Discovering Nature: An Activity Guide for School Children

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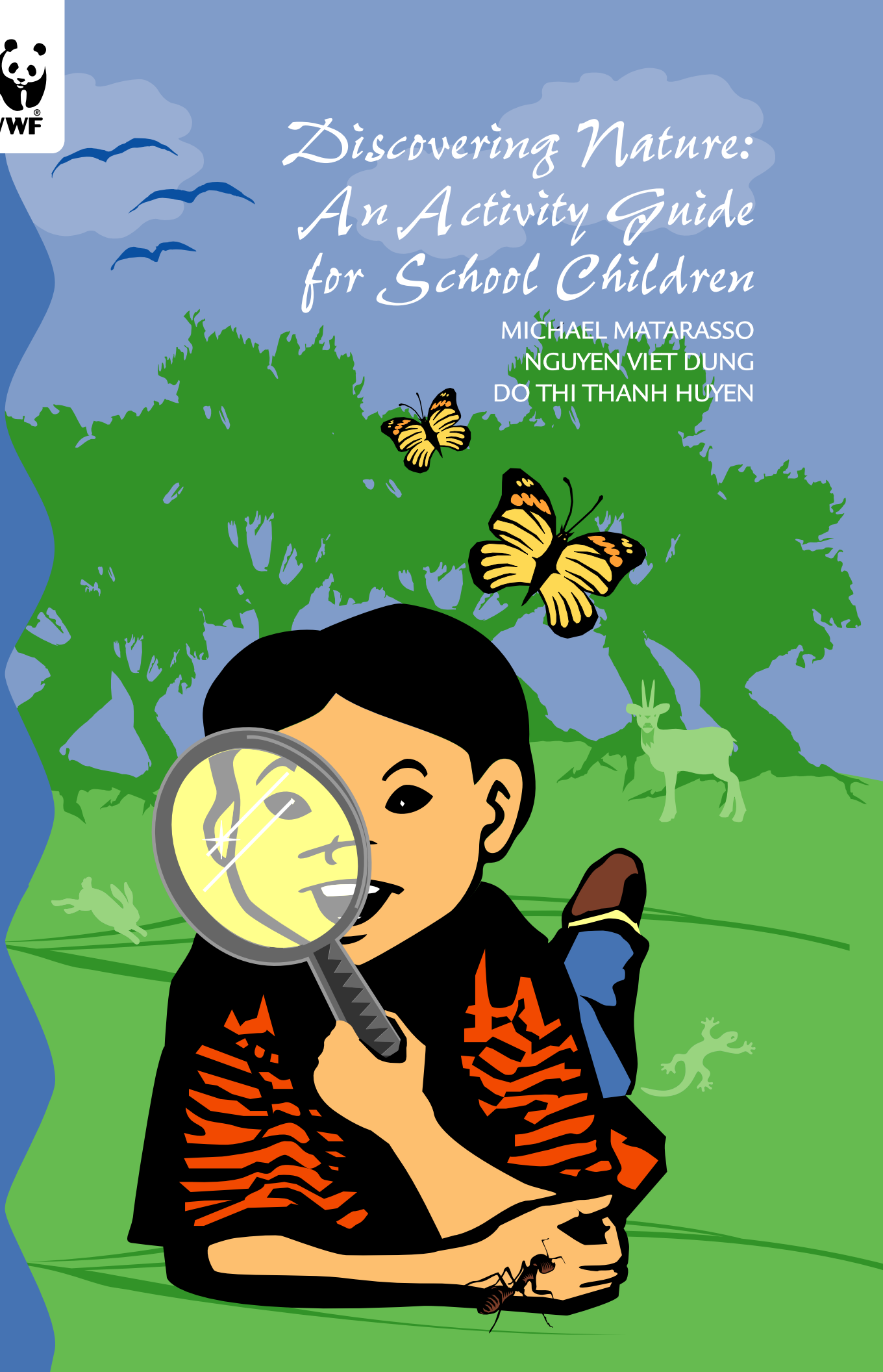


Acknowledgements

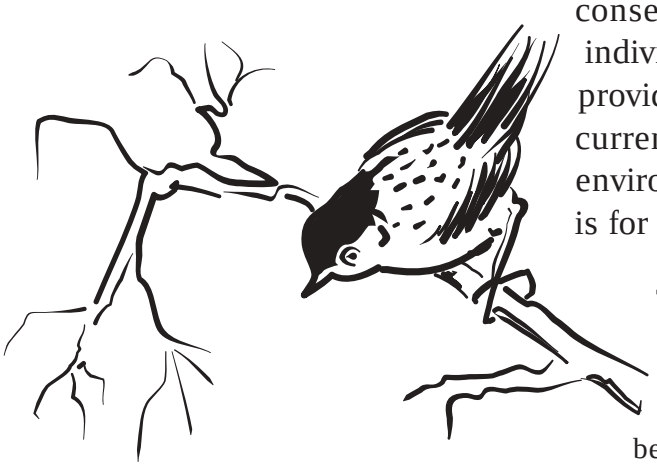
This book and the other books in this series are dedicated to Nguyen My Hanh, a dear friend whose passion, devotion, and love for humanity have inspired every page.

Publication of this book would not have been possible without the support from Cat Tien National Park Conservation Project, Gert Polet, Chief Technical Advisor of this project and Tran Van Mui, Cat Tien National Park Director. Thanks also to the conservation education staff of Cat Tien National Park and the teachers from twelve schools who were involved in testing the content of this book. Special thanks also to Jane Story for all her help in editing in English. We are also grateful to Erika Gildersleeve for her hard work and creativity in designing this book. A final thanks to all the staff of WWF Indochina.

Table of Contents

Introduction

Long-term conservation of the natural world cannot be achieved unless each individual takes responsibility for protecting the rich biodiversity found in his or her backyard. In order for people to change their behaviour and participate in conservation, they need three things. First of all, they must clearly see and acknowledge the problems they and their environment are facing. Secondly, they should realize the benefits of change and the consequences if they don't change. And thirdly, individuals need to have alternatives, which will provide them with comparable benefits to their current lifestyles that often negatively affect the environment. This is equally true for adults as it is for children.



Time and time again, people use the cliché "Children are the Future". There is a reason for the repetition, and we would like to emphasise it yet again. Children always, sooner or later, become responsible for protecting the environment. It will be up to our children and their children after them to find ways to meet daily needs while at the same time protecting the Earth.

Children are constantly learning and absorbing what they see and hear. They begin to formulate ideas, learn to analyse situations and make educated decisions from their birth until adolescence. What they learn today will form the foundation for the ideas and values that they follow tomorrow. It is, therefore, imperative that we continue to teach our children about the environment, and give them opportunities in the outdoors to discover nature and develop a wonder for it. We must also equip our children with the skills they need to be responsible citizens and to live in harmony with nature.

This activity guide was developed with two goals in mind. The first goal is to enhance the ability of teachers to develop action oriented extra-curricular programmes for environmental education in secondary schools. The guide was also designed to prepare children for adulthood so that they are able to adopt livelihoods that have a benign, or, ideally a beneficial impact on the natural world. There are twenty-nine lessons in the guide, allowing for one activity each week of the school year. This activity guide equips the teacher with a comprehensive set of tools to develop environmental learning activities that are fun for their students.

The Environmental Education Programme of WWF Indochina has developed teaching targets based on a multidisciplinary range of subjects that we feel people should be knowledgeable in to be able to participate in nature conservation. The book is set up so that all activities in this book are based on one or more of these knowledge targets and also so all targets are covered at least once. This full curriculum provides students with a holistic understanding of how the Earth works, what impact human activity has on the Earth, and what people can do to protect the planet. The teaching targets for this guide are:

Area and Location: Students will learn to appreciate the wealth of biodiversity and the importance of nature in their own communities and understand how this links to people and ecosystems of the global community. Students should also be aware that the Earth is rapidly shrinking in terms of distance and resources.

Atmosphere and Cosmos: Students will be able to describe and measure simple climatic factors of the local environment and appreciate their significance in terms of food production. They will also recognise the role the atmosphere plays in the life of plants and animals. Students will be able to identify the major biomes of their region and the world.

Landforms, Soils, and Minerals:
Students will know that soil is dynamic and understand: (a) how it forms, (b) that it contains life and supports plant growth, (c) and that it erodes and can become less fertile. They will also appreciate the relationship between soil and other living things and know that mineral resources are limited.

Plants and Animals: Students will be able to recognise various kinds of plants and animals in or near their own communities. They will become familiar with the web of life and food chain and understand the inter-dependence between producers such as plants, consumers like animals and humans, the soil, and the atmosphere. Students will become aware of endangered species locally and globally, threats to them and measures being taken to conserve them.

Energy: Students will know the different forms of energy available to humans, and the means of harnessing different energy sources. They will understand the energy cycle and know that the sun is a primary source of energy. Students will also know the origins of fossil fuels and the human impact of their use.

Water: Students will recognise that water is needed for life and understand its importance as a natural resource. They will learn the water cycle and be aware of water pollution and understand that water is a limited resource.

People: Students will understand culture and recognise how it influences the behaviour of people and especially the way in which they use natural resources. They will recognise different cultural practices that lead to sustainable use of resources. Students will also become aware of population growth and know how it affects the Earth's resources. Students will be able to recognise the way in which humans use and influence the environment in their everyday lives.

Social Organisation: Students will learn to take responsibility both as individuals and as part of their community for the environment. They will understand the impact of Government policy, how policy is made and how to influence policy. Students will also know the major local and global agencies trying to resolve environmental problems and appreciate that cooperation is essential for dealing with the environmental crisis facing our planet. They will also understand that local, regional, and national laws are vital to the protection of nature.

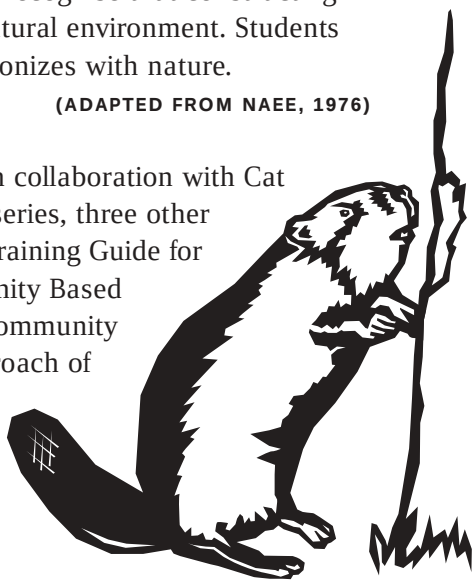
Economics: Students will understand that the need for food, clothing, and shelter has to be met by using available natural resources and that humans need to use resources wisely in order for future generations to survive. Students will recognise how resources are used in farming, forestry, fishing, mining, manufacturing, servicing, transportation, and communications.

Aesthetics, Ethics, Literacy: Students will be able to use the visual arts and music to describe and interpret various natural areas. Students will learn what ethics are, how ethics relate to the environment and how to adopt behaviour that reflects these ethics. Students will also learn and be able to use new words related to the environment and nature conservation.

Human Constructed Environment: Students will be able to recognise that constructing different buildings and public works has an affect on the natural environment. Students will also be able to plan or promote construction that harmonizes with nature.

(ADAPTED FROM NAEE, 1976)

The Environmental Education Programme of WWF Indochina in collaboration with Cat Tien National Park developed this book. This book is part of a series, three other books are included in this series: Environmental Education: A Training Guide for Practitioners; The Agro-forestry Field Guide: A Tool for Community Based Environmental Education; and Monitoring and Evaluation for Community Based Environmental Education Programs. The underlying approach of these guides will, hopefully, also provide governments, NGO's and donors with an alternative method to conservation that can be integrated into environmental plans and policies.



ACTIVITY ONE

How the Earth and Its First Organisms Were Formed

Objective:

To understand the general process of how the Earth and its first organisms were formed.

Knowledge Targets:
Atmosphere and cosmos; landforms, soils and minerals

Skills:
Reading comprehension and working in groups

Time:
55 minutes

Materials:
Photocopies of survey

The Formation of the Earth

According to theory, about 12 billion years ago there was a "Big Bang" in the universe. A highly concentrated mass of gaseous matter about the size of a needlepoint exploded. The universe then began to expand away from this point of explosion creating a "soup" of stone, ice, dust and gases. About 4.5 billion years ago, these fragments collided. The impact of the collision caused these fragments of rock, ice and dust to coalesce into one large hot mass. This large mass was the early Earth. The new Earth was extremely hot (about 5000°C) and when the surface cooled the heat from the core rose to the surface by convection causing volcanic activity. Volcanic eruptions of gas and steam created water and an early atmosphere of nitrogen and carbon oxide with no oxygen.

About 3.5 billion years ago, the Earth's surface became considerably cooler. Oceans were formed and the first microscopic life appeared. The first living organisms were bacteria such as the yeast that is used by humans to make bread rise. These bacteria were anaerobic one-celled organisms with no nucleuses which lived in oceans in high temperatures, darkness, and which were exposed to high levels of ultra-violet rays from the sun. As time went by, these bacteria, together with blue-green algae, began to convert carbon dioxide, water and sunlight by photosynthesis into oxygen.

About 545 million years ago, these ocean dwelling organisms also began to evolve from their primitive forms into multi-celled nucleic organisms. The addition of oxygen into the atmosphere eventually made once uninhabitable areas of the Earth habitable. About 460-440 million years ago, some life forms, such as plants and invertebrate animals, began to colonize the land. About 320 million years ago, plants spread extensively across the Earth and created the Earth's first forests. With the growth of these forests, the level of oxygen in the atmosphere increased dramatically to a level even higher than that on Earth today. This high level of oxygen enabled the emergence of a diverse range of animal life such as amphibians and reptiles, including the first known form of vertebrates and egg laying creatures. These included huge reptilian-like creatures known as dinosaurs. About 65 million year ago, dinosaurs became extinct and 45 million years ago, flowering plants, snakes, birds, and mammals predominated the landscape. The first primitive humans, according to archeological records, appeared in eastern Africa about 2.5 million years ago and modern humans appeared about 100,000 years ago.

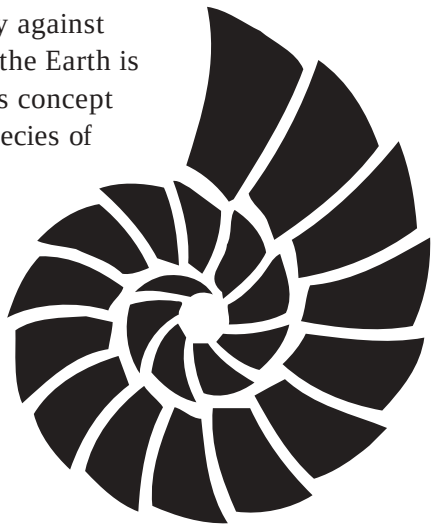
(PALMER, 2000)

Theory of Continental Drift

In 1915, a German scientist named Alfred Wegener proposed a theory about the early geography of the Earth. According to this theory, all of the Earth's continents used to be one large land mass called Pangaea. This land mass was pulled apart, breaking into pieces and eventually creating the seven continents that exist today. Many years after Wegener proposed his theory, scientists have come up with conclusive evidence to support and expand this claim.

According to many scientists around the world, the Earth is composed of a hot liquid center and an outer crust. The outer crust is not one single shell but is broken into several pieces or plates. These plates are solid rock that drift and move across the globe on a sea of hot liquid, which lies at the Earth's center. Continental landmasses are attached to this subsurface oceanic crust. Rising mantle plumes from within the core of the Earth can cause the plates to break and drift apart. Convection currents from the Earth's hot liquid center cause the plates, and thus the continents attached to the plates, to move. The plates move in three ways. The plates may move apart, collide, or slip laterally against each other. During this movement, the geological formation of the Earth is constantly changing and the continents are subtly moving. This concept helps explain why and how many fossils of floral and fauna species of Africa and South America are exactly the same and suggests that, in fact, at one time these two continents were part of the same land mass.

(US GEOLOGICAL SURVEY; ENCHANTED LEARNING)



Activity

PREPARATION:

Make photocopies of the survey, What Do You Know About the Formation and Development of the Earth.

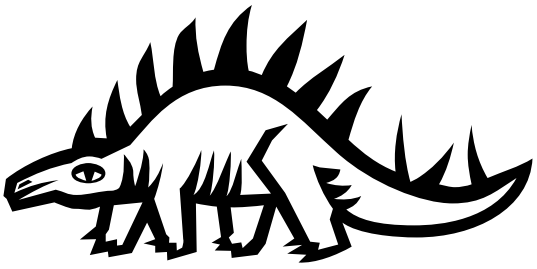
SURVEY: WHAT DO YOU KNOW ABOUT THE FORMATION AND DEVELOPMENT OF THE EARTH?

1. Scientists of the world state that the Earth was formed:
   a) 2.5 billion years ago
   b) 4.5 billion years ago
   c) 12 billion years ago
2. According to scientists,
   a) The present location of continents is the same as when the Earth was formed
   b) The present location of continents occurred after a long period of time because of a constant drift of the continents
   c) All continents are one continuous block of land separated by seas and oceans.
3. Of the following planets, which one is known to support life?
   a) Mars
   b) Moon
   c) Earth
   d) Sun
   e) Saturn
   f) Jupiter
4. According to scientists, life on Earth began:
   a) 1 billion years ago
   b) 2.5 billion years ago
   c) 3.5 billion years ago
5. According to scientists, the essential ingredient needed for the first living organism to form was:
   a) Carbon dioxide
   b) Oxygen
   c) Water
   d) Stone and dust
   e) Phosphorus
   f) Sunlight
6. In your opinion, the first living organism on Earth was:
   a) Unicellular
   b) Multi-cellular
7. The Earth is made up of a:
   a) Biosphere, atmosphere and hydrosphere.
   b) Hydrosphere, biosphere, and lithosphere.
   c) Biosphere, atmosphere and lithosphere
   d) Lithosphere, hydrosphere, atmosphere and biosphere
8. Which appeared first?
   a) Plants
   b) Animals
   c) Plants and animals appeared at the same time.
9. The Earth's surface is covered by what percentage of water?
   a) 45-50%
   b) 55-60%
   c) 70-75%
   d) 80-85%

10. Humans appeared:
    a) 500,000 years ago
    b) 2.5 million years ago
    c) 5 million years ago

11. In your opinion, which of the following statements are true?
    a) Organisms can live at an altitude of 6-7 kilometres above sea level.
    b) Organisms can live at a depth of 10 kilometres in the ocean
    c) Organisms can live up to 10 metres deep in the soil

12. Dinosaurs became extinct about:
    a) 5 million years ago
    b) 15 million years ago
    c) 65 million years ago



PROCEDURE

1. Divide students into groups of three or four. Ask them to name the major events that made the Earth the place it is today. Some examples might include the Big Bang, the appearance of the first fauna and flora, the appearance of humans, the Ice Age, and the extinction of dinosaurs. Review with them the basic concepts about how the Earth was formed and about continental drift.

2. Give each group a copy of the survey, What Do You Know About the Formation and Development of the Earth? Have the groups take the survey home for one week to fill in the answers. Students can use books, magazines or interview their parents or other adults to gather information.

3. One week later, after the students have completed the survey, go over the answers with them and have them explain why they selected their answers. Create a discussion about major events that made the Earth the place it is today such as the Big Bang, the appearance of the first flora and fauna, the appearance of the first humans, continental drift, the Ice Age and the extinction of dinosaurs.

ANSWER KEY

Question 1: b	Question 5: c	Question 9: c
Question 2: b	Question 6: a	Question 10: b
Question 3: c	Question 7: d	Question 11: all
Question 4: c	Question 8: a	Question 12: c

ACTIVITY TWO

The Earth's Biomes

Objective:

To understand that the Earth is divided into different biomes and to know where they are.

Knowledge Targets:
Area and location; landforms, soils, and minerals; plants and animals

Skills:
Gathering, organising, and working in groups

Time:
90 minutes

Materials:
Wall map or atlas and geography books for research, and pencils or markers.

BIOME

The Earth is a living planet that includes the biosphere, atmosphere (air), hydrosphere (water) and lithosphere (soil and stone). The Earth contains several different biomes or vast ecological areas consisting of plants and animals with similar life forms and environmental conditions. These biomes are determined by temperature, altitude, rainfall, and proximity to and quantity of water present. The following are the main biomes represented on the Earth.

Tundra

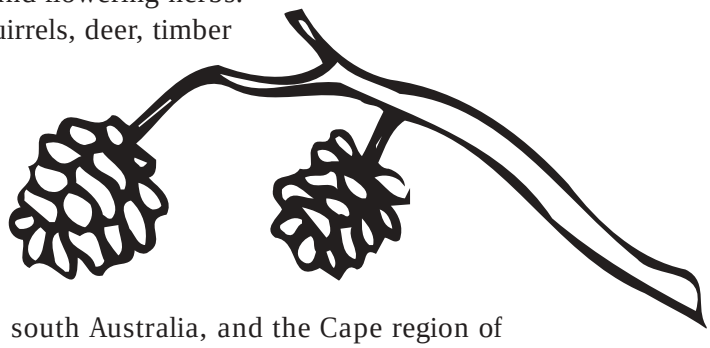
From the Finnish word tunturia, tundra is a plain without trees. Located roughly at 70° N and S, and found in the Antarctic, and in the Arctic regions of Greenland, northern Europe, Siberia and northern Canada, this biome is noted for its extreme cold, frost, lack of precipitation, and short growing season. Mosses, lichens and grasses dominate the landscape. Dominant animals here include reindeers, polar bears, wolves, arctic foxes, hares and penguins.

Taiga or Boreal Forest

Located just south of the tundra biome, the taiga can be found roughly at 60 to 50° N in North America, northern Europe and Asia. Tundra can also be found at high altitudes in temperate and tropical climates. Typical vegetation of this biome includes vast stands of evergreen coniferous trees such as pine, spruce and fir. There is little grass or shrubs in this biome because snow and ice frequently cover the soil and the soil is highly acidity. Fungi and lichen are, however, abundant. Dominant animals include rabbit, fox, wolf, bear and lynx. The largest taiga biome is found in Siberia with an area of 85 million square kilometres.

Temperate Forest

Distributed between approximately 30-45° N in North America and between 40 and 60° N in Europe and Asia. This biome is found in western and central Europe, eastern North America, eastern China, Japan and Korea. Typical vegetation includes deciduous trees such as oak, birch, beech, maple and hickory, and evergreen species such as cedar, pine, and yew. Under the canopy, there are shrubs and flowering herbs. The fauna is rich and includes rabbits, squirrels, deer, timber wolves, foxes, bobcats, bears and birds.



Mediterranean Forest, Woodland and Scrub

This biome is located approximately at 30-40° N and S. Mediterranean forests can be found in the Mediterranean, southwestern United States, central Chile, south Australia, and the Cape region of South Africa. The vegetation includes short, thick evergreen, drought resistant shrubs with deep roots. Fires are common in this biome so most plant species have fire resistant seeds.

Tropical Rain Forest

This biome is located between 23.5° N and 23.5° S. Tropical rainforests can be found in the Amazon and Orinoco basins, along the Atlantic coast of South America, in Central America, and in western Africa, east to the Congo, in parts of Rwanda, Burundi, and Uganda, in Southeast Asia from eastern India to Viet Nam, in the Philippines, Indonesia, Borneo, Papua New Guinea, and parts of Australia. These forests are the richest in terms of species diversity. High rainfall from 1.500-4.500 millimeters per year and an average temperature of 25°C characterise the tropical forest. The vegetation includes a multi-layered canopy, which allows little light to penetrate to the under story and is dominated by evergreen trees with some deciduous trees in the emergent layer of the canopy. The forest has many climbing lianas (woody vines), epiphytes (plants that grow on the branches of other trees), as well as some small shrubs and flowering herbs. The soil is nutrient poor and acidic with a thin layer of rich organic matter. Forest fauna is diverse and includes insects, large carnivorous animals, hoofed herbivorous animals, primates and birds.

Mangrove Forest

These forests are found between the latitudes of 32° N and 38° S along the tropical coasts of Africa, India, and Southeast Asia, and in the Americas. Mangroves lie at the interface between land and ocean and are equipped with special aerial roots and salt-filtering taproots that enable them to thrive in salt water. Most mangroves live on muddy soils, but they also grow on sand, peat, and coral rock. The forest detritus, consisting mainly of fallen leaves and branches, provides nutrients for algae, fish and other sea life. Mangroves provide a temporary home for migratory bird species while they also provide breeding grounds for juvenile fish, crabs, shrimp, and mollusks. Other wildlife such as manatees, crab-eating monkeys, fishing cats, monitor lizards, sea turtles, and mudskippers also live and thrive in the mangroves.

Temperate Grassland, Savanna and Shrub Land

The largest areas of this biome are primarily found in central North America, Eastern Europe, central Asia and Russia at about 28° N to 60° N in South America at 28° to 56° S, and southeastern Australia at 27° to 33° S. The dominant vegetation is grass with some flowering herbs and very few trees or shrubs. These grasslands have extremely hot summers and cold winters. The soil is extremely fertile due to the decomposition of dead grass roots. Fire has a very important influence in this biome. Wildlife consists of wild horses, wolves, prairie dogs, jackrabbits, deer, mice, coyotes, foxes, badgers, snakes, and falcons. Prairie and steppe are two types of temperate grassland.

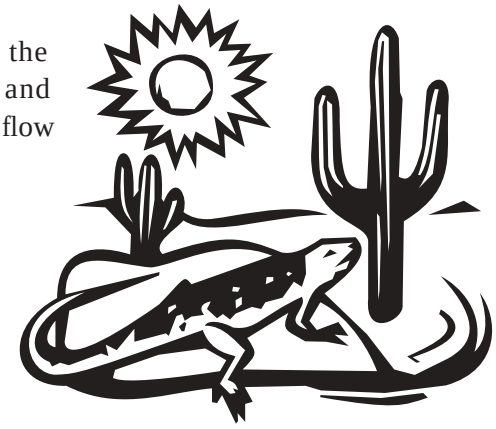
Tropical Grassland, Savanna and Shrub Land

Tropical savanna is found roughly between 25° N to 28° S in Africa, as well as South America in areas of Colombia, Venezuela, Brazil, Paraguay, Uruguay, and Argentina, and in the north of Australia. Savannas are found in hot climates where the season of high annual rainfall of 1000–1500 millimetres is followed by a long period of drought and fire. Vegetation includes grasses, forbs and some trees such as baobab and acacia. Common animals of Africa savannas include zebra, elephants, antelope, gazelle, buffalo, lion, hyena, leopard, and wild dog.

Desert

One-fifth of the world's land surface is covered in desert. Deserts include the Sonoran, Chihuahuan, Mojave and Great Basin deserts in the southwest United States, the Sahara in North Africa, Kalahari and Namib in southern Africa, Atacama in Peru and Chile, and Gobi Desert in central Asia. There are also other extensive deserts in Mexico, central Asia, the Arabian Peninsula, the Middle East, Australia, India, and Pakistan. Deserts are characterised by low rainfall (< 250millimetres/year) and daily extremes in temperature. Soils are usually coarse, and shallow with good drainage. The vegetation is sparse and highly specialised to survive in the heat. Plants usually have thick stems and are covered with a thick waxy outer layer and often spines. Dominant animals include reptiles and small nocturnal mammals that can withstand the heat. Deserts also are home to camels, birds, and many different arachnids and insects.

Rivers and Streams



Big rivers of the world include the Mississippi in the United States, the Amazon in South America, the Nile in Africa, the Volga in Europe, and the Yangtze in Asia. Streams and rivers are freshwater bodies that flow in one direction from the source of water to larger bodies of water such as oceans. Melting ice and snow and freshwater springs are generally the source of rivers and streams. The characteristics of rivers and streams generally change as they move from upstream to downstream. The water temperature is generally cooler and the level of oxygen is generally higher at the source of the stream. The mouth is warmer and has less oxygen. This allows for a greater diversity of species at different points in the same water body.

Ponds and Lakes

Ponds and lakes form in any kind of depression and are often a product of glaciations, rift formation due to geological shifting of the Earth's crust, and separation of river bends cut off from the main river. These biomes can be divided into two zones: the littoral zone and the limnetic zone. The littoral zone is the shallow area near the shore where vegetation can grow and amphibians, snails and crustaceans can be found. The limnetic zone is the open area of the water body away from the edges where the primary vegetation that grows is phytoplankton, which is home to many freshwater fish. Ponds and rivers can also be divided into vertical layers based on the level of light penetration. These different layers become habitats for different aquatic life as well.

