PROBLEM BASED LEARNING

GRADE 5

SCIENCE

TEACHER'S GUIDE

IUCN

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INTRODUCTION

This Teacher's Guide is intended for science teachers (grade 4-6) to use as a complimentary guide in their science teaching. The main aim of this book is to provide teachers a support and a flexible choice in their teaching and learning activities. It is hoped that through these local problems teachers can situate their teaching activities both in the classroom and outside and provide students with real-life situations where these science concepts are at work. Through this method of teaching, students learn science through inquiry, work as scientists, and socially construct the meaning of their learning through collaboration and peer assistance.

The Grade 5, Problem Based Learning teacher's guide provides learning problems, which are localized for the following topics from the curriculum:

- **Habitats of Plants**
- **Impacts of Habitats**
- **Greenhouse Effect**
- **Natural Disasters**
- **Ecological Footprint**
- **Conserving Water**
- **Conserving Energy**

Of this, the topics **Greenhouse Effect** and **Natural Disasters**, cross over with the curriculum indicators from Grade 6 as well. This is one way in which it shows that these themes and ideas of science are not grade-bound and it is important that students take this message from their learning of science as well.

This Teacher's Guide provides teachers a clear set of instructions and paves the way to utilize the science process skills more effectively in their teaching. Printable worksheets are provided, which can be used in the classroom, together with some background information for teachers and websites that can be referred to. In doing so, it is important that teachers do not restrict or limit their knowledge or students' to only what is provided here. The idea is teachers to guide the students, not to lead them.

HOW TO USE THIS BOOK

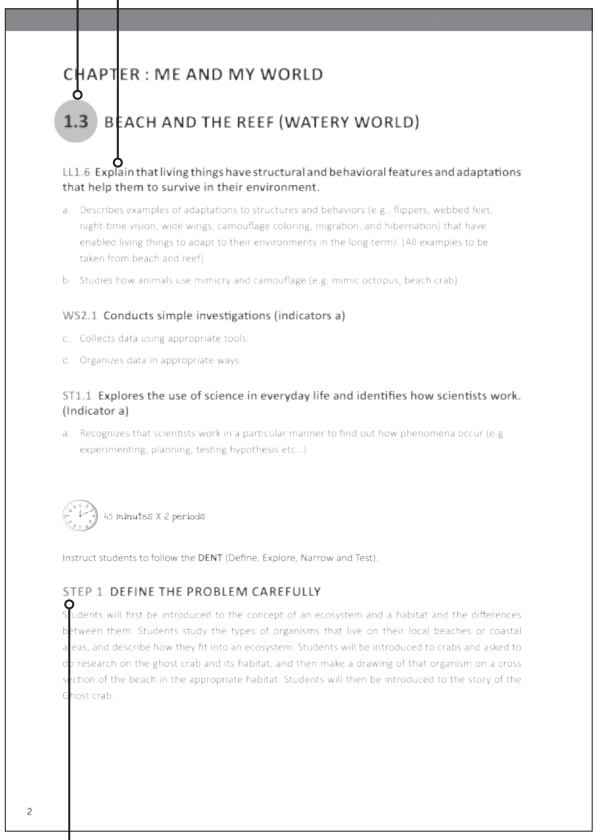
This book is meant as a teacher's guide for Key Stage 2 science teachers. Each chapter in this book is designed around the curriculum outcomes and indicators for the Key Stage 2 of the Science Syllabus of the National Curriculum with consultation from National Institute of Education's curriculum developers.

Each topic in the book starts with the relevant curriculum outcomes and indicators the problem addresses to. Each topic ends with suggested method to assess students learning from these lessons. This structuring will help teachers to use these problems when those curriculum areas are taught in the class.

Each topic consists of a real-life problem, and the **DENT** approach will be used in the PBL process. The assessments in this book reflect contemporary assessment methods, which are aligned with the assessment policy of MOE and the national curriculum's Pedagogy and Assessment guidelines. The student resource sheets and the teacher resource sheets are printable and can be printed off the book for use during teaching- learning process.

