

NEW NORMAL CURRICULUM

Instructional Guide

Environmental Science

Class X



Royal Education Council

Paro, Bhutan

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Instructional Guide
Environmental Science
Class X



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Foreword

COVID-19 has suddenly caused unforgiving disruptions in the public education all over the world, and brought about threats of fragmentation due to disparities in accessibility and connectivity in many systems. In Bhutan too, continuity of education and learning has been severely affected as a result of nationwide school closures and due to restrictions and health protocols. The disruptions have led to challenges in many existing patterns and trends in education, resulting in a massive shift away from learning and teaching in traditional settings with physical interactions to the maximum in terms of relevancy and efficiency. This has caused a major problem for children living in poverty worldwide, who often rely on the physical settings of their schools for educational materials, guidance, and, sometimes, the only decent meal of the day.

In the new normal education, human interaction and well-being is a priority. Technology, particularly digital technology that enables communication, collaboration and learning across distance, is a formidable tool – not a panacea but a source of innovation and expanded potentials. As we embrace this exceptional opportunity to transform the world, and as we reimagine the organization of our educational institutions and learning environments, we will need to think about where we want to go and how we go.

In the post COVID 19 era, we must prioritize the development of the whole person not just academic knowledge. Inspiration for the change can be drawn from the 1996 Delors report, *Learning the treasure within*, in its specification of four pillars of learning as “learning to know”, “to do”, “to be”, and “to live together”. Therefore, curricula must be increasingly perceived as an integrated and based on themes and problems that allows learners to learn to live in peace with our common humanity and our common planet. This has the potential in the development of a strong base of knowledge about one’s self and about the world and find purpose and be better able to participate in social and political milieu.

The New Normal Curriculum is, not just a mere response to the pandemic, but a culmination of the curriculum reform work for the last four years by the Royal Education Council. It is an attempt to transform education from the teaching of “what” to learning of “how” and “why” towards empowering learners with the transversal competencies and the 21st century skills, and preparing them to be lifelong learners. We are optimistic that this move orients our educational processes towards nurturing nationally rooted and globally competent citizens.

Wish all our learners and teachers a life enriching experiential teaching and learning.

(Kinga Dakpa)

DIRECTOR GENERAL

Introduction

The conventional education, which is predominantly knowledge based and examination centred teaching and learning has been the time old practices; stress of this model is on the learning of textual information perceived by educators important for the grade. On the other hand, with the advancement in ICT, world is flooded with such information, which are widely read by all at their leisure. What learners cannot acquire from the multiple sources are the skills, values and change of behaviour, which are crucial in facilitating learners realise their potential to be socially responsible and productive individuals, and optimize their contribution in the nation building processes – economic, social, political development. In the contemporary world, the knowledge-based education compromises the development of psychomotor and affective domains of learning, which affects the holistic development and psychosocial wellbeing of learners.

The pandemic situation also explicated that the old ways of working, teaching and learning, and lifestyle have limitations. Consequently, new normal ways of how we work and live, teach and learn, stay connected are the contemporary traditions. In this context, an overhaul of how we think and do is an imperative, not of a choice. The transformation of classroom instruction from the teacher centred to that of learner centred learning however calls for the following adjustment, or even the overhaul of some of the practices.

- i. Reduction of learning content to facilitate deep learning as opposed to the width of the teaching and learning, through active engagement of learners.
- ii. Integration of ICT as tools and ends of the learner's education. The use of multimedia and ICT software are commonly utilized in teaching and learning as innovation to introduce variation in stimuli and sustain learner's interest and zeal in learning.
- iii. Adoption of theme-based learning content facilitates in broadening the horizon of learning beyond the four walls, and stimulates transfer of the learnt concepts to learner's immediate environment. This arrangement makes learner aware of the realities of the social, political, economic and cultural practices and ethos of the society. Being aware of the immediate environment of the scopes and challenges, learners are sensitized to the opportunities and issues, which may need attention for better future for the society.
- iv. Consideration to ground the curriculum design and instruction approaches on the epistemological theories is imperative to facilitate deep learning as opposed to the factual learning. The selection and use of them, however is subject to the nature of the subject. For instance, constructivism is more apt for science, while connectivism may be relevant for languages and ICT curricula to facilitate the deep learning and inspire the generation of new knowledge and ideas.
- v. Active engagement of learners is imperative of the competency-based education and learning. Inevitably, summative assessment has limitation in gauging the progressive development of the learner. This is achieved objectively by the use of the continuous formative assessment (CFA). However, if summative assessment evidences are used to provide feedback to help learner in learning, it can serve as one of the techniques of CFA.

The curriculum grounded on the wisdom and principles of competency-based learning, built on reality of the immediate environment, and the belief system of the society, may be arbitrarily termed as the New Normal Curriculum. It is a form of personalized learning, life enriching experiences, which inspires youth to generate new knowledge and create new ideas to innovate as young scientists or enterprising individuals.

Towards this, learning is facilitated through the “Instructional Guide” with learners taking responsibilities of their learning. Roles of teachers are facilitation, guide, evaluation in the course of learners’ active engagement, and assess the performance of them for improvement and enhance their learning. Therefore, the NNC Environmental Science Instructional Guide (ES IG) is an attempt to transform education from the teaching of “what” to learning of “how” and “why” towards empowering learners with the transversal competencies and the 21st century skills, and preparing them to be lifelong learners.

Purposes of the Instructional Guide

In the New Normal Curriculum, deep learning synonymous to “less is more” is facilitated with the use of Instructional Guide for each subject and specific class. The content of the instruction in the guide for respective subjects are aligned with the subject’s curriculum framework. Therefore, the ES IG is purported to achieve the following objectives towards facilitating uninterrupted teaching and learning:

- i. Strengthen competency based learning and experiential learning to foster sensitivity to realities of the life and environment.
- ii. Strengthen blended learning and flip classroom with multimedia, digital pedagogies and ICT devices and websites as tools and ends of the learning.
- iii. Prioritize learning content with emphasis on creating time and space for deep learning and raise sensitivity of the realities of the world around them through active engagement of learners.
- iv. Facilitate the use of CFA for learning using diverse appropriate assessment techniques and tools commensurate with individual differences in learning, and gather evidence to guide planning of educational programs and activities for learners.
- v. Promote inclusive learning learning through the blended learning which facilitates learning anywhere, any time with learner being responsible for the learning.
- vi. Inspire teachers to assume the roles of facilitation, guide, motivator and evaluator.
- vii. Guide both teachers and parents in facilitating learning of their children.

The experiential and personalised learning practices are widely used around the world and are grounded on different models. One of such models that suites the current situation and expectation of education for the 21st century is the ADDIE model (Analyze, Design, Develop, Implement and Evaluate).

How to Use Instructional Guide?

The New Normal Curriculum (NNC) is inspired by the ideologies of competency based education and the experiential learning ethos of educational practices. Therefore, the function of the NNC Instructional Guide (IG) is to facilitate deep learning and foster the learning of how to learn through active engagement and provisioning of diverse learning experiences. They include, but not limited to, real time interaction with the life realities, designing and modeling of artefacts, knowledge hunt through diverse sources – books and digital, and the epistemological processes of investigation and analysis to generate knowledge and create ideas of doing things differently to suite the situation and the problems.

The NNC IG is arranged and aligned with the NNCF in a progressive manner, encompassing all the aspects of competency-based learning and assessment. The content of Instructional Guide for Environmental Science is organized as follows:

1. Chapter

Each chapter is introduced with a broad overview of the bigger ideas, issues and concerns setting context of the learning and sensitises learners of what learning experiences they are to engage in. The context is also to raise curiosity and be concerned with issues and challenges related to the content, society and the environment.

The teacher presents the chapter with brief explanation, sensitization, or questions to stimulate learner's thinking and curiosity. Learner also reads the overview and formulates expectations he or she aspires to gain from the chapter.

2. Competency

Based on the chapter, a set of competency statements are outlined as the expected outcome of the chapter. Competency *per se* is the ability to analyze and synthesize information and apply the knowledge, skills and abilities required to successfully perform the tasks in diverse situation. It is generally framed based on three domains of learning; cognitive/intellectual, performance, social and emotional, and behavioural competencies.

These competencies are the basis for identification and selection of competencies that the learner is expected to achieve as the desired outcome. Teachers must develop clear understanding of the expected competencies.

3. Topic

Towards achieving the stated competencies, each chapter contains two to five topics in order to cover the desired fundamental concepts and principles. Each topic begins with an overview of the fundamental concepts, ideas, laws and principles, issues and concerns to set context of the learning and sensitise learners of what learning experiences they are to engage in.

The teacher presents the topic with brief explanation, sensitization, or questions to stimulate learner's thinking and curiosity. Learner also reads the overview and formulates questions and hypothesizes answers to the questions, and validates during the course of learning.

4. Scope

Scope in each topic informs of the expected key concepts, ideas, laws, laws, principles and issues that the topic is expected to emphasise. This serves as the basis for formulating learning objectives both for the formal instruction and the informal setting.

5. Learning objective

The learning objectives are statements of what learners will know, be able to do, and be able to display by the end of every lesson of experiential learning. Every learning objective contains action word relevant to the domain of the competency based learning, which includes cognitive, psycho-motor and affective.

The learning objectives under every topic are aligned with the competencies identified. The learning objectives inform the design and selection of learning experiences that the learner is envisaged to engage with. It also informs teachers, learners and parents of the target or purpose of their teaching and learning.

6. Learning experiences

This section is crucial in the NNC. Learning experiences are a wide variety of experiences across different contexts and settings which transform the perceptions of the learner, facilitate conceptual understanding, yield emotional qualities, and nurture the acquisition of knowledge, skills and attitudes. In educational settings, learning experiences are ideally challenging, interesting, rich, engaging, meaningful, and appropriate to learner needs. Previous learning experiences are considered to be key factors predicting further learning (IBE n.d.). As such, learning experiences in ES IG are based on specific content knowledge and skills that facilitates experiential and deep learning. Such experiences foster the development of critical thinking and problem solving, creativity and innovation, communication, collaboration, citizenship and sensitivity to social and cultural values and practices.

The epistemology of NNC informs that teachers assume the roles of facilitation, guide, motivator and evaluator. Learners are the active players in the competency based learning paradigm. In order to facilitate uninterrupted learning as influenced by the situation, the design of the ES IG and selection of learning experiences are based on the Blended Learning and Flip Classroom modes of instruction delivery. Therefore, cognizant of the ideology of experiential learning, need for uninterrupted learning, and helping learners learn how to learn, the NNC IG provides only the suggestive pedagogical strategies and approaches arranged based on spiral curriculum for progressive learning, with digital technologies as one of the main drivers. Therefore, teachers have the freedom to deploy diverse teaching methods, mechanism of classroom management, and implementation of continuous formative assessment.

By this token, learner is expected to participate in every learning activities, choose wide range of forms and means of recording of their experiences and communicating to others, and reflect on the learning. Further, teacher needs to inform learners that based on the progressive step-by-step organization of the learning experiences, learner can continue learning any time, anywhere.

The blended learning and flip classroom modes of lesson delivery mandate that teachers develop their own tutorial audio visual materials and use them to inspire learners. They also upload any audio visual in the Google classroom or in any of the recommended social media to support learning. One crucial role of teacher is to guide learners use various sources of information and ideas by using websites and library resources as stipulated by learning experiences. The teacher also digitises assessment. Owing to heavy reliance of pedagogies on digital technologies, particularly the use of apps and online tools, teachers need to develop digital competencies. At the same time, teachers and schools need to ensure that accessibility and connectivity is not the learning barrier.