Wetlands

Wetlands are also non-flowing water bodies, but they support the growth of many aquatic plants. Wetlands as an ecosystem have very high biodiversity. Wetlands may be freshwater or saltwater. This biome is home to many amphibians, reptiles, birds, and small mammals, as well as plants, such as cattails, sedges, lilies, cypress, and gum. Wetlands have the ability to filter pollutants from freshwater and to protect the inland from the erosive capacity of the ocean.

Estuaries

An estuary is a transition environment between the river's mouth and the sea. The unique mixture of freshwater and saltwater, as well as the high level of sediment and nutrients carried down stream and deposited at the river's mouth, allows for a high level of species productivity. In tropical areas, this is where mangrove forests grow. This biome is rich in seaweed, marsh grasses, worms, crabs, and birds.

Sea and Ocean

Oceans cover 70% of the Earth's surface. The Earth's oceans include the Pacific Ocean, Indian Ocean, Atlantic Ocean and Arctic Ocean. This biome includes a high number of species of coral, sea grass, fish, mollusk, crustaceans, polychaetes, echinoderms, sponges, marine turtles, dolphins and whales. The ocean biodiversity changes in the different zones of the water, which are affected by depth, temperature, currents, tides, and underwater substrate.

(RICKLEFS AND MILLER, 2000; VU, 2000; UNIVERSITY OF CALIFORNIA)

Activity

PREPARATION

Make copies of the, Game With the World Map for each group of students. Give each group of student's photocopies of the information on all biomes.

PROCEDURE

1. Break students into groups of four to six. Have each group draw one world map including latitude and longitude lines on a large sheet of paper (students can glue smaller papers together if this is not available). Students can use the wall map or atlas as a reference for the drawing.

2. Have the students work as a group at home to fill in the world map. Have them label the following information with its respective number or letter with a black pen.

   a) The seven continents

   I. Asia
   II. Europe
   III. Africa
   IV. North America
   V. South America
   VI. Australia
   VII. Antarctica

   b) The Earth's twenty most important rivers

   1. Nile
   2. Amazon
   3. Mississippi
   4. Ob-Irtysh
   5. Yangtze
   6. Yellow
   7. Yenisey
   8. Congo/Zaire
   9. Amur
   10. Lena
   11. Mekong
   12. Niger
   13. Parana
   14. Volga
   15. Danube
   16. Ganges
   17. Brahmaputra
   18. Indus
   19. Tigris
   20. Euphrates

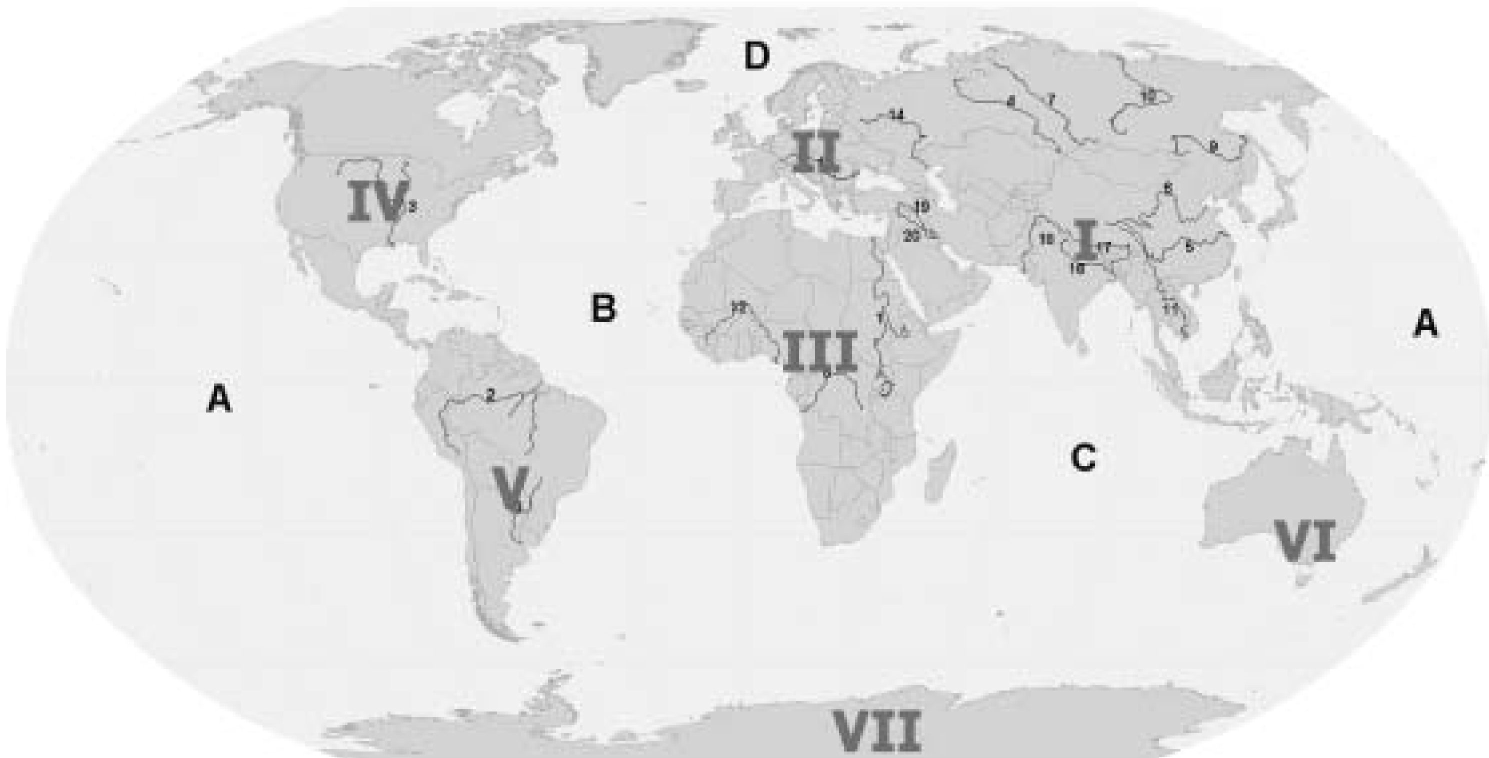
   c) The Earth's oceans

   A. Pacific
   B. Atlantic
   C. Indian
   D. Arctic

3. After one week, once the students have finished labeling their maps with the above information, have a representative of each group present their maps to the class. The teacher can help to correct the location of the world's continents, oceans and rivers.

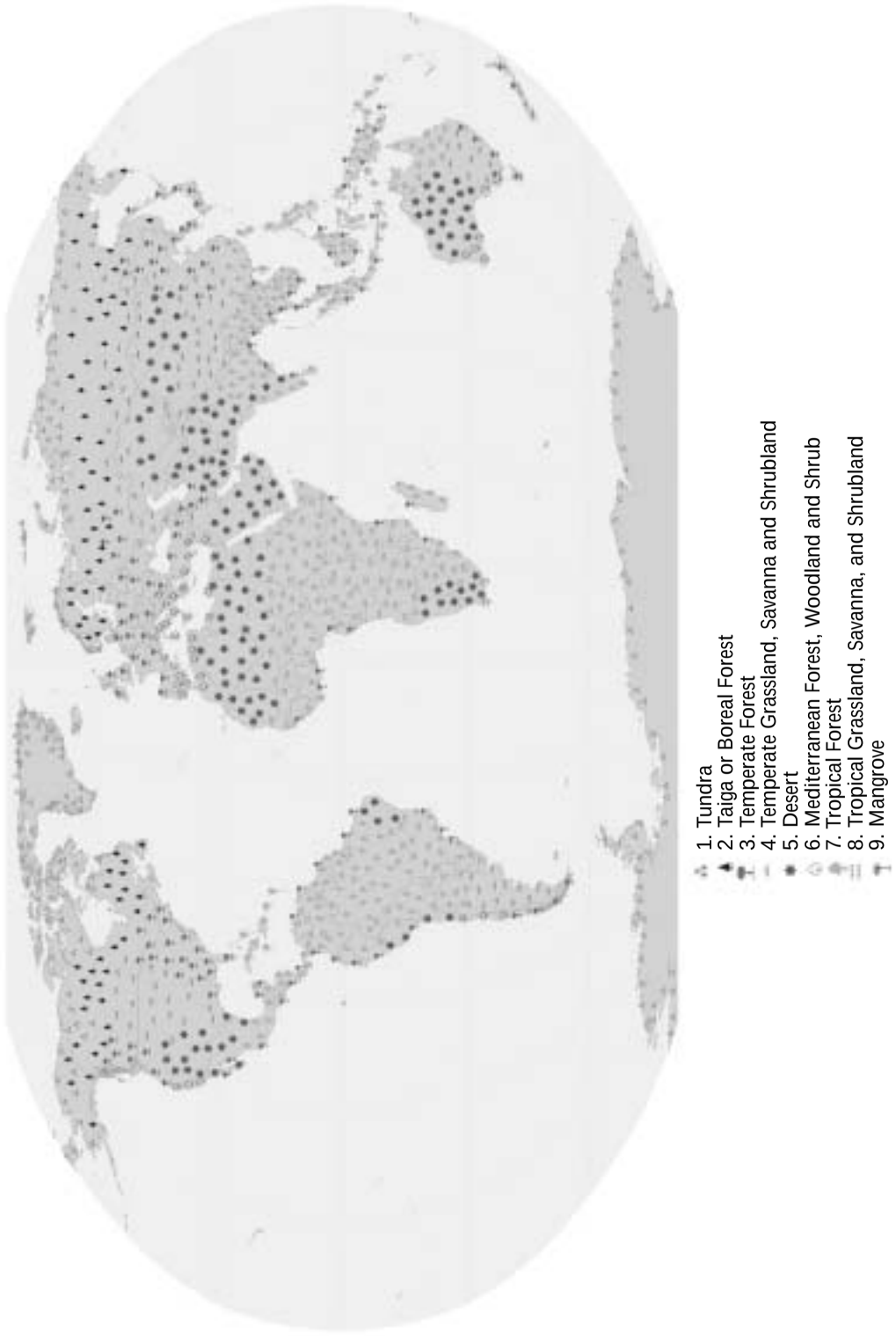
4. Now hand out information about the biomes to the students and introduce the 9 symbols for each biome to them. Have them use the information on the biomes provided above and an atlas or geography book to identify the biomes on the map. After the area has been identified, have them draw several of the symbols in the approximate area of the respective biome on their world map.

5. When the students finish their work, hang the maps in the classroom and have the students select the map that is most accurate and beautiful. Review the answers with the students, add comments based on the answer key, and return the maps to the students.



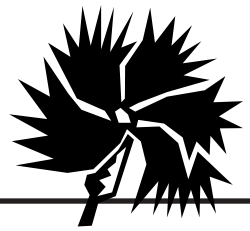
Continents	Rivers			Oceans
I. Asia	1. Nile	8. Congo/Zaire	15. Danube	A. Pacific
II. Europe	2. Amazon	9. Amur	16. Ganges	B. Atlantic
III. Africa	3. Mississippi	10. Lena	17. Brahmaputra	C. Indian
IV. North America	4. Ob-Irtysh	11. Mekong	18. Indus	D. Arctic
V. South America	5. Yangtze	12. Niger	19. Tigris	
VI. Australia	6. Yellow	13. Parana	20. Euphrates	
VII. Antarctica	7. Yenisey	14. Volga		

THE WORLD'S BIOMES



ACTIVITY THREE

What is Biodiversity



Objective:

To become familiar with the concept of biodiversity and understand how it increases in an enlarged ecosystem.

Knowledge Targets:
Area and location; landforms, soils and minerals; plants and animals

Skills:
Gathering, organising, analysing, interpreting and working in groups

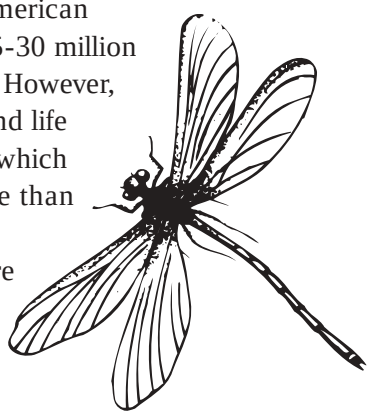
Time:
4 hours

Materials:
Tape measure, 4-9 stakes (more than 50 centimetres high), one ball of twine (80-100 metres long), scissors, ten nylon bags, flipchart, sticky tape, markers and handouts

What Is Biodiversity?

Biodiversity is the wealth of life found on the Earth. This includes genetic diversity, species diversity, and ecosystem diversity.

Biodiversity On Earth



According to E.O.Wilson, an American entomologist, there are about 5-30 million species of organisms on Earth. However, only over 1.4 million species and life forms have been described, of which about 751,000 are insects, more than 41,000 are vertebrate animals including 4,000 mammals, more than 9,000 species of birds, more than 10,400 species of reptiles and amphibians, and more than 18,000 species of bony fish. There are also about 248,000 plants described. The remainder of species described includes invertebrate animals, fungi, algae and microbes. Of all the biomes on Earth, the tropical rain forest ecosystem contains the highest level of biodiversity. This habitat covers only 7% of the Earth's surface, but it is home to more than 50% of known species.

(WILSON AND PETER, 1988)

Biodiversity In Viet Nam

In Viet Nam, 10,500 species of plants have been described. There are an estimated 275 species of animals, 828 species of birds, more than 470 species of fresh water fish, nearly 2,000 species of salt-water fish and tens of thousands of species of insects, worms, and crustaceans.

(VO QUY, 2000)

There is a diverse array of ecosystems including evergreen and deciduous tropical rain forests, subtropical and temperate montane forests, coastal mangrove forests, fresh and brackish water marshes, grasslands, and ocean.The species found in Viet Nam include the Javan rhino (*Rhinoceros sondaicus annamensis*), Asian elephant (*Elephas maximus*), Indochinese tiger (*Panthera tigris corbetti*), leopard (*Panthera pardus*), gaur (*Bos gaurus*), muntjac (*Muntiacus muntjak*), sambar deer (*Cervus unicolor*), and wild pig (*Sus scrofa*).

Biodiversity is not only important for the maintenance and balance that it provides the Earth, but it also has value for human use. In Cat Tien National park for example, 150 species of tree are used by humans for timber; 120 species of plants are used for medicine; 55 species are used for ornamental; 18 species of plants are used for oil and resin; 33 species are used for their fruits; and 40 species are non-timber plants such as rattan and bamboo.

(BECKER, 1999)

SETTING UP PLOTS FOR A BIODIVERSITY SURVEY

Setting up survey plots is a fun and easy way to discover biodiversity, and to monitor changes in biodiversity over time. Survey plots can be used as a tool for many different purposes. Some of the purposes include: to determine the composition and structure of animal and plant populations in a given area; to measure the changes in the quality and density of specific animal and plant species; to measure the height, diameter and biomass of individual plants; to determine the quality of a habitats soil and water and; to measure the level of impact that humans may have on a specific resource or habitat. The data gathered from the research of the plots provides important information that may be organized into charts and graphs for easy analysis. The results of the data found in survey plots may be used to assist policymakers in making decisions and for local resource managers to develop a suitable sustainable management and conservation scheme for the resources being surveyed.

Plots can be used to investigate most kinds of habitats such as primary or secondary forest, scrub land, grassland, mangrove forest, rivers, streams, and human formed landscapes such as pasture. Plots are often square or rectangle with stakes and twine used to mark the boundaries of the plots. The size and number of the plots should be determined by the aim and scope of the study. There should be enough plots, however, to provide sufficient data for statistically correct analysis and comparison. Plot size may be from 1m, 2m, 5m, 8m, 10m, 25m to 100m or more. Plots to monitor the level of change in forest cover used by the Forest Protection Department in Viet Nam are 1000m x 1000m (equal to 100 hectares). Plots are often monitored over a period of time, which will vary based upon the objective of the research.

Activity

PREPARATION

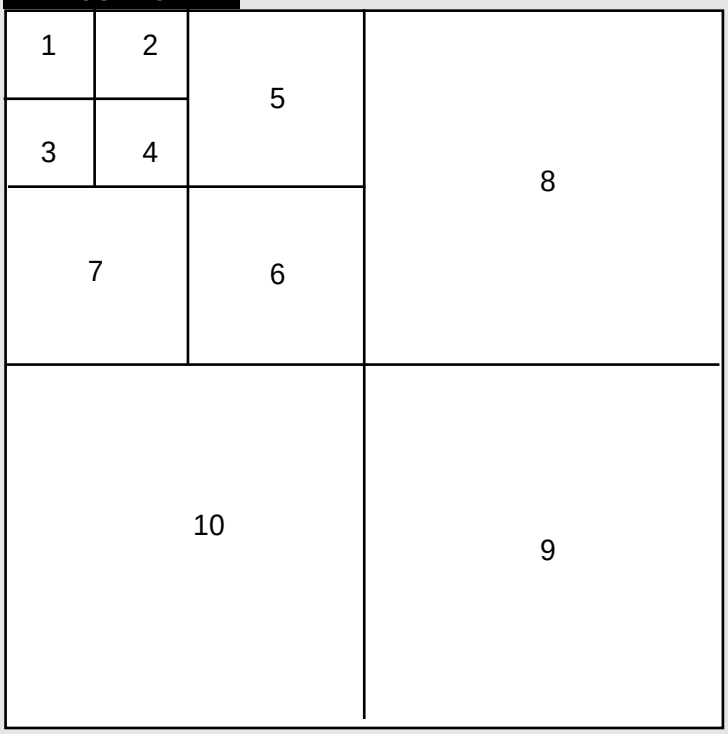
1. This activity is conducted both outdoors and indoors. Samples will be collected outside in a forested area where there is a diversity of indigenous woody species and analysed in the classroom. Set up a survey plot in the forest in advance. Mark an 8m x 8m square plot with stakes and twine and further divide this square into ten plots as illustrated in Figure 3.1. Four plots will be 1m x 1m; three plots will be 2m x 2m; and three plots will be 4m x 4m. Make sure that the overall plot is not degraded and that the plot is easy for students to access and move around in. Also check to make sure that there are no poisonous plants in the plot.

2. It is suggested that 13 participants collect samples in each 8 x 8m survey plot. One person can collect data in all four $1m^2$ plots. One person can collect data in each $4m^2$ plot and three people can collect data in each $16m^2$ plot.

3. Photocopy sheets of Leaf I.D and make a flipchart with the sheet, Sample Data Log for the students to identify the plants after they've finished collecting them. Provide some plastic bags in which the students can collect their leaf samples.

SURVEY PLOT LAYOUT

FIGURE 3.1



PROCEDURE

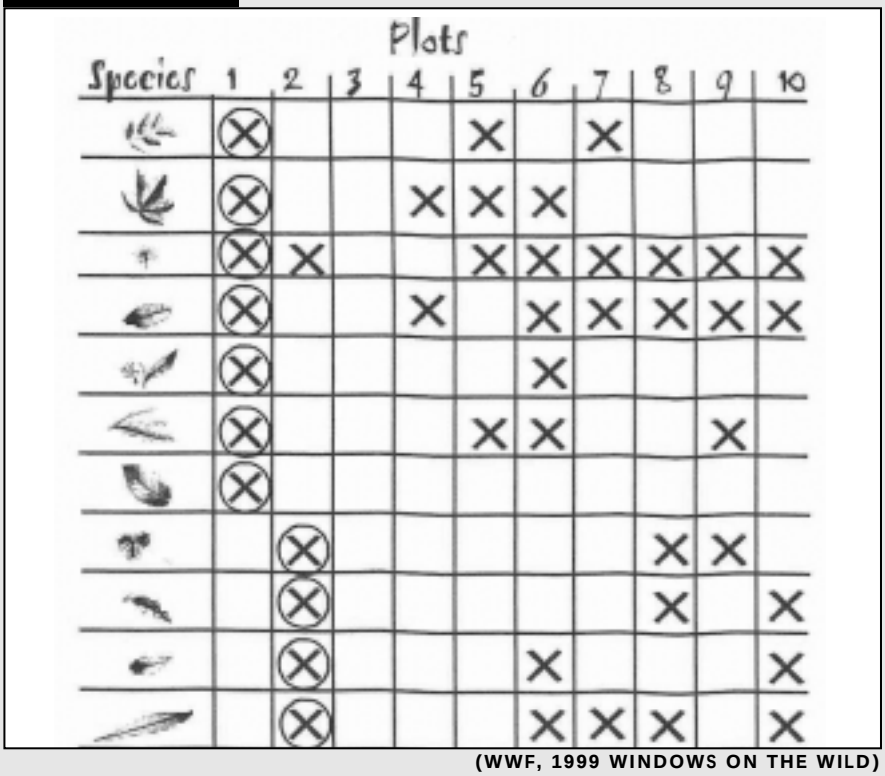
1. Bring students to the plot and familiarise them with the objective of the exercise, the method, and the location and layout of the plot. Assign each student to his or her plot number.

2. Ask the groups to collect a leaf from each different species they find in their plot and put it in a plastic bag. Make sure they do not collect leaves from herbs or grasses. Mark the plot number the sample was taken from on each bag. Encourage the students to be careful when working in the plots not to damage any of the trees. Recommend to them not to take more than one leaf from each species if possible. Have the groups collect samples from all the plots and be careful not to miss any species. Give students 30 minutes for collection.

3. Introduce and distribute copies of the sheet, Leaf ID to the students and teach them how to differentiate between different species based on leafstalk, veins, leaf edge, and leaf tip. Pick two leaves of two different species and ask the students to comment on how the leaves are different from each other. Now pick two leaves that are the same species and ask them if these are different species. For this exercise it is not necessary for students to know the name of all the species in the plot. What's important is that they are able to recognise the difference between the plants and identify them as different species.

SAMPLE DATA LOG

FIGURE 3.2



(WWF, 1999 WINDOWS ON THE WILD)

4. Now it is time to log the samples: After collecting samples, return to the classroom. Have all the groups make sure that they don't have any overlapping species. If they have more than one, have them select the leaf that's in the best condition to represent that species and discard the other one.

5. Have the students bring their samples to the sheet, Sample data log prepared on the flipchart like the one on the previous page and log the species by plot number beginning with plot one. Have the students from plot one tape each leaf sample in the "species" column on the data log. Any species that appears for the first time in the plot is called a new species and should be marked with a circle "Ⓧ" . This means that all species that are found in plot one are new species and have a circle marked "Ⓧ" next to them. Next stick the leaves on the log sheet from plot two. If a student has a sample of a plant that is already in plot one, that leaf should not be stuck on the board but instead simply mark an "r" next to that leaf under the column for plot two. Do the same for the rest of the plots. Tape any new species to the log and draw a circle "Ⓧ" next to it to show that this species has appeared for the first time. Draw an "r" in the space if this species has been seen already. Oversee and support the students to make sure they categorise the leaves and record the data properly.

(WWF 1999, WINDOWS ON THE WILD)

6. Once groups have finished categorising and taping the samples on to the data log, fill in a data summary table such as in Figure 3.3 with the results from the data log. Below is an example of a data summary table with data.

DATA SUMMARY TABLE

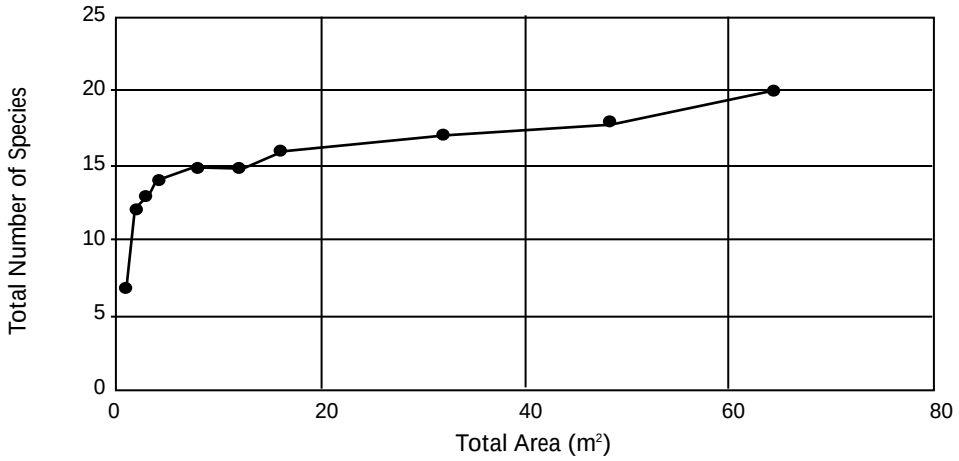
FIGURE 3.3

	Plot Number									
Data	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
New species (first seen in plot – marked with Ⓧ)	7	5	1	1	1	0	1	1	1	2
Total number of species	7	12	13	14	15	15	16	17	18	20
Plot Area (m2)	1	1	1	1	4	4	4	16	16	16
Total sample area (m2)	1	2	3	4	8	12	16	32	48	64

Instruct the students to use the information from the summary table to make a graph that shows the connection between the number of new species and the plot area. They will use the "Total sample area" row for their x-axis and the "Total number of species" for their y-axis. The graph below is based on the data summary table from the previous page.

TREE PLOT DATA

FIGURE 3.4



7. Interpret the graph and discuss the results and conclusions about biodiversity with the class. Have the students answer the following questions:

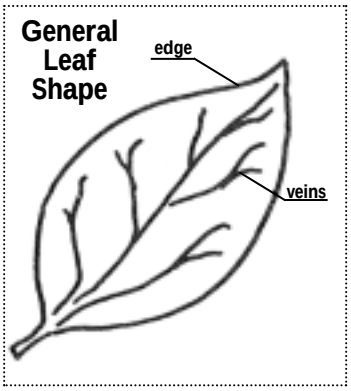
a) How many plant species are there in the plot?
b) Does the number of new species and total number of species increase as the size of area increases?
c) How does the number of species change, as the plot area gets increasingly smaller?

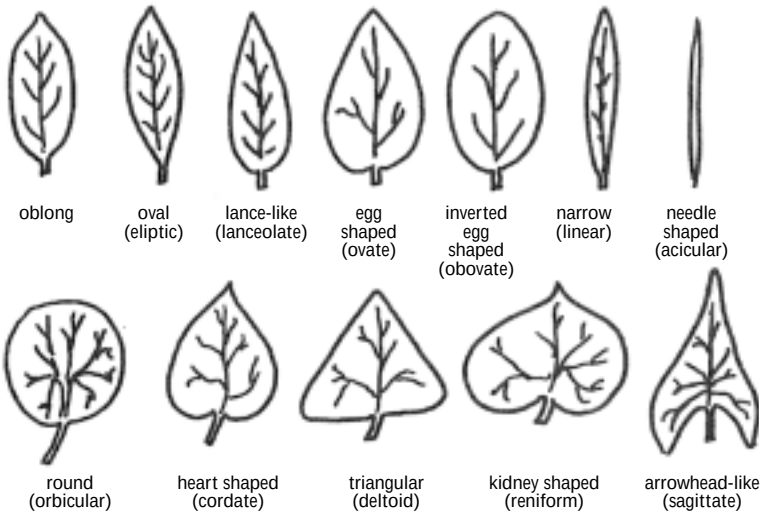
The above graph shows the connection between the number of species in an area and size of an area. If a habitat is larger, the number of new species and total number of species will increase. Competition within habitats for food and water is stronger within densely populated and small areas, so the number of species diminishes significantly when habitats are broken into small areas. For example, top predators cannot survive in small areas but need to live in large habitats in low densities in order to survive.

(ADAPTED FROM WWF WINDOWS ON THE WILD, 1999)

LEAF I.D.

SHAPES:





VEINS:

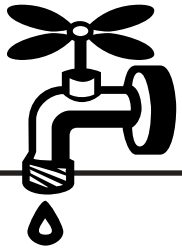
There are three main ways that veins are arranged on leaves

EDGES:

(WWF US, WINDOWS ON THE WILD, 1999)

ACTIVITY FOUR

Adventure of Water



Objective:

To know that water is essential to the lives of all organisms; to understand how water returns from oceans, ponds, lakes, and rivers to the ground in the water cycle; to know how rain is formed.