Represents the corresponding unit from the Science Student Books

Shows the Outcomes and Indicators from the Science Syllabus



CHAPTER : ME AND MY WORLD

1.3 BEACH AND THE REEF (WATERY WORLD)

LL1.6 **Explain that living things have structural and behavioral features and adaptations that help them to survive in their environment.**

a. Describes examples of adaptations to structures and behaviors (e.g., flippers, webbed feet, night-time vision, wide wings, camouflage coloring, migration, and hibernation) that have enabled living things to adapt to their environments in the long term). (All examples to be taken from beach and reef)

b. Studies how animals use mimicry and camouflage (e.g. mimic octopus, beach crab)

WS2.1 **Conducts simple investigations (indicators a)**

c. Collects data using appropriate tools.

d. Organizes data in appropriate ways.

ST1.1 **Explores the use of science in everyday life and identifies how scientists work. (Indicator a)**

a. Recognizes that scientists work in a particular manner to find out how phenomena occur (e.g. experimenting, planning, testing hypothesis etc...)

45 minutes X 2 periods

Instruct students to follow the **DENT** (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM CAREFULLY

Students will first be introduced to the concept of an ecosystem and a habitat and the differences between them. Students study the types of organisms that live on their local beaches or coastal areas, and describe how they fit into an ecosystem. Students will be introduced to crabs and asked to do research on the ghost crab and its habitat, and then make a drawing of that organism on a cross section of the beach in the appropriate habitat. Students will then be introduced to the story of the Ghost crab.

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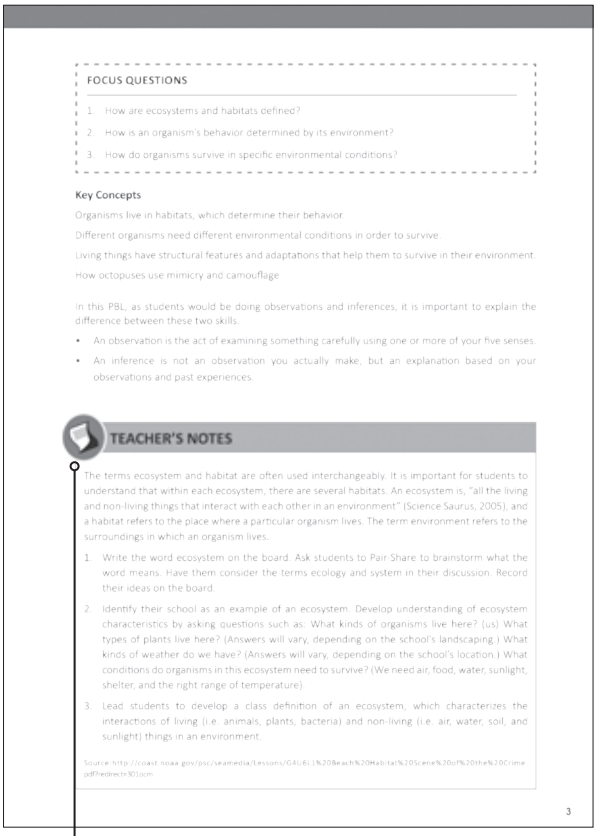

FOCUS QUESTIONS

1. How are ecosystems and habitats defined?
2. How is an organism's behavior determined by its environment?
3. How do organisms survive in specific environmental conditions?

Key Concepts

Organisms live in habitats, which determine their behavior.

Different organisms need different environmental conditions in order to survive.

Living things have structural features and adaptations that help them to survive in their environment.

How octopuses use mimicry and camouflage.

In this PBL, as students would be doing observations and inferences, it is important to explain the difference between these two skills.

- An observation is the act of examining something carefully using one or more of your five senses.
- An inference is not an observation you actually make, but an explanation based on your observations and past experiences.

TEACHER'S NOTES

The terms ecosystem and habitat are often used interchangeably. It is important for students to understand that within each ecosystem, there are several habitats. An ecosystem is, "all the living and non-living things that interact with each other in an environment." (Science Saurus, 2005), and a habitat refers to the place where a particular organism lives. The term environment refers to the surroundings in which an organism lives.