Based on the subject nature, the ES IG envisages that learner participates in real time research studies, interaction with the environment and stakeholders, and investigations. During field visits and trips, school administration, local authorities and parents support and facilitate the conduct of studies in the community setting. Teachers and learners must plan and get all necessary approvals and consensus by taking all the safety measures and protocols into consideration. Teacher also conducts reflection sessions by asking a few questions and follow up lesson based on the topic.

7. Questions

Learning experiences, whether visual viewing or reading, classroom task completion, investigations or field observations, are concluded with a set of questions. Teachers are to use these questions to evaluate the learner's actual participation in the learning processes, and hence assess their learning. They can serve as the means of assessment as an integral part of CFA, or learners can use them to stimulate reflection to strengthen their metacognition of learning.

8. Assessment and Reporting

In the context of competency based learning, assessment of intellectual, psychomotor, social and emotional competencies are imperatives; unfortunately, they can not be assessed summatively, rather must be assessed on the real time basis when learners are displaying their competencies and dispositions. The continuous formative assessment (CFA) is conducted throughout the educational process with a view to enhancing student learning. It implies: eliciting evidence about learning to close the gap between current and desired performance; providing feedback to students; and involving students in the assessment and learning process (CCSSO 2008).

Uncertain of diversity of learners and purpose and context of assessment, the IG does not provide specific assessment techniques and tools, rather the teacher can use appropriate assessment tools and techniques of CFA based on the topics and lessons. The assessment must happen in a continuous mode in accordance to the assessment section in the NNCf for Science (REC 2021).

Teachers use any appropriate techniques and tools leveraging on digitized assessment, both for gauging learning progress on quarterly basis, recording and reporting.

9. Resources

This section provides an overview of resources, digital - online and offline, and physical materials. It must be noted that in the NNC, textbooks are to be used as one of the resources. This discourages textbook teaching, but promote teaching the learners.

10. Challenge Your Thinking

This section provides suggestive questions covering all the topics to assess learners' intellectual, psychomotor, social and emotional competencies. It has the mix of knowledge based and competency and intellectually challenging questions. Challenging your Thinking can help learners understand and be aware of their performance, and of the areas for improvement. The diversity of questions is to stimulate learners to exercise the use critical thinking, creativity, analytical, making connections and draw conclusion as the means to generate knowledge and ideas.

11. Annexure / Appendix

In helping the teacher and learners in the effective teaching and learning, there is need for pertinent information, ideas and clues which can not be covered in the main text. Such resources are generally annexed for ready reference and information.

The teacher and learners refer to sample assesment techniques and tools in using CFA during the teaching and learning process, clarify their misconception by referring the assessment scheme and modes with assessment matrix, and plan lessons based on the topicwise weighting and instructional time for each topic and chapter.

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Chapter 1: Ecosystem

An ecosystem consists of biotic and abiotic components. Within biotic components, flow of energy takes place through feeding relationships called food chains and food webs. The hierarchical levels in a food chain are called trophic levels. The abiotic components provide materials and energy for the survival of biotic components. Hence, there exists continuous interactions between biotic and abiotic components that contribute to biogeochemical cycles. However, threats to biodiversity, such as habitat destruction, species introduction, hunting and others disturb the ecosystem and lead to change in habitat, and even extinction of some of the organisms. Do you sometimes wonder why carbon dioxide never exhausts despite it being used by the plants continuously?

Competencies:

- *Analyze the roles of biogeochemical cycles based on the knowledge and understanding of gaseous and sedimentary biogeochemical cycles and how humans influence the nutrient flow in the ecosystem.*

1.1 Biogeochemical Cycles (250 minutes)

(Scope: Gaseous biogeochemical cycle-carbon and nitrogen and sedimentary biogeochemical cycles-calcium and phosphorous cycle. The influence of human activities or disruption of the biogeochemical cycles)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *explain biogeochemical cycles.*
- *analyse the roles of biogeochemical cycles in maintaining the nutrient flow.*
- *evaluate how human influence or disrupt the biogeochemical cycles in general and in the community.*

Learning Experiences

The biogeochemical cycle or nutrient cycle is the complete cyclic path of essential elements of living matter, such as carbon, hydrogen, oxygen, nitrogen, water and phosphorus within the living and nonliving components of an ecosystem. The biogeochemical cycles are classified into gaseous cycles and sedimentary cycles. How do these cycles happen? Why are these cycles important for the resilience of the environment?

The learner explores the information on the biogeochemical cycles and their differences from the web link <https://bit.ly/3qANIUq> and <https://bit.ly/38mD3RC>.

Apply the knowledge of the gaseous biogeochemical cycle by completing the Activity 1.1 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Sedimentary biogeochemical cycle's reservoir is the Earth's crust. Elements such as phosphorus and calcium needed for plants are abundant in the Earth's crust. However, owing to the nature of the substance, they take a long time to enter into the biogeochemical cycle. Unlike in the gaseous cycles, in the process of circulation in the sedimentary cycle, nutrient elements are prone to leaching and may also get locked into sediments; thus, becoming unavailable for immediate cycling.

The learner can learn more on calcium cycle and phosphorus cycle from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

The learner revisits or uses other resources to learn about the phosphorus and calcium sedimentary biogeochemical cycle at <https://bit.ly/3emiiJL>.

One may also refer to the Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Then, the learner creates a flowchart to describe the process of calcium and phosphorus cycle and present the work to the class, or upload it in Google Classroom.

Question

1. Deduce the relationship between the gaseous and sedimentary biogeochemical cycle for the growth of a plant.
2. How are biogeochemical cycles important for a farmer?
3. Use Design Thinking model to strategize ways to maintain balance in the biogeochemical cycles in the ecosystem.

Human activities have increased atmospheric carbon dioxide by about 40% over pre-industrial levels, more than double the amount of nitrogen available to the ecosystem. Similar trends have been observed for phosphorus and other elements, and these changes have major consequences for biogeochemical cycles. Altered biogeochemical cycles increase the vulnerability of biodiversity, food security, human health and water quality. However, natural and managed shifts in biogeochemical cycles can help limit the rate of changes. For this, it is crucial that people understand and be aware of how long these elements take to enter into the cycle. What would be the consequences for the humans, if the occurrence of cycles stops? What sustainable measures should people take?

Watch the video on nutrient pollution at <https://bit.ly/2OkN4YP> or other websites. Based on the video, make an analysis of how humans interfere with the nutrients in nature and how can the nutrient pollution be prevented. Further, relate this situation to Bhutanese context.

Assessment and Reporting

Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2021
3. Difference between gaseous and sedimentary biogeochemical cycles - <https://bit.ly/3qANIUq>
4. Biogeochemical cycles - <https://bit.ly/38mD3RC>
5. Difference between gaseous and sedimentary biogeochemical cycles - <https://bit.ly/3emiiJL>
6. Nutrient pollution - <https://bit.ly/2OkN4YP>

Challenge Your Thinking:

1. Draw differences between gaseous and sedimentary biogeochemical cycles.
2. What is the role of each of the following in the carbon cycle? Give an example of each.
 - a. Primary producers
 - b. Secondary producers
 - c. Decomposers
3. Trace the route of the phosphorus after leaching with the help of a simple illustration?
4. Calcium and phosphorus cycles are sedimentary cycles. Justify.
5. Our farmers apply chemical fertilizers to ensure good yield. Explain how these practices impact the nutrient flow.
6. Discuss how industrialization influences biogeochemical cycles.

Chapter 2: Balance in Nature

An ecosystem is composed of both living and non-living things. These components, biotic and abiotic, are directly or indirectly interdependent and are responsible for maintaining the balance in nature. Living organisms need various resources, biotic and abiotic, to grow, reproduce and survive. However, any given ecosystem can produce only a limited amount of resources. The type and population of species in an ecosystem depend on the availability of resources. Thus, the populations of species as well as the species composition of an ecosystem may change over time.

Competencies:

- *Explain the relationships among the factors of population, production and consumption in determining the state of a carrying capacity of a locality through mathematical calculations and facilitate individuals to infer the consumption behavior.*
- *Analyse the ecosystem based on the factors such as extrinsic, intrinsic, and species diversity that influence the ecosystem equilibrium and stability for maintaining balance in nature.*

2.1 Carrying Capacity (100 minutes)

(Scope: Carrying capacity, and factors influencing carrying capacity)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *relate population, production and consumption to carrying capacity.*

Learning Experiences

The ecosystem contains numerous types of living organisms in varying population sizes interacting for food and shelter. However, there is limitation to the capacity of the ecosystem to support these organisms. This capacity of the ecosystem to support a size of population indefinitely by the available resources is called carrying capacity. What are population and available resources? What is the relationship between the carrying capacity and population and resources? What do you think is the carrying capacity of your house?

The learner carries out Activity 2.1 of Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> to deduce the relationship between population, production and consumption.

Further, browse through the web link <https://bit.ly/3qxK888> and other weblinks. You can also view the link on carrying capacity at <https://bit.ly/3et8ygG>.

The carrying capacity of an ecosystem may vary for different species and may change over time. Visit the sample weblink to find out more on the factors that affect carrying capacity <https://bit.ly/3vaP0ni> and represent the ideas gained by using mind map or other graphical representations.

Question

1. Based on your understanding from the preceding information, use the 5E model to explain carrying capacity with appropriate examples.
2. Making use of two species of plants or animals and a common resource in a given ecosystem, explain the relationship between population, productivity, consumption and carrying capacity of that ecosystem.

Visit weblink <https://bit.ly/30w1414> and <https://bit.ly/3eqaxT1> or other similar web sources to find more information.

Assessment and Reporting

Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Carrying capacity - <https://bit.ly/3qxK888>
4. Carrying capacity - <https://bit.ly/3et8ygG>
5. What factors affect the carrying capacity of the environment? - <https://bit.ly/3vaP0ni>
6. Ecological carrying capacity - <https://bit.ly/30w1414>
7. Carrying capacity - <https://bit.ly/3eqaxT1>

2.2 Measuring Carrying Capacity (150 minutes)

(Scope: Calculating carrying capacity)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *calculate the carrying capacity of an ecosystem.*

Learning Experiences

The carrying capacity of an ecosystem may vary for different species and change over time. The methods to calculate carrying capacity may also differ from one species to another. In order to maintain the ecological balance, it is vital to be aware of what elements and how they affect the balance in nature. For example, how many books can you carry in your school bag comfortably? What will happen if you increase the number of books?

The learner may carry out Activity 2.2 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> to apply the learner's understanding on the calculation of carrying capacity.

The learner search for information and create methods or ways to measure the carrying capacity of an ecosystem in their locality. Based on this, analyse the importance of carrying capacity measurement for an ecologist.

Question

1. Why is knowledge of carrying capacity important for people?
2. What is the relationship between the carrying capacity and productivity of an ecosystem?

Assessment and Reporting

Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020

2.3 Ecosystem Stability (150 minutes)

(Scope: Influence of extrinsic and intrinsic factors on ecosystem stability)

Learning Objectives: At the end of the lesson, the learner should be able to:

- assess the influence of extrinsic and intrinsic factors on ecosystem equilibrium and its stability.