Knowledge Targets:
Water; plants and animals

Skills:
Analysing, applying, presenting and working in groups

Time:
85 minutes

Materials:
Flipcharts, permanent marker, colour pencils, plastic bag, water and elastic bands

Life cannot exist without water. About 65 to 80 per cent of living matter is made up of water (Cambodian Environment Advisory Team, 1994). Water is not only essential to organisms as a constituent of the body or as an important nutrient, but it also influences the life of the organisms by the role water plays in weather and climate. Have you ever seen good green grassland after a shower? Plants in your garden or in the field need water. If they are not watered frequently, they will not grow well and may even die. Animals also need water to drink and if plants don't have water they cannot grow and thus animals will have nothing to eat. When there is a drought or a lack of rain for a long time, plants and animals die, crops are destroyed and people starve.

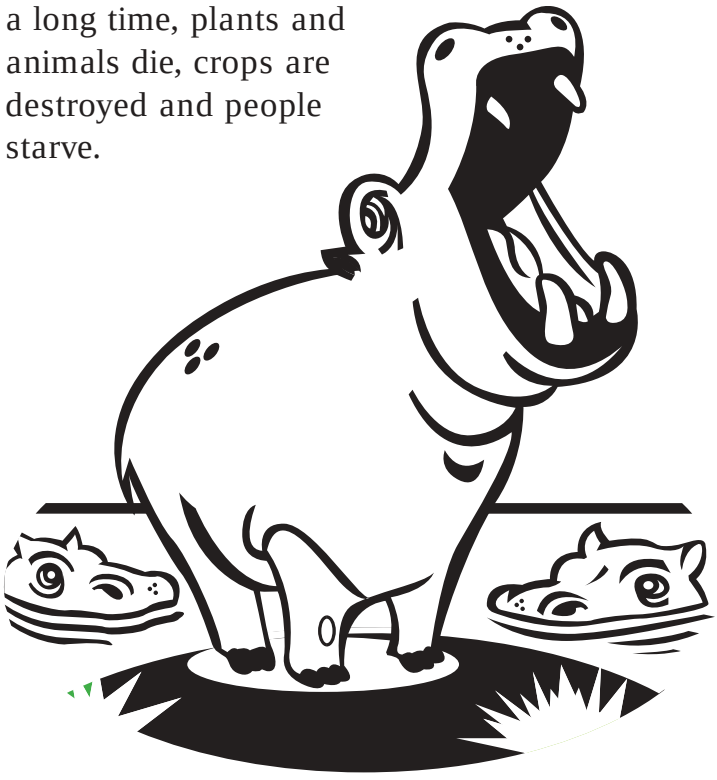
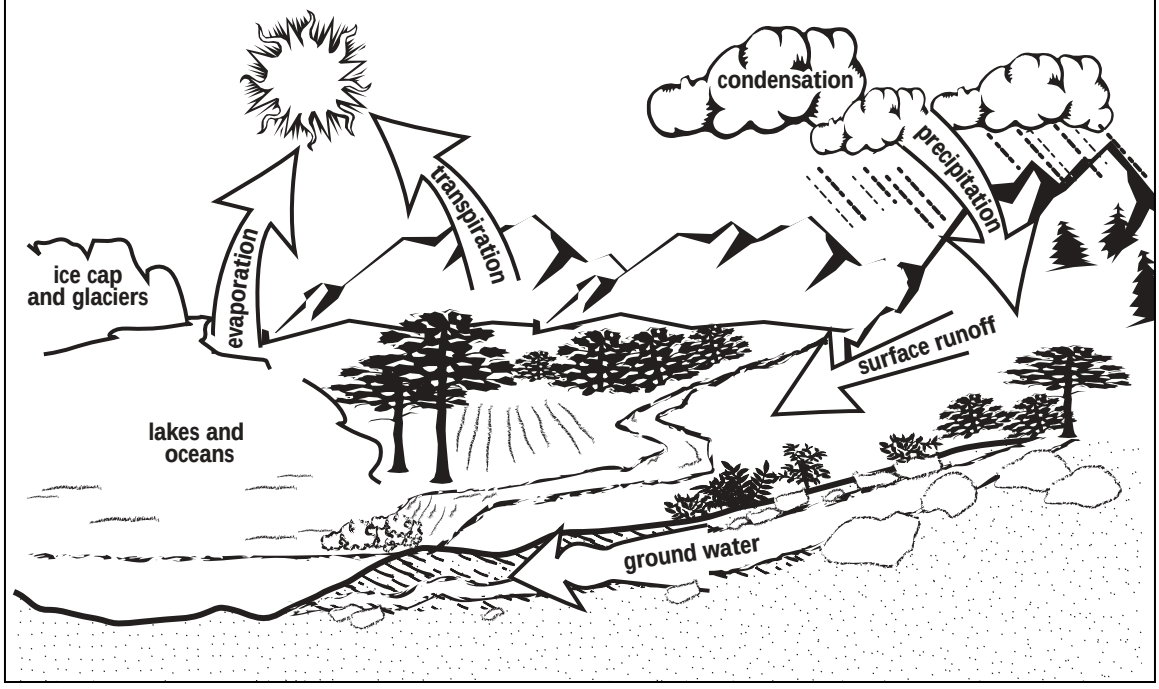


FIGURE 4.1

THE WATER CYCLE



(ADAPTED FROM WWF US, WINDOWS ON THE WILD, 1999)

On the other hand, too much water is also not good. During a flood, rivers get very full and water rushes over the rivers' banks, spilling into villages, washing away roads and houses and drowning people and animals. Soil is also washed away and rocks slip, causing landslides.

(ADAPTED FROM WWF HONG KONG, 1996. NATURE DETECTIVE EDUCATION BACK.)

You may ask where the water comes from and where it will go. The answer is found in the water cycle. Water from soil, oceans, rivers, and ponds is heated by the sun and evaporates. Water in plants also evaporates through their leaves. The water vapours cool and eventually condense into small droplets to forms clouds from which water falls back to the ground or oceans as rain and snow. Rain may also run off the surface of the ground into ponds, lakes, rivers and eventually the ocean.

Rain may also mix with underground water and then flow into the ocean (Figure 4.1). During this process, a huge amount of water is permanently trapped as snow at the Earth's polar circles or on high mountain peaks.

Activity

PREPARATION

Make copies of Background and Figure 4.1, The Water Cycle to give to students. Activity should be conducted on a sunny day.

PROCEDURE

1. Ask students if they like rain and why or why not. (Students may say that they do not like rain because it makes their feet and arms cold and wet; so they cannot go to the playground and have fun). Ask the students what would happen if there was no rain or too much rain. Based on the background of this activity to check answers of the students. Ask the students if they know how rain is formed. Tell them that they will have the answer after participating in the following experiment.

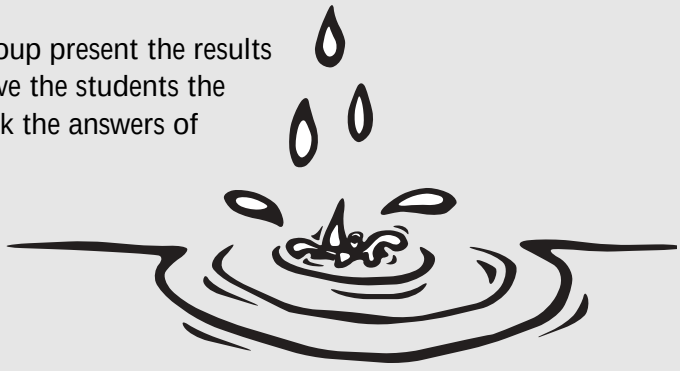
2. Instruct the students to put a cup of water into the plastic bag, tighten the bag with the elastic band and put it in the sun. Ask the students to observe the formation of water droplets on the top and sides of the bag. Ask them how these droplets got there? (Heated by the sun, water evaporates. These vapours cannot escape from the bag and become the droplets).

3. Ask the students to transfer the bag to a cool place and observe what happens to the water droplets (The droplets condense, form bigger drops, and fall down into the bag) (CEE, 1995. Joy of Learning). Explain to the students that the same process of evaporation and condensation occurs in nature. Explain the water cycle to them and hand out, the Background Information. Ask them to gauge how much they understand about the water cycle by participating in the following exercise.

4. Divide the students into groups of four to six. Give each group a flipchart, permanent markers and coloured pencils. Each group has to draw a water cycle, which includes the elements – sun, clouds, rain, rivers, oceans, evaporation, transpiration, condensation, underground water and snow. Then they have to develop a story about the adventure of a drop of water.

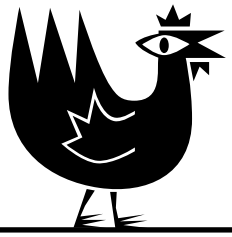
(Each group has 30 minutes for discussion)

5. Have a representative from each group present the results of their group's discussion. Then, give the students the handout, The Water Cycle and check the answers of each group.



ACTIVITY FIVE

Where Does Energy Come From?



Objective:

To understand the different forms of energy, their origins and how they transfer in the energy cycle; and to demonstrate that energy can be generated from waste such as animal dung.

Knowledge Targets:
Energy, landforms, soils and minerals.

Skills:
Analysing, applying and demonstrating

Time:
Two days
(45 minutes each day)

Materials:
A tin can or box of about 10-15 litres without any holes except the opening, rubber cork with one-hole through it, a soft plastic tube which can fit into the hole in the cork (tube used for blood or other transfusions will do), a hypodermic syringe that can fit in the soft plastic tube, wet cow dung, water, funnel, basin, string and a box of matches

Most energy on Earth comes from the sun. Green plants absorb carbon dioxide from the air and with the energy from the sun, and in a process called photosynthesis, form organic compounds which, accumulate in their roots, stems and leaves. These plants then become food for animals. Both producers and consumers transform a part of the organic material in food back into carbon dioxide when they breathe. When these organisms die, their bodies may be burned as fuel (such as firewood) or be buried for a long time under certain climatic and physical conditions to form fossil fuel (oil and coal). When these fuels are burnt, carbon dioxide or carbon monoxide is released back into the air. Later, green plants use these gases for photosynthesis. Dead plants and animals decay and return to the energy cycle through the food chain. (Figure 5.1).

(ADAPTED FROM CAMBODIAN ENVIRONMENTAL ADVISORY TEAM, 1994. GUIDE ON ENVIRONMENTAL EDUCATION FOR CAMBODIAN PRIMARY SCHOOL TEACHERS.)

Activity

PREPARATION

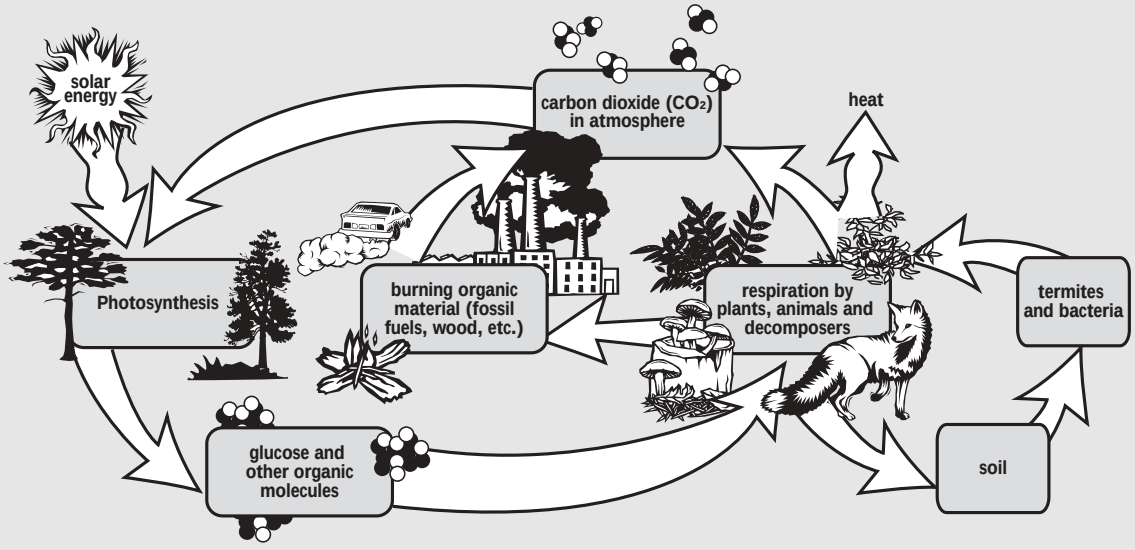
1. Handout copies of the background and Energy Cycle.
2. Select a site for carrying out the experiment, preferably in an empty or open room.
3. Collect about 3-5 kg of wet cow dung.
4. Gather all equipment listed under materials at the site of the experiment.

PROCEDURE

1. Gather students in the selected place and ask them if they know where energy comes from. Explain to them that a primary source of energy is the sun. Continue by asking them where the energy goes. Tell them about the energy cycle and give them five minutes to read the copies of the Background and Energy Cycle. Answer any questions they might have.

THE ENERGY CYCLE

FIGURE 5.1



(WWF US, WINDOWS ON THE WILD, 1999)

2. To begin the experiment, ask the students questions like:

   a) What kind of energy do you use for cooking at home?

   b) Where does it come from?

   c) Is there any relationship between that energy and nature?

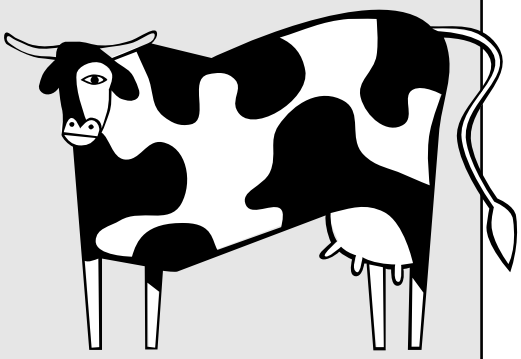
   (Students may say that they use wood, gas, or oil for cooking. These energies come from animals or plants and thus are related to solar, water or wind energy. Explain to the students that they will conduct an experiment about energy transfer, which will illustrate how energy can be generated from waste including animal dung.

3. Instruct the students to put the wet cow dung into a basin, along with three litres of water and stir well with a stick. Place the tin can in an appropriate site and pour the mixture into the can through a funnel. Fit the plastic tube through the opening of the one-hole rubber cork and close the can with this cork. Attach the hypodermic syringe to the other end of the plastic tube. Tie the tube with a string to prevent the biogas from escaping through the hypodermic needle. Allow the tin can to stand for 24 hours. Keep the windows of the room open during this time so that if the biogas leaks, it can escape.

4. The next day gather the students together at the experiment site. Ask a student to loosen the string on the tube. The students should be able to smell the gas. Ask another student to light a match near the opening of the needle. The gas will burn with a tiny flame.

(CEE, 1995. JOY OF LEARNING)

Tell the students that biogas can be generated from cow dung or other animal dung. In many villages of Vietnam, farmers use cattle or poultry dung to produce biogas for many purposes. Ask the students if they know how this biogas can be used. (Cooking, lighting, heating or running engines). Explain to them that using animal dung to make biogas not only helps keep the environment clean but also saves money they would have to pay to buy other fuels.



A C T I V I T Y S I X

Climate and Plants

Objective:

To know the effects of climate on a plant's growth and to observe how sunlight and water affect plant growth.

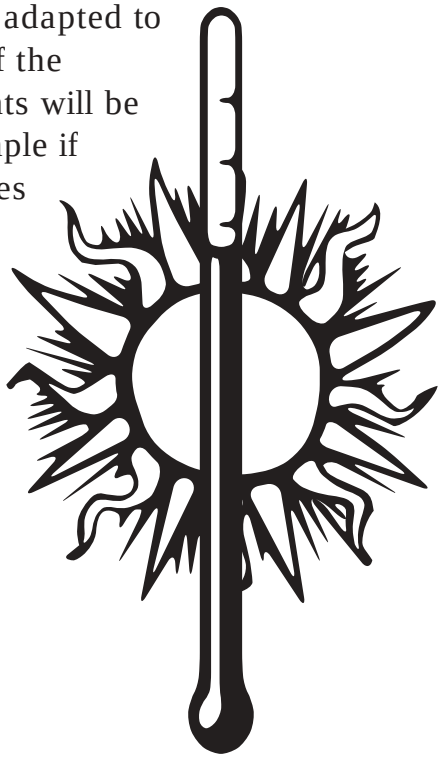
Knowledge Targets:
Atmosphere and cosmos, plants and animals

Skills:
Observing, analysing, applying, presenting and working in groups

Time:
10-15 days

Materials:
Bowls (alternatives are metal or bamboo boxes, or any shallow wide- mouthed jar the volume of which is similar to that of a bowl; mung bean seeds and carbon paper.

Plants have basic requirements in order to grow and survive just as humans and other animals have. The climate plays an important role in determining how successful growth is. Plants need water since this vital resource is an essential carrier of nutrients to every part of the plant and a major component of plant cell structure. Plants also need sunlight and air, particularly carbon dioxide, to carry out photosynthesis, the process by which plants turn carbon dioxide and water into food using energy from sunlight. Climate, which includes the amount of water, sunlight, and wind available, varies from region to region and these differences allow for different habitats to develop around the world. Different plants are adapted to the different habitats and if the climate changes these plants will be severely affected. For example if a tropical plant that requires large amounts of rainfall were moved into the desert it would die of drought. Thus, any change in water, sunlight, or air directly affects plants.



Activity

PREPARATION

1. To conduct their experiment, each group needs six pots, two carbon papers that are large enough to completely cover the seedlings in the pot, enough mung bean seeds to plant densely in the six pots (each pot needs about 20-30 seeds). Students may be required to prepare these things at home.

2. Make photocopies of the sheet, Experiment Results on Table 6.1 to give to each group.

3. This activity includes two sections. In section one, students set up their experiment at home and in section two, students bring their experiment to the classroom.

PROCEDURE

Divide students into groups of six to eight. Each group will carry out one set of experiments that helps them to observe how water and sunlight affect plants. Provide them with guidelines on how to set up the experiment at home.

I. Setting up experiment

1. Rub the seeds gently by hand to help the mung beans sprout faster. Put soil into six pots and scatter some mung bean seeds on the surface of the soil. Cover the mung bean seeds with a thin layer of soil. When the seedlings have the second leaves (about 8 to 10cm tall), students can start to carry out their experiment.

2. Divide the six pots into two sets of three. Set one is labeled as Ia, Ib and Ic while set two is labeled as IIa, IIb and IIc as follows:

Set 1: Seedlings are lit with normal sunlight but watered with different amounts	Set 2: Seedlings are watered with the same amount but the amount of sunlight varies
Ia: water once with half a teacup of water per day Ib: water twice a day with two teacups of water Ic: water three times a day with three teacups of water	IIa: without any sunlight IIb: with sunlight only half a day each day IIc: with normal sunlight

All of these pots are watered twice a day with two teacups of water. Cover the seedlings that are not lit by using the carbon paper to make a box or a funnel that fits on the pot as well as the seedlings. Make sure that all seedlings in the pot that are not lit are covered. When watering the seedlings, lift the carbon paper quickly and then cover the pot right away.

3. Students observe the seedlings' growth and report on their experiments, as in the following example:

EXPERIMENT RESULTS

FIGURE 6.1

SET I: DIFFERENT AMOUNTS OF WATER

Factors	**Ia:** Half a teacup of water, once a day	**Ib:** Twice a day with two teacups of water	**Ic:** Three times per day with three teacups of water
Height of the seedlings at the beginning of the experiment			
Height of the seedlings after ___ days (measured on the day of the report)			
Morphology of leaves and stems			
Reasons for seedlings' morphology			

SET II: DIFFERENT AMOUNTS OF SUNLIGHT, WATERED WITH TWO TEACUPS OF WATER, TWICE A DAY

Factors	**IIa:** Without sunlight	**IIb:** With sunlight for only half a day	**IIc:** With normal sunlight
Height of the seedlings at the beginning of the experiment			
Height of the seedlings after ___ days (measured on the day of the report)			
Morphology of leaves and stems			
Reasons for seedlings' morphology			

II. In the classroom

4. Have all groups bring their experiments and reports to the classroom. A representative of each group presents the report, which includes an explanation of the results of the experiment.

Key references for the teacher:

a) In set I, as seedlings are lit normally, they do not bear any characteristic of a tree that lacks sunlight. In pot Ia, the seedlings are stunted and short because of a lack of water; in pot Ib, the seedlings grew normally and have strong stems and green leaves; In pot Ic, stems and leaves of the seedlings are a yellow green colour because they have been inundated with water.

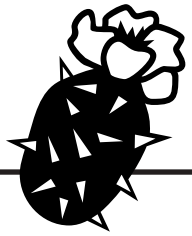
b) In set II, seedlings are watered appropriately but are exposed to various amounts of sunlight. In pot IIa, because of a lack of sunlight, the stems have become abnormally long and thin while the leaves are pale green (Seedlings in this pot are the tallest). In pot IIb, because seedlings have had more sunlight than those in pot IIa, they look better but still bear some characteristics of those that lack sunlight i.e. thin and long stems, and pale green leaves. In pot IIc, as the seedlings have been given enough sunlight and water, they grew well and have green leaves and strong stems. The seedlings in this pot should be similar to those in pot Ib.

5. After the students present their group's reports,they should know exactly what caused their seedlings' to look the way they do. Now, ask students if they know how to grow healthy seedlings. Explain that seedlings should have enough water and sunlight. If there is a lack or excess of these elements, plants will not grow well. This is also the case for other plants. If the ecological factors such as sunlight and water are appropriate, plants will grow well and productively. On the other hand, if these elements are not suitable, plants will grow poorly and even die. Thus, different plants suite different environments or different climates. In other words, climatic factors determine structure and productivity of plants.

Note: Keep all pots of mung beans for activity 26.

ACTIVITY SEVEN

Plant Adaptations



Objective:

To understand what adaptation is and recognise how different organisms in nature adapt to survive.

Knowledge Targets:
Plants and animals

Skills:
Gathering and interpreting

Time:
90 minutes
(45 minutes in class and 45 minutes on the site)

Materials:
Blank paper, pencils, handouts, and coloured string

Concept of Adaptation

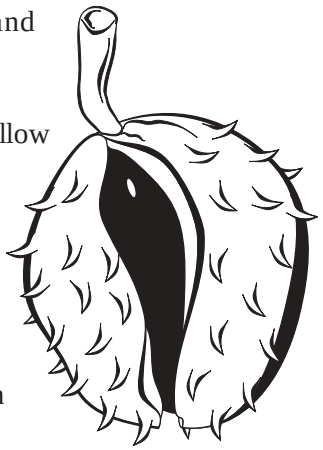
Humans can adapt to the environment in many different ways. When it is cold, they can wear more clothes. When it is too hot, they can sit in the shade, or have a cold drink. Houses are built to protect humans from weather conditions such as rain, cold and heat. Humans also know how to store food between crop seasons and trade with other areas for the products they need.

Animals have similar strategies for survival. Many species are able to adapt to the surrounding environment by constructing different types of homes such as nests or burrows or by living in groups; some species also migrate to avoid extreme weather. However, most plant species are unable to move and, therefore, have to use the morphological characteristics they obtained in the evolutionary process to help them survive in their habitats. From this activity, students will observe and analyse the consequences of different local plant adaptations. Below is a description of some specialised characteristics of leaves, flowers, fruits, roots and stems of plants from tropical rain forest and dry forest ecosystems. Note that this information is not comprehensive but is generally true for many species.

Tropical Rain Forest System

Leaves: The surface is smooth and the tip is pointed. These two characteristics allow raindrops or accumulated dew to dissipate rapidly from the leaf surface, preventing the growth of fungi and bacteria and preventing insects from laying eggs on the surface.

Flowers: Flowers are either colourful or have strong scents. According to scientists, the colour and scent attract different insects such as bees, ants, and flies that aid in pollination.



Fruits: Many kinds of fruits also have adapted physical characteristics that allow their seeds to germinate and thus grow into seedlings. At the emergent layer, many trees have light fruits with a thin papery structure that allows them to be dispersed by the wind. The colour, odor and sweetness of the fruit of some other trees make them attractive to animals. Birds, bats, rats, and monkeys eat these fruits and disperse these seeds. Other trees have heavy fruits that fall to the ground when ripe and animals, such as deer and wild boar, eat them and disperse the seeds in their dung. Other types of fruits can explode; the hard shell cracks and the seeds shoot out in many directions.

Stems and roots: Trees have many different types of roots, which allow them to survive in different environments. Roots enable trees to stand firm and upright while allowing them to take up organic substances and water. Some trees develop aerial roots such as mangroves, which are designed to avoid the excessive moisture and salt in the soil. Other trees have deep rooted systems to access nutrients and water, which are unavailable at the surface, and some trees have shallow widely spread root systems allowing the trees to take advantage of a thin nutritive surface soil.

Climbing plants: Due to the competition for light in the dense canopied tropical rainforest, many types of plants had to specialise and become climbers. These plants have tendrils that allow them to wrap themselves on the trunks of other trees and climb above the shade on the under story and into a niche where light is available.

Dry Forest

Leaves: Many types of leaves have adapted to arid environments. Some have developed a narrow shape, which reduces the surface area and leads to a low degree of water loss. Other leaves have a velvety layer of hair on the surface to reduce transpiration and still other plants such as cactus have a thick waxy skin and prickly spines, which are actually its modified leaves.

Another important adaptation of plants is the dropping of leaves during the dry season, which helps to prevent water loss from the tree during a time when water conservation is so critical. In addition, the thick layer of fallen leaves on the ground helps to minimise water evaporation from the soil. When the rainy season comes, this layer of leaves decays, providing the soil with organic compounds, and sheltering the soil from the erosive impact of rain.

Flowers: Flowers are colourful and attractive to insects. They are the main food source for insects and other species during the dry period and, in turn, these species help fertilise the flowers.

Activity

PREPARATION

1. Identify a site for students to visit. Make sure that the route is approachable and easy to walk to within 15-20 minutes.

2. Mark some plants with a coloured string that illustrate some adapted characteristics you want to demonstrate.

3. Make handouts of the Exploring the Adaptation of Plants.

PROCEDURE

1. Introduce the students to the Concept of Adaptation. Ask them about what humans do to adapt to a cold climate, hot climate, and a shortage of water or food.

2. Explain that humans can adapt to different conditions by their behaviour, or by changing their environment by migrating. Explain further that plants adapt to the environment based on physical characteristics developed through evolution. Tell students that they are going to explore how local plants adapt to environmental conditions.

3. Describe some local plants adaptations that the students might find in the field. Ask them to pay special attention because they will have to find evidence of these characteristics when they go out. Hand out a copy of, Exploring the Adaptation of Plants.

4. Before going to the field site, pair students up and give each pair a blank sheet of paper and pencils. Ask them to observe plants along the chosen route. Have each pair find plants with the characteristics listed in the Exploring the Adaptation of Plants sheet. Have them make sketches of the plant or the part they are focusing on such as a leaf or fruit, and take some general notes of what they see. If they discover other types of adaptations not mentioned, they should also document this information.

5. Tell students not to break branches or pick any leaves and flowers of any plant on the route. Tell them to observe only. Remind them not to wander from the trail.

6. Take students to the field site. Ask them to begin to look for the adapted characteristics listed in the handout. Encourage them to share information among groups.

(45 minutes)

7. Take students back to the class. Have each group describe the plants they documented and the observations they made.

8. Have the students work individually on the following questions:

a) What would be the consequences if all those adapted features disappeared?

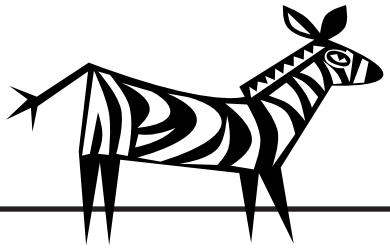
b) If you were asked to create a plant that could grow in an extremely cold and windy area, what adapted features would you give it? Explain why and draw the plant as you imagine it.

EXPLORING THE ADAPTATION OF PLANTS

1. Two species with smooth and shiny leaves to reflect sunlight and allow rain and dew to dissipate quickly from the leaf surface
2. Two species with thorny trunks or leaf stems to prevent animals from eating them
3. One species with small leaves to minimize water transpiration in the dry season
4. One species with large leaves to maximize photosynthesis
5. One species with leaves that are covered by a velvety hair to limit water transpiration
6. One species with tendrils that allow it to climb up other trees
7. One species with leaves that can “move” to limit its transpiration
8. One kind of fruit with papery wings (This fruit can fly and be scattered by the wind.)
9. One species with colourful or odorous flowers that attracts insects for pollination
10. One species with a flower slanting downwards. (Its leaves shelter the flower from raindrops.)
11. One species that can store water (Bromeliad, Cactus)
12. _____
13. _____

A C T I V I T Y E I G H T

Hide and Seek



Objective:

To understand what camouflage is and how different organisms change their appearance to survive.