1. Write the word ecosystem on the board. Ask students to Pair-Share to brainstorm what the word means. Have them consider the terms ecology and system in their discussion. Record their ideas on the board.
2. Identify their school as an example of an ecosystem. Develop understanding of ecosystem characteristics by asking questions such as: What kinds of organisms live here? (us) What types of plants live here? (Answers will vary, depending on the school's landscaping.) What kinds of weather do we have? (Answers will vary, depending on the school's location.) What conditions do organisms in this ecosystem need to survive? (We need air, food, water, sunlight, shelter, and the right range of temperature).
3. Lead students to develop a class definition of an ecosystem, which characterizes the interactions of living (i.e. animals, plants, bacteria) and non-living (i.e. air, water, soil, and sunlight) things in an environment.

Source: http://coast.noaa.gov/psc/seamedia/Lessons/G4L6L1%20Beach%20Habitat%20Scene%20of%20the%20Crime.pdf?redirect=301.aspx

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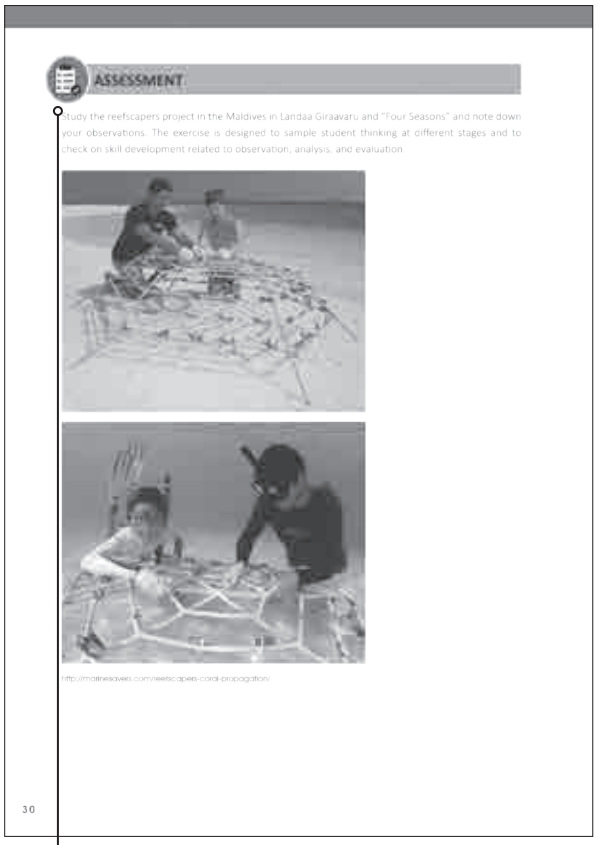
Provides relevant additional information for teachers

Provides ideas and activities for teachers through the DENT approach



ASSESSMENT

Study the reefscapers project in the Maldives in Landaa Giraavaru and "Four Seasons" and note down your observations. The exercise is designed to sample student thinking at different stages and to check on skill development related to observation, analysis, and evaluation.