Learning Experiences

The natural world is very dynamic. The varieties of species and their populations in an ecosystem may change over time. These changes are influenced by various factors that affect their growth and reproduction. Nevertheless, the ecosystem as a whole always tends to remain in an equilibrium.

Ecosystem stability is defined in two parts, its resilience and its resistance. Both can occur at the community, population and individual level. An ecosystem can have high resistance to disturbance, but low resilience, and vice versa. Low resistance can sometimes be advantageous, such as in ecosystems that rely on natural disturbances to temporarily change their conditions in order to remain stable over the long term.

To explore more on resistance and resilience of ecosystem, the learner may read the text on state of ecosystem from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

The ecosystem stability may be influenced either by extrinsic or intrinsic factors.

The learner read “factors influencing ecosystem stability” to know more on extrinsic and intrinsic factors from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Browse other suggestive weblinks for further information <http://soilquality.org/basics/stability.html> and <https://slideplayer.com/slide/6016982/>.

Through a small research study, evaluate measures towards improving the ecosystem stability. Make a report of the finding and share through any feasible means.

Question

1. Why should an ecosystem bounce back quickly to pre-disturbed state even in the face of the disturbance?
2. How is ecosystem stability crucial in Bhutanese drive to achieve the goals of Gross National Happiness?

Assessment and Reporting

Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Ecosystem stability - <http://soilquality.org/basics/stability.html>
4. What is ecosystem stability - <https://slideplayer.com/slide/6016982/>

2.4 Species Diversity and Ecosystem Stability (100 minutes)

(Scope: Relationship between species diversity and ecosystem stability)

Learning Objectives: *At the end of the lesson, the learner should be able to:*

- explain the relationship between species diversity and ecosystem stability in maintaining the balance in nature.

Learning Experiences

Species diversity refers to the number of different species present in an ecosystem and relative abundance of each of those species. It is a measure of the diversity within an ecological community based on species richness, the number of species in a community, and the evenness of species abundance. Different species of organisms living in an ecosystem have different resource requirements and tolerance to environmental changes. They may also interact differently with other species. Hence, the number of different species living in a particular area and their populations have major influence on how the ecosystem functions, and therefore, the ecosystem stability.

Learner may explore more on the species diversity and ecosystem stability from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

The natural law is that an ecosystem will maintain its stability, either by its ability of resilience or resistance, unless either it is destroyed or its resources are over exploited. Maintaining ecosystem stability is vital because it ensures life for the organisms that live in it.

Learner may read a sample case study given in Activity 2.3 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> to know more about ecosystem stability.

The learner may play with the food chain Gizmos following the link and draw the relationship between the species diversity and the ecosystem stability available at <https://bit.ly/3emxfLO> and present the work to the class or upload it in Google Classroom.

Assessment and Reporting

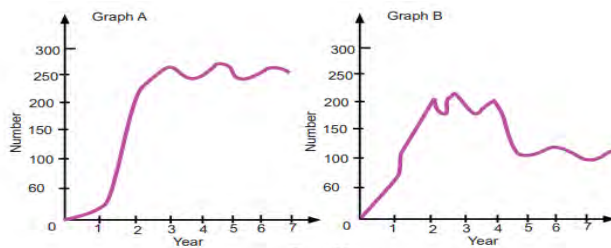
Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Food chain Gizmos - <https://bit.ly/3emxfLO>

Challenge Your Thinking:

1. What is the relationship between the productivity and consumption of resources by an organism that lives in that ecosystem?
2. Discuss your role towards maintaining a stable ecosystem.
3. Species diversity is crucial for maintaining the stability of an ecosystem. Justify?
4. Discuss the impact of removing one species from an ecosystem.
5. Study the graphs that represent the carrying capacities at two situations, Graph A and Graph B, in Figure 2.1 and answer the question that follows:



- Figure 2.1
- A B
- a. What are the carrying capacities shown by graph A and B in the 7th year?
 - b. Which graph represents a stable carrying capacity? Why?

Chapter 3: People and Environment

The environment supports all forms of life found on the Earth. There has been mutual interconnection and interdependence between people and the environment. It has supported the human race since the early periods of human settlement. People rely on the environment to meet their needs, whether vital or secondary. The dependence of human beings on the environment is so great that people are destroying the environment at a rate which the environment is not able to replenish itself. This is due to the increasing population pressure, change in lifestyle, and factors like industrialization, which have resulted in exploitation of environmental resources for economic purposes. Hence, humans have a greater role to play in the conservation of the environment and natural resources. Some human culture and tradition have helped in conservation of the environment.

In Bhutan, most of the natural features like rivers, lakes, rocks, and trees are considered important religious sites. A blend of Animism, Bön, and Vajrayana Buddhism, has protected Bhutan's natural environment, allowing about two-thirds of the nation to remain under forest cover. But, how long can this coexistence endure?

Competencies:

- Evaluate one's own ecological footprint to understand how lifestyle influences resource consumption and waste generation, and infer its impact on the state of carrying capacity of the locality.

3.1 People and Resource Consumption (150 minutes)

(Scope: Lifestyle and resource consumption)

Learning Objectives: At the end of the lesson, the learner should be able to:

- analyse the relationship between lifestyle and the resource consumption.

Learning Experiences

The term 'lifestyle' refers to the way people live, which is influenced by the natural environment, social, economic, cultural, political, and other conditions people live in. It is generally expressed through our consumption patterns, habits, attitudes, tastes, and moral standards. In recent years, advancement in science and technology has also brought about major changes in people's lifestyle. Today, the entire world population of 7.8 billion, and people on the Earth are using more of its resources than it can provide or regenerate. Every new born person is a new consumer, which adds to that increasing demand for resources and space. Some of us take or consume far more resources than others, which can lead to more exploitation and extinction. Therefore, we must find ways or steps to make our consumption sustainable.

The learner may watch the video from the weblink <https://bit.ly/3vcTsBS> to find relationships between lifestyle and resource consumption.

The learner carries out Activity 3.1 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> to understand more on changing lifestyle and resource consumption, and make a presentation to the class or upload the report in the Google classroom for peer review.

Further, visit website Population and Resources at <https://bit.ly/2N9wIBO> or the learner may explore more for deeper understanding of the topic.

Question

1. Based on the information gathered through the reading and the video, explain the factors that influence the resource consumption.
2. What generalization can you draw between the resource consumption and the lifestyle?
3. The use of smartphones is becoming mandatory. How has the use of technology influenced your lifestyle?
4. What type of lifestyle will you adopt to minimize your resource consumption?

Assessment and Reporting

Teachers may develop rubrics emphasising on comprehension of the concepts, and skills such as analysis, interpretation, articulation demonstrated by the learner. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NCFSE- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Future generation story - <https://bit.ly/3vcTsBS>
4. Population and resources - <https://bit.ly/2N9wIBO>

3.2 Ecological Footprint (150 minutes)

(Scope: Ecological footprint and factors which influence ecological footprint, Calculating ecological footprint)

Learning Objectives: At the end of the lesson, the learner should be able to:

- explain the concept of Ecological Footprint based on the factors that influence it.
- calculate one's own ecological footprint to interpret the resource consumption.

Learning Experiences

A lot of resources are consumed by people to improve their lifestyles. The resources required are derived from the bio-productive areas of the Earth. Bio-productive areas of the Earth include both land and sea, which provide resources people consume and absorb the waste generated. Cropland, grazing land, forest, built-up land and fishing grounds are some examples. The amount of resources required by people and its availability in the bio-productive areas is best explained by Ecological Footprint. The Ecological Footprint is the area of productive land and water ecosystems required to produce the resources that the population consumes and to absorb the wastes that the population produces. How does the ecological footprint affect the resource consumption? What must one do to ensure that the resources are conserved for the future generations?

The Ecological Footprint is the only metric that compares the resource demand of individuals, governments, and businesses against Earth's capacity for biological regeneration. Ecological Footprint analyzes the consumption and lifestyles of an individual, country or any activity against nature's ability to

provide resources for consumption. This tool can provide information by examining the extent to which a nation uses more or less than is available within its territory, or the extent the nation's lifestyle would be replicable to worldwide. The Ecological Footprint can also be a useful tool to educate people about the carrying capacity and over-consumption to change the lifestyle of people.

Access the information on ecological footprint at <https://bit.ly/3epfuLH> and <https://bit.ly/2Og6Gx2>

Now, locate an Ecological Footprint calculator. It will ask for your eating, driving, travelling and energy-using habits. All of these factors get added into a formula that should give you an approximate calculation of how many resources you use. The learner checks out a sample Ecological Footprint calculator available at <https://www.footprintcalculator.org> from the Global Footprint Network.

Learner may carry out the Activity 3.3 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

After calculating the Ecological Footprint, analyse and interpret the findings.

Question

1. Explain Ecological Footprints in your own words.
2. Rationalise the purpose of calculating the Ecological Footprint.
3. Illustrate your Ecological Footprint in the form of pie diagram by using the information from the summary chart.
4. Why do environmentalists around the world insist that every person strive to reduce their ecological footprint?

Assessment and Reporting

Teachers may develop and use checklists, rubrics or any other assessment tools to assess a learner's content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Ecological footprint animation - <https://bit.ly/3epfuLH>
4. Ecological footprint explained - <https://bit.ly/2Og6Gx2>
5. What is ecological footprint? - <https://www.footprintcalculator.org>

3.3 Reduction of Ecological Footprint (200 minutes)

(Scope: Measures to reduce ecological footprint)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *investigate and suggest measures to reduce an individual's ecological footprint.*

Learning Experiences

According to the Global Footprint Network, we currently consume more resources per person than our planet can produce in the same timeframe. Their calculations show that it takes the planet 18 months to

regenerate everything that we use in a 12-month period. In 2017, Earth Overshoot Day was 2nd August - meaning that by that date we had taken more from nature than our planet is able to renew in the whole year.

There are many simple things an individual can do to reduce their ecological footprint. Learn how to reduce footprint in consumption categories like transportation, housing, food and goods by visiting the suggested weblink <https://bit.ly/3epgQGh> and <https://bit.ly/3vc3vHh>.

The learner apply knowledge acquired after visiting the above suggested weblink and come up with multimedia clips or posters or banners to sensitize on the measures to reduce the individual's ecological footprint and upload it on social media for the teacher's review. Later after review, share multimedia clips or posters or banners to the public through suitable medium.

Question

1. Use a design thinking model to create an animation or illustration to explain the ways of reducing one's own ecological footprint.
2. List some initiatives to change your lifestyle to reduce your Ecological Footprint.

Assessment and Reporting

Use rubrics to assess learner's learning that is exhibited in multimedia clips or posters or banners. Emphasis should be focused on content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Reduce your ecological footprint - <https://bit.ly/3epgQGh>
4. Eight ways to reduce ecological footprint - <https://bit.ly/3vc3vHh>

Challenge Your Thinking:

1. Name three components of the bio-productive land that influence the Ecological Footprint.
2. Forest plays a dual role in influencing the Ecological Footprint. What are they?
3. Discuss the factors that are responsible for the changes in lifestyle with reference to Bhutan.
4. Explain ways of controlling one's own Ecological Footprint.

Chapter 4: Natural Resource Degradation

Natural processes and human activities put pressure on natural resources. Humans have been exploiting the natural resources since the start of the industrial revolution in the 18th century. The quality of the natural resources has been deteriorating due to various forms of pollution, such as air, water and soil. The quantity and the quality of the resources have been in decline due to deforestation, land degradation and biodiversity loss. The environmental degradation has had various implications on the well-being of all living organisms on the Earth.