Knowledge Targets:
Plants and animals

Skills:
Observing, analysing, and presenting

Time:
45 minutes

Materials:
Coloured yarn (5-7 colours) cut into short pieces, flipchart, and markers

In the natural world, all organisms have to fight and compete with other species for food and habitat. Many species also have to protect themselves from danger. Some animals, including insects, reptiles and large carnivorous mammals, have an ability to camouflage themselves by changing their shape, colour, size and sound.

A gecko is a common type of reptile that lives in the forest, garden, and even in the house, which is easy to observe. It can change the colour of its body quickly. When it is on a tree trunk, stone or on the soil, its skin has a gray, brown, or dark colour like that of the object it is resting on. This allows the gecko to mix with the environment and hide from enemies or prey. When creeping in the leaf canopy, a gecko has a greenish colour like that of the leaves. When it is chased, a gecko's body changes from red to green, to brown and yellow, and sharp pointed scruffs on its body puff out, which makes some enemies frightened.

A stick bug and leaf butterfly also display typical types of camouflage. A stick bug's body is segmented with a brown, green or gray colour like that of dry stick. A leaf butterfly when it perches on a tree branch and closes its wings looks like a leaf on the tree.

Fish and other aquatic organisms such as squid also have the ability to change their body colour quickly. Fish living at the bottom of the sea often have a dark colour, which is similar to the colour of mud, thus making it difficult for other fish to see and eat them.

Camouflage is also common with large mammals. Panthers and wolves in snowy areas always have white fur to blend in with the snow. A zebra's typical black and white stripes make it difficult for predators to see when running. Likewise, the tiger's yellow and black stripes allow it to lie in reeds and cane waiting for an ambush without being noticed.

Activity

PREPARATION

Cut coloured yarn into short pieces of 10-15cm. Count and record how many pieces you have of each colour. Lay the pieces of yarn in the grass or on the dirt. The area should be limited to about 50-100m^2.

PROCEDURE

1. Divide students into five groups. Take all students to the designated area and inform them that there are many coloured pieces of yarn in the area and their task is to find and collect them in five minutes.

2. After five minutes of collecting, have all groups count their pieces of yarn. Write the number of each colour of yarn that each group collected as in the following chart:

RESULT OF THE YARNS COLLECTION

FIGURE 8.1

	Dark Green	Green	Pink	Dark Red	Red	Dark Blue	Violet
Group 1	6	6	8	17	7	13	10
Group 2	10	1	13	9	16	10	6
Group 3	1	0	6	10	15	19	25
Group 4	9	3	16	10	9	10	9
Total	26	10	43	48	47	42	50

Note: Data in this table is an example for your reference

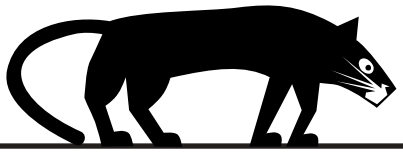
3. Ask every group to report to the class about the number of each colour yarn that they collected: which colour yarn did they collect most? (Yarn that is brightly coloured and easy to find like red, pink, white and violet should have been collected most. The more similar the yarn is to the color of the grass and soil, such as black, brown, green, and yellow, the more difficult it is to find. In Table 8.1, the number of green yarn found is the least compared to the brighter colours.)

4. Ask students if it is easy to find animals in the forest and why or why not. Ask the students why animals use camouflage. Ask students to give examples of animals, birds, and insects that use camouflage. Then, show them some pictures of animals that use camouflage such as walking sticks, zebra, lions, and leaf butterflies. Summarise the objective of this activity with the students. (To understand what camouflage is and that many types of wildlife use camouflage to protect themselves in nature.)

ACTIVITY NINE

Predator and Prey

Predators and their prey have a unique relationship, one that is far from friendly. Predators eat prey. This relationship, though precarious for prey species, is essential for both parties to exist. The constant struggle for food provides equilibrium in the population levels of both predators and their prey.



Objective:

To understand the food chain and the constant struggle that animal populations face.

Knowledge Targets:
Plants and animals

Skills:
Observing and analysing

Time:
30-45 minutes

Materials:
Paper or coloured cards and old tyres

Predators can be large mammals such as tigers, panthers, wolves, and dogs. Prey are usually herbivores such as deer, wild boar, monkeys, and birds, though some prey can also be other small predators such as civet. Both predator and prey have developed different skills and body types to perform the role they have in nature. Predators have developed a great skill in watching, and waiting in ambush. They are usually extremely agile and they usually have extremely sharp claws and teeth for catching and eating their prey. Prey often is very quick. It may be able to camouflage itself to hide and has developed defense techniques for when predators chase it.

In general, the number of animals of prey in one environment is higher than the number of predators. Creatures that are prey also have a greater ability for breeding. This allows them to maintain a large population so that there is sufficient food for predators and so there are enough individuals in the population to produce enough offspring. If the population level of prey is too low, predators will not have enough food and will struggle for survival. Furthermore, in an ecosystem without predators, those that are prey will over breed, and the population will compete for food to the extent that there is a scarcity in resources resulting in the starvation of many individuals.

Activity

PREPARATION

Draw two parallel lines of 8-10m long, about 10-15m apart to create the game area. One line will represent the "food source", and the other will represent the "hiding place". Between these two lines, randomly draw five circles of 50cm in diameter. These circles are called "temporary hiding place". Old tyres may be placed on the ground to act as "temporary hiding places". Scatter cut paper or coloured cards or anything else you can think of to symbolise food, along the line representing "food source". Write the names of some predators and prey on cards for the students to stick on their backs. Some predators might include tiger, leopard, wild dog, fox and human. Some prey might include deer, wild pig, wild rabbit, jungle foul, monkey, squirrel or rat.

PROCEDURE

1. Before carrying out the game, ask students what kind of food wild animals eat. Ask them to give examples of some food that different predators and prey eat. After the discussion, introduce the rules of the game to the students.

2. Divide students into three groups. One group will act as prey (about half of the students will be in this group). The other group (about one-quarter of the students) will act as predators, and the other group will act as game monitors. To start the prey should stand behind the line called "hiding place". The predators should stand at any place between the two lines, except in the circles called "temporary hiding place". The monitors should stand around the boundaries of the play area.

3. At the beginning of the game call to the prey "Hey all you deer, zebra and rabbits, wake up. Go and find your food for today". All the prey should move from behind the line called "hiding place" and run to the line called "food source" and take one piece of food and return back to the "hiding place".

4. Each predator has to catch at least two animals of prey or it will die and have to sit out of the game. The predator has to catch the prey by tagging students. When "prey" is caught it has to sit out of the game.

5. Animals of prey have one way of defending themselves: They can hide in the circles called "temporary hiding place" (each circle can hold only one prey at a time). Prey can stay in the "temporary hiding place" as long as it wants, provided that it has taken enough food before the game ends. Each round should last about five minutes. The game can last two to three rounds.

6. The game monitors have to check how much food or prey each predator has taken. At the end of each round, count the number of animals of prey and predators left.

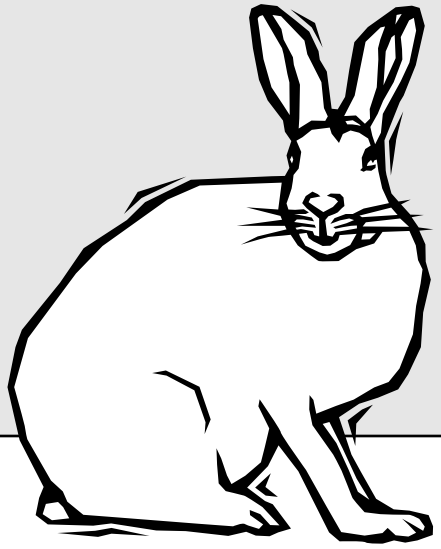
7. When the game has finished, ask the students questions such as:

a) How was the prey able to escape? What was the best and most effective way for escape?

b) What were the best methods for predators to catch prey effectively? Make a comparison between the number of prey and predators that survived. Why is there this result?

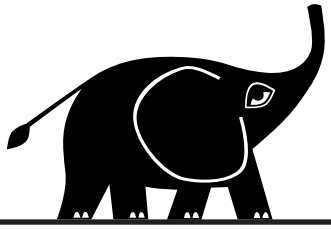
Note: All groups should be rotated so that the students who act as monitors are given a chance to be predators or prey.

(ADAPTED FROM CEE 1997. GREEN GAMES)



ACTIVITY TEN

A Suitable Habitat



Objective:

To understand the relationship between organisms and their habitats.

Knowledge Targets:
Plants and animals

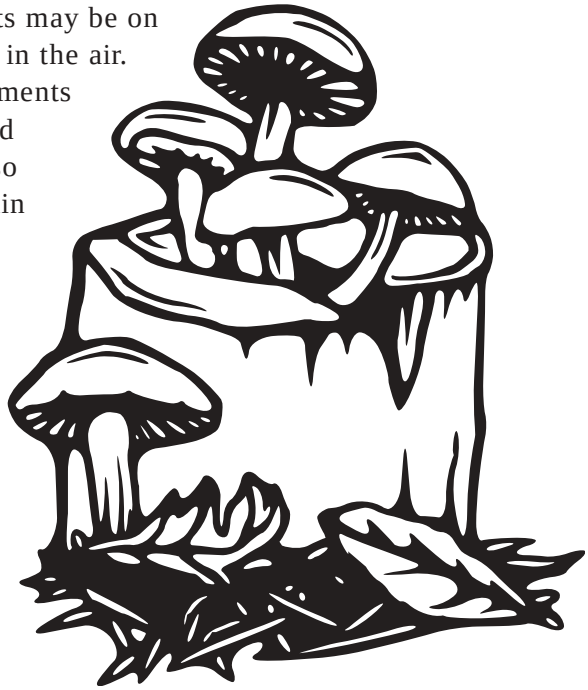
Skills:
Observing and analysing

Time:
45 minutes

Materials:
The set of cards Web of Life (refer to activity 12), papers, pens and box

Different animals live in different habitats. Each species has a preferred type of environment where it gets the food, water, and shelter that it needs to survive. The habitat of each species has an optimal temperature, humidity, light, and precipitation.

The preferred habitat of one species can be large. Elephants, tigers, and whales can have a preferred range of up to a thousand hectares. Other organisms such as a lichen or fungi, can be limited to just a few centimetres. Some species can live in different habitats, while others can live in only one. Habitats may be on land, in water or in the air. Artificial environments such as fields and fishponds are also habitats for certain organisms.



Activity

PREPARATION

Write the names of local habitats on paper in large and clear letters. Each paper should contain the name of one different habitat/ecosystem such as wetland, evergreen forest, ocean, desert, rotten log, etc.

PROCEDURE

1. Ask the students to stand in a circle. Have some students stand outside of the circle about five to ten metres away. Have each of the students outside the circle stick one of the papers with a habitat written on it on their chest. Make sure that the students in the circle can see the name of the habitats clearly.

2. Place a Web of Life card with the picture facing the ground in front of each student in the circle. Have the students sing a song about the environment while moving clockwise around the circle. When the song stops have them pick up the card closest to them.

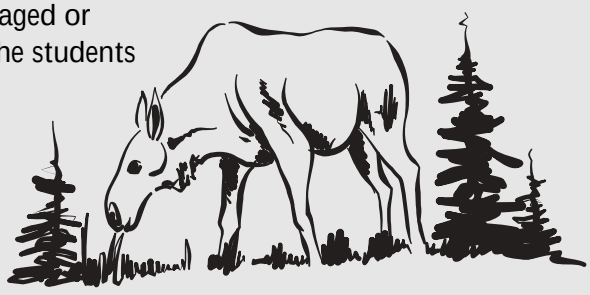
3. Within ten seconds have the students find out what animal they have and run towards the student outside the circle holding the appropriate habitat for that animal. For example, a fish has to run to the river or lake habitat.

4. Now ask the students why they chose the habitat they did. If they picked the wrong one, or they did not run to their habitat in time, they lose.

5. Ask the students some final questions:

    a) Does each species have only one habitat?
    b) Why do different species need different habitats?
    c) How do some species live together in the same habitat?
    d) What would happen if this habitat was damaged or completely destroyed?

6. Have the students put their cards back on the floor in the circle to play a second round. Remove some habitats from the outer circle and repeat the game as in steps two and three. As a result some students may not be able to find their habitats. Ask the students what would happen if this habitat was damaged or completely destroyed in real life? Now ask the students what people should do to protect habitats.



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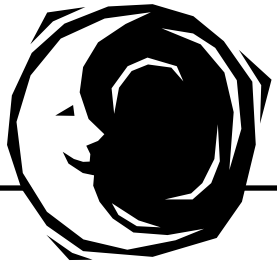
A C T I V I T Y E L E V E N

Cosmic Connection

This activity is closely related to activity 12, The Web of Life.



Objective:

To understand the interrelationships which exist in nature.

Knowledge Targets:
Plants and animals

Skills:
Collecting, analysing, and presenting

Time:
75 minutes

Materials:
Handouts

Activity

PREPARATION

Make copies of the worksheet Nature Connections for each group.

PROCEDURE

1. Divide students into groups of two or three. Give each group of students one copy of the "Nature Connections" worksheet. Ask the students to act as if they were scientists who are exploring the relationship between organisms in nature.

2. Ask the students in the groups to read the Nature Connections worksheet and have a discussion amongst themselves to gather the information required.
(45 minutes)

3. After all groups have finished with the worksheet, have them give their answers to the class.

4. Ask the students some questions:

   a) What relationships in nature did you learn about that you didn't know about before?

   b) How do humans relate to other living organisms in nature? Can humans cause the web of life to become unstable? How?

5. Explain to the students that the symbiotic relationships that they have just explored are an ever-present part of life on Earth and create the balance and harmony that exist today.

Nature Connections Worksheet

For each answer that you provide give an explanation.

1. Name a small animal that other larger animals have to rely on to exist.
2. Name a large animal that other smaller animals have to rely on to exist.
3. Name a species of plant that has to live on the trunks of trees.
4. Name an exotic animal (which has immigrated from another place) that causes damage to native species.
5. Name an exotic plant (which has immigrated from another place) that causes damage to a native species.
6. Name a species of wild animal that lives around or inside a house.
7. Name an animal that lives from eating the dead bodies of other organisms.
8. Name an animal that lives on or inside tree trunks.
9. Name a plant species that benefits human life.
10. Name an animal species whose activities benefit humans.
11. Name an animal that may look like part of a tree.
12. Name two living organisms that benefit each other in their survival.
13. Name an organism that lives inside another and gets its food from this organism.
14. Name an animal that has to live in two different habitats.
15. Name an animal that eats fruit and excretes seeds in its feces allowing new plants to grow.
16. Name something that turns to soil.
17. Name a plant that relies upon animals to some degree to exist.
18. Name a plant that plays a key role in the food chain.
19. Name an animal that plays a key role in the food chain.

ACTIVITY TWELVE

The Web of Life

Objective:

To understand the interdependent relationship and interactions that occur among components in nature.

Knowledge Targets:
Atmosphere and cosmos; landforms, soils and minerals; plants and animals; energy; water; people

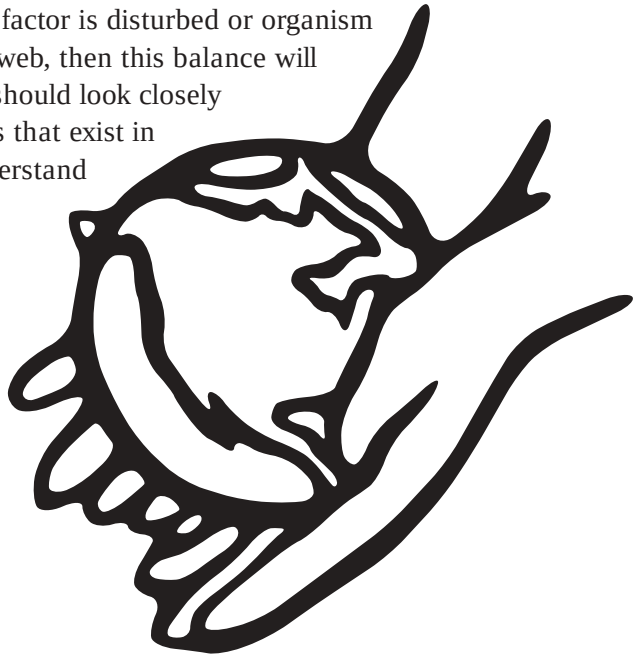
Skills:
Deducing and assessing

Time:
50 minutes

Materials:
A set of Web of Life cards, 100-200 metres rope, and tape/ pins

The environment is a complex system of intricate relationships between non-living resources such as soil, water, light and air, and living organisms such as animals, plants, bacteria and humans. The sun and moon are also critically linked to this system.

All organisms on Earth are interdependent and connected to each other by symbiotic relationships. They depend on each other for nutrition (food), for accommodation, and protection. The sun is the primary source of energy for all organisms on Earth. Plants synthesize this energy together with water and air into organic compounds (starch and sugars). These plants become a food source for herbivores such as insects, birds, monkeys, giraffe, deer, buffalo, and even humans. Carnivores such as tigers, wolves, and bears, on the other hand, eat these herbivores. Microbes, at the same time, depend on the decaying carcasses of these animals and the detritus of plants for their survival. This complex system of relationships is called the web of life. The web of life exists in a fragile balance or equilibrium. If any factor is disturbed or organism removed from the web, then this balance will be destroyed. We should look closely at the relationships that exist in nature to fully understand the wonders of the web of life.



THE DIFFERENT TYPES OF RELATIONSHIPS THAT EXIST IN NATURE

- Competition: when many species seek the same resources and the impact that each individual has on the amount of the shared resource available to others is negative. For example wild buffalo and deer species compete for the same grass resources.
- Mutualism: when different species interact and the result of the interaction is positive to all parties involved. An example is a bird pollinating a flower.
- Parasitism: when one species benefits from the interaction and negatively impacts on the other species. An example is an intestinal worm in a pig.
- Commensalism: when one species interacts with another and the relationship is beneficial to one species and the other species receives no benefit but is not damaged. An example is an orchid growing in the branch of a larger tree.

Some non-living components of the web of life:

Water

Seventy-three per cent of the Earth's surface is water. The vast majority - 97.6% - of this water is salt water found in the Earth's seas and oceans and 2.08% is solid in the form of ice and glaciers. Humans or land dwelling wildlife do not utilise these forms of water. The rest (0.03%) of the water that exists is fresh water and is used by humans and other terrestrial wildlife. This water is found in rivers, streams, and underground aquifers.

Soil

Soil has formed by a process of weathering that has taken millions of years. Temperature, rain, sunlight, wind, humidity, and volcanic eruptions are some of the natural processes that cause weathering. A nutrient rich organic layer called humus is important to the survival of many plants. This layer is made from animal dung, decomposing plant detritus and decaying animals. This nutrient rich layer of soil is also home to a number of worms, insects, fungus, algae, moss, and bacteria. Soil holds water, which then is taken up by trees. Soil also contains many types of minerals that are important for plants and animals. Minerals such as calcium, phosphorous, manganese, iron, and zinc are taken from the soil by plants. Mammals get these minerals in turn by eating vegetation or from salt licks. Elephants, for example, may lick ashes from bush fires to get minerals.

Atmosphere and Air

Carbon dioxide (CO^2) and oxygen (O^2) are essential for the survival of all organisms. By photosynthesis, plants use CO^2 to produce organic compounds and release O^2 into the atmosphere for humans and other animals to breathe.

Activity

PREPARATION

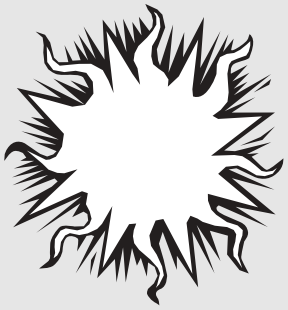
Photocopy and cut out the set of cards, Web of Life and laminate them. Get a long rope or strong string for students to hold onto when making the web of life.

PROCEDURE

1. Gather the children in the playground. Introduce the objective of the activity to the students, which is to understand the complex relationships in nature, the "web of life".

2. Ask the students to form a circle. Hand each student one Web of Life card, and have him or her stick it to his or her shirt with tape. Each card represents one component of the web of life including the sun, soil, water and air.

3. Begin the game by giving the student with the card for the sun the end of the rope and explain that the sun is the initial source of energy for all creatures, and if there were no sun, there would be no life on Earth. Next have the "sun" pass the end of the rope, to the student with the card that he or she thinks has the most immediate relationship with him or her (The "sun" should pass the rope to a "plant"). When the student passes the rope to the next student have him or her explain why he/she is related to the component represented in the card. The "sun" should mention that he or she is related to the "plant" because it provides energy to the plant for photosynthesis.



4. Continue the game by asking the "plant" to hold the rope tightly to maintain its relationship with the "sun" and to pass the rope to another student that it is connected to in nature and to give reasons for that connection. For example, a "bird" may use trees to build its nest in and others may find food in trees. The relationships that the students choose may be relationships about food, living space, protection, etc. The more relationships the students can think of, the better. Continue the game in this way until all students have become part of the web.

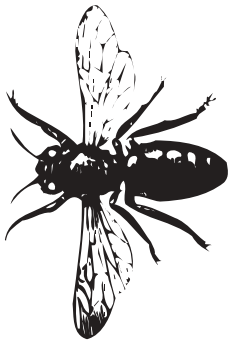
5. After all the students have become part of the web, ask them to stretch the rope so there is no slack. Tell them that they have just built a web of life and emphasize the interrelationships between the different components of the ecosystem. Ask the students if they think there is any part of nature that is not connected to the web of life or if there is any component that is less important than others and have them explain why.

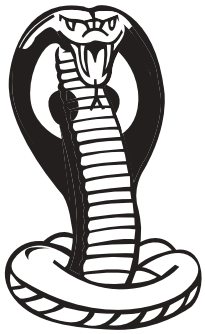
6. Now take one part of the rope and press on it sharply. Explain to the students that you want to illustrate that a web of life always faces external pressures such as drought, storms, pollution, hunting and deforestation. Now take your hand off of the rope so that it goes back to normal. Explain to the students that the diversity of relationships in an ecosystem allows for the environment to be resilient to outside pressures and for it to recover when these pressures are removed.

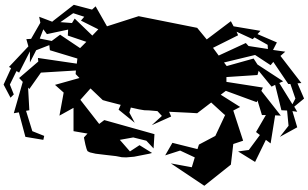
7. Ask students to imagine what would happen if components of the web were damaged or removed, for example, if trees were all chopped down. Ask the student with the tree card to drop the rope he/she is holding. All the other students that have connections with the tree will immediately see the rope that they are holding become loose. When the web of life becomes disturbed as such, ask the students what would happen if pressures occur again from outside? Now press on the rope again so that the web becomes loose. Conclude that when the web of life is broken, many relationships are disturbed and thus the survival of different species will be threatened. If activities such as deforestation, over hunting, and pollution are not prevented, the environmental equilibrium will be destroyed and even human lives will be affected.

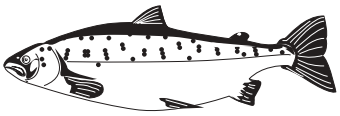
(ADAPTED FROM CEE 1996. JOY OF LEARNING)

Web of Life Cards









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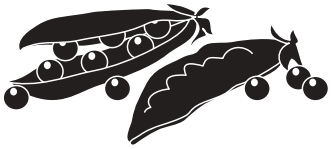

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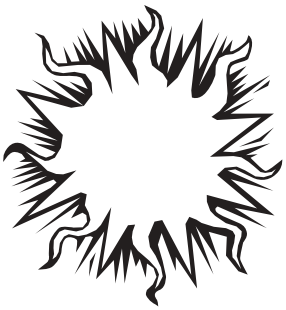

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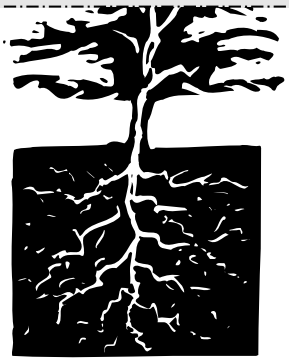
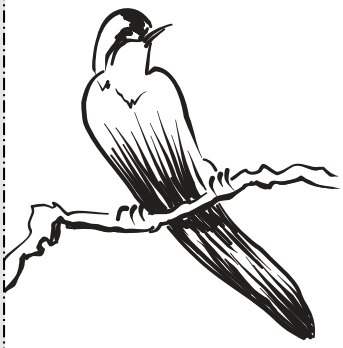
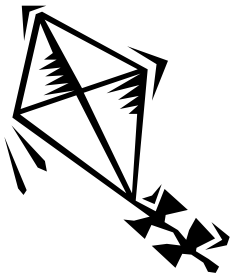
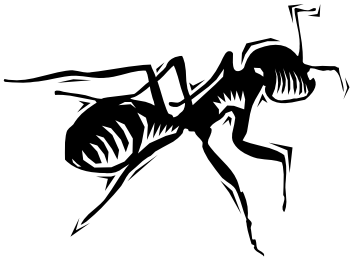








ACTIVITY THIRTEEN

Ecosystem Services

The Earth, wildlife and people benefit greatly from intact natural ecosystems. Without being noticed, ecosystems are always working hard to serve people's lives whether they are eating, sleeping, working, traveling or entertaining. Forests clean the air; oceans moderate climate; and wetlands filter and clean water, while reducing the effects of storms and controlling floods. It is difficult to see all the useful services that ecosystems provide to people.This activity will help students to see the benefits of ecosystems.

(WWF US, 1999)

Objective:

To learn about the benefits that ecosystems provide to the land, animals and humans.

Knowledge Targets:
Atmosphere and cosmos; landforms, soil and minerals; plants and animals; and water

Skills:
Demonstrating, organising, interpreting, presenting and working in groups

Time:
Two days,
45 minutes each day

Materials:
Materials needed for each experiment are listed in the description of each experiment

Activity

PREPARATION

1. Make handouts of Ecosystem Services for each student.

2. Make handouts of Experiment's Description for each group.

3. Gather all materials that are listed in each Experiment's Description. The students may be asked to prepare these materials.

4. Select a large room in which to conduct the activity. Divide the room into four stations where the students can carry out their experiments. Another alternative is to conduct this activity outside near a lake or forested area.

PROCEDURE

I. Day 1: Setting up the experiments

1. To start, tell the students that all ecosystems work continuously and provide important services to people, which they will have a chance to see in this activity. Divide the students into four groups and assign each group one experiment in one station. The members of each group should not discuss their experiment with the other students in the class.

2. All groups should read their Experiment Description carefully before setting up the experiment. Tell the students that on the second day they will have to conduct their experiments before the class, briefly introducing it as well as reporting on the results. Thus, each group must answer the questions under What will happen? in their experiment descriptions.

II. Day 2: Present results of experiment and match information.

1. Give the handout, Ecosystem Services to the students and ask each group, one by one, to explain the procedures, demonstrate the experiment and present the results for their group. All the groups should provide the class with enough information to answer all questions in the section, What will happen? After each group has finished its presentation, each students must match the experiment with the service provided as described in the handout, Ecosystem Services. After all information has been matched, check the answers of the students. (Key: 1-b; 2-d; 3-a and 4-c).

2. Now, ask the students how ecosystems benefit people. (Flood control, water cleaned and filtered, oxygen production and climate moderation).