http://marinesaves.com/reefscapers-coral-propagation/

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STUDENT RESOURCE SHEET 1

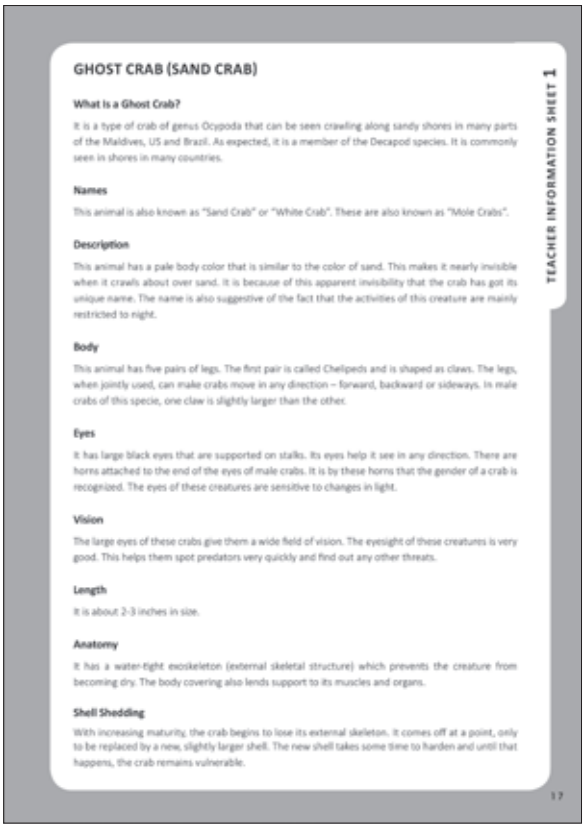
Name _____ Date _____

LIFE ON THE BEACH

Shells	Sea weed
Large crabs	Tiny crabs
Small shrimp	Small fish
Jelly fish	Star fish

Illustrates how to assess student learning for the tasks carried out

Provides printouts for students to be used while carrying out the tasks



TEACHER INFORMATION SHEET 1

GHOST CRAB (SAND CRAB)

What Is a Ghost Crab?

It is a type of crab of genus Ocypoda that can be seen crawling along sandy shores in many parts of the Maldives, US and Brazil. As expected, it is a member of the Decapod species. It is commonly seen in shores in many countries.

Names

This animal is also known as "Sand Crab" or "White Crab". These are also known as "Mole Crabs".

Description

This animal has a pale body color that is similar to the color of sand. This makes it nearly invisible when it crawls about over sand. It is because of this apparent invisibility that the crab has got its unique name. The name is also suggestive of the fact that the activities of this creature are mainly restricted to night.

Body

This animal has five pairs of legs. The first pair is called Chelipeds and is shaped as claws. The legs, when jointly used, can make crabs move in any direction – forward, backward or sideways. In male crabs of this specie, one claw is slightly larger than the other.

Eyes

It has large black eyes that are supported on stalks. Its eyes help it see in any direction. There are horns attached to the end of the eyes of male crabs. It is by these horns that the gender of a crab is recognized. The eyes of these creatures are sensitive to changes in light.

Vision

The large eyes of these crabs give them a wide field of vision. The eyesight of these creatures is very good. This helps them spot predators very quickly and find out any other threats.

Length

It is about 2-3 inches in size.

Anatomy

It has a water-tight exoskeleton (external skeletal structure) which prevents the creature from becoming dry. The body covering also lends support to its muscles and organs.

Shell Shedding

With increasing maturity, the crab begins to lose its external skeleton. It comes off at a point, only to be replaced by a new, slightly larger shell. The new shell takes some time to harden and until that happens, the crab remains vulnerable.

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Gives additional information for teachers

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CONTENTS

PROBLEM BASED LEARNING

Problem based learning (PBL) is an interesting and fun way to learn science. PBL engages students in solving authentic problems related to science and everyday life. Such classroom activities will stimulate discussions among students and reinforce learning making the learning more meaningful and interesting for the students. PBL involves students being challenged to solve genuine problems. In addition to developing science process skills identified in the science curriculum, general skills such as critical thinking and abstract reasoning will be enhanced through PBL. PBL is often used as a way for students to develop experience in the process of solving a problem, rather than simply seeking a 'correct' solution. For this reason, problems used for PBL include well-defined ones with a clear solution (or set of possible solutions), as well as more loosely defined ones or those without a known solution.

PBL is an adaptable approach that can be applied in most disciplines, from the practically focused to the more theoretical. The approach works well as an activity for individuals, but is especially effective when used with groups because it encourages the students to develop their interpersonal, team-working, creativity and communication skills. A PBL environment emulates the workplace and develops self-directed learners. These kinds of learning environments is preferable to a learning environment in which students only watch and memorize and repeats what they have been told.

The case studies/problems used in this book are adapted for grade 5 level students and contextualized to make it more meaningful for the students. The problems chosen for this grade level is not too complex, however, with a few possible answers/solutions, the students can come up with in their respective groups. The problems chosen are from the immediate environment of the students and very much geared towards finding out extra information to create more curiosity among the students and to respect their own environments. More importantly, these case studies are formulated to develop and enhance the process skills and critical thinking skills identified in the science curriculum.