Bhutan has one of the best conservation policies as envisioned by our leaders. Hence, Bhutan has been able to maintain a pristine natural environment. However, like other countries, Bhutan's natural resources are also under pressure resulting in various forms of natural calamities and deterioration of the health of ecosystems. The health of an ecosystem can be studied through its carrying capacity. Have you ever wondered what activities in your locality put pressure on the environment?

Competencies:

- *Classify factors of natural resources degradation and evaluate how they contribute to their degradation.*
- *Use the knowledge of carrying capacity to justify the need for change in one's own lifestyle for sustainable livelihood towards minimizing the use of natural resources.*

4.1 Natural Resource Degradation (250 minutes)

(Scope: Impacts of anthropogenic factors on natural resources degradation)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *evaluate the impacts of anthropogenic factors on natural resources degradation.*

Learning Experiences

Unlike other countries around the world, Bhutan has been able to conserve its environment fairly well so far. This is mainly due to its small population size, late start of developmental activities, and timely implementation of sound environmental conservation policies and laws. Despite that, Bhutan's natural resources are increasingly coming under various pressures mainly due to gradual increase in population, urbanisation, industrialisation and change in people's lifestyles. Furthermore, the increasing frequencies and intensities of natural disasters intensify the pressures. The pressures on natural resources either deteriorate the quality of the available resources or reduce their availability. This leads to natural resource degradation, which in turn results in the environmental degradation.

Learner explore more on natural resource depletion from weblink at <https://bit.ly/2ObqGBc> or other online resources like the types of land degradation in Bhutan at <https://bit.ly/3qAhKCp>.

A case study given as Activity 4.1 in the Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> can be read by the learners to explore pressures on natural resources and its implication.

The learner selects one degraded plot and evaluates the impacts of anthropogenic factors on any natural resources degradation in Bhutan by using Google Earth. Identify the consequences of the impact and present to the class or upload it in the Google Classroom.

The learner may visit one degraded area within the locality and identify the consequences of the impact of degradation. Make narration on factors that have caused degradation. Use photographs and illustration with effective use of ICT to create awareness on impacts of natural resource degradation. Use social media platforms like Facebook, Telegram, WeChat and other relevant platforms to enhance the outreach.

Question

1. List down the anthropogenic causes of degradation of natural resources in your locality.
2. Sacred lakes, places and mountains help in preserving the natural resources. Explain.
3. Predict Bhutan's future in terms of natural resources preservation with the present rate of development.

Assessment and Reporting

Use rubrics or checklists to assess learner's learning from exploring the Google Earth or field visit. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC – 2019
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. What is natural resource depletion? - <https://bit.ly/2ObqGBc>
4. Types of land degradation in Bhutan - <https://bit.ly/3qAhKCp>

4.2 Carrying Capacity of the Earth (250 minutes)

(Scope: Carrying capacity, carrying capacity overshoot and factors that influence carrying capacity of the Earth)

Learning Objectives: *At the end of the lesson, the learner should be able to:*

- *explain the carrying capacity overshoot and deduce the carrying capacity of the Earth.*

Learning Experiences

When a population surpasses its carrying capacity it enters a condition known as overshoot. Populations always decline to (or below) carrying capacity. How long a population stay in overshoot depends on how many stored resources there are to support their increased numbers. Resources may be food or any resources that help to maintain their numbers. For humans, one of the primary resources is energy whether it is tapped (sunlight, wind, biomass) or stocks (coal, oil, uranium). A species usually enters overshoot when it taps a particularly rich but exhaustible stock of a resource.

The carrying capacity of a given ecosystem can be extrapolated to larger ecosystems, or even the whole world. Extrapolation of simple calculations of the carrying capacity of an ecosystem to the Earth can give us insights into the capacity of the Earth's resources to support life on the Earth.

The learner studies the carrying capacity overshoot graph available at <https://bit.ly/2N1w74S> and deduce the factors that influence the carrying capacity.

The learner interviews their parents to find out the total land availability to the family. Calculate the carrying capacity of the land based on the family member. Interpret information in the form of graphs to explain the carrying capacity. Upload the graph in the Google Classroom or share in the class for assessment.

For more information on carrying capacity of the Earth, visit Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Question

1. What factors help to prevent populations reaching their carrying capacity?
2. “Carrying capacity is the Earth’s limit”. What would happen to the well-being of humans if the human population exceeds the carrying capacity of the Earth?

Assessment and Reporting

Use rubrics or checklists to assess learner’s learning in interpreting carrying capacity information into graphical representation. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Carrying capacity and overshoot - <https://bit.ly/2N1w74S>

Challenge Your Thinking:

1. With the construction boom in the country, there are lots of timber extraction activity. Explain the impacts of this activity on the carrying capacity.
2. Explain any policy or law implemented in Bhutan to minimize the natural resource degradation.
3. What do you think are the possible reasons for the increase in Black necked crane population in Phobjikha? Give at least two reasons.
4. Browse websites to retrieve data on degradation of natural resources in Bhutan. Interpret the data in terms of the status and impacts on human life.

Chapter 5: Environment Degradation and Disaster

The environment is our life support system. We already learnt that it supplies the basic necessities for life, such as food, shelter, water, air, soil, energy, medicines, fibres, raw materials, and many other things. The environment maintains atmospheric composition and protects all life forms on the Earth. As the dependence of humans on the environment accelerates, the quality of environment degrades at a greater pace, leading to various kinds of man-made disasters, and may trigger natural calamities. We all feel the impact of environmental degradation and disaster on our health, social life, economy and politics. In this chapter, we shall study the relation of environmental degradation to natural calamities and disasters, and some strategies to reduce the impacts of disasters.

Competencies:

- *With the knowledge and understanding of disaster mitigation process and the phases of Disaster Risk Management (DRM), develop a disaster risk management plan and implement to promote safety of school and community.*

5.1 Environment Health and Disaster (200 minutes)

(Scope: Environmental health and disaster)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *correlate environmental degradation with disaster.*

Learning Experiences

The environment by itself remains stable due to the ecological balance in nature. The degradation of the environment occurs as people carry out excessive exploitation and unscientific management of natural resources in craving for fast materialistic development. There is evidence of environmental degradation leading to a series of disasters that impact the life of every person.

Let us explore a few examples of how a catastrophic and misguided interference with nature results in disaster and impacts the human life. The learner may visit <https://bit.ly/3cgKhI1> and <https://bit.ly/30rjbZn> to find out correlation between environmental degradation and disaster.

The learner may explore more examples from the internet and from books from the school library. What kind of disaster might occur if environmental degradations are left unchecked? Why?

The learner carries out Activity 5.1 from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> to investigate environmental degradation in the locality. Write a comprehensive report based on your findings and share it with the whole class.

Based on the sample activity, the learner writes a comprehensive report on the findings. Poster may be designed using relevant ICT tools. Share posters to create awareness to conserve the environment to minimise disaster through relevant social media platforms.

Question

1. What are the impacts of environmental degradation on people's livelihood?
2. Relate environmental degradation to changing lifestyle of people.
3. Illustrate how the community can contribute toward minimizing the environmental degradation.

Assessment and Reporting

Use rubrics to assess learner's learning in investigating relationship environmental degradation and disaster. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Dust bowl - <https://bit.ly/3cgKh11>
4. The great sparrow campaign was the start of the greatest mass starvation in history - <https://bit.ly/30rjbZn>

5.2 Disaster Risk Management (200 minutes)

(Scope: Disaster risk management phases-Pre-disaster, response, and post disaster)

Learning Objectives: At the end of the lesson, the learner should be able to:

- develop school disaster risk management plan incorporating the phases of DRM to reduce the impact of a disaster.

Learning Experiences

Bhutan is vulnerable to a range of natural disasters, including floods, earthquakes and landslides. Different forms of disasters affect the condition of the environment and people's lives. The effects of any disaster are of varied nature and magnitude. At times, a disaster may lead to another disaster. For example, a flood leads to an epidemic.

Disasters are seen as catastrophic events beyond human control. However, their impacts on the environment and humans can be minimized by following proper Disaster Risk Reduction (DRR) procedures. Understanding disaster risk, improving disaster management systems, and investing in DRR by preparing Disaster Management and Contingency plans, including evacuation plans are some of the ways to reduce the disaster risks and its impacts.

Now, let us explore "Disaster Management and Contingency Plan" for any dzongkhag available at <https://bit.ly/3bw7IDj>. Evaluate if the plans have ways to reduce the disaster risks and its impacts. Share your views to the class.

Disaster Risk Management includes a wide range of actions, whose primary aim is to lessen the impacts of natural hazards and technological disasters. These actions are divided into steps of the disaster management cycle as shown in Figure 5.1.

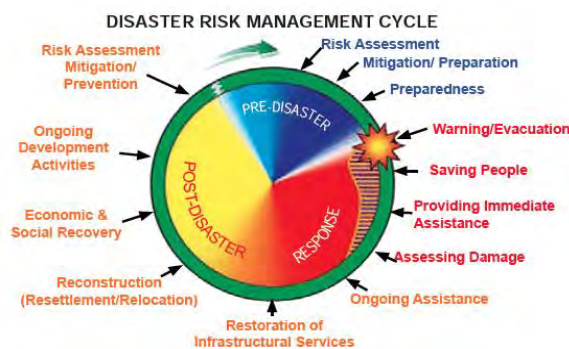


Figure 5.1 *Disaster Management Cycle*

The learner browses relevant internet sources to find out more details of the steps of Disaster Management Cycle.

Watch the video on Disaster Risk Management at <https://bit.ly/30wf6mt>.

Apply the knowledge to review the school disaster risk reduction management plan. Provide appropriate suggestions to be incorporated in the plan. In groups, advocate the plan to general students to ensure the safety in the school.

Question

1. What is disaster risk reduction?
2. Why do schools need disaster risk reduction management plans?
3. Prepare a disaster risk management plan for your house along with the risk map. Create awareness among the family members.

Assessment and Reporting

Use rubrics or checklists to assess learner's learning to develop disaster management plans. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Dzonkhag disaster management contingency plan - <https://bit.ly/3bw7IDj>
4. A decade of progress in disaster risk management - <https://bit.ly/30wf6mt>

5.3 Disaster Mitigation (200 minutes)

(Scope: Mitigation, challenges of disaster mitigation process)

Learning Objectives: At the end of the lesson, the learner should be able to:

- analyse the challenges in the disaster mitigation process and address through proper measures.

Learning Experiences

Mitigation focusses on long term measures for reducing the risk and impact of a hazard or disaster. These activities are designed to reduce the risk of loss of life and injury with good evacuation plans, environmental planning, and standard structural designs. For example, improving the quality of structures of schools, houses and other buildings minimize the risk during a disaster

Let us watch a video “What caused the flash floods in Chamoli, Uttarakhand” from the web link <https://bit.ly/38rcKcY>. The learner may watch similar videos available on the internet. Hydro power projects in Bhutan are also at risk for such an event that would lead to disaster. Relate the situation in Bhutanese context and list down some mitigation measures.

The learner in groups can assess mitigation of a family. A sample Activity 5.5 “Family emergency plan” from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> can be adopted to assess mitigation processes. Identify the challenges faced by the family.