EXPERIMENT 1:
DIRTY WATER - CLEAN WATER

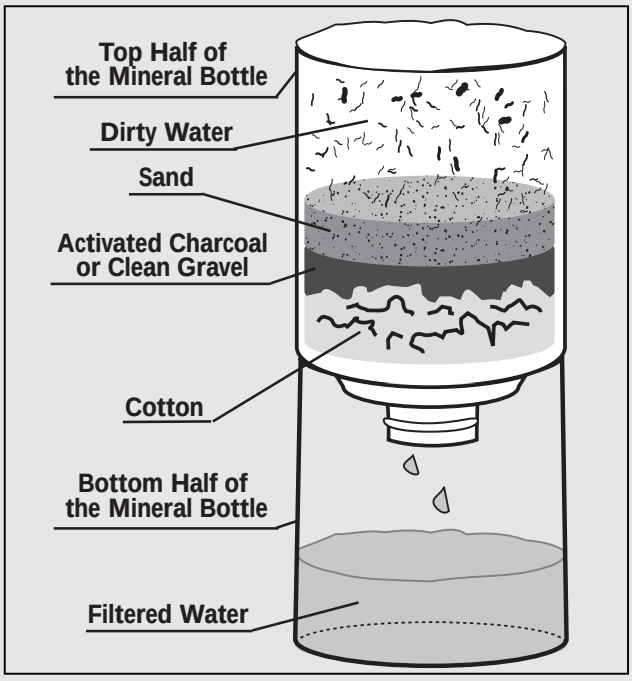
INFORMATION

(Do not share this information with other groups)

Soil is made up of mineral particles, air, water, microorganisms and other organic matter, which come from the decay of dead plants and animals. Soil is structured in layers and hundreds of years are needed to form one layer several centimetres thick. When polluted water runs through the layers of soil, contaminated suspended compounds are trapped in the soil particles. Thus, soil cleans and filters water. Soil also helps to eliminate toxic pollutants such as chemical fertilizers and pesticides. Many minerals in soil bond with these toxic chemicals and remain in the soil instead of leaking into underground water. That is to say that soil can detoxify some contaminated chemicals, thereby reducing the harmful effects on organisms.

What do you need?

An unlabeled plastic mineral water bottle cut horizontally into two equal parts, cotton wool or toilet paper, activated charcoal (alternative is clean gravel), sand, water and a glass.



How to set up the experiment?

1. Turn the top half of the bottle upside down and put in a thick layer of cotton wool or toilet paper. Place on this layer some activated charcoal or clean gravel and then put a layer of sand on the top. Put the top half of the bottle on the bottom half.

2. Put soil in a half glass of water and stir well. Then, slowly pour this dirty water into the top half of the prepared bottle.

What will happen?

Describe the appearance of the filtered water (water in the bottom half of the bottle). Observe which materials filter water and decide which layer traps the most soil including which layer traps most of the coarse soil particles and which layer traps fine soil particles. (Note that coarse soil particles will be trapped in either the layer of gravel or the layer of activated charcoal, while the fine soil is trapped in the layer of sand). Why does this happen?

(ADAPTED FROM WWF US, 1999. WINDOW ON THE WILD)

EXPERIMENT 2:
TRANSPORTATION OF WATER INSIDE A PLANT

INFORMATION

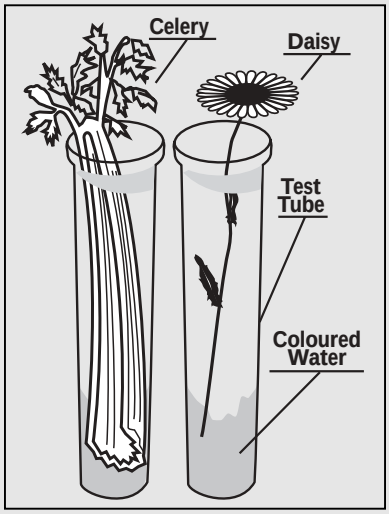
(Do not share this information with other groups)

There are small tubes or capillaries inside the stem of a plant, which transport water from the root to all parts of the plant. If the water is polluted, the toxic contaminants can also be transported to the plant tissues and will accumulate there. This does not mean that toxic pollutants disappear, but that they will be released into the environment slowly and in small amounts compared to when they polluted the water. When the plants die, all these toxic chemicals will be released immediately into the environment. One plant that accumulates a large amount of toxic pollutants is the water hyacinth. When water in the pond is polluted, high concentrations of toxic chemical accumulate in the stems and roots of this plant. Thus, water hyacinths growing in a pond will eliminate pollutants, but eventually they must be removed and incinerated.

What do you need?

A celery stalk with leaves and without a root (Alternatives are Indian taro, water taro or taro with leaves, water hyacinth, dahlia, or daisies), three to five test tubes, different coloured food dyes (Ink can be an alternative), water, knife, and magnifier.

How to set up the experiment.



1. Pour water into test tubes and add a different colour of food dye into each. The colour of the dye represents toxic pollutants in natural water (for example, pesticides, oil, and heavy metals such as mercury or lead).
2. Cut off a short piece of the plant and put the remaining stalk in the test tube with the coloured water until the next day. The plants in this experiment represent water or wetland plants such as the water hyacinth, reeds, and grass, while the coloured water represent polluted water.
3. On the second day, cut the plants into pieces about 2-3 centimetres in length for all group members to observe. Use the magnifier for better observation.

What will happen?

Describe what you observe. Where do you see coloured water on the plant? What has happened to the plant's leaves and petals? (You can see coloured lines on the plant. They are capillaries which help to transport water and minerals to all parts of the plant. You will also notice that the edges of the leaves and flowers are the colour of the dye. Using a magnifier, observe that the veins of the leaves and petals are also coloured). Ask the students what happens when people apply chemical fertilizers and pesticides to vegetables. If they were a farmer would they use these chemicals after what they learned?

(ADAPTED FROM WWF US, 1999. WINDOW ON THE WILD)

EXPERIMENT 3:
CLIMATE CONTROL

INFORMATION

(Do not share this information with other groups)

Plants absorb water through their roots and then the water escapes into the air through the leaves, in a process called transpiration in which water evaporates through small holes on the surface of the leaves. Regardless of whether the water absorbed by the plant is clean or dirty, it is clean when it transpires into the air. These vapours will then mix with water which has evaporated from oceans, rivers, and springs to form clouds and then rain — one essential process of the water cycle. In ecosystems, plants play an important role in determining the amount of water in the atmosphere and thus they have a major effect on the climate of the area.

(ADAPTED FROM WWF US, 1999. WINDOW ON THE WILD)

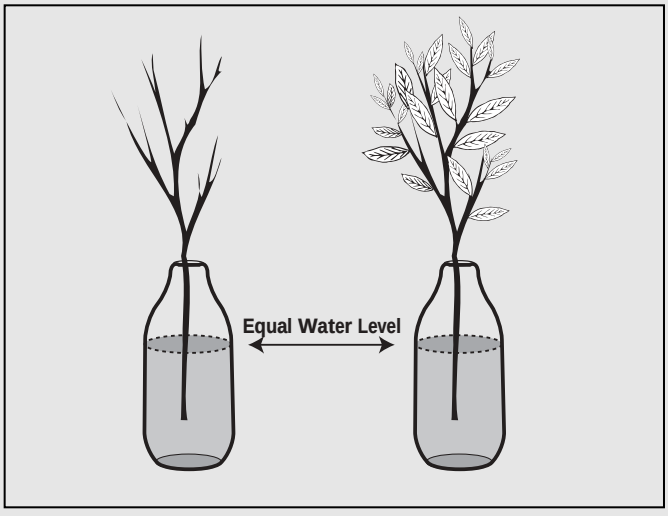
What do you need?

Two branches of a tree with leaves that are similar in size. Trees with large leaves are preferable.
Two transparent narrow-mouthed glasses or plastic bottles, which are similar to each other.

How to conduct the experiment?

1. Pour the same amounts of water into the two bottles. Put one branch with leaves in one bottle. Take off all the leaves of the second branch and put it into the second bottle. Make sure that the water level in these two bottles is the same. Mark this level.

2. Put the two bottles with the branches in the sun or by the window for one day and observe.



What will happen?

How do the water levels in the two bottles change? Which bottle loses more water? Why? (The water level in the bottle with the branch with leaves is lower because water transpires through the leaves. That shows the transpiration in plants).

EXPERIMENT 4:
OXYGEN PRODUCTION

INFORMATION

(Do not share this information with other groups)

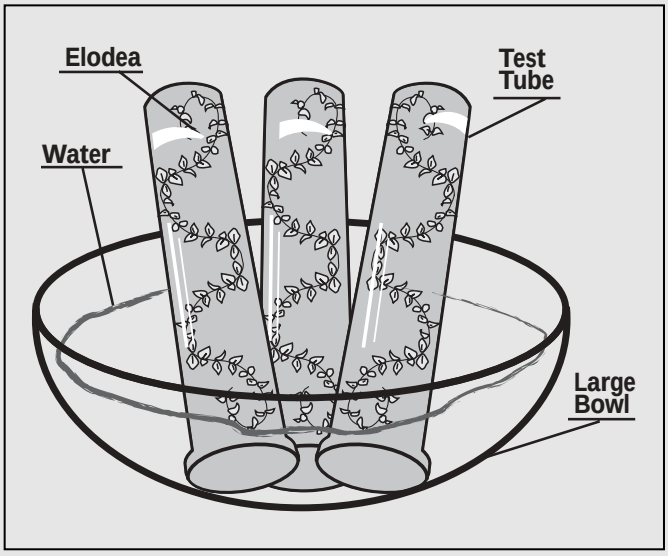
Like animals, plants need food to survive. However, unlike animals, plants can produce food on their own through the process of photosynthesis. In this process, plants use carbon dioxide (CO^2), water and sunlight to produce food (sugar) and oxygen. It is this oxygen that helps to ensure terrestrial life. The photosynthesis process of plants also helps to reduce air pollution. Plants in houses and offices help to clean the air.

(ADAPTED FROM WWF US, 1999. WINDOW ON THE WILD.)

What do you need?

One bowl, three to five test tubes with water, and a water plant such as the elodea or anacharis (Water plants that are put in a fish tank can be used).

How to conduct the experiment.



1. Fill the large bowl with water.
2. Put a water plant into each of the three to five test tubes and fill the test tubes with water. Cover the mouth of the test tube with the thumb and slowly turn the test tube upside down and place it at the bottom of the large bowl of water so that the test tube is still full of water and contains no bubbles. Do this for all test tubes.
3. Keep the plant lit overnight. Observe the plant and test tubes the next day.

What will happen?

Is there any difference in the test tubes? Why? (Next day, a bubble floating in the test tubes can be observed. Because of the light, the water plant carries out photosynthesis and releases oxygen. As oxygen is lighter than water, it floats and is trapped by the glass. After one night, all oxygen released gathers to create a bubble in the test tubes). Ask students why the concentration of carbon dioxide in the air has not become toxic though many people breath out this gas. Ask the students what would happen if there were no more trees on the Earth.

(ADAPTED FROM WWF US, 1999. WINDOWS ON THE WILD.)

ECOSYSTEM SERVICES

a. Plants absorb water through their roots and then the water escapes into the air through the leaves, in a process called transpiration in which water evaporates through small holes on the surface of the leaves. Regardless of whether the water absorbed by the plant is clean or dirty, it is clean when it transpires into the air. These vapours will then mix with water which has evaporated from oceans, rivers, and springs to form clouds and then rain - one essential process of the water cycle. In ecosystems, plants play an important role in determining the amount of water in the atmosphere and thus they have a major effect on the climate of the area.

b. Soil is made up of mineral particles, air, water, microorganisms and other organic matter, which come from the decay of dead plants and animals. Soil is structured in layers and hundreds of years are needed to form one layer several centimetres thick. When polluted water runs through the layers of soil, contaminated suspended compounds are trapped in the soil particles. Thus, soil cleans and filters water. Soil also helps to eliminate toxic pollutants such as chemical fertilizers and pesticides. Many minerals in soil bond with these toxic chemicals and remain in the soil instead of leaking into underground water. That is to say that soil can detoxify some contaminated chemicals, thereby reducing the harmful effects on organisms.

c. Like animals, plants need food to survive. However, unlike animals, plants can produce food on their own through the process of photosynthesis. In this process, plants use carbon dioxide (CO^2), water and sunlight to produce food (sugar) and oxygen. It is this oxygen that helps to ensure terrestrial life. The photosynthesis process of plants also helps to reduce air pollution. Plants in houses and offices help to clean the air.

d. There are small tubes or capillaries inside the stem of a plant, which transport water from the root to all parts of the plant. If the water is polluted, the toxic contaminants can also be transported to the plant tissues and will accumulate there. This does not mean that toxic pollutants disappear, but that they will be released into the environment slowly and in small amounts compared to when they polluted the water. When the plants die, all these toxic chemicals will be released immediately into the environment. One plant that accumulates a large amount of toxic pollutants is the water hyacinth. When water in the pond is polluted, high concentrations of toxic chemical accumulate in the stems and roots of this plant. Thus, water hyacinths growing in a pond will eliminate pollutants, but eventually they must be removed and incinerated.

ACTIVITY FOURTEEN

Erosion Control

Objective:

To understand the importance of trees in protecting soil and preventing soil erosion and floods.

Knowledge Targets:
Landforms, soils and minerals; plants and animals; water

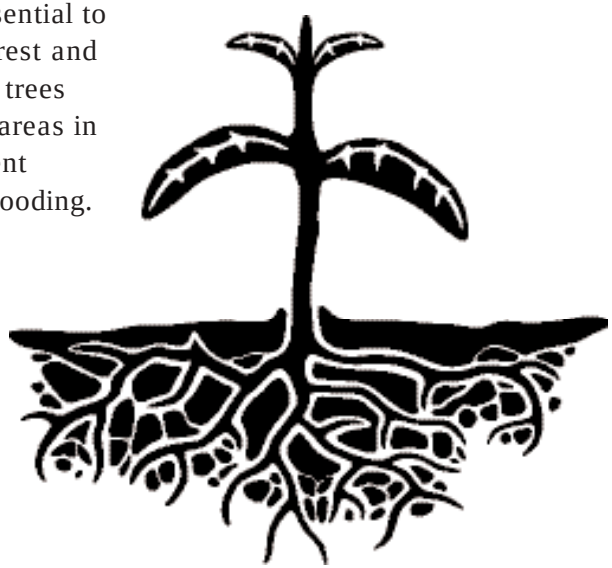
Skills:
Observing, applying, and evaluating

Time:
Two weeks including time for preparation

Materials:
Two wood trays of 50cm (length) x 30cm (width) x 6cm (height), with the bottom made of wood or metal for carrying soil; soil; a saw; two watering cans; seeds (rice, beans or peanuts);

Trees and forests, especially those on hillsides and mountains and those near rivers and springs play an important role in regulating the water table and in preventing floods and erosion. Their roots not only anchor them into the ground but also stabilise the soil around them and absorb excess water from the earth. The canopy of trees also helps in protecting the soil. During a big rainstorm, the dense foliage will reduce the speed and impact of the raindrops on the soil.

Furthermore, dry leaves that fall from a tree create a thick layer on the ground, which also reduces the impact of the rain and limits the speed of the surface water. Flash floods occur frequently in Viet Nam, which cause damage to humans and property. The main cause of these floods is the loss of forest cover. It is essential to protect the forest and to plant more trees in deforested areas in order to prevent erosion and flooding.



Activity

PREPARATION

Design two wood trays to germinate seedlings in.

PROCEDURE

1. This experiment requires ten to twelve days to prepare. Divide students into groups of six to ten. Ask the students to take two trays made from wood, and put plastic at the bottom to prevent water from leaking out. Cut a V shape 4 cm deep into the 30cm width side of the tray.

2. Fill both trays with garden soil. Leave one tray aside for now and plant seeds such as rice, peanuts, beans, or sesame at a high density in the other tray. Water the seeds regularly until the seedlings are about 8-10cm in height.

3. When the seedlings have reached 8-10cm in height, ask the groups to begin the next step of the experiment. Tell them that the tray without seedlings represents bare hills where forest was completely cut down and the tray with seedlings represents a healthy forest.

4. Ask the students to lean the two trays at an angle of 10-15^{o} representing the slope of a hill. Place a basin under the tray so that it can catch the water runoff. The two trays should be placed so that the V cut is at the bottom. Ask students to spray an equal amount of water into both trays using a water bottle.

5. Five to ten minutes after spraying the water have the students observe and comment on the amount of water that flowed into the two basins. (In the tray without seedlings, more water should have run into the basin and faster than in the tray with seedlings).

6. Ask students to pour out the water in the basins and observe which basin contains more soil. (The basin containing water from the tray without seedlings should have more soil).

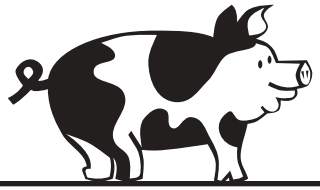
7. Now ask the students the following questions or questions of your own for discussion:

    a) Why is the amount of water and soil in the two basins different?

    b) Do trees have the ability to prevent soil erosion? Which parts of a tree play a role in preventing erosion?

    c) What are some examples in your local area of erosion caused by rain and its effects?

(ADAPTED FROM CADE, ADAMS, SCIENCE OF SURVIVAL)



CHAPTER FIFTEEN

Life Cycle

Objective:

To understand the life cycle of animals, especially local butterflies and moths, and to nurture a love of nature in students.

Knowledge Targets:
Plants and animals

Skills:
Collecting, observing, analysing, applying, presenting and working in groups

Time:
3 - 4 weeks

Materials:
Wide-mouthed transparent plastic or glass bottles or vases. Milk cartons or yogurt containers for keeping the plants that are food for the insects (a small mineral bottle is an alternative). Bright, thin cloth to cover the mouth of the bottles so that the air can come through easily (use coarse gauze), string or elastic bands, soil or absorbent paper (toilet

Different animals on Earth have different life cycles. Dogs, cats and pigs give birth to young ones that look like the adult. Hens and other birds lay eggs and after incubating for a time, chicks hatch that may look quite different from the adult birds. There are amphibians and insects, such as butterflies, whose young do not resemble the adults at all.

Most insects hatch from eggs and pass through several stages before completing their life cycle. This process is called metamorphosis. Some insects such as cockroaches, grasshoppers and dragonflies have incomplete metamorphosis that consists of three stages: egg to nymph to adult. Other insects such as butterflies, moths, ants, bees and beetles go through complete metamorphosis, i.e. four stages of life: egg to larva to pupa to adult.

(ADAPTED FROM CEE, 1997, THE GREEN ACTION GUIDE).

In those cases, the adults not only have a different appearance but also eat different food. For example, a butterfly looks quite different from the caterpillar, which is the larva of the butterfly; also the butterfly eats different food than it did as a caterpillar: the butterfly feeds on pollen and nectar while the caterpillar feeds on leaves. If you spend time observing animals around you, you will discover many wonderful things about them. Sometimes, you may think that the two animals that you see are different species while they are actually only

Activity

PREPARATION

1. Big experiment bottle: Clean a wide-mouthed transparent bottle or vase. The bottles should be at least 8-10cm in diameter. A large mineral water bottle with the top half cut off is an alternative.

2. Food plant carrying bottle: This bottle is filled with water to keep the plant that the caterpillar eats fresh. Water in this bottle should be kept separate from the caterpillars or they may fall into the water and die. If a yogurt container is not available, a smaller mineral water bottle with the top half cut off may be used.

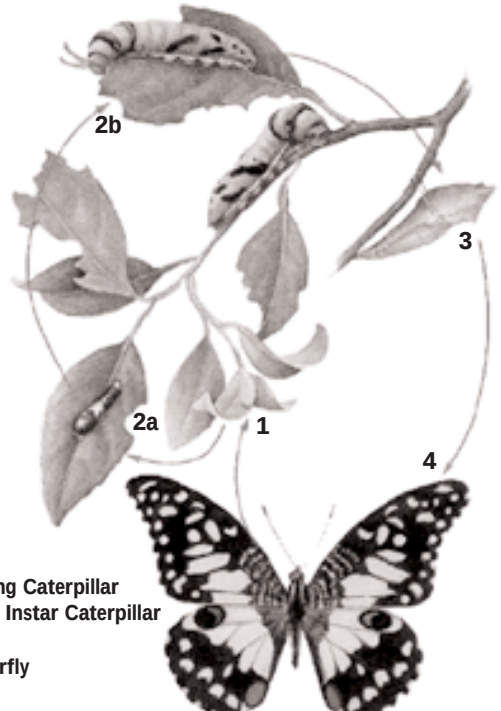
3. Cloth cover: Cut a piece of cloth into round pieces with a diameter of about 7-10cm larger than the mouth of the bottles and into smaller pieces to cover the inside mouth of the bottle if needed.

4. Carry out the activity both in the classroom and outside if necessary.

PROCEDURE

FIGURE 15.1

LIFE CYCLE OF A BUTTERFLY



1. Egg
2a. Young Caterpillar
2b. Last Instar Caterpillar
3. Pupa
4. Butterfly

1. To start, ask students if there is any relationship between butterflies or moths and caterpillars or between frogs and tadpoles. Explain that butterflies and caterpillars are different life stages of one species as are frogs and tadpoles. Hand out the background information to the students for them to read in five minutes. Answer all questions from the students related to the background information. Tell them that they can observe the life cycle of butterflies right in their classroom if they carry out the experiment below.

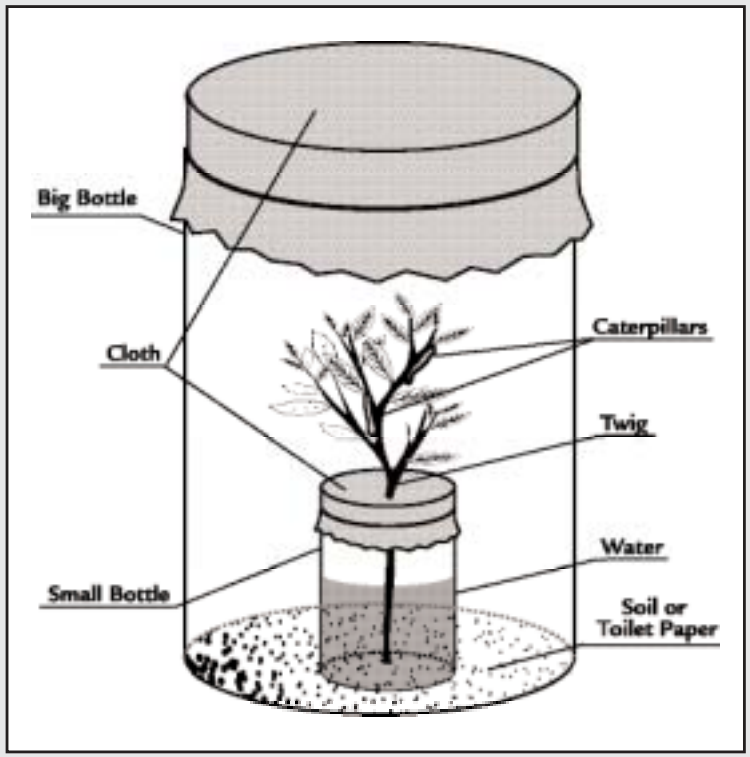
2. Divide the students into groups of five or six. Each group will set up an experiment to observe the life cycle of butterflies. Give each group one set of prepared bottles (one larger and one smaller bottle), the round pieces of

3. Have each group collect the caterpillars from different sources such as rose apple, lime, orange, pomelo, guava, longan, litchi, and sapodilla trees, gladioli, tuberose, roses or from vegetables. Students should collect twigs and leaves off the trees they found the caterpillars on, to feed them. The students should remember which trees they collected the food from, as they will frequently have to gather fresh materials. If an outdoor collection is planned, then the teacher should observe this to make sure that the students do not collect too many caterpillars or pick up too many twigs and leaves which could harm the ecosystem. Take care that students are aware of any poisonous insects that exist in the area.

   Students should use stiff paper to collect the caterpillars, as they may injure the caterpillars if they use their fingers. Also, instruct the students not to touch the caterpillars as some of them can irritate the skin. The paper should be placed under or by the side of the caterpillar. Use the other paper or leaves to gently push it onto that paper without harming the caterpillar.

   (CEE, 1997)

4. Have the students bring their caterpillars and their food to the classroom. Place absorbent paper on the bottom of the large bottle. A thin layer of soil may be used instead of the absorbent paper because some caterpillars make pupa in soil. Put the plants for food in the small bottle through the hole after filling it with water. Put this bottle inside the larger one and then add the caterpillars. Then, cover the mouth of the bottle with the thin cloth and tighten it with the elastic band. This helps prevent caterpillars from being attacked by other animals such as ants, spiders or rats. The number of caterpillars in one bottle depends on the size of the bottle. The larger the bottle, the higher number of caterpillars. Bottles from all groups should be put together in one corner of the classroom that is convenient for all students to observe.



5. Students should take turns to feed their groups' caterpillars every day, i.e. replace old leaves with fresh, clean, wet leaves (there should be enough leaves for the caterpillar to eat). When the caterpillar is fully grown, they will stop eating, and settle on a twig, on the side of the bottle or in the soil where it will attache itself. The next day, it sheds its skin and begins to look like a pupa. During this time, students do not need to replace the leaves anymore but just need to wait till the pupa becomes a butterfly. One day, the butterfly will be ready to come out and when it does its wings will be wet and crumpled. Then it will stretch its wings. Students should observe the butterfly carefully, and then open the bottle and gently free it, allowing it to flap is wings and fly away.[1]

[1]Note that a really large caterpillar (around 10cm) will become a very large adult moth or butterfly. When the adult emerges, it needs plenty of space (about 15cm) to expand its wings. If it can not stretch its wings at this stage, the insect will be unable to fly and will die.

6. When all the groups have completed their experiments, they should report their observations and describe where they found their caterpillars, their feeding habits, the appearance of the caterpillars, the time they became pupas, the appearance of the pupas, the time the butterflies emerged, the appearances of the butterflies, and the differences between the caterpillar and the butterfly. They should also describe the most exciting event for them during the experiment. (It may be when the pupa was formed, when the butterfly came out, or when the butterfly flapped its wings for the first time. Representatives of each group should present their group's report. If there is any group that fails in the experiment, i.e., cannot observe the life cycle of a butterfly or moth, ask them the reason and show them where they made a mistake.

The teacher should know that after the pupa is formed, the students could have one of four results:

a. The pupa is alive and a butterfly or moth emerges.

b. The pupa dies and nothing emerges, possibly for several reasons including inappropriate light, the wrong temperature or because of attacks by ants or spiders

c. All pupas of which caterpillars were collected from one tree are alive and butterflies emerge but are two different colours. This is because male and female butterflies or moths often have different colours.

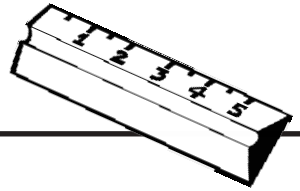
d. Instead of a butterfly or moth emerging, students see another smaller insect such as a wasp coming out or they see only a small hole in the pupa and nothing else. The reason is that an insect, often a parasite, has laid its eggs on the caterpillar. When the caterpillar becomes a pupa, the egg hatches and the larva will eat the pupa and become another pupa inside the caterpillar's pupa. Later, the pupa will grow up and become an insect. This insect makes a small hole and comes out. Thus, students can see a hole in the pupa or both a hole and an insect but not a butterfly. If this happens, the teacher can explain that people can kill unwanted caterpillars by allowing enemy insects of these caterpillars to lay eggs on them.

Ask students how a caterpillar was born. Explain to them that the butterflies or moths that they freed will lay eggs and the caterpillars will hatch from these eggs. A caterpillar will grow up and become a pupa, and then the butterfly will emerge, as students have observed. That's the complete life cycle of the butterfly.

Encourage students to observe nature so that they can discover many other interesting things about the world around them.

ACTIVITY SIXTEEN

Measuring a Tree



Objective:

To learn how to estimate the height of a tree.

Knowledge Targets:
Plants and animals

Skills:
Observing, applying, evaluating, and working in groups

Time:
45 minutes

Materials:
Roll of 50m string, metre or stick of 30-100cm, paper and pen

A tree is an important part of nature, and is deeply connected to human life. Not only do trees provide us with oxygen to breath, but they also provide us with wood to build our houses, fuel for cooking and heat in the winter, medicine, fruit, and peace of mind when we walk in the forest. A fun way for children to learn about trees and to develop a love for them is to have them study them and care for trees in the schoolyard. Positive attitudes towards trees can be developed when students work with them and begin to understand that trees are living things like people. Measuring the relative height of a tree is one activity for students to get more familiar with trees.

