such topics by heart and hence cannot use the information for thinking. However, with help of an ICT tool called simulation students could not only see the time consuming ecological processes happening on their screen but also can test what will happen to the ecosystem in focus if some of the factors are altered by human activity or through natural process. In this activity, an applied ecological situation is provided to the students, cultivating fish which eats only algae. Teachers should support students to connect variation in the number of algae and concomitant change happening in the number of fishes while playing the simulation. This activity has another target; making students familiar with using graphs for visually representing complex phenomena

that are difficult to describe using words. Hence teachers should encourage students to come up with ecological questions about fish pond and to test it using the simulation and understand it using the graphical representation generated by it. For instance, you could ask students to tell what will happen if all the algae are removed from a pond (set number of algae at 0 and run the simulation) or if growth rate of algae is very high (which happens during eutrophication) etc. and discusses the ecological process leading to the result obtained.

***Lesson 7-activity 2*:** Introduces various steps involved in the preparation of vermicompost, a manure prepared by many farmers in India to the students. Teachers are encouraged to make a setup in the school to maintain earthworms with the support of students. Food waste produced by children could be used for feeding earthworm and the students could use worm cast as a manure for the plants present in the school garden.