Meet with the school disaster focal person to further discuss the disaster mitigation plan in place, identify challenges and ways of curbing it. Develop and share some mitigation measures to be suggested to the family.

Question

1. What actions are taken by the government to reduce the risk from hazards?
2. How would a disaster impact the communities and environment if there is no mitigation measure?
3. What should be the roles of the community in making their places safe to live and work?

Assessment and Reporting

Use rubrics or checklists to assess learner’s learning to assess mitigation measures to prevent disaster. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. What caused the flash floods in Chamoli, Uttarakhand? - <https://bit.ly/38rcKcY>

Challenge Your Thinking:

1. Forest fire is very prone during winter in Bhutan. Identify some mitigation measures to prevent forest fire.
2. Disaster is human made; therefore, they are responsible for mitigation of hazards. Relate hazards, risk and disaster to strategize mitigation plans
3. Identify few challenges in mitigating risk of floods in Bhutan.
4. How does disaster management cycle help to reduce the impacts of disaster?

Chapter 6: Pollution and Climate Change

Natural events and human activities contribute to the pollution of soil, water, and air. The polluted air is generally composed of dust particles, gases and water particles. Some of these gases, such as carbon dioxide, nitrous oxide, chlorofluorocarbons, and methane are greenhouse gases. These gases in the atmosphere deplete the ozone layer, and cause global warming. Global warming causes the global temperature to rise which brings changes in weather and climate patterns. Climate change has significant influence on the life cycles of plants and animals, and also brings challenges to our environment.

Competencies:

- *Analyze the relationships of greenhouse effect with global warming and climate change, and assess the risk posed by them to social, physical, economic and wellbeing of people and the environment.*
- *Justify the role of phenology as biological indicators of climate change by making predictions based on the past available data and develop strategies or plans to minimize the causes of climate change.*

6.1 Greenhouse Effect (150 minutes)

(Scope: Relationship between Greenhouse effect and global warming)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *explain the greenhouse effect by using a model and relate it with global warming.*

Learning Experiences

The greenhouse gases, such as water vapour, carbon dioxide, methane, nitrous oxide and fluorinated gases in the atmosphere are capable of trapping the infrared radiation radiated from the Earth surface that help to maintain the average temperature of the Earth. This phenomenon is known as the greenhouse effect. Without greenhouse effect, there would be no weather on the Earth. The temperature of the Earth would be about -18°C instead of its present 15°C .

With modern urbanization and industrialization, humans have been releasing more quantities of greenhouse gases into the atmosphere, thus contributing to enhanced greenhouse effects. The enhanced greenhouse effect traps more heat and gradually increases the average temperature of the Earth.

The learner uses “greenhouse effect simulation” available at <https://bit.ly/2Om8tRc> and uses design thinking to come up with a greenhouse model and correlate the phenomena in real context.

More information on greenhouse effect is also available at <https://on.nrdc.org/3t6q7ax> and <https://bit.ly/3eqTv7q>. Explore other relevant sources from internet and library.

The learner gathers evidence of global effect in the community and impacts on the life of people.

Question

1. Correlate greenhouse effect with global warming.
2. What impact will rising greenhouse gases have on climate?
3. How do you justify the increase in global warming in the world?

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learner’s learning to check the design thinking in development of a greenhouse model. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Greenhouse effect simulation - <https://bit.ly/2Om8tRc>
4. Greenhouse effect 101 - <https://on.nrdc.org/3t6q7ax>
5. The enhanced greenhouse effect - <https://bit.ly/3eqTv7q>

6.2 Climate Change (150 minutes)

(Scope: Climate change, factors causing climate change and its impact at national and global level)

Learning Objectives: At the end of the lesson, the learner should be able to:

- evaluate risks that climate change poses to agriculture, water, human health, national security, and ecosystem.

Learning Experiences

The anthropogenic greenhouse gases enhance absorption of heat from the sun in the atmosphere and reduce the amount of heat escaping into space. This extra heat is among the primary causes of observed changes in the climate system over the 20th century.

Climate change refers to the change of weather patterns over the periods of time that may range from decades to millions of years. The changing climate constantly affects people and the environment in many ways. People experience effects of climate change, such as stronger hurricanes, severe heat waves, heavy precipitation and droughts. Some of these effects of climate change are life threatening. On the other hand, longer growing seasons for crops can be good. However, as the Earth keeps getting warmer, the negative effects are expected to outweigh the positive ones.

The Earth’s climate is dynamic and always changes through natural cycles. Such changes have occurred for millions of years that always cause changes in the weather and climatic patterns. However, today the climate change that we are concerned about is primarily caused by human activities.

The learner watches “Climate Change - We are the problem & the solution (Animated Infographic)” from the web link <https://bit.ly/2OqdnMG>. The animated infographic clip explains the science behind accelerated climate change, how it affects the Earth, why an individual needs to act on the issue and how an individual can contribute to the solution.

There is also explanation on the concept of climate change available at <https://bit.ly/2OsEEy1>. The information on climate change and its impact in Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn> can also be used to learn about climate change and its impacts.

Applying the knowledge on climate change and its impacts, the learner designs a multimedia clip or poster to advocate on impacts of climate change within their local community. Some suggestive measures must be included in the advocacy tools.

Question

1. How will global climate change influence ecosystems?
2. How can a change in global average temperatures impact our lives?
3. Rising sea levels would affect mountainous countries like Bhutan. Justify.
4. What are the objectives of Bhutan's initiative to remain carbon negative?
5. How does climate change affect the life of Bhutanese farmers? Justify with the real time evidence.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' multimedia clip or poster. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 202
3. "Climate Change - We are the problem & the solution (Animated Infographic)" - <https://bit.ly/2OqdnMG>.
4. Concept of climate change - <https://bit.ly/2OsEEy1>

6.3 Initiatives on Climate Change *(150 minutes)*

(Scope: Global initiatives and national initiatives to combat and mitigate climate change)

Learning Objectives: At the end of the lesson, the learner should be able to:

- analyse the salient features of national and global regulations on climate change.

Learning Experiences

Bhutan's development is highly dependent on climate-sensitive sectors such as agriculture, hydropower, and forestry. The most significant impact of climate change in Bhutan is the formation of supra-glacial lakes due to the accelerated retreat of glaciers with increasing temperatures. Bhutan's entire northern region has glacier/snow-fed lakes near its mountaintops. With a majority of Bhutan's population and infrastructure development concentrated in large river valleys, climate-induced Glacial Lakes Outburst Floods (GLOFs) could cause significant human and economic devastation.

There has been a rise in temperature of about 1°C in summer and 2°C in winter since 2000; reduction in irrigation water availability in some areas and other global warming effects; shifting precipitation patterns; changing growing zones; more severe weather; and worsening of air and water pollution and water scarcity. Since climate change is a global concern, various measures to combat and mitigate the causes of climate change are initiated at global, regional and national levels.

Let us explore some global initiatives to combat and mitigate climate change by surfing the internet. While surfing the internet, focus on initiatives such as Earth Summit, United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Paris Agreement.

The learner completes the Table 6.1 by applying the knowledge acquired from surfing the internet.

Table 6.1: *Global initiatives on climate change*

Global Initiatives	Institution date	Objective	Actions taken on climate change
Earth Summit			
UNFCCC			
Kyoto Protocol			
Paris Agreement			

The learner interviews a Dzongkhag Environment Officer or any local leader (*gup, tshogpa, mangmi*) to find out various initiatives taken to combat and mitigate climate change. Frame questionnaire for the interview with the help of a teacher. Write a report of the finding and share to the class. Upload it in the Google Classroom. The learner may write the finding in the environmental profile book.

More information on initiatives on climate change can be assessed from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>

Further, view the video at <https://bit.ly/3140dS8> and <https://bit.ly/2OC6JTO>

Applying the knowledge of global and national initiatives on climate change, develop a climate change mitigation measure that can be practiced at the school, household or at community level. Share the measures to bring changes at individual or community level. Use relevant platforms to share the information.

Question

1. What are the benefits of Bhutan being a member of Kyoto Protocol?
2. List down three strategies adopted by Bhutan towards climate change.
3. How is UNFCCC relevant to Bhutan?
4. What are some of the sacrifices that Bhutan has to make as signatory to international conventions on climate? How do these commitments affect Bhutanese people in different areas of development?

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess how interview questionnaires are relevant and report writing of their findings. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. New UN climate change initiatives - <https://bit.ly/3140dS8>
4. Innovative climate action initiative from Swedish firm welcomed by UNFCCC - <https://bit.ly/2OC6JTO>

6.4 Phenology (100 minutes)

(Scope: Phenology and its importance, and factors influencing phenology)

Learning Objectives: At the end of the lesson, the learner should be able to:

- describe and explain different phenophases of plants.

Learning Experiences

The environment changes under the influence of various factors and conditions. The biotic components of an ecosystem respond to the changes in order to survive and reproduce. Organisms demonstrate morphological and physiological changes with the changing physical conditions of the environment.

Phenology is a science to measure the timing of life cycle events (phenophases) for plants, animals, and microbes, and infer how the environment influences the timing of those events. Observed phenological events include sprouting and flowering of plants in the spring; changing of colour of plants in the fall; birds migrating; insect hatching and animals hibernating. The timing of phenological events is sensitive to environmental conditions.

The learner identifies any plant within the school compound or around your house. Observe the phenophases of that plant on a periodic basis for 2 months. Take photographs and record any other information you think is useful, and maintain a record in your environmental profile.

The timing of phenophases tends to vary in between years based on patterns of weather, climate and resource availability. Since phenological studies are based on environmental sensitivity, they are simple and cost-effective ways to measure the environmental changes, including climate change over the long-term.

Phenology study has been found to be viable and an engaging citizen science program that stimulates significant interest and support from public and schools. It provides insightful information about the impacts of climate change on the phenology of plants and animals. Besides generating yearly phenological records, it also promotes broad understanding and appreciation of nature among the younger generation and citizens.

For more information on phenology, visit <https://bit.ly/3c7sH9b> or browse the internet to search relevant information. Similarly, phenology information can be assessed from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Learners interview few farmers in the locality to collect information on how they apply the knowledge of phenology in farming and in other spheres of their life. Prepare a Nature Notebook available in websites as a report to communicate their interesting findings to the class.

Question

1. What are the factors that influence phenology?
2. Every winter, black necked cranes migrate to Bhutan from Tibet. What are the cues that the cranes use to start their migration?
3. How do people use the knowledge of phenology for anthropogenic activities?
4. How do you relate phenophases with climate change?

Assessment and Reporting

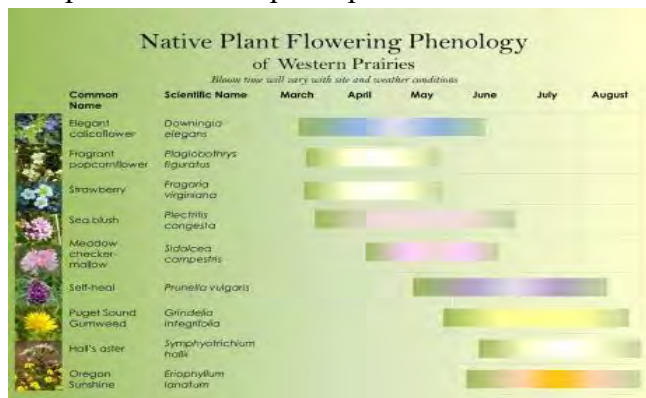
Use rubrics or checklists or any other assessment tools to assess learner’s observation skills and their recording skills in the environmental profile. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Phenology and climate change - Changing natures clock - <https://bit.ly/3c7sH9b>
4. Equipments required – Camera, Digital thermometer, Digital Hygrometer, Digital Rain Gauge, Altimeter

Challenge Your Thinking:

1. How does global climate change influence biodiversity and the causes of extinction of species?
2. List some initiatives at individual level to maintain the carbon negative status of our country.
3. Collect data on arrival and departure dates of Black-necked Cranes of over 5 years from the link <http://www.rspnbhutan.org/> or call Royal Society of Protection of Nature, Bhutan and Analyse the data to predict and explain phenology of Black-necked Crane in next 10 years.
4. Correlate the importance of phenology to understand climate change.
5. Study the picture and interpret in terms of phenophases.