Activity

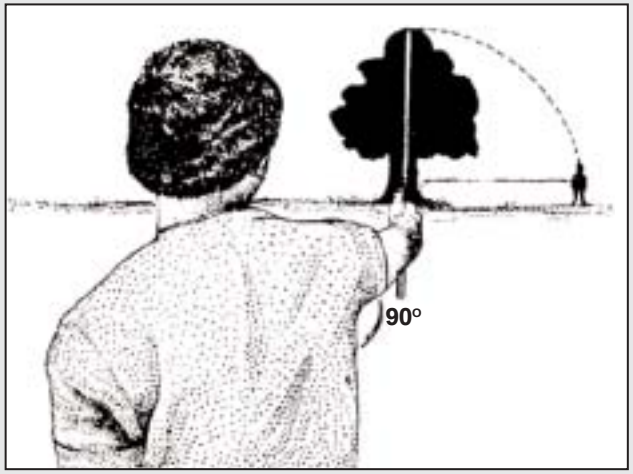
PREPARATION

Select a schoolyard or any open place where there are many high trees.

PROCEDURE

1. Divide students into groups of three or four. In each group, one student will use a measuring stick; one student will use a string; one student will log data; and one student can assist the others. Have students select one tree for them to measure its height.

2. Have one student take the measuring stick and, facing the tree, back away from it. Have the student hold the measuring stick straight in front of him or her so that the top of the measuring stick should line up with the trees top and have them slide their thumb down the stick until it line up with the base of the tree.



3. Now, have the student keep their thumb firmly in place and rotate the measuring stick 90 degrees so that it is parallel to the ground. Have the student hold the measuring stick at eye level and look down the end that was aligned with the top of the tree opposite to the end where his or her thumb is.

4. Have another student tie one end of the string to the base of the tree. The person with the string should continue moving sideways parallel to the person with the measuring stick until the student looking down the end of the measuring stick can see the person with the string aligned with the end of the stick.

5. The person holding the string can now measure the distance from where he/she is standing to the base of the tree by the length of the string. The length of the string should be equal to the relative height of the tree. This activity should be repeated three times to compare results. This method can be used to measure the height of a house or a person. Have the students try this method to measure another student and compare the results of the measurement with the person's real height.

ACTIVITY SEVENTEEN

Species I.D.

Objective:

To understand how different species are identified and to be able to identify and distinguish some local species.

Knowledge Targets:
Plants and animals

Skills:
Analysing and interpreting

Time:
60 minutes

Materials:
The set of cards, "Web of life" (refer to activity 12), pin/ tape

The natural world is a diverse place. If we were to go into any natural area and sit for a long time, we could identify and count many different types of animal species. We can identify them as different based on their structure, appearance, colour, the type of food they eat, and the habitat in which they live.

Different species can be found in trees, in caves, in water, in the soil, in the forest, and in grassland etc. Species that move in the air must have wings to fly. Most species that move on the ground usually have legs. Some have two, four or six and even more. Some species that move on the ground have no legs at all such as snakes. Some species only feed on grass and fruits, while others only feed on meat and insects. Many species look for food during the daytime, others look for food at night. Most species are coloured to help them to hide in their environment and defend themselves against enemies.

By watching nature closely and examining the many different and unique physical characteristics and behaviours that the Earth's creatures possess, we can learn a lot about the splendid world we live in.

Activity

PREPARATION

Set of cards, Web of Life.

PROCEDURE

1. Introduce the rules of the game to the students. Explain that some of the students will have to guess the name of an animal, selected by other students from the set of Web of Life cards, by asking different questions about the animal's behavior and physical characteristics. Show the students a picture of an animal as an example. Present some possible questions they might ask, based on the animal's appearance, colour, habitat and food.

   For example they might ask:

   a) Do I live in the forest?
   b) Do I have four legs?
   c) Do I feed on grass, leaves or meat?
   d) Is my fur yellow, black or is it striped?
   e) Do I have wings?
   f) Do I look for food at night?
   g) Is my house in a cave?

   Each student gets to ask five to ten questions before guessing his/her animal. The teacher can reduce the number of questions that the students can ask to make the activity more difficult.

2. Ask the students to make a circle.

3. Have one student stay in the center of the circle. Have another student pick a card and stick that card on the student's back in the center of the circle. Don't let the student see which animal is on the card.

4. Ask the student to go around the circle so that others can see the picture of the animal on the card (without speaking). Now the student with the card has to ask five to ten questions to other students to find out which animal is on his/her back. Other students can only answer "yes" or "no".

5. After some students have had a chance at the game, discuss the basic ways to identify and distinguish between animal species based on body structure, colour, food, and habitat.

CHAPTER EIGHTEEN

Population and the Earth

Objective:

To know about population distribution and the wealth of different regions on the Earth; to be aware of the impact population growth has on biodiversity and the distribution and use of natural resources; to help students to understand that the Earth's capacity is limited and finite.

Knowledge Targets:
Area and location, economy, people, and social organisation.

Skills:
Role-playing, analysing, interpreting, applying and working in groups

Time:
80 minutes

Materials:
A roll of string 50m long, five hard boards, permanent markers, sticky tape, about 80 candies, and

The number of people living in one area, the population, has a great impact on the environment. Population growth leads to an increase in consumption of natural resources, especially food, water and energy.

In 2001, the population of the Earth was 6.1 billion people. It is estimated that the Earth's population will double in 25 years, having a huge impact on the Earth's resources. Also, population distribution and the way people in different cultures use the resources have a great impact on the environment. However, it's not simple to measure these effects.

(WWF US, 1999)

FIGURE 18.1

STRING MAP

Activity

PREPARATION

1. Select a large classroom or an open space to carry out the activity. If the activity is to be conducted in the classroom, all tables and chairs should be put aside to create enough space for the activities.

2. Write the regions of the Earth — North America, Latin America, Africa, Europe and Asia — on the five boards.

3. Cut the string into pieces in lengths defined in Table 18.1 for the different regions. Tie the ends of each string together and place them on the floor, and if possible, arrange them in the shape of the boundaries of the regions. (Oceania is not suitable for this activity because its population is too small). After that, place the boards naming the regions under the respective strings.

4. Make a photocopy of the Ambassador Cards; separate them and give them to five students who represent ambassadors.

5. Based on Table 18.1, count the candies that represent the gross national product (GNP) or the wealth of each region and put them into different plastic bags. Write the names of the five regions, their GNP and the number of candies on labels and attach these to the respective bags.

PROCEDURE

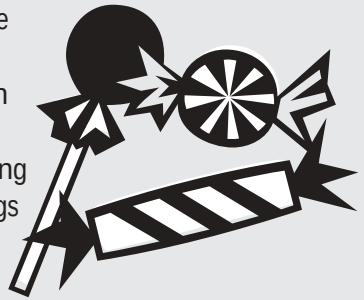
1. Explain to the students that this activity is designed to help them understand the impact of population distribution and the use of resources on the quality of people's lives in different regions of the Earth. Ask five students to volunteer to be ambassadors of the five regions (Each region has one ambassador). Ask each ambassador to stand inside the string map of the respective regions.

   Divide the students into regions so that they represent the real population of the areas. (To divide the students into regions, the teacher must find out how many people on the Earth one student represents by dividing the Earth's population by the number of students in the class. For example, if there are 40 students in the class, one student will represent about 150 million people. Then the teacher should calculate the number of the students who will represent the real population of that region by dividing the region's population by 150 million people). If the class has 40 students, divide them into regions as in Table 18.1. Ask the students to go to their respective regions.

2. When all the students are divided into regions, ask them to determine which region has the highest population and which region has the highest population density.

   Then, require the five "ambassadors" to read their card out loud to the class one by one, emphasising how many years it will take for their population to double. Ask the students what would happen if the number of students in each region doubled. Where would people live? Would there be enough food for everyone? Would the energy consumption increase or decrease? Where would the energy come from? How would ecosystems and the environment be affected? (Students may not have exact answers for all the above questions, but they should think about the problems caused by population growth).

3. Hold up all the candy bags and say that they represent the GNP — the value of all goods and services that people of one country provide in one year. The number of candies in each bag represents the money that one person of that region would receive if the GNP were divided equally among all people. Each candy is equal to 600USD. Give these bags to the appropriate ambassadors and ask all ambassadors to hold up his or her bags so that the students can see the disparity in the wealth of the different regions of the Earth. Then, each ambassador should divide the candies among his or her people. Some students will see that they have fewer candies than their friends and may feel that is unfair to divide up the candies in that way. The students with fewer candies may migrate into regions that have more candies without alerting anyone. Those students with more candies may want to share them with his or her friends or some students may fight to keep their candies. If this situation occurs, the teacher should ask all students to stand still and keep silent for a moment and observe what has happened. Ask them to think about what happens in the real world. Do people migrate to regions with more resources? Do people receive charity or aid? Is there war?



4. Discuss the following questions:

   a. How do people from Asia, Africa and Latin America feel when they have only a few candies while North Americans have many candies? What would you do? What has happened in the real world? (Students may suggest that migration to North America and aid from rich countries are solutions. In reality, many people migrate or want to migrate to rich countries for a better future. Some poor countries receive foreign aid such as food and medicine. However, foreign aid, while useful, cannot meet all the requirements of poor countries. It is very important that poor countries establish policies to develop their economies so

b. How do the students with more candies feel? (Some of them may feel uncomfortable because they have more than others and they may want to share with people who have less. Some may understand how difficult it is for others to have fewer resources, but they do not want to share their wealth with anyone).

c. What would happen if poor countries suffered from environmental catastrophes such as large-scale pollution or natural disasters such as a volcano eruption, earthquake, or flood? (Many people would die and others might receive foreign aid).

d. How does the Earth's population affect natural resources? (Population growth is always followed by an increase in consumption of food, fossil fuels and other energy. Thus, people will have to exploit more resources to survive, which will lead to the exhaustion of natural resources, pollution of the environment, the destruction of habitat and the loss of biodiversity).

e. What would happen if the world's population continuously grows? (To some degree, there are not enough resources on Earth to support all people. Although scientists do not know exactly how many people the Earth can support, they all agree that the number of people that the Earth can support is not unlimited. In other words, the Earth's capacity is limited. When the Earth becomes too crowded, resources will be exhausted. War over the dwindling resources might break out and no one knows if humans would continue to exist).

Distribution Among Regions

FIGURE 18.1

	Asia	Africa	Europe	Latin America	North America
Total area (Km^2)	30,533,652	39,296,194	22,482,739	20,280,824	18,174,586
Length of the string (m)	10.2	13.1	7.5	6.7	6.0
Population in 2001 (Number of students)	3,726 million (25 students)	818 million (5 students)	727 million (5 students)	525 million (3 students)	316 million (2 students)
Gross National Product per capita (number of candies)	$2,490 (4 candies)	$650 (1 candies)	$13,710 (23 candies)	$3,710 (6 candies)	$27,100 (45 candies)

Ambassador Cards

ASIA AMBASSADOR

I represent Asia:

1. Our population is 3 billion, 726 million.
2. At the current growth rate, our population will double in 46 years.
3. On average, one woman of our region bears 2.8 children.
4. Our life expectancy at birth is 65 years

AFRICA AMBASSADOR

I represent Africa:

1. Our population is 818 million.
2. At the current growth rate, our population will double in 27 years.
3. On average, one woman of our region bears 5.6 children.
4. Our life expectancy at birth is 52 years

EUROPE AMBASSADOR

I represent Europe:

1. Our population is 727 million .
2. At the current growth rate, our population will never double.
3. On average, one woman of our region bears 1.4 children.
4. Our life expectancy at birth is 73 years

NORTH AMERICA AMBASSADOR

I represent North America:

1. Our population is 316 million.
2. At the current growth rate, our population will double in 117 years.
3. On average, one woman of our region bears 2 children.
4. Our life expectancy at birth is 76 years

LATIN AMERICA AMBASSADOR

I represent Latin America:

1. Our population is 525 million.
2. At the current growth rate, our population will double in 38 years.
3. On average, one woman of our region bears 3 children.

ACTIVITY NINETEEN

Noodles and Ecosystems

Objective:

To understand and analyse the impact of consumer behaviour on the environment and the relationship between economy and biodiversity.

Knowledge Targets:
Area and location; people; social organization, economics, aesthetics, ethics,literacy

Skills:
Listening, organising, analysing, interpreting cause and effect, problem solving, presenting, and working in groups

Time:
150 minutes

Materials:
Packs of instant noodles, flipchart, white-board marker, scissors, and glue

Most humans in modern society consciously and unconsciously are involved in the market economy. Humans are involved in the economic system whether as producers, service providers, or consumers. All of us benefit in different ways from the market and interact and participate in it daily because of our need and desire for food, shelter, medicine, clothing, transport, and entertainment. The manner and extent of our participation in the market is determined by the amount of money and resources available to us and the extent of the knowledge we have about the market and alternatives to the market. Because of the importance of the market in our lives, it has a powerful influence on our daily decisions and behaviour overall.

Since resources are limited and desires are unlimited, there is always a relative scarcity of raw materials. There is also a constant negative impact on other resources such as the air and water caused by waste and pollution from the production process. We need to be aware of how the way we interact with the market affects the environment and biodiversity and alter the way we produce and consume in order to create a balance between ourselves and the natural system that sustains us.

Activity

PREPARATION

Prepare handouts and flipchart or overhead with General Pyramid of Production and Instant Noodle Pyramid of Production.

PROCEDURE

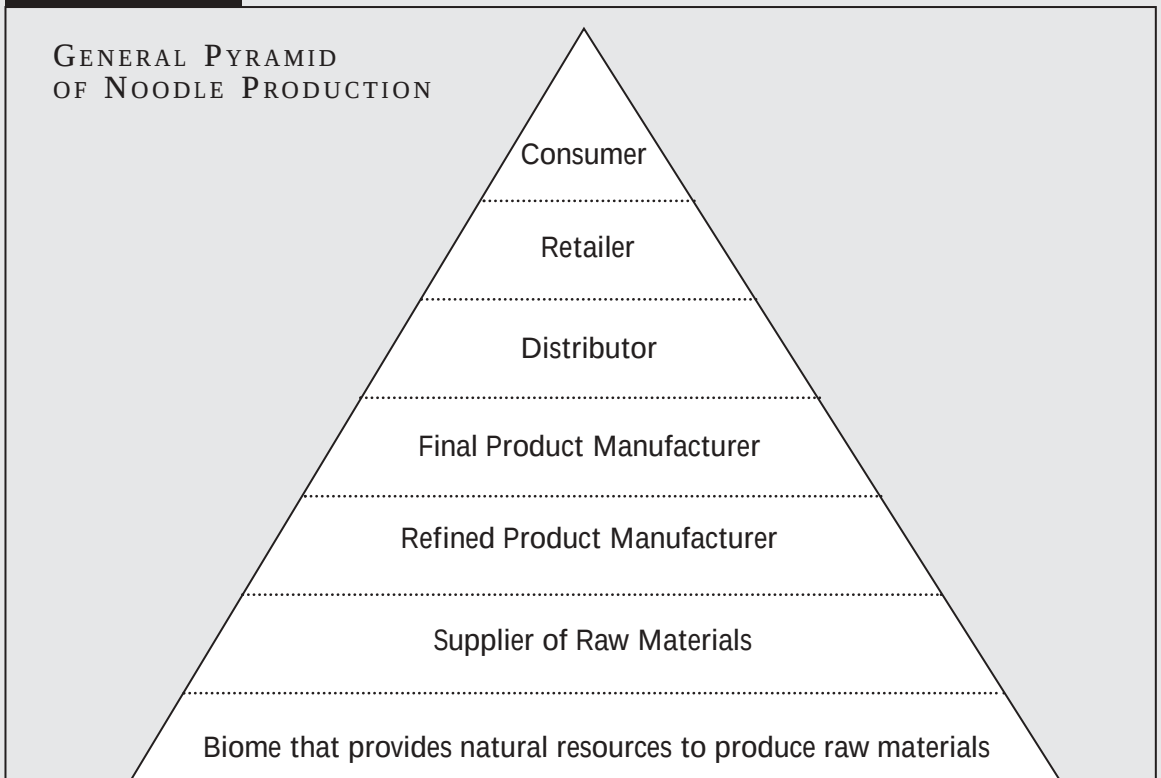
1. Break students into groups of four or five. Inform the students that they will now study the connection between types of goods we consume and produce and the natural environment and biodiversity.

   Have groups answer the question: What does it take to make one product? Write the question on the board or flipchart.

2. Present the General Pyramid of Production, Figure 19.1, to the students and highlight the levels of production

3. Have the groups draw the General Pyramid of Production on flipchart paper.

FIGURE 19.1



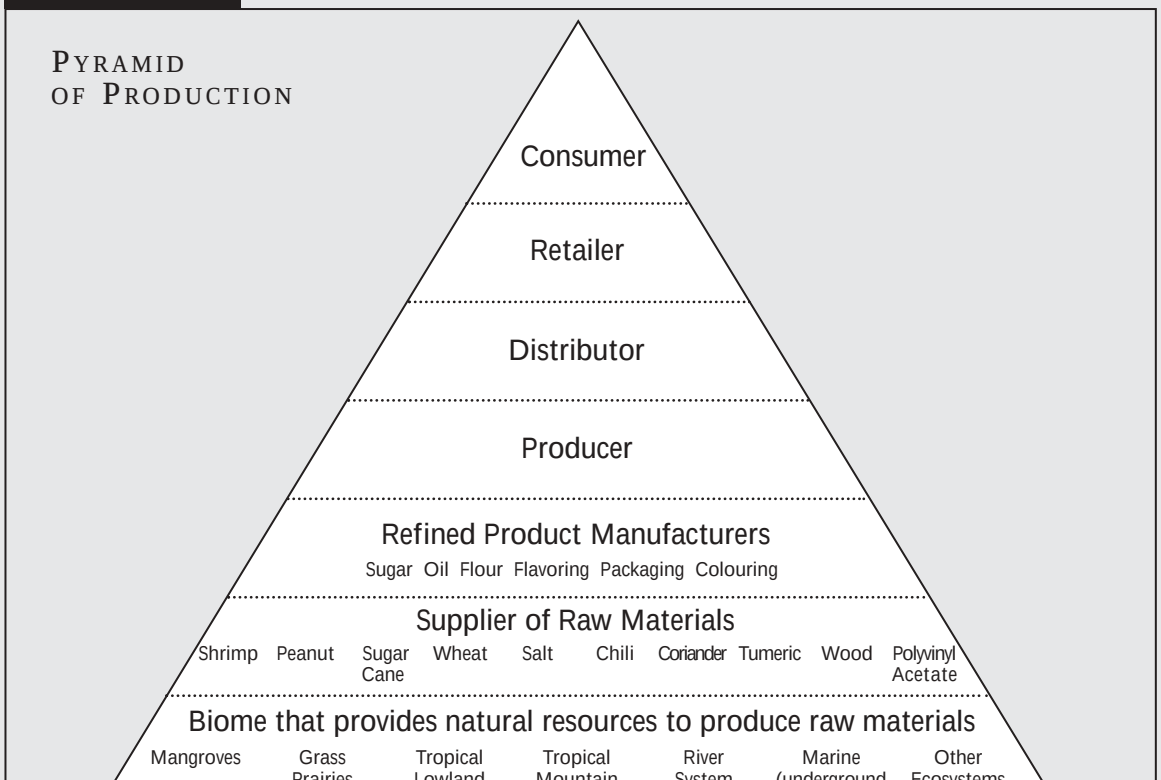
4. Distribute one noodle packet to each group and explain that these are final products. Explain that the groups will now study the relationship between biodiversity and consumerism based on the analysis of the noodle production process

5. Have the groups identify the ingredients of the noodles and make a list of all the raw materials needed to make the final product. For example, sugar should be identified at its source from sugarcane. (Main ingredients also include packaging)

6. Have the group use the Pyramid of Noodle Production on flipchart paper and list the different resources under the appropriate production levels and the ecosystems they come from. For example, shrimp are raised in mangroves. The different resources include, sugarcane, wheat, spices, shrimp, salt, paper and nylon packaging, electricity, petrol, oil, gas, and water used for production, and transport.

8. After recording the results on flipcharts, have the groups present the results to the class.

FIGURE 19.2



9. Now present the final example of the Pyramid of Noodles Production, Figure 19.2. Highlighting again that there are so many people who are involved in producing a product at different phases using resources many different ecosystems for such a small product.

10. Now analyse the effects of noodles consumption on the environment with the students.
(45 minutes)

Have groups understand thoroughly the process that a noodle packet goes through to reach consumers. Ask the students to name some of the positive and negative effects that noodle production can have on people and the environment. (Refer to the pyramid) Ask the students to analyse some of the following situations:

At one time large sections of forest were cleared and converted into agricultural land to cultivate wheat, peanuts, and sugarcane. Have the students name at least three positive and negative effects this might have on the environment and the inhabitants of the area.

For example, what might be some negative effects from factories on the environment? Some examples are loss of biodiversity, deforestation, and pollution of air, water, and land).

Positive Effects	Negative Effects
_____	_____
_____	_____
_____	_____

11. Summarise the activity and ask some questions.
(40 minutes)

Have the groups work on the following issues:

a) If producers stop producing noodles, name some of the positive and negative effects this might have on people, the environment, and the economy.

b) Think about the products you and your family buy every week. What are some of the common products you purchase? How does you purchasing these products affect other people and the environment? Make a list and explain how can you change your consumer behaviour to have less of a negative impact on the environment.

Wrap up the exercise by emphasizing that purchasing products and using services have an impact on the environment. Any product you buy is connected to the environment in some way. All products include components that come from nature and can cause environmental pollution when produced, consumed and disposed of. People around the world, including producers and consumers, are seeking ways to make products that have less of a negative impact on the environment. Explain that the students can play a role in conserving nature by adjusting their consumer behaviour and thinking about the different ecosystems affected by their consumerism including transport and water.

ADAPTED FROM WWF US, 1999. WINDOWS ON THE WILD, BIODIVERSITY BASICS: AN EDUCATOR'S GUIDE TO EXPLORING THE WEB OF LIFE. CALIFORNIA. ACORN NATURALISTS

ACTIVITY TWENTY

Getting to Know the World

Objective:

To understand what culture is, how it influences human behaviour and the role it plays in the relationship humans have with the natural environment. To also understand and learn about different cultural practices from around the world that interact with the environment and identify ways that people can adapt their cultural lifestyle so that it is more environmentally friendly.

Knowledge Targets:
People; social organisation; aesthetics, ethics, literacy; human constructed environment

Skills:
Reading, interpreting, analysing, thinking critically, making presentations and working in groups

Time:
120 minutes

Materials:
Flipchart, white-board

Culture is the totality of physical and spiritual values, which are created by and accumulated from realities and experiences of people in their different environments. Simply, culture is the totality of behaviour patterns, arts, religious and social beliefs, institutions, and all other products of human work and thought.

Culture is created from the interaction of human life with the natural environment. People have to depend on nature and survive in nature to earn their living. They also have to protect nature for themselves and future generations. Cultural behavioural patterns are reflected by different types of institutions, food, dress, transportation, festivals, ceremonies for marriage, birth and death, planting methods, and construction of houses, etc. Each region, and each nation has its own typical culture.

Activity

Getting to Know the World

PREPARATION

Make sets of cards from the pictures and information of the different cultures. Write questions on a flipchart or overhead slide.

PROCEDURE

1. Have a discussion with the trainees and use the following questions to get them to think about culture. Write their answers on cards and pin them on a board.

   a) **Q:** What is culture?
   A: Culture is the totality of socially transmitted behavioural patterns, arts, beliefs, institutions, and all other products of human work and thought.

   b) **Q:** Describe some examples of culture that can be seen in your daily life.
   A: Some examples of culture we see daily are houses (materials, design, direction), food, communications (ways of shaking hands, greeting, talking), dress (Vietnamese long dress, four panel traditional dress), methods of cultivation (wet rice, dry rice), religion and beliefs (ancestral worship, Buddha worship), ceremonies for different events or traditional festivals.

2. Now break the trainees up into groups and give each group five different picture cards. Have the students read the descriptions on the back and discuss the pictures within the group.

3. Have the students answer the following questions based on an analysis of the pictures and the description.

   a) How do the cultural activities in the pictures relate to the natural environment?

   b) Are these activities environmentally sustainable?

   c) Which factors or pressures may threaten these activities to make them environmentally unsustainable?

   d) Think about your culture, what are some examples of positive and negative cultural practices in relation to the environment in your life?

   e) What aspects of your culture can be changed in order to live more harmoniously with the environment?

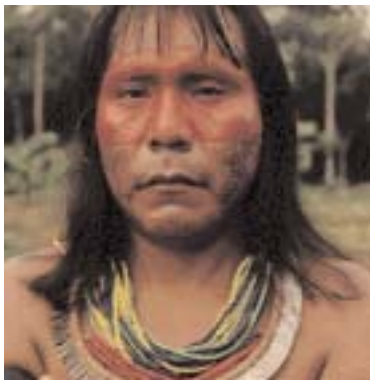
   f) What steps can you take so this can actually be done?

4. After the groups finish discussing, have a representative from each group present the group's analysis to the whole class. Emphasise the relationship between culture and the environment. Stress that people need to be aware of their individual cultural relationship with the environment. They should be able to identify what cultural aspects in their life are not in harmony with the environment and think of alternatives to these behaviours. As they are part of a global community, they should be able to make conscious decisions to change their behaviour to live more in balance with the environment. They may also look at examples of other cultures around the world, which are centuries old, which may provide alternative paradigms for sustainability.

Cultures of the World Cards

TUAREG

The Tuareg are nomadic and number about one million. They inhabit the Sahara in the countries of Algeria, Mali, Niger, Mauritania, Libya, and Burkina Faso. The weather is hot, ranging from 60 degrees during the day, to 22 degrees during the night. The people rely on trade to obtain food such as millet, barley, wheat, onions, dates, and spices. Meat is rarely eaten except for holidays and rites of passage. The intense aridity requires quick movement between water supplies and grazing areas. The Tuareg rely on the camel for survival. Camels are used to travel across the inhospitable desert, provide milk, and are prized and loved as a part of the family.



The Kayapo traditionally are semi-nomadic and live in houses made of palm leaves and wood poles. They alternate between village living and nomadic wandering. During their nomadic phase, they make use of the "ibe" or old gardens, which are actually gardens they have cultivated which appear to be part of the forest. They have been managed so that semi-domesticated species dominate the garden for multi-purpose uses. They also use these gardens to attract certain animals. The untrained eye cannot recognise these gardens. The Kayapo also plant fruit and vegetables along frequently used trails.

MAASAI

The Maasai people and related tribes live in East Africa in Kenya and Tanzania in semi-arid and arid lands. These tribes are semi-nomadic herdsmen. Their movement is based on seasonal rotation of their livestock. Under normal situations the pasture is fallowed and guarded by warriors. Livestock are used to bond relationships and for economical purposes.

Eighty percent of the diet of these tribes is milk, with blood as a supplementary part. Meat is only eaten on special occasions, which helps to maintain cattle populations at a level that does not have a negative impact on the land. The cattle that are killed also provide hides used for mattresses and utensils. Their dung is used for plastering walls, and urine has medicinal properties. When there is drought, the animals are bled and this provides the nourishment for the people to survive. The Maasai believe that tilling the land to farm is a crime against nature.

CAMBODIAN THERAVEDA BUDDHIST MONK

The monk lives a simple lifestyle. All material possessions are rejected. Cigarettes and alcohol are also given up forever, as well as a life with wife and children. He wears a simple cloth robe and sandals. The monk lives a life of meditation and contemplation in a monastery. He grows fruits and vegetables and eats one meal per day with no meat.

Hmong women weave textiles using thread made from hemp and then dying it with indigo. Many women use their skills to make batik and embroidery to decorate traditional clothes and baby carriers. Cloth is also made for rituals. Hmong believe that in order to join their ancestors in the other world, they should be buried in hemp cloth.

Cultures of the World Cards

MAYA

The Maya believe in cosmology, which refers to the existence and experiences of commonality with all that is and that we and all organisms and entities are aspects of a single unfolding reality. This means that all is connected, and we are part of the animal world and the animal world is part of us. If we disturb the animal world, we are thus harming ourselves. Everything in nature must be respected, therefore, to maintain a perfect balance.