PROCESS SKILLS REQUIRED FROM THE SCIENCE CURRICULUM ARE:

The Science syllabus identifies a range of practical skills that need to be acquired by the students. Some of these fundamental skills include: [1]

1. Observing
2. Classifying
3. Recognizing patterns
4. Estimating and measuring
5. Questioning
6. Making and testing
7. Predicting
8. Investigating and experimenting
9. Recording and communicating
10. Designing and making

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[1] NIE (2014), Science Curriculum

HOW DOES PBL RELATE TO SCIENCE LITERACY?

1. The capacity to formulate questions; seek, comprehend and use available information; gather and interpret data; and draw logical inferences in relation to an area of investigation;

2. The ability to comprehend and communicate the language, concepts, theories and practices of science, mathematics and technology in ways that promote mutual understanding, cooperative problem solving and shared vision;

3. The awareness that science, mathematics and technology are ongoing processes and growing disciplines, constantly evolving and being refined through inquiry and open- ended investigation;

4. The awareness that science, mathematics and technology are interdependent and that the tools and methods of each are interrelated and mutually supportive; and

5. The understanding that science, mathematics and technology have strengths and limitations, in both theory and application, particularly as they relate to societal and ethical issues .

The students will work in groups according to the problem presented. Group sizing is for the teacher to decide. For example, if the teacher feels that five students in a group will work better with a given case study, it will be left for the teacher's judgment to decide so. Group based PBL is a good opportunity for students to develop skills of working together and respecting the views of others because the students are able to make use of their individual strengths and learn from each other.

In PBL situations, the process is the most important aspect of the activity. In some cases, particularly where the problem has no clear solution, the approach that the students take in trying to solve the problem is a more valuable learning experience than finding the correct answer. Regardless of the actual choice made, it is extremely common for students to be required to record their process in PBL. This serves two purposes: firstly, it produces evidence that the students have legitimately attempted to solve the problem; and secondly, it provides something for the students to use as the basis of future reflection.

PBL also offers an ideal platform to introduce knowledge and expertise from resource people outside of the school. For example, outside experts in the problem domain could be made available for the students to question, provide feedback on ideas, or give first hand insight into the problem. Similarly, potential users and beneficiaries of the solution could be made available in the same way to provide their own perspective on the problem and the students' work.

POSSIBLE TECHNOLOGIES TO SUPPORT THE APPROACH

The technologies used to support PBL will primarily depend on the problem that is being investigated and it is likely that these will be quite similar to the ones that would be used outside of a school setting. However, there are some general tools that would be useful for most PBL activities, particularly those where students are working in groups. The group or individuals can use all these tools. The students can use the Internet, blogs, other social media and search for articles related to the case.

Good internet sites for resources:

http://data.worldbank.org/topic/environment

http://www.eoearth.org/

http://www.sciencekids.co.nz/sciencefacts/nature.html

http://www.listofenvironmentalissues.com/environmental-issues-facts-for-kids/

http://environment.nationalgeographic.com/environment/

http://earthecho.org/news/did_you_know_some_interesting_facts_about_the_environment

METHOD FOR STUDENTS

Follow the DENT procedure: Define, Explore, Narrow and Test

STEP 1 DEFINE THE PROBLEM

What are you trying to determine? Does the problem have many components? If so state them separately. Does everyone in the group agree with the way the problem has been framed? Ask group members to think out loud as this will slow down the process of reasoning and focus on understanding the problem at hand. Select a group leader and ask him/her to take the lead and discuss the problem for comprehensibility.

STEP 2 EXPLORE POSSIBLE SOLUTIONS

Brainstorm ideas that may contribute to a solution. Ask individuals to justify the ideas to the group. Clarify for them the science process skills involved in solving the problem. Have them rephrase the ideas. Listen carefully and guide the group by providing cues and ideas to the group. Ask the group leader to list what the group is learning. For example. 1-what do we know 2- what don't we know? 3- do we have any information or past experience/knowledge 4- what are the science process skills involved in solving this problem. 5- Ask the group leader to assign tasks to individual students in the group for solving the problem.