You can assess the above image from <https://bit.ly/3ehis1A>

Chapter 7: Biodiversity and its Conservation

Conservation of biological diversity is important for the survival of all life forms. Without a healthy biodiversity, there will be adverse effects on livelihoods, ecosystem services, natural habitats, and food security. Biodiversity is under threat as a result of human activities, such as population growth and resource consumption; climate change and global warming; habitat conversion and urbanisation; and introducing invasive alien species. To conserve and enrich biodiversity, the government has initiated various conservation efforts like in-situ and ex-situ, including the implementation of stringent legislations and policies. Traditional conservation practices also contribute to conservation of biodiversity. Through the efforts for the conservation of biodiversity, the survival of many species and habitats threatened by human activities is ensured

Competencies:

- *Assess the threats to different types of biodiversity in Bhutan and develop creative and technological solutions to promote the conservation of biodiversity.*

7.1 Biodiversity (200 minutes)

(Scope: Biodiversity and its types and measuring biodiversity)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *carryout study on species diversity in a local ecosystem.*

Learning Experiences

An ecosystem is a community of living organisms, together with the physical environment they occupy at any given time. Our planet as a whole is an ecosystem, but it contains many others: forests, deserts and rivers which are themselves made of smaller ecosystems. Different kinds of plants, animals and microorganisms live and interact in an ecosystem. Different organisms are collectively known as biodiversity. It varies from one ecosystem to another. A rich biodiversity is very important for maintaining the stability of an ecosystem. How does this happen?

Visit your library and explore the types of biodiversity. Internet sources can also serve as the information. Maintain notes and upload it in Google Classroom for review by your teacher.

Biodiversity of a habitat is quantified by taking into account the number of species present, as well as the abundance of each species. As species richness and evenness increase, so diversity increases. Simpson's Index of Diversity is a measure of diversity which takes into account both richness and evenness.

Now let us learn how to calculate species diversity using quadrat sampling and Simpson's Diversity Index. Information on quadrat sampling is available at <https://bit.ly/3rokhkf>. Simpson's Diversity Index is available at <https://bit.ly/3c1SWho> and can be assessed from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Apply the knowledge on calculation of species diversity and calculate diversity of three to four plots. Plot a graph using the data collected. Analyse the diversity for different plots and interpret the findings.

Question

1. Identify the predominant species from each plot. What could be the possible reason?
2. What can you conclude from your study?
3. Draw some importance of calculating diversity in conservation of natural resources?

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learner's observation, recording and calculation process. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Quadrat sampling - <https://bit.ly/3rokhhk>
4. Simpson's Diversity Index - <https://bit.ly/3c1SWho>
5. Equipments required - Quadrat

7.2 Biodiversity Inventory (150 minutes)

(Scope: Flora and fauna diversity in Bhutan, and Biodiversity inventory)

Learning Objectives: At the end of the lesson, the learner should be able to:

- maintain Biodiversity inventory.

Learning Experiences

Biodiversity inventory is an attempt to document and identify all biological species living in some defined area, usually a park, reserve or research area. These inventories are usually presented in the form of species lists, which are important for identifying rare or threatened species, useful or harmful species, geographical distribution of species and new species for research on future industrial and agricultural application. Inventories also provide data for establishing biodiversity patterns and endemism and evolution.

Biodiversity inventories are important because ecosystem management requires baseline data on the occurrence, distribution, and the state of biodiversity for a defined area. Information from a species list can be used to calculate the percent of species per area. For example, the result of an inventory of a wetland habitat may include 40% birds, 25% toads and frogs, 15% snakes, and 20% lizards.

The information on the threatened and endangered species of plants and animals of Bhutan can be obtained from the web link <https://bit.ly/3kL3xBr> or any other relevant web sites. Established in 1964, International Union for Conservation of Nature (IUCN) Red List of Threatened Species provided global conservation status of animal, fungi and plant species. The category are data deficient (DD), least concern (LC), near threatened (NT), Vulnerable (VU), Endangered (EN), critically endangered (CR), Extinct in the wild (EW) and extinct (EX). Now, let us document biodiversity of the school compound. Develop and record the findings in a table. The Table 7.1 is a sample developed for you.

Table 7.1: Biodiversity inventory

Species	Number observed	Habitat	Category
Eg. Deer	12	Grassland, forest	Least concern

Use the data and calculate Simpson's Diversity Index. Determine the potential diversity of school.

Similarly, conduct inventory outside the school area. Compare the species counts in the school compound with species counts of the new area. Which area has higher biodiversity?

The learner does a library research to identify endangered flora and fauna of the country. Record the findings with pictures and drawings followed by a short description. Upload in relevant social media platforms for public awareness.

There is information on flora and fauna in Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>.

Question

1. Rich biodiversity maintains the stability and health of an ecosystem. Justify.
2. Biodiversity contributes to the economy of our country. Explain.
3. Why does Bhutan have rich biodiversity?
4. What are the important roles Bhutan can play towards the global conservation of biodiversity?

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learner's observation, identification, recording process and action plan. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NCFSS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Bhutan biodiversity information - <https://bit.ly/3kL3xBr>

7.3 Conservation of Biodiversity in Bhutan (200 minutes)

(Scope: National and community conservation initiatives, Traditional conservation practices)

Learning Objectives: At the end of the lesson, the learner should be able to:

- investigate and develop the measures to conserve biodiversity.
- design a model to address the degrading natural habitats of wild animals.
- evaluate the roles of indigenous practices in biodiversity conservation.

Learning Experiences

According to the Convention on Biological Diversity, at least 40 percent of the world's economy and 80 percent of poor people's needs are obtained from biodiversity. The benefits people derive from the ecosystem are termed as ecosystem services. Greater biodiversity in the ecosystem leads to greater stability of the ecosystem. However, global biodiversity is under serious threat due to population growth, which increases the resource consumption and waste generation affecting the climate. Identify some potential threats to biodiversity. What can we do to conserve our biodiversity?

View the video conservation at <https://bit.ly/3t3QHB4>

Revisit the school compound biodiversity inventory conducted earlier. Identify some threats to the species recorded in the findings.

Numerous conservation initiatives have been implemented for the sustenance of biodiversity. Explore through the internet and library books to find out the roles of the following organisation in conserving biodiversity.

Table 7.2: *Organisation involved in biodiversity conservation*

Organisation	Conservation roles
Department of Forests and Park Services	Protected area management, forest management, etc.
National Biodiversity Centre	
Department of Livestock	
Department of Agriculture	
Bhutan Agriculture and Food Regulatory Authority	
National Environment Commission	
Department of Geology and Mines	
National Land Commission	
Royal Society for Protection of Nature	
World Wide Fund for Nature (WWF)	
Bhutan Trust Fund for Environmental Conservation	
United Nations Development Programme	
Bhutan for Life	

For more information on biodiversity conservation, visit Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>

Now, based on the findings on school compound biodiversity inventory, design a simple action plan to conserve biodiversity. Present the plan to the school administration to seek help and guidance to conserve biodiversity of school.

Visit a nearby community to find out the indigenous practices, for example <https://bit.ly/38mmmG3>, towards biodiversity conservation and come up with a concept map and discuss their roles. Communicate the findings to the class. Upload it in the Google Classroom for teachers review.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' action plan to conserve biodiversity. Assess the investigation of indigenous practices towards biodiversity conservation. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Conservation in Bhutan: Journey of Bhutanese foresters - <https://bit.ly/3t3QHB4>
4. Buli community: Guardians of conservation - <https://bit.ly/38mmmG3>

Challenge Your Thinking:

1. Rationalize the effect of climate change on loss of biodiversity?
2. Draw the benefits that Bhutan cherishes from the rich biodiversity?
3. Explain the importance of traditional practices in biodiversity conservation?
4. Biological corridors help in conservation of biodiversity. Support with reasons.
5. Download any flora identifier App and maintain the list of the plants found in your school/ home surrounding and write their status with reference to the IUCN Red data Book.
6. Review Article 5 of the Constitution of the Kingdom of Bhutan (The Constitution of The Kingdom of Bhutan, 2008, pp 11) and states its importance towards conserving our rich biodiversity.

Chapter 8: Land Use and Management

Bhutan is an agrarian country; therefore, land is its most important resource. Land resources are used for a variety of purposes, such as farming, afforestation, infrastructure development, water management and ecotourism activities. The ways in which a land is used can be managed to minimise the degradation of forest and watersheds, and enhance the productivity of the land.

Competencies:

- Analyze the negative impacts of various land use practices to generate innovative solutions for sustainable use of land resources with minimum negative impacts on the environment.

8.1 Land Use Pattern (200 minutes)

(Scope: Land use in Bhutan and impacts)

Learning Objectives: At the end of the lesson, the learner should be able to:

- identify various land uses in Bhutan to evaluate the impacts on the environment.

Learning Experiences

The land use is defined as how humans use the biophysical, or ecological properties of the land. Land-uses include the modification and management of land for agriculture, pasture, settlements, forestry, mineral extraction and nature reserves, etc. However, land use patterns are dictated by its topography, climatic conditions, natural resources availability, population growth, economy of the society or country, etc. what are the most dominant land use forms in Bhutan.

The learner identifies land use (forest, agriculture, settlement and pasture land) change in their Dzongkhag or other Dzongkhags of their interest using Google Earth. The learner may use Web based Google Earth available at <https://bit.ly/3emVzgi> or install Google Earth software in your computer. Google Earth App is available for both Android and IOS smartphones. Based on the observation made, the learner makes an analysis of the land use trend for the past 5-10 years of their locality or one's interest. Record the observations. Design a flow chart to analyse different land use and its impacts on the environment.

Applying the knowledge of land use change, develop a smart land use model. While designing the smart model, seek help from agriculture extension officers. Share smart land use models to the community.

Question

1. Speculate the causes of the change in the land use.
2. What are some of the impacts that you foresee on the environment due to land use patterns in the locality?
3. Land use for settlement has only slightly increased over the years, but has a huge impact on the environment. Justify.
4. Explain the various land uses and land use patterns in Bhutan.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' use of Google Earth skill and development of Smart Land Use Model. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Web Based Google Earth - <https://bit.ly/3emVzgI>

8.2 Waste (200 minutes)

(Scope: Waste and type of waste)

Learning Objectives: At the end of the lesson, the learner should be able to:

- segregate waste into types on the basis of properties.