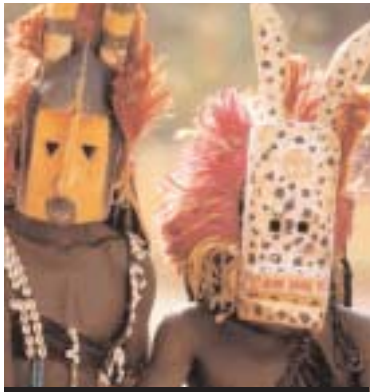
Maize is also considered sacred as it is given to us (the children) from the mother (Earth). The mound of earth that the maize grows from is believed to be a symbol of a breast of the mother, and the maize is like the milk that a mother feeds her baby with. The clothing worn by the Maya is also very important in representing the connections of man, nature, and the universe, as there are many stars, flowers, animals, and plants interwoven on the colourful fabric. The design also signifies which village a person is from.

RED DAO

The Red Dao mainly live in mountainous areas and practise slash and burn agriculture. They plant their rice and corn in one area for up to two years and then shift to another area after the soil becomes infertile.

ABORIGINAL

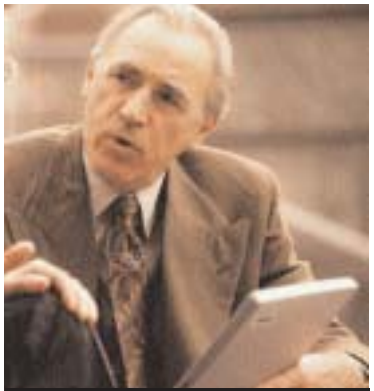
The Aboriginal people are the original inhabitants of Australia. Many of them still live a traditional lifestyle as hunter gatherers. They believe that their ancestors were born from the land, trees, sky and water. Aboriginals consider the desert and the barren hills in their home as parts of their own body. They believe that the land does not belong to them, but they belong to the land. When they die, they believe that they merely return to the source of their birth. They return to and become part of the hills, the forest, the desert, the land, and the soil. They will also become part of the birds, animals, and insects living on Earth. A person who has developed the ability, can see the spirit of the dead in these natural systems and objects. Water is such a rare resource in the desert and when it is found, it is perceived to be the property of all living things: human,



DOGON

The Dogon inhabit the Bandiagara cliffs in southern Mali. They live in houses made of sun dried mud and stone with thatched roofs. The Dogon retain symbolic relationships with respect to the environment and animals play a major role in their lives and ceremonies. The Dogon religion categorizes and ranks all living things. Semi-domestic crocodiles are kept as sacred protectors of the village. The desert tortoise, which can endure the harshest conditions, is believed to be holy and kept in villages as a sacred symbol. Each village is led by a religious leader in charge of the cult of Lebe, a mythical serpent and God of Plant rebirth who was born from the original creator Amma. Amma created all the forces of the universe. Nommo, the spirit of water, is also worshiped together with Amma.

The Dogon are known for their elaborate woodcarving. Stylized human and animal symbols are used on the doors to protect their grain. They also carve many different types of masks in the form of animals, which are used in special ceremonies. Believing the tree from that the wood was cut contains a spirit that must be respected, the wood is carved in a sacred and ceremonial way.

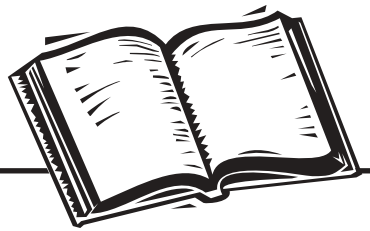


WESTERN BUSINESSMAN

Western businessmen often dress in suits made from various materials, some of which are artificial. They also often use a computer, FAX, mobile phone, and spend long hours in the office. They eat most meals in restaurants or cook food that comes in cans and boxes. They travel frequently by plane or car to meet clients and entertain themselves with activities such as golf.

ACTIVITY TWENTY-ONE

The Ethics of Bears



Objective:

To understand what environmental ethics are and how they influence behaviour. The student will be able to identify their own ethics and identify ways to become more friendly with the environment.

Knowledge Targets:
Social organisation; people; aesthetics, ethics, literacy

Skills:
Interpreting, analysing, comparing and contrasting, presenting and applying

Time:
65 minutes

Materials:
Flipcharts, card sets

An ethic is a code of values that that recognises that humans are interdependent. This reality is dictated by the human need to live in groups and the necessity, thereby, to share the Earth's resources and land. In order to create order and avoid chaos, people living in societies need to adopt generally accepted or normative rules of conduct and follow social norms. These codes of conduct for the "right way to act and live" imply that each individual has the duty and responsibility to care for other humans now and in the future and they set out the criteria, which defines specifically what an individual's rights and duties are. Furthermore, ethics justify a method that may be used to appraise the actions of individuals and institutions, while specifying the qualities to be encouraged and discouraged in an individual's character (virtues and vices). Peer pressure and the law play a role in enforcing this system.

(BENSON, 2000)

Though there are general norms in ethics, which are agreed upon, there are great differences between views of ethics towards the environment. Below are two distinct environmental views or ethics that relate to the environment.

Non-human centered moral status and intrinsic value:
The human is only a component of a larger cosmos. All living forms must be respected regardless of their human value. Human development must not threaten nature and the survival of other species. Humans must treat all other living things with respect and avoid causing them unnecessary misery and death. Each person should be responsible for his/her impact on nature.

Human centered moral status and material value:
Nature is there for our use. It has been created to help humans survive and flourish and it is our right to exploit it for our benefit. There is no need to worry about the future, as nature always will provide for us.

Activity

PREPARATION

Photocopy the set of the cards, Ethics of Bears and cut out for groups to use. Have glue and large paper for them to paste the cards on.

PROCEDURE:

1. To begin, ask the students what ethics are. Ask them how ethics affect their behaviour. Have the students write their answers on cards while you stick the cards on a board. Group similar answers together.

(15 minutes)

2. Break the class into groups and distribute the six cards on different environmental ethics, a large sheet of paper and glue. Ask students to read the statements carefully and stick them on the flipchart respectively from left to right. At the far left, place the statement which represent an ethic that is most concerned about the environment and then continue sticking the cards on the paper moving to the right as the statements become less concerned with the environment.

(25 minutes)

3. Ask the students to analyse the paragraphs below to identify which ethic most closely relates to theirs. Have each student make a list of the steps he or she should take to change their behaviour so that they move closer to the environmental ethic most concerned with the environment.

4. Have the groups present their results.

Note: Cards one to five are in order from most concerned (card one) with the environment

ETHICS OF BEARS CARDS

1. My grandmother believes that all animals and plants have their own spirit and are connected by a cosmic web. My grandmother believes that the Earth is a living body and she is her great mother. Humans are only one component of the universe. In order to survive, sadly, she must sacrifice some of the other living things on the Earth for food and shelter. But when she does this, she must pray for their forgiveness and thank them for their life. She has been offered rice wine with bear gall bladder, but every time she refuses. She would never harm a bear for this use, as he or she is equal to a human being. Could my grandmother take gall bladder from a human to drink?

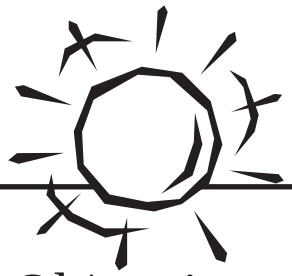
2. My brother works for a conservation organisation and believe that nature is precious. He could not imagine any other job. Everything on Earth is interconnected and animals are beautiful creatures. If we destroy nature, we are destroying the balance and this might cause us to suffer. My brother recently went out with his friends to drink wine. They ordered wine that contained bear gall bladder. My brother feels that it is ok to drink this wine with his friends on special occasions as he already does a lot to protect nature and a few times won't affect the balance. Besides, bears are not endangered yet.

3. My mother is a traditional Chinese doctor just as she dreamed she would be when she was a child. She works to save the lives of people and to make sure they are healthy. She learned to treat many types of diseases and to produce many types of medicine from plants and, sometimes, animal parts. We are lucky that the Earth is so bountiful in resources that we can find cures in our forests. We need to use these resources in a sustainable way, as no one knows exactly if we can discover cures for human diseases like cancer or AIDS. My mom often prescribes medicine to her patients made from bear gall bladder. She loves nature but she says it is necessary to exploit these animals to save lives, and besides, they aren't killed but just kept in cages.

4. My father is a teacher. He works to teach children to be better citizens. He also teaches some lessons about protecting natural resources. As the Earth's resources are limited, if one generation uses too much, the next generation will not have enough to meet their requirements for development and to live a materially comfortable life. So it is up to us to use them wisely so we can pass them on to future generations. When he goes out with his friends on weekends, he even enjoys drinking wine made from nature. Sometimes they drink gecko wine and other times they drink bear gall bladder wine.

5. My uncle works for a timber company, which harvests old growth trees for export to Japan. He says it is great for our country as we are beginning to get richer from this business. We should harness the power from all natural resources so we can grow richer and richer. After all, nature has been given to us to use to industrialize and develop. If we don't use it, he says, it is going to waste. Every week he drinks a glass of wine with bear gall bladder because it can make him live longer.

Natural Resource Exploitation



Objective:

To understand the difference between renewable and non-renewable natural resources; to see the consequences of unsustainable exploitation of natural resources; and to direct students toward the sustainable use of natural resources.

Knowledge Targets:
Area and location, and social organisation

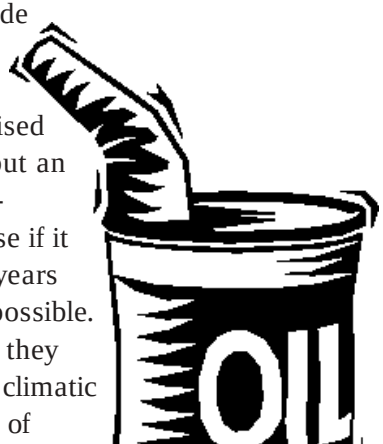
Skills:
Analysing, critical thinking, interpreting and presenting

Time:
60 minutes

Materials:
Many candies (alternatives can be peanuts in shells, buttons or marbles),

Natural resources are divided into two categories: renewable natural resources and non-renewable natural resources. Renewable natural resources are those that can be maintained or replenished after a couple of generations. This category of natural resources includes living things such as plants, animals and micro-organisms, which can grow and reproduce, and non-living things such as air, water, soil and sunlight, which are maintained or complemented by natural cycles and energy flows. The time needed for these natural resources to be renewed is quite different. Some natural resources, such as soil, need decades to be replenished, while others, such as sunlight, are renewed every day.

Non-renewable natural resources are those that cannot be replenished or recovered in a couple of generations if people over use them. These include radioactive elements, minerals, and fuels such as oil, gas, and other fossil fuels. A tree is categorised as a renewable natural resource, but an ancient forest is considered a non-renewable natural resource because if it is destroyed, it takes hundreds of years for it to regenerate if that is even possible. Though fossil fuels are renewable, they need millions of years and certain climatic and physical conditions. This kind of



Many scientists agree that we are using natural resources faster than their capacity to be replenished. However, we cannot stop using them. We should use natural resources in a sustainable way, which means using them in such a way that allows people to meet their needs while ensuring that the needs of future generations are also met.

(WWF US, 1999.)

It is not easy to determine the sustainable use of natural resources. Strategies for using different categories of natural resources should vary. Strategies for the sustainable management of temperate and tropical forests are quite different, as are the strategies for using renewable and non-renewable resources. Furthermore, it is difficult to judge whether or not people's consumption of natural resources, which changes over time, is sustainable.

Activity

PREPARATION

1. Copy Table 22.1, Results of Natural Resources Exploitation onto a flipchart or a board on which students can write their results.

2. Select a relatively large place for carrying out this activity, either in a classroom or an open space. If this activity is to be carried out in a classroom, all chairs and tables should be put aside to provide more space.

3. Draw a circle in the centre of the floor and place 100 candies into this circle (Candies can be put into a shallow box so that the students can see the candies clearly).

RESULTS OF NATURAL RESOURCE EXPLOITATION

FIGURE 22.1

Generation	Non-renewable natural resources		Renewable natural resources	
	Round 1	Round 2	Good crops	Bad crops
Great-great grandparents				
Great-grandparents				
Grandparents				
Parents				
Children				

PROCEDURE

1. Divide the students into five groups of equal size. The surplus students will record the data. One group will be great-great grandparents; one group will be great- grandparents; one group will be grandparents; one group will be parents; and one group will be children. Ask all the groups to sit or stand 1 to 3m around the circle.

2. Tell the students that the candies in the circle represent non-renewable natural resources (such as iron ore, gold, oil, or timber from a primary forest). Ask the students what a non-renewable natural resource is. Give examples of them that are used by people? (Teacher should refer to the background of this activity to check the answers of the students). Emphasise that all generations need non-renewable natural resources to survive. Each individual has the opportunity to exploit these natural resources.

3. Non-renewable natural resource exploitation round 1: When the teacher says "great-great-grandparents exploit the resources", all students in that group will go to the circle, take whatever number of candies that they want, bring them back to their group and count them. Each student in the group has only one chance to collect candies. Record the number of candies collected on Table 22.1 in the appropriate column. Next, groups of great-grandparents, grandparents, parents and children respectively "exploit the resources" and then record the number of candies that they collected. The teacher counts the remaining candies in the circle after all groups have taken their share. These candies represent the natural resources that are handed down to future generations.

   If any of the groups takes all the candies, the first round of the game is finished. Ask the students question c in step 5 and inform the students that there are no more natural resources to support all the people and to hand down to future generations.

4. Non-renewable natural resource exploitation round 2: Ask the students to put all the candies that they took back into the circle. Tell them that these candies still represent non-renewable natural resources. Inform the students that each individual needs only a certain amount of natural resources, equal to two candies, to survive. Repeat all the steps in round 1 and ask the groups to record their results in the results table. The teacher counts the remaining candies, which represent the non-renewable natural resources that are passed on to future generations.

   Ask the students to determine how many people took two candies (enough to survive); how many students took fewer than two candies (not enough to survive); and how many students took more than two candies (more than needed to survive).

5. Encourage discussion by asking the students the following questions:

   a. Did the latter generations take more candies than the generations preceding them? (Later generations often have fewer candies (natural resources) for exploitation than their ancestors).

   b. In which of the two rounds did more candies remain. (If most of the students just took enough candies to survive, then in the second round all students might have enough candies to survive and there would be more candies remaining in this round than in the first. In other words, if natural resources were exploited only to extent that allowed people to survive, there would be more resources to hand down to future generations).

   c. Why do so many people want to exploit as much of the natural resources as possible? (They may not know that they are exhausting the natural resources or they may not know how much is enough. Sometimes people are just greedy and want as much as possible).

   d. Why do other people want to protect natural resources? (They want their children and future generations to have the chance to use the natural resources, or they may think that conservation of natural resources is essential for the survival of communities and cultures, the health of the environment and for the benefit of other species).

   e. Once the students knew how many candies were enough, did they take a different number of candies than in the first round? (Students that want all people to have enough natural resources took just enough candies for survival).

6. After some discussion, ask the students to put all the candies back in the circle. Tell them that now the candies represent renewable natural resources. Ask the students to give examples of renewable natural resources that people use. (E.g. water, crops, solar energy. Find more information about this in the background of this activity).

7. Keep the groups the same and tell the students that the candies now represent fish in a pond. Generations will catch a lot of fish, i.e., after the catch of each group, the fish remaining in the pond will double. Stress that each individual needs only two fish to survive. The group of great-great-grand parents will catch fish first (each student takes whatever number of candies that they want). Record the results of the fish catch of the group in the results table. The teacher counts the remaining fish in the pond and adds the same number of fish to the pond. Then, the group of great-grand parents will catch the fish and record their results in the table. The remaining fish are doubled. Continue like this until the groups of grand parents, parents and children respectively catch fish. The teacher

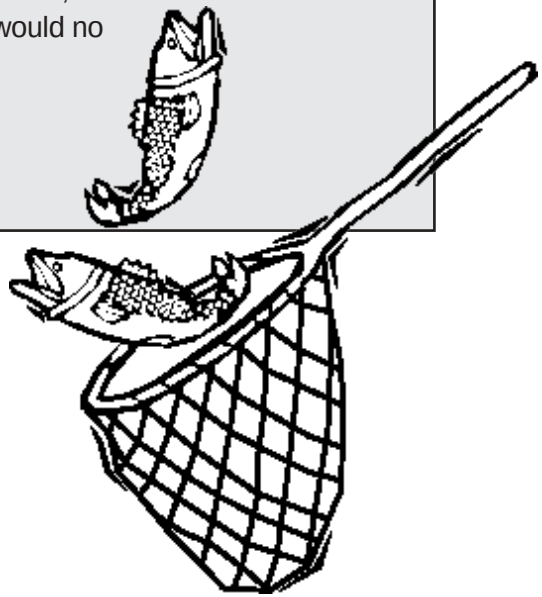
8. Require the students to put all candies back into the pond to represent fish again. Explain to the students that after they catch their fish, only half that number will remain. The students still need only two fish to survive. All groups catch as many fish as they did when they were plentiful. However, after each groups' catch, the teacher takes away half of the remaining fish. Record the results of all groups in the results table.

9. Encourage discussion among the students by asking them such questions as:

a. What would happen if we used natural resources faster than their capacity to be replenished? (Natural resources will be exhausted). Give some examples? (Forests all over the world are disappearing because trees are being logged so quickly and in such quantity they can not be replaced by new growth.; Grasslands have turned into deserts because of overgrazing. Levels of underground water in many regions of the world have been depleted because of over consumption or poor management).

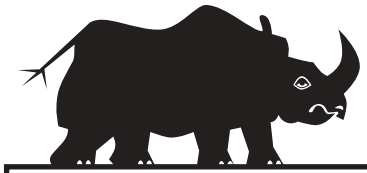
b. Did the students catch a different number of fish in the two cases? (Some students decided not to catch as many fish when their numbers were low and to catch more fish when there were more of them)

c. How are renewable and non-renewable natural resources similarly managed? (Both need to be conserved and alternatives for each are necessary. In many cases, people consider renewable natural resources as alternatives to non-renewable natural resources. However, it should be remembered that, if renewable natural resources are over exploited, they would no longer be renewable).



ACTIVITY TWENTY-THREE

Threats to Endangered Species



Objective:

To understand the dangers that threaten wildlife including the Javan rhinoceros in Cat Tien National Park.

Knowledge Targets:
Plants and animals

Skills:
Interpreting, analysing, working in groups

Time:
60 minutes

Materials:
10-20 blindfolds, 20-25 stakes of 50cm in height, paper, markers and hammer

Rhinoceros in Cat Tien National Park

The Javan rhinoceros *(Rhinoceros sondaicus annamiticus)* also called the small, one-horned rhino measures about 130-150cm in height and can weigh up to 1,500 kg. The horn is actually a dense formation of hair; it is not bone. The males have a horn; the females only have small bump or no horn at all.

The Javan rhino is basically a solitary animal. They become sexually mature after four to six years and their gestation period is about 16 months. A young rhino stays with its mother for about three to four years. They live in semi-evergreen forest and like to search for food in more open areas. They like to eat shoots of trees, herbs, and herbaceous plants. To supplement their diets, rhinos need to consume salt regularly. They frequent a number of saltlicks or springs that are rich in minerals. They can die if they lack these minerals. Because rhinos are very large, they prefer to avoid the sun and like to bathe in mud. The dry mud on their skin helps to protect them from the sun and also against all kinds of parasites.

In Cat Tien National Park, it is estimated that there are only six to eight rhinos left. This number is thought to have declined by 50% since 1990 and is at risk of dropping even lower in the near future. One rhino needs about 600 to 1,000 hectares of territory to survive. But with the rapid fragmentation of the forest, this range is quickly diminishing. The biggest threat to the population of rhinoceros in Cat Tien is that too many people are living within the national park. People continuously cut down the forest for firewood and to convert it to agricultural land. Another direct threat to the rhino is poaching. The rhino's horn is valued as a source of medicine. If something isn't done soon to reverse this negative trend, the rhinos in Cat Tien will become extinct.

(REFERENCE: JAVAN RHINOCEROS IN VIET NAM, GERT POLET & TRAN VAN MUI, 1999)

Activity

PREPARATION

Mark the playing area in the field and place wooden stakes in the field with the threats written on them.

PROCEDURE

1. Before starting the game ask the students: Who has seen a Javan rhino before? What do they look like? Are there many Javan rhinos left in the wild? After students answer the questions, have them look at some photos of Javan rhinos.

2. Tell the students that the rhino population in Cat Tien, which is also the only rhino population in Viet Nam, consists of only a few individuals and is in danger of extinction. Ask them to list the possible threats to the rhino and have them write them down on a card. (Some possible threats mentioned might include: poaching, illegal trade in horns, forest fires, lack of food, lack of minerals, lack of water during the dry season, loss of habitat due to people cutting down the forest to cultivate coffee, cashews and rice; loss of habitat as local people settle in the national park,)

3. Review the threats on the cards that the students wrote and select the ones that are most accurate and urgent. Hammer the stakes into the schoolyard. Take the cards and stick them to the stakes. Arrange them randomly. These stakes will represent the many possible threats to the survival of the rhinoceros.

4. Make two lines about 20-30 m apart. Divide students into two teams and ask the students to stand behind one of the lines called “home”. The other line is called “kitchen”. Tell the students that they should imagine that they are rhinos. Explain to them that they have to search for food in their habitat and reach the line called “kitchen”. Tell them that when you say, “start”, they have to move to the “kitchen line” blindfolded. Any “rhino” that touches or knocks over a “threat” stake will be disqualified and have to sit out. After the first team goes, then have the second team go. The team with the most rhinos reaching the “kitchen” is the winner.

5. End the game by asking the students the following questions:

    a) Was it easy for you as a rhino to search for food? Was it dangerous?

    b) Who/what creates these threats? Which threat is the most dangerous?

    c) Can the threats to rhinos be lessened or eliminated? How?

    d) Apart from rhinos, do other wild animals face similar threats? Why?

6. Explain that the precariousness that the students faced when treading across the field from “home” to the “kitchen” is similar to the daily experience of rhinos. These threats are often unexpected but always a constant possibility as a danger to their lives.

How Aware of Garbage Are You?

Objective:

To understand that garbage has negative impacts and what they are; to develop a sense of responsibility for not littering; to find ways to dispose of garbage.

Knowledge Targets:
Economics, people, aesthetics and social organisation

Skills:
Analysing, critical thinking, presenting and working in groups

Time:
60 minutes

Materials:
Different kinds of garbage (including bottles, cans, waste paper, old newspapers, plastic bags, scrap iron, fruit skins); 6 bags or boxes; flipcharts or transparencies (together with overhead projector), permanent

In modern society, people have many consumer goods to choose from. These products are more and more diverse, and sold in quantities, which people only a decade ago could not imagine. When the amount of goods consumed becomes large, the amount of garbage also increases rapidly. The individual's decision about what he or she consumes determines the quantity and kind of garbage that blights the environment.

Garbage is everything that is thrown away or no longer wanted. Garbage comes from households, offices and industries. Garbage that can be recycled includes old newspapers, waste paper, plastic bottles, nylon, glass, cans, and scrap metal. (WWF Hong Kong, 1996). This garbage is washed, ground up and turned into materials from which new products are produced. These may include your notebooks, your sandals, glass vases or your family's pots and pans. Some garbage such as glass and plastic bottles can be reused. These things are washed and labeled to contain new products. Household organic waste can be composted and made into good fertilizer for gardens and agriculture. However, there are many other kinds of garbage, such as waste from hospitals and printing companies, textile and mining industries that cannot be reused or recycled but must be incinerated or buried in an

Garbage negatively affects the environment and human health, occupies space, is unsightly and smells bad. In general, most garbage is harmful to the environment, mainly because it is not disposed of wisely.

(WWF HONG KONG, 1996.)

Thus, if each individual is conscious of the garbage he or she produces and never throws garbage away improperly, and if garbage is treated appropriately, people can live in a clean environment without worrying about the danger garbage poses to the environment and to their health.

Activity

PREPARATION

1. Label six bags or boxes as glass (bottle), waste paper (old newspaper), cans, plastic, organic waste, and scrap metal.

2. Make handouts of the test, What do you do? and the table, Scoring your test.

3. Draw the tables, Scoring your test and Test results on transparencies or on a flipchart.

PROCEDURE

1. When students arrive, hand them the test, What do you do? which is below. Have students complete their tests by marking the appropriate box.

WHAT DO YOU DO?

	Never	Rarely	Don't Know	Sometimes	Always
1.Do you throw away sweet wrappers on the street or do you leave waste papers and old newspapers lying around anywhere?					
2. Do you leave your garbage around because you are too lazy to find somewhere to put it?					
3. If you see garbage in the school and your classroom, do you pick it up?					
4. Do you care about how the garbage you throw away affects other people?					
5. Do you care about what other					

What Do You Do?, Continued

	Never	Rarely	Don't Know	Sometimes	Always
5. Do you care about what other people think of you if they see you littering?					
6. Do you feel offended when you see someone litter?					
7. Does the sight of garbage in your house, your class, and your school or at a tourist spot offend you?					
8. Have you ever participated in cleaning up a public place in your community or anywhere else?					
9. Do you think about the garbage that you create when buying a product and the impact it has on the environment?					
10. Are you willing to pay a little more money for a product that produces less garbage and, therefore, is less harmful to the environment?					

2. When students finish their tests, hand them the table, Scoring Your Test (Table 24.1) and ask them to mark their tests based on this table

Scoring Your Test

FIGURE 24.1

Number	Never	Rarely	Don't Know	Sometimes	Always	Your Score:
1.	5	4	3	2	1	_____
2.	5	4	3	2	1	_____
3.	5	4	3	2	1	_____
4.	1	2	3	4	5	_____
5.	1	2	3	4	5	_____
6.	1	2	3	4	5	_____
7.	5	4	3	2	1	_____
8.	1	2	3	4	5	_____
9.	1	2	3	4	5	_____
10.	1	2	3	4	5	_____

Results of the test:

50-41 scores: You are highly aware of garbage
40-31 scores: You are concerned about cleanliness and the appearance of the environment
30-25 scores: You should pay more attention to garbage and the environment
Below 25 scores: You do not care about garbage and the environment. You must do something about this.

3. Take students to a dumpsite or an area with a lot of garbage.

   Ask students how they felt when they saw a lot of garbage at the dumpsite? How can garbage negatively affect people's lives? (Students may say that garbage smells bad, causes disease, attracts pests like flies, cockroaches and rats, and looks terrible)

   Continue to ask students if they want to live in an environment with a lot of garbage like that at the dumpsite and what can be done to create less garbage and to reduce the negative impact of trash on the environment. Examples might include buying products with less packaging and which are less toxic.

4. Scatter the garbage on the floor so when the students come back, it will be there. Ask them how they felt when they first walked into the classroom. (Shocked, surprised, angry, sad, or nothing) Ask them if they should clean up the classroom. Why or why not? The students may say they should not clean up the mess because they did not produce the garbage. Explain that this is a common attitude, but people have to decide if they want to live in a clean environment or a dirty one. Even if other people leave garbage around, it is a good idea to clean up the mess. By doing so, we set a good example which perhaps next time others will follow.

5. After the discussion, divide the students into six groups. Give each group a labeled box or bag. Students have to pick up the items listed on their group's box/ bag in – five to ten minutes.

6. Once all garbage has been collected, ask the students to gather in their groups and in 15 minutes discuss ways to reuse, recycle or dispose of their garbage.

7. Have a representative of each group present the results of their group's discussions. If possible, encourage students to dispose of the garbage in the ways proposed.

Composting

Objective:

To know how to dispose of organic waste such as kitchen garbage, leftover food and garden cuttings by composting, which does not have a negative impact on the environment and to understand the role microorganisms play in the decay of organic matter in nature.

Knowledge Targets:
Plants and animals; landforms, soils and minerals

Skills:
Collecting, organising, analysing and applying

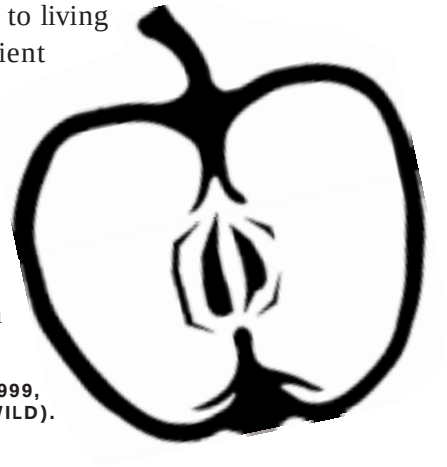
Time:
Three to four months

Materials:
Items to compost such as leftover food, vegetable peelings, nutshells, leaves, twigs (better to have leaves or twigs of green manure trees or trees in the Fabaceae family), grass, straw and shredded

Microorganisms are important in the formation of soil. Over an extended period of time, mother-stone is broken down into fine particles by the effects of heat, rain, waves and wind. Microorganisms add nutrients to this inorganic product by converting organic matter into other forms that make the soil fertile.

Moreover, microorganisms are a component of the natural food chain, which is made up of producer organisms (plants), consumer organisms (herbivores and carnivores), and decomposers (microorganisms). Decomposers feed on dead plants and animals by making them decay. Without decomposers, the Earth would be full of dead organisms that had not decayed. Decomposers also make the nutrients in the dead organisms available to living plants and animals. Any nutrient they use to build their own bodies becomes available to other animals that eat them. Also, the nutrients that pass through the decomposers as waste end up in the soil in simpler forms that plants can absorb with their roots.

(ADAPTED FROM WWF US, 1999, WINDOW ON THE WILD).



The decomposers allow us to make use of kitchen waste, leftover food, leaves and branches by composting them to make fertilizer for plants. If this organic matter were used as fertilizer without first having been composted, it would not be useful to the trees or

Activity

PREPARATION

1. Select a site at the far end of the school garden to set up a compost pit. If space is a problem, organic waste can be composted in a large flowerpot.

2. Gather all organic material needed for the compost including vegetables, fruit peels, leftover food, tea leaves, nutshells, grass, dead flowers, leaves, twigs (if possible, can use green manure trees or trees in the Fabaceae family such as tephrosia, cassia, peanut, and mung bean) rice straw and shredded newspaper. (Each student can be requested to provide some of the above materials).

3. Hoe and shovel to dig compost pit; basin or vessel to water the pit.

PROCEDURE:

1. To start, ask the students why only the bones remain after an animal has been dead for a long time. Has the flesh disappeared? The teacher may ask why a rotten tree eventually disappears. Explain that microorganisms or decomposers make organic matter decay. These organisms feed on organic matter that comes from dead plants and animals. Through this process, dead plants and animals decay and turn into simple forms of organic matter that trees can absorb. Microorganisms (decomposer) help to make the soil more fertile by adding many nutrients from plants and animals that have decayed.

   Ask students what would happen if there were no microorganisms. Tell them that the Earth would be full of dead plants and animals, and people would have no space to stand. Moreover, the soil would not be fertile enough to grow crops, which people depend on to survive.

   Ask students if they know of any way to make use of these organisms (decomposers) and organic waste produced in their own homes. Introduce them to one of the ways to compost and suggest that they make a compost pit for their school garden.

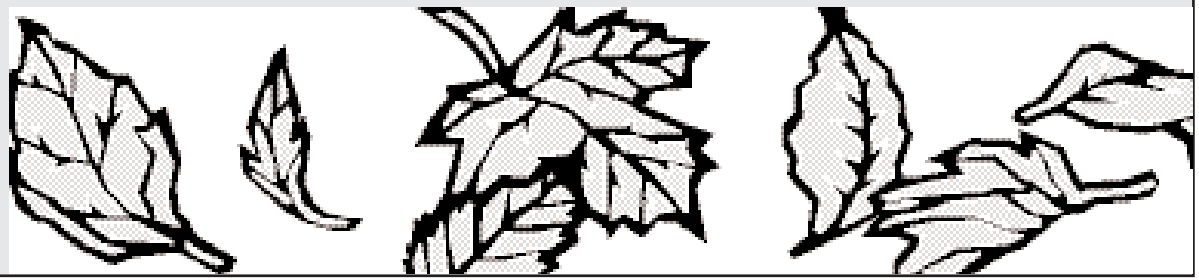
2. Take students to the site of the chosen compost pit and have them dig a hole about 1m deep, 0.5m wide and about 0.6 to 1m long.

3. Have the students fill the compost pit with the materials that they have prepared. The bottom of the pit should be lined with straw (alternatives are dry leaves, dry grass or shredded newspaper). Continue to add the organic matter layer by layer. Do not add a large amount of one item. Instead, build the layers by adding something of a different texture, such as leaf mulch, between layers of leftover food and fruit skins. When finished, cover the pit with a sprinkling of dried leaves and soil.

4. Gather students in the class and tell them that they have just built a compost pit for their school garden. To help the decaying process of the decomposers, the pit should be watered once or twice a week for three months. Moreover, to ensure hygienic conditions, the compost pit should be covered with dried leaves and soil every day. Now, divide the students into groups (two or three students per group). All groups have to take turns watering the pit and making sure that the dried leaves and soil cover the pit till the compost is mature.

5. Three months later, gather the students around the compost pit. Ask the students to take away the surface soil and layer of dried leaves. Dig the content of the compost and show students how the organic matter that they added three months ago had become compost. Help students to fertilize plants in the school with this compost. Encourage students to make a compost pit in their family garden, if possible. Building a compost pit not only helps their families to dispose of organic wastes but also creates organic fertilizers, which is good for their garden.

Note: Students can use the compost to fertilize the pots of mung beans that they grew in activity 6.



ACTIVITY TWENTY-SIX

Advice on Building a House

Objective:

To understand that the construction of buildings and any public works has a negative effect on the environment; to make students more aware that there are alternative and less negative ways for building and thus help them make wiser planning decisions in the future.

Knowledge Targets:
Human constructed environment, social organisation, people and aesthetics

Skills:
Organising, critical thinking, analysing, presenting and working in groups

Time:
75 minutes

Materials:
Flipchart, permanent markers, colour pencils

Long ago, when humans had just appeared on the Earth, they lived in caves, which protected them from rain, sunshine, the cold and fierce animals. Later people learned to build houses for shelter.

Together with the development of human societies, houses become more modern and comfortable. Simple shelters that were made from grass, branches and leaves were gradually replaced by earth-walled houses, wooden houses, tile-roofed houses, multi-story houses and skyscrapers. Each culture has its own distinct designs for houses. Nomadic shepherds regard tents as their homes, while many tribes in Africa, America, Asia and Australia live in shelters made from grass, branches, mud and leaves. Meanwhile, urban residents live in comfortable multi-story brick houses or concrete skyscrapers.

People all over the world exploit natural resources to build their houses both small and large. In regards to how this affects the environment, the biggest difference between building a small house and a big one is the degree to which natural resources are exploited and the impacts on the environment caused by constructing the house. Decisions about building a house, which are influenced by culture and the knowledge of the individual, determines to what extent natural resources are exploited.

The environment is negatively impacted by the construction of any public works such as roads, railways, bridges, canals, dams, dykes, reservoirs, factories, offices, exhibition centres, museums, laboratories, temples and pagodas. There are ways

People should think carefully when making decisions about building any public infrastructure or even their own house. The cost and benefits of these works should be taken into account. Also, the environmental aspect should be considered in order to maintain the Earth's balance.

Activity

PREPARATION

Make photocopies of the set of cards, Building a House. The number of the cards should equal the number of the students. Cut all the cards and fold each one in half for the students to select randomly. Also make photocopies of the Table 26.1, Advice on Building a House for each group.

PROCEDURE

1. Ask the students if building a house has an impact on the environment or ecosystems. Tell them that they will have the answer after participating in this exercise. Ask each student to randomly select a card from the set, Building a House. The students who have the same card will form one group.

2. Distribute flipcharts, permanent makers and colour pencils to each group. The students have to advise on building the house described on their card. They have to determine what materials are needed to build the house and from what ecosystems or areas these materials come. They also have to name at least three negative impacts caused by the exploitation of each of the materials and decide why or why not the house should be built. The students should then draw a picture of the house.

ADVICE ON BUILDING A HOUSE

FIGURE 26.1

Materials for building the house	Ecosystems or areas where the materials come from	Negative impacts caused by exploitation of the materials	Benefits (Number of people to benefit)
Should the house be built? Why or why not?		**A drawing of the house**	

3. Each group has 45 minutes to discuss and write their advice on a flipchart as in the sample on the table, Advice on Building a House that they were given. A representative of each group will present the conclusions of their group's discussions.

   Some materials that are commonly used to build houses include brick, tile, lime, sand, gravel, cement, steel, and wood. Excavating clay, from which bricks and tiles are made, can destroy the landscape and negatively affect the underground water. Moreover, burning coal to make bricks and tiles causes air pollution and can cause the vegetation around the kilns to burn. The production of cement has a similar impact. To produce steel for construction, mines are needed, and the extraction of iron ore, in particular, can devastate the landscape, destroy vegetation, and pollute the water. Polluting gases are emitted during the smelting of iron, which is not good for the air and people's health. In addition, wood is also needed to build a house but harvesting timber destroys the vegetation and results in the degradation of forests. As a consequence, people suffer from floods, drought, erosion, poor crops, and air pollution.

4. Regarding the question, Should the house be built, many students may agree that the house should be built while others may disagree. Explain to the students that careful consideration should be given to cost and benefits, as well as environmental impact, before building a house. These factors should also be taken into account when any public work is to be constructed. That way, people can still benefit without doing harm to the environment.

Building a House Cards

1. My uncle was born in a poor family and his dream is to have a very nice and big house. Now he is a rich trader and he can make his dream come true. He wants to build a big **five-story villa** in the suburbs for his four-member family.

2. My family is Tay. We have always lived in a traditional wood house. We used to cut trees to build our houses. Now, we see Kinh people building houses made out of brick and cement. My parents want to build this type of house too. We want to build a **three-section house with a tiled roof**.

3. We are a Kinh family who have just moved to an area predominated by the E De. E De people live in traditional wood stilted houses, which are warm in winter and cool in summer. My parents want to build a **wooden stilted house** for my family.

4. There is a very big, nice and sacred pagoda in my village where every year, millions of people come to worship. The pagoda helps people to feel calm and get away from the stress of their daily lives. Unfortunately, the pagoda caught fire and while some parts were saved, the **pagoda's beauty needs to**

Deciding on a Highway Project

Objective:

To understand the conflicts that can occur when making decisions; to know that it is necessary for all stake-holders to participate in making a decision; to familiarise students with the participation process of making decisions.

Knowledge Targets:
Social organisation

Skills:
Analysing, critical thinking, presenting, and working in groups

Time:
80 minutes

Materials:
Flipcharts, permanent

Making decisions about using or conserving a forest is always difficult because there are many conflicts among those who have a stake in the forest. Each decision that is made by one group of people will affect, in some way or another, other groups of people — perhaps in a completely different part of the world. No human group can expect to live solely within their own environment without being affected by the outside world, as we are living in a "global village"

(ADAM CADE, 1986).

It is clear that making decisions about the development of any region is a very complex, yet sensitive process. If all stakeholders participate, this process can be successful and will be supported by most people. Only when all stakeholders express their opinions about the development, will a wise decision be made that ensures all parties benefit.

Activity

PREPARATION

1. Make photocopies of the set of cards, Role Playing. Cut each card separately and fold it for students to select randomly. The number of the cards should

2. Arrange tables and chairs in the classroom to make five groups in the shape of a pentagon so that each student can discuss in their group and each group can debate with others. At the site of each group place signs made from cardboard on which the name of each group is written. These names include Local Community, Centre for Forest Research and Extension, Thien Duong Tourist Company, Bridge and Road Consultant Company and Decision Maker.

PROCEDURE

1. To start the activity, ask each student to randomly choose one folded card. All students who have the same card will form one group. After they have selected a card, divide the students into five groups named Local Community, Centre for Forest Research and Extension, Thien Duong Tourist Company, Bridge and Road Consultant Company, and Decision Maker. Have each group gather in one designated place.

2. Ask the students to read their cards carefully. Then, have each group (except the Decision Maker) discuss and prepare a three-minute talk to convince the others whether or not a highway through the forest should be built, from the perspective of the role each group has been assigned. Each group has 25 minutes to prepare.

3. A representative of each of the four groups will present their arguments. The Decision Makers listen carefully and ask questions, noting the benefits and cost of building the highway. The teacher should help this group to ask the right questions in order to determine the benefits and cost of construction. Then, the Decision Makers will have 15 minutes to list all the benefits and costs on which they will base their final decision whether or not to build the highway. Their discussion should be written on a flipchart and a representative of this group will present the results of the group's discussion.

4. Now ask the students the following questions to encourage discussion of such issues as:

    a) Are the benefits and cost of the construction of the highway for the four target groups similar? (The cost and benefits of development are different for each stakeholder. In the role playing game that students carried out, building the highway to improve transportation benefits the Thien Duong Tourist Company because it can operate tours to remote villages. However, the highway does not benefit, but harms the Dao, as they do not want to be disturbed by strangers. In many real cases, development decisions lead to conflicts among stakeholders and ways should be found to mitigate conflicts).

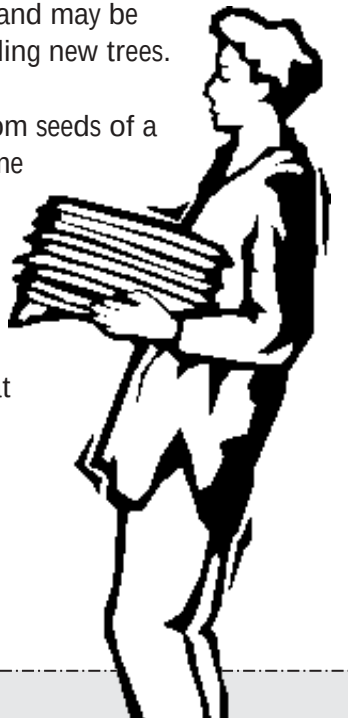
    b) What would happen if the Decision Makers did not listen to the other groups and

Local Community:
You are a member of the Dao in the Dai Ngan forest. Your mountain village is isolated from the outside world. Your traditional customs are seen in your clothes, language, style of housing, food, religion and festivals. Your village is self-sufficient and your people depend on growing cereal crops and forest products. The Dao are highly knowledgeable about medicinal plants, which they collect in the forest to cure many serious diseases.

Until about 50 years ago, the Dao had no contact with the outside world. Today there is still very little contact and your community does not want tourists to intrude. You do not want the highway to go through Dai Ngan forest, as it will make it too convenient for people to come to your village, disturbing people's lives and eroding traditional customs. You do not want such a future and wish only for social stability.

The Centre for Forest Research and Extension:
Your job with the Centre for Forest Research and Extension involves discovering useful plants in Dai Ngan forest. You have to work with the Dao who have lived in the forest for a long time to find out which plants they use. Then you collect samples and send them to the centre's laboratory, where they are analysed and may be applied as medicine, food additives, oils, and dyes or for breeding new trees.

You have made two important discoveries: a drug extracted from seeds of a plant growing under the leafy canopy that helps to control some types of cancer and a dye made from the bark of a plant that is being used in the dyeing industry. The Dao have used these plants for a long time, the first to control harmful insects and the second to colour their clothes. Other useful discovers may be made in any part of the forest. As a conservationist, you do not want this forest to be destroyed because of its great scientific value, which may have many useful applications. You strongly object to the construction of the highway through the Dai Ngan forest.



Thien Duong Tourist Company:
You are an employee of Thien Duong Tourist Company, which makes a large profit each year. Your company is famous for operating tours to remote villages for tourists who otherwise would only know of these villages from magazines and television. Each tour earns large profits for your company.

Your company has identified Dao village in Dai Ngan forest as an attractive destination for tourists. However, because transportation is difficult you cannot operate tours there. A highway through Dai Ngan forest will make it convenient for you to bring in tourists, thereby increasing profits. You know that the Dao do not welcome outsiders, but you think you can persuade them to accept tourists. You have succeeded in persuading many other communities to welcome tourists. You strongly support the highway going through Dai Ngan forest and you are even willing to contribute as much as you can to the project.

Bridges and Roads Construction Consultant Company:
Your prestigious company has had great success consulting about the construction of many important national roads and bridges. Because of your reputation, your company has been asked to be a consultant with the government about the construction of this new highway. The construction of the highway through Dai Ngan forest will entail:

a) Building 800 kilometres of road linking many important industrial zones

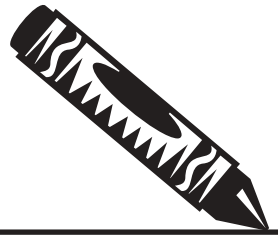
b) Selling wood in 100ha of forest to the Timber Exportation Company

You really want this highway to go ahead as your company will earn a large profit managing its construction. You persuade people that the highway will create jobs for numerous people, relieve the pressure of population in the delta, bring more income to the country by exporting wood, and introduce modern ways to the remote area.

Decision Maker:
You are the one who makes the final decision on whether or not the highway through Dai Ngan forest will be constructed. Your tasks include listening to all stakeholders, and asking questions about the costs and benefits of constructing the highway, so that an appropriate decision can be made. Only if the benefits of constructing the highway outweigh the cost should you decide to build the highway. You must be objective and

ACTIVITY TWENTY-EIGHT

Campaigning/Green Wall Newspaper



Objective:

To learn how to develop an awareness campaign about the environment. Also, to raise awareness of the local community about a conservation issue and improve creative writing and drawing skills.

Knowledge Targets:
Social organization; aesthetics, ethics, literacy

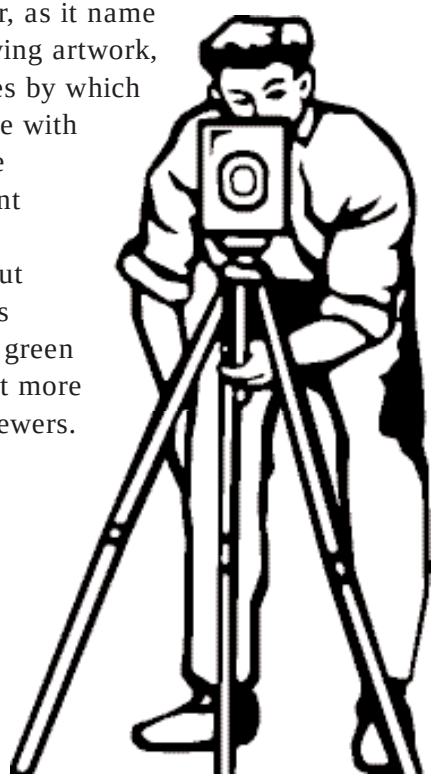
Skills:
Gathering, organising, analysing, interpreting, applying, evaluating, presenting and working in groups

Time:
One or two months

Materials:
Public notice board, art materials including

To celebrate such holidays as Teachers Day - 20th November, Anniversary of the Youth Union - 26th March, Earth Day, April 22nd and World Environment Day, 05th June, it is common for Vietnamese students to make a wall newspaper. It helps students to improve their writing, teamwork, research, communications and artistic skills, while encouraging them to learn about the environment.

The green wall newspaper, as it name suggests, is a wall displaying artwork, poems, photos and articles by which students can communicate with others in an effort to raise their awareness of different environmental issues. Information and data about local environmental issues should be included in the green wall newspaper to make it more relevant to some of the viewers.



Activity

PROCEDURE

1. Split the class so that only about ten to 15 students work together on the same green wall newspaper. Have the students choose a name or theme for the green wall newspaper. Assist the students to think about topics that are of global importance or issues that are urgent and relevant locally. This is very important as the theme that they choose will determine and guide their research and final product.

2. A month before displaying the green wall newspaper, have each student select a topic relevant to the overall theme of the wall. Ask the students to research this topic by reading books, magazines, newspapers, and the Internet and by conducting interviews. Encourage the students to be creative and give them a sense of control of what they will achieve.

3. Have the students, based on their research; illustrate what they have learned by writing a poem, or short story, or by painting or drawing a picture or composing a photo essay, etc. Students can ask their parents, village elders, and national park staff for more information.

4. Have students write directly on the wall or paste their contributions on the wall in a fun, artistic, and appealing arrangement.

5. After completing the wall, on the day of the festival or public event, hang it in the school's auditorium or in a public area such as the village meeting house where many people can see it. Teachers can judge the walls and give an award to the best one. After the event is over, the school can present the winning green wall newspaper to the People's Committee, or continue to hang all of them where they are.

ACTIVITY TWENTY-NINE

Nature Discovery

Objective:

To review what students have learned.

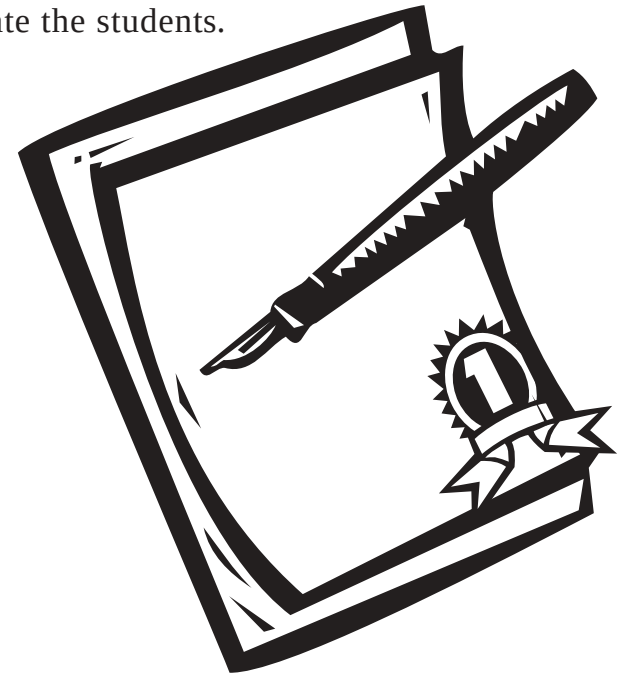
Knowledge Targets:
Area and location, atmosphere and cosmos, landforms, soils and minerals, plants and animals, energy, water, people, social organisation, economic, aesthetic, and human constructed environment

Skills:
Critical thinking, analysing, and working in groups

Time:
90 minutes

Materials:
A4 papers and pens

After participating in activities from one to twenty-eight in this book, the students have discovered many wonderful things about nature. This last activity is designed to give students the chance to consolidate what they learned. This activity should be conducted during the final meeting of the Green Club or during the last meeting of the school year. The questionnaire for this activity is only one example of what can be used. The teacher can develop other questionnaires that are more suitable for his or her students. A small prize or award should be given to motivate the students.



Activity

PREPARATION

Make a photocopy of the Questionnaire and cut into separate questions. Fold each question and put all of them in a box for students to select randomly.

PROCEDURE

1. Divide the students into four groups. Each group should choose a name. Explain to the students that today they will engage in a contest to find out who knows more about nature. Inform the students of the rules of the contest.

2. To start, one student from each group will go to the box and randomly choose a question. Each group has five minutes to answer. Then, have a representative of each group reads aloud the question before the class and give their group's answer. Correct answers get five points. If a group answers incorrectly or the answer is not complete, other groups have the chance to answer for which they can also score points.

3. This is repeated until all questions in the box have been answered.

4. The group with the highest score is the winner and gets the prize.

Questionnaire

1. How many continents and oceans are there on the Earth? (2 points) Name all the continents and oceans? (3 points)
2. Arrange the following biomes from the one that is nearest to the equator to the farthest one: taiga, temperate forest, tundra and tropical rain forest (3 points)? Which biome has the highest number of species? (2 points)
3. Can soil be formed without the presence of organism? (2 points) Why? (3 points)
4. List the two most important physical factors that affect plants? (2 points). What would happen if these two factors changed (3 points)?
5. Describe the adventure of a drop of water in nature (5 points)
6. Which is more easily eroded, forest-land or bare land? (3 points) Why? (2 points)
7. Can energy be generated from animal dung? (2 points) How can we use this energy? (2 points). What are the benefits of this energy (1 point).
8. What is the relationship between caterpillars and butterflies? (3 points) Why? (2 points)
9. Why do animals camouflage themselves? (2 points) How do they camouflage themselves (2 points) Give examples? (1 point)
10. How can the number of prey and predators change in one specific area? (3 points). Can predators catch all the prey? (2 points)
11. What threat do rare animals face? (Each threat gets 1 point)
12. What is biodiversity? (3 points) Which has higher biodiversity, tropical or temperate forests? (2 points)
13. What are the benefits of ecosystems? (Each benefit gets 1 point)
14. Is the carrying capacity of the Earth limited? (2 points) Why or why not? (3 points)
15. What would happen if people used natural resources faster than they could be renewed? (3 points) Why? (2 points)
16. What would happen if the world population continued to grow at the current rate? (5 points)
17. Does building a house affect the environment? (2 points) Why? (3 points)
18. You are walking in a park full of flowers. Should you pick a few to take home? (2 points) Why or why not? (3 points)
19. When you finish a picnic, what should you always do? (3 points) Why? (2 points)
20. When you go shopping, what should you carry with you besides money? (3 points) Why? (2 points)

1. **There are seven continents and four oceans in the world.**

   a) The seven continents are Asia, Europe, North America, South America, Africa, Australia, and Antartica.

   b) The four oceans are Atlantic Ocean, Pacific Ocean, Indian Ocean and Arctic Ocean.

2. **Tropical rain forest, temperate forest, taiga and tundra.**

   a) Tropical rain forest is the biome that has the most species

3. **No.**

   Microorganisms are important in the formation of soil. Over time, mother-stone is broken down into fine particles by heat, rain, waves and wind. Only after microorganisms appeared, did the organic layer form to become soil with enough nutrients for agriculture today

4. **These factors are light and humidity (water).**

   If there is too much or not enough water, plants cannot grow well and can even die. If light is lacking, photosynthesis of plants will be affected and thus plants may lack “food” and become stunted and may die.

5. Water in oceans, rivers, ponds and plants evaporates. These vapors become cool and condense to form clouds. Then, water from the clouds falls to the ground as rain or snow. Surface runoff runs into rivers and then flows to oceans. Water from rain also leaches into underground water and then flows to oceans. A huge amount of water is trapped as snow in polar regions and on high mountain peaks. That is the adventure of a drop of

6. **Bare land.**

   Because if the land is covered by vegetation, when it rains the speed of the raindrop will be decreased thus the impact of the rainfall on the ground is minimised. This helps to reduce erosion. Moreover, fallen leaves create a thick layer of decaying organic matter, which also helps to reduce the speed of the surface runoff, thereby controlling erosion.

7. **Yes.**

   a) Used in cooking, lighting, heating and running engines.

   b) Helps to protect the environment and save money by not having to buy other fuels.

8. **The caterpillar and butterfly are two stages of a metamorphosis of one species.**

   A caterpillar grows up and turns into pupa and then the pupa become a butterfly. Later the butterfly will lay eggs and caterpillars hatch from these eggs.

9. **To hide themselves in the environment to escape from an enemy or to catch food.**

   a) Change shape, size, colour and sound.

   b) For example, a leaf butterfly looks like a leaf; a stick bug looks like a dry branch; a gecko can change its skin colour to hide in the environment.

10. **If the number of prey decreases, the number of predators may also decrease. To some degree, fewer prey can cause food shortages for the predator population. This means the number of predators will also be reduced.**

    In nature the predator can never eat all the prey, except, when they are hunted by people.

11. **Poaching; habitat loss because of deforestation; pollution; tourism; illegal trading.**

12. **Biodiversity is the diversity of life forms on Earth, which includes genetic diversity, species diversity and ecosystem diversity.**

    Tropical forest has greater biodiversity than temperate forest.

13. Flood control; cleans and filters water; oxygen production; climate control; and erosion control.

14. **Yes.**

    Because natural resources on Earth for basic needs of people including food, cloth and shelter such as water, energy and food are limited.

15. **Natural resources will be exhausted.**

    Because of over exploitation, these natural resources cannot be replenished to replace those that have been exploited. In other words, these resources lose their capacity to renew.

16. **There will be not enough resources to support people in terms of food, clothes and shelter. War and starvation may occur and people could become extinct.**

17. **Yes.**

    Because when you build a house, you have to use materials from different ecosystems and thereby you affect the ecosystems. Moreover, building a house can release pollutants and contaminate the area.

18. **No, you should not pick flowers in the park.**

    Because if everyone picked a few flowers like you, there would be none left in the park and the beauty of the park would be destroyed.

19. **Put all the litter in the bin or take it home if you cannot find a bin.**

    Litter will spoil the picnic area and some people or animals may get hurt.

20. **Bring your own shopping bags.**

    If you do not take a new plastic bag, you help to reduce the plastic waste in the environment and because plastic doesn't decompose easily in nature, you protect the environment.

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