Learning Experiences

A huge amount of waste is produced everyday by humans, and is increasing with changing lifestyles of people. Traditional Bhutanese lifestyle is environmentally friendly as it generates less waste. This is because people generally use natural and organic materials. Waste produced may be solid, liquid or gas. The non-degradable wastes pollute our environment posing a serious threat to human health and the environment. Understanding the types of waste and its management is important to protect the health of living beings and the environment. What are some of the wastes produced at your home and classroom?

Let us watch a video on introduction to waste available at <https://bit.ly/2PCwXWJ>. Visit a community nearby school. Observe, identify the origin of wastes and categorize the waste into different types. Record your observation in the journal.

The information of wastes can be retrieved from Environmental Science textbook for class X (2019) or from the web link <https://bit.ly/2PPzRrn>

In the field trip, classify waste into types. Use POE model to explain reasons for generating different amounts of waste by types. To create awareness of the community, use digital tools to design posters or other means to sensitize the community on waste generation because of people's lifestyle. Display in the class, or upload in social media for peer reviews and suggestions.

Learners design a template to record non degradable waste generated with reasons on a daily basis. Periodically share the record in social media; teachers also sometimes review the record.

Lastly, this video is interesting for the youths to participate in Trash Challenge at <https://bit.ly/3v9A1Kg>

Question

1. Distinguish between hazardous and non-hazardous waste? Give examples.
2. Design a mind map of waste with types and impacts.
3. What are some of the impacts that you foresee on the environment with the present amount of waste generation?
4. Which categories of waste are common in your community? Predict reasons why some wastes are generated more than the others.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' field visit to categorise wastes into different types. Evaluate the process of how learners conduct awareness programs in the community. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Introduction to waste - <https://bit.ly/2PCwXWJ>
4. TrashTag Challenge going viral in Bhutan - <https://bit.ly/3v9A1Kg>

8.3 Waste Management (150 minutes)

(Scope: Waste management hierarchy)

Learning Objectives: At the end of the lesson, the learner should be able to:

- draw a waste management plan to manage waste in the school and the community.

Learning Experiences

Waste management is an organized strategy to control generation of wastes by minimizing their quantity and adverse impacts through administrative, financial, legal, planning and engineering functions of storage, collection, transfer and transportation, treatment and disposal. Waste management is usually based on the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations.

There is no single approach for waste management. Different waste problems require different approaches. Good waste management practices involve an integrated approach. For instance, based on sustainability, the hierarchy waste management approach is the preferred approach. What are some of the waste management practices you follow at home?

Virtually, in all countries, the waste management hierarchy is similar to that shown in the Figure 8.1.



Figure 8.1: *The waste management hierarchy*

The learner browses relevant internet sources to find out more types of waste management hierarchy. Explore for information on waste generated in Bhutan. Then study and explain waste management practices in the community. Design and implement waste segregation devices. Display in the classroom or share in google classroom.

Applying the knowledge, develop an environmentally friendly waste management plan for the school. Share the plan with school administration for effective implementation.

The learner may explore more information on waste management hierarchy from <https://bit.ly/3eguony>, Environmental Science textbook for class X (2019) or the web link <https://bit.ly/2PPzRrn>.

Finally, use the Design Thinking model to solve waste problems in the community or classroom. Make a memoir of reflection on how and why of the model for waste management in the community.

Question

1. Describe how unmanaged wastes impact the environment of the locality?
2. In Bhutan, what are the challenges faced by people on waste management?
3. What are the roles of local government/municipal (thromde) in waste management?
4. Relate waste management with the Buddhist belief and practices.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' waste management plan. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. The waste hierarchy explained - <https://bit.ly/3eguony>

Challenge Your Thinking:

1. As an literate student in the environment, how do you react when you people throw waste from cars?
2. How does waste affect the health of people and the environment?
3. Visit <https://bit.ly/3t0Z28q> “Current Waste Management System for other wastes in Bhutan” and draw a concept map showing different departments or stakeholders involved and the ways for curbing the problem.
4. Why is non-biodegradable waste a concern? Explain with examples.
5. Draw a Problem Tree of waste management in the school or home and identify with solutions.
6. Study the picture and comment on waste management practices.



Chapter 9: Energy Resources

Energy is one of the most fundamental components, which is responsible for the functioning of the universe. Humans use energy in many ways, all human activities are enhanced by energy in one form or the other. In ancient times, energy was derived mainly from burning fuels and was used to light and warm houses and cook food. Today, more energy is produced from sources such as water, solar, wind, biomass for doing different tasks making human lives better. Energy growth is directly linked to the well-being and prosperity of a country.

Competencies:

- *With the knowledge of various methods of energy conservation, design technology to save energy for economic and long-term sustenance of energy resources.*

9.1 Energy Sources (250 minutes)

(Scope: Renewable and non-renewable energy, energy sources- hydro, wind and solar, and their impacts)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *make an analysis of various sources of energy available in Bhutan to evaluate as the potential source of energy for Bhutan.*

Learning Experiences

There are many sources of energy which are classified as renewable and non-renewable. The use of some energy resources pollutes the environment, while others do not. The energy derived from the latter is considered 'green' or 'clean'. Green energy sources are considered clean since the use of such energy resources does not emit pollutants, or produce any kind of hazardous wastes. These energy sources are readily accessible all over the world.

Green energy is harnessed from renewable resources such as sunlight, wind, river water, ocean tides, plants, algae and hot springs. On the other hand, fossil fuels are non-renewable because it takes millions of years to replenish. What are some common sources of energy found in Bhutan? Is it safe to rely on one source of energy?

The learner conducts literature review using library or web resources on different types of energy sources Bhutanese are dependent on. Identify challenges and impacts faced by people while using energy. Information available at weblink <https://bit.ly/3veiJMe> and Environmental Science textbook for class X (2019) or web link <https://bit.ly/2PPzRrn> and other relevant sources can be used for the review.

The weblink at <https://bit.ly/38tLvyq> narrates the history of electricity in Bhutan. Then, represent the information in the form of mind map or concept map or in any other forms.

By using Design Thinking model, design a prototype device to generate energy. Make a report of how and why of the plan. Display in the class or upload in google classroom.

Question

1. Debate on the impacts of each energy resource used in Bhutan.
2. Enumerate the potential sources of energy in Bhutan with evidence.
3. What considerations are vital in deciding energy sources for the community or the nation?
4. Why should people pay Green tax in Bhutan?

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' literature review on different types of energy. Evaluate whether learners' ability to identify challenges and impacts faced by Bhutanese. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Renewables readiness assessment: Kingdom of Bhutan - <https://bit.ly/3veiJMe>
4. The developing of hydropower creates new opportunities and economic growth in Bhutan - <https://bit.ly/38tLvyq>

9.2 Conservation of Energy (250 minutes)

(Scope: Purposes and methods of energy conservation)

Learning Objectives: At the end of the lesson, the learner should be able to:

- develop an energy conservation plan that can be used by the school and the community.

Learning Experiences

Energy is important for the functioning of all the living organisms and the environment around us. Energy is an indispensable component of industrial product, employment, economic growth, people's lifestyle, and the environment. In the past, the demand for the energy resources was less. However, with the increase in population and rapid economic development, demand for energy increased in every sector, domestic, commercial, industrial, etc.

The need of energy conservation is felt by all countries around the world due to depletion of energy sources. Let us explore the purpose of energy conservation and methods to conserve energy.

View web link like at <https://bit.ly/30r5SIIm> to gain insights on energy efficiency.

Read information on national energy efficiency and conservation policy of Bhutan available at <https://bit.ly/3v32AsF>. More information on energy conservation is also available in the Environmental Science textbook for class X (2019) or available at <https://bit.ly/2PPzRrn>

Based on the understanding, illustrate energy conservation practices in Bhutan with explanation of how and why.

Make a survey of energy conservation practices at home or in the school. Make a presentation of the findings. What conclusion can you draw from the practices?

The learner develops an action plan to conserve energy for the school or for their house by applying the knowledge gained by reading the materials from textbook and relevant sources.

Present the plan to the school management or your parents.

Question

1. How does your action plan enhance sustainable use of energy? What are some challenges you foresee in the implementation of your action plan? Discuss the ways to overcome the challenges.
2. What are some of the factors that challenge the practice of energy conservation in Bhutan?
3. Suggest interventions for the challenges.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' action plan to conserve energy for the school or for their house. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021)

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Energy efficiency improvements among industries in Bhutan - <https://bit.ly/30r5SIIm>
4. National energy efficiency and conservation policy - <https://bit.ly/3v32AsF>

Challenge Your Thinking:

1. Why is hydropower development feasible in Bhutan?
2. Why should Bhutan conserve energy?
3. Illustrate the strategies for energy conservation in the form of an energy priority pyramid?
4. Read the pros and cons of electricity at <https://kidsdiscover.com/teacherresources/whats-good-and-whats-bad-about-hydropower/>. Analyse the pros and cons of hydropower. What is your stand? Why?

Chapter 10: Environment and Development

We all depend on the natural environment for our health, wealth and happiness. The everyday decisions that we make about how to live, what to eat and drink, what to wear, how to travel to school and work have strong influences on the environment and the society. To reduce our ecological footprint and to share the Earth's resources more judiciously, individuals and societies need to make conscious lifestyle choices based on the sustainable development principles.

With the advent of modernization, we are faced with numerous challenges to sustain our environment and cultural integrity. Bhutan is a member of various multilateral environmental agreements to pursue sustainable development goals and objectives. The concept of Gross National Happiness enunciated from the throne envisions a way to address such challenges for a balanced socio-economic development.

Competencies:

- *Relate sustainable consumption and production with the lifestyle of people and the sustainable development without compromising the health of the environment.*

10.1 Sustainable Development (250 minutes)

(Scope: Sustainable development, initiatives taken by Bhutan Government to achieve sustainable development and model of sustainable consumption and production)

Learning Objectives: At the end of the lesson, the learner should be able to:

- *devise ways to achieve sustainable consumption and production.*

Learning Experiences

We consume goods and avail services every day to satisfy our needs and desires, but the rate at which we do has a direct impact on the environment and the society. Firstly, these goods and services require natural resources, and the rate at which we consume these materials and services increases with the increasing number of people. This has immense pressure on the Earth's natural resources. Secondly, a large amount of waste is generated from the goods and services which pollute our environment.

The essence of sustainable development is maintaining a stable relationship between human activities and the natural world. This implies that the economic growth does not deteriorate the quality of environment and social life in the community. People concerned about sustainable development suggest that meeting the needs of the future depends on how well we balance social, economic, and environmental objectives or needs when making decisions today. Hence, the objective of sustainable development is to ensure that the sustainable consumption and production are sustainable.

The learner may visit the web link <https://bit.ly/3chTkIL>, <https://bit.ly/38sE4rv> and <https://bit.ly/30m1Alt> or Environmental Science textbook for class X (2019) or web link <https://bit.ly/2PPzRrn> to explore more on the goals of sustainable development.

More insight is available at <https://bit.ly/3ryxMhu> on SDG 12: Explaining responsible consumption and production.

The learner interviews two generations, one old age (more than 50 years) and younger generations (20 to 30 years) to compare the lifestyle and consumption patterns. The learner will develop the survey questionnaire with the help of the teacher. Analyze the findings.

Prepare a report to communicate the findings to the class with a message for adoption for consumption and production behavioural change.

Question

1. What can you conclude about the consumption and production in the community and among varying ages from the above survey?
2. Analyse consumption and production of people and illustrate in any form to communicate your ideas or views.
3. Suggest some measures to achieve sustainable consumption and production in your locality and inform them through different platforms.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' analysis of lifestyle and consumption patterns based on questionnaires. Evaluate the report based on the findings. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021)

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. What is sustainable development? - <https://bit.ly/3chTkIL>
4. Two minutes to understand sustainable development - <https://bit.ly/38sE4rv>
5. Sustainable development goals - <https://bit.ly/30m1Alt>
6. SDG 12 - Explaining responsible consumption and production - <https://bit.ly/3ryxMhu>

10.2 Sustainable Development Initiatives In Bhutan (250 minutes)

(Scope: Global and national initiatives for sustainable development initiatives and Challenges)

Learning Objectives: At the end of the lesson, the learner should be able to:

- identify the sustainable development initiatives and the challenges relevant to Bhutan.

Learning Experiences

Sustainable development is fundamental to the global developmental process towards promoting equitable, social and economic well-being of people. Bhutan upholds its commitment to the future generations through the alignment of national developmental priorities with the global sustainable development goals. At the global level, Bhutan is signatory to various international treaties and conventions.

Environmental Science textbook for class X (2019) or web link <https://bit.ly/2PPzRrn> provides more information on sustainable development initiatives in Bhutan.

The learner watches the video from the web link <https://bit.ly/2N0uEMm> “Group of experts boosts Sustainable Development in Bhutan” or visit libraries or search relevant information and review various sustainable development initiatives in Bhutan.

The weblink provides information on the global initiatives on sustainable development <https://bit.ly/3eqMO4Y>. Further, view videos available at weblink <https://bit.ly/3rEEaE4> and <https://bit.ly/2PQw64Y>.

Based on your understanding on the sustainable development initiatives, make an analysis of sustainable development of Bhutan including the challenges in implementation in context to the SDG. Make a presentation to the class or upload in Google Classroom.

Question

1. Justify how the SDGs are for the wellbeing of the world’s people and environment.
2. What are some of the challenges in the implementation of the above initiatives?
3. Justify GNH as the SGD for Bhutan.
4. Assess the advantages and disadvantages of sustainable development in the eyes of rural communities in Bhutan.

Assessment and Reporting

Use rubrics or checklists or any other assessment tools to assess learners' presentation on the analysis of sustainable development of Bhutan including the challenges in implementation in context to the SDG. Emphasis to assess the content knowledge, environmental process, and scientific values and attitudes to assess the poster design. For recording and reporting, refer to the New Normal Curriculum Framework in Science (NNCFS- 2021).

Resources:

1. Environmental Science Textbook for Classes X, REC - 2019 Edition
2. New Normal Science Curriculum Framework Class PP - XII, 2020
3. Group of experts boosts sustainable development in Bhutan - <https://bit.ly/2N0uEMm>
4. Initiatives to achieve SDGs - <https://bit.ly/3eqMO4Y>
5. Sustainable development goals: 17 ways to act - <https://bit.ly/3rEEaE4>
6. How can we make the world a better place by 2030 - <https://bit.ly/2PQw64Y>

Challenge Your Thinking:

1. Sustainable consumption can ensure that the environment has resources available for the future. Justify with relevant examples.
2. What components of SDG are related to the wellbeing of the people?
3. Compare the Bhutan’s initiatives for sustainable development with the global initiatives.
4. How do the developing countries benefit from sustainable development?
5. Study the diagram on “*Rethinking Sustainable Development in terms of Commons*” and elaborate its meaning based on your understanding.

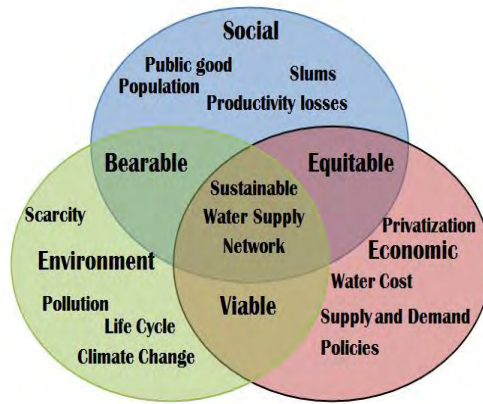


Figure adopted from <https://blog.p2pfoundation.net/33764/2013/10/18>

Appendices I: Checklist and Rubrics

Sample Checklist for continuous formative assessment (CFA) on three assessment domains in environmental science

Sample checklists: Scientific Knowledge (SK)

No.	Class:	Scientific Knowledge (CK) Topic: Ecosystem - Organisation and types					
	Key: √ - Yes X - No Learning objectives Name:	Explains ecosystem	Describes biome, niche and ecology	Describes levels of ecosystem	Explains the role of components and interactions in an ecosystem	Recognizes habitats, dominant plants and animals	Comments
1	Tshering						
2	Wangmo						

Sample checklists: Working Scientifically (WS)

No.	Class:	Working Scientifically (WS) Topic: Ecosystem - Organisation and types							
	Key: √ - Yes X - No Learning objectives Name:	Follows the activity instructions correctly.	Participates actively in group activities .	Records the observation appropriately.	Identifies the raw materials needed for exploring ecosystem	Records all the biotic and abiotic components of ecosystem	Has a ability to use observations to answer the questions in the learning activities	Displays ability to collect relevant photographs, notes and information experiments .	Comment
1	Choeki								
2	Jigme								

Sample checklists: Scientific values and attitudes (SVA)

No.	Class:	Scientific Values and Attitudes (SVA)						
	Key: √ - Yes X - No Learning objectives Name:	Topic: Ecosystem - Organisation and types						
		Respects others views in the group discussion.	Shares responsibilities in carrying out activity.	Shows cooperation in group discussion and activities.	Demonstrates willingness to learn and try new things.	Exhibits concerns for self, others and	Demonstrates curiosity to learn more on the topic.	Comments
1	Tashi							
2	Zomba							

Sample Rubrics for continuous formative assessment (CFA) on three assessment domains in Environmental Science

Domain	Criteria	Performance Rating				Remarks/ Feedback
		Exceeding (4)	Meeting (3)	Approaching (2)	Beginning (1)	
SK	Explanation of Concept	Explanation is thorough and specific. All the ideas are clearly explained.	Explanation is thorough but not specific. Most ideas are explained.	Explanation is not thorough and not specific. Few ideas are explained.	Explanation is not thorough and ideas are not explained.	
	Stating Example	Example is meaningful and specific. All the concepts are supported with an example.	Example is meaningful but not specific. Most of the concept are supported with an example.	Example is not meaningful and not specific. Only few concepts are supported with an example.	Example is not meaningful and not specific. The concepts are not supported by an example.	
	Making Analysis	Organizes and synthesizes evidence to reveal insightful patterns, differences, or similarities related to all the concept.	Organizes evidence to reveal important patterns, differences, or similarities related to the most concept.	Organizes evidence, but the organization is not effective in revealing important patterns, differences, or similarities.	Lists evidence, but it is not organized and/or is unrelated to the concept.	
WS	Experimental design / materials / procedure	Procedure is detailed and sequential. All materials are listed. Safety issues have been addressed.	Procedure is detailed but not sequential. Most materials are listed. Safety issues have been addressed.	Procedure is not detailed and not sequential. Few materials are listed. Few safety issues have been addressed.	A few steps of procedure are listed. No materials are listed. Safety issues were not addressed.	
	Investigation	Variables have been identified, controls are appropriate and explained.	Variables have been identified and controls are appropriate but not explained.	Variables have somewhat been identified, controls are somewhat known.	Missing two or more of the variables or the controls. Sample size is	

		Sample size is appropriate and explained. Data collected from maximum sources.	Sample size is appropriate. Data collected from enough sources.	Sample size is not appropriate. Data collected from few sources.	not considered. Data collected from one sources.	
	Analysis and Reporting	Conclusions are supported by the data and explicit analysis is made. Reflection of what was learned and how it could be made better is excellently made.	Conclusions are supported by the data and acceptable analysis is made. Reflection of what was learned and how it could be made better is acceptable.	Conclusions are not supported by enough data and analysis is not satisfactory. Reflection of what was learned and how it could be made better is not clear.	Conclusions are not supported by data and no clear analysis is made. Reflection of what was learned and how it could be made better is not stated.	
SVA	Inquiry and creativity	Demonstrates inquisitiveness and creativity in all the works. Behold values and attitudes in carrying out tasks.	Demonstrates inquisitiveness and creativity in most of the works. Behold values and attitudes in carrying out tasks.	Demonstrates inquisitiveness and creativity in works rarely. Have less values and attitudes in carrying out the tasks.	Do not demonstrates inquisitiveness and creativity in works. Lack values and attitudes in carrying out tasks.	
	Personal Development and Responsibility	Develops and maintains portfolio all the time to document his/her educational growth and habits of scientific exploration.	Develops and maintains portfolio most of the time to document his/her educational growth and habits of scientific exploration.	Develops and maintains portfolio rarely to document his/her educational growth and habits of scientific exploration.	Do not develops and maintains portfolio to document his/her educational growth and habits of scientific exploration.	

Appendices II: Assessment Matrix

Assessment Matrix (Key Stage IV)

Assessment Matrix (Key Stage IV)												
		CFA <i>(In all the lessons for feedback and support)</i>	CSA <i>(Scheduled performance level assessment)</i> - 50%				SA (Examination) - 50%				Grand Total	
		Technique	Technique	Domain			Total	Domain				
				SK	WS	SVA		SK	WS	SVA	Total	
Areas of Assessment	Quarter 1	Assignment, Class activity, Environmental Profile, Experiment, Project work, etc.	Assignment	1	1	1	13	Term I				
			Class activity	1	2	1						
			Test	1	1							
			Project work	0.5	1	0.5						
			Environmental Profile	0.5	1	0.5						
	Quarter 2	Assignment, Class activity, Environmental Profile, Experiment, Project work, etc.	Assignment	1	1	1	12					
			Class activity	1	1	1						
			Test	1	1							
			Project work	0.5	1	0.5						
			Environmental Profile	0.5	1	0.5						
	Quarter 3	Assignment, Class activity, Environmental Profile, Experiment, Project work, etc.	Assignment	1	1	1	13	Term II				
			Class activity	1	2	1						
			Test	1	1							
			Project work	0.5	1	0.5						
			Environmental Profile	0.5	1	0.5						
	Quarter 4	Assignment, Class activity, Environmental Profile, Experiment, Project work, etc.	Assignment	1	1	1	12					
			Class activity	1	1	1						
			Test	1	1							
			Project work	0.5	1	0.5						
			Environmental Profile	0.5	1	0.5						
		Grand Total	16	22	12	50		22	16	12	50	100

Appendices III: Chapter-wise time allocation and weighting

Chapter-wise time allocation and weighting

Chapters	Chapter Title	Maximum Time Required (mins)	Weighting
Chapter 1	Ecosystem	250	9%
Chapter 2	Balanced in Nature	500	12%
Chapter 3	People and Environment	500	12%
Chapter 4	Natural Resources Degradation	500	11%
Chapter 5	Environmental Degradation and Disaster	600	9%
Chapter 6	Pollution and Climate Change	550	9%
Chapter 7	Biodiversity and its Conservation	550	9%
Chapter 8	Land Use and Management	550	11%
Chapter 9	Energy Resources	500	9%
Chapter 10	Environment and Development	500	9%
Total		5000	100%

The total time required to complete the topic is 5000 minutes or 100 periods of 50 minutes in a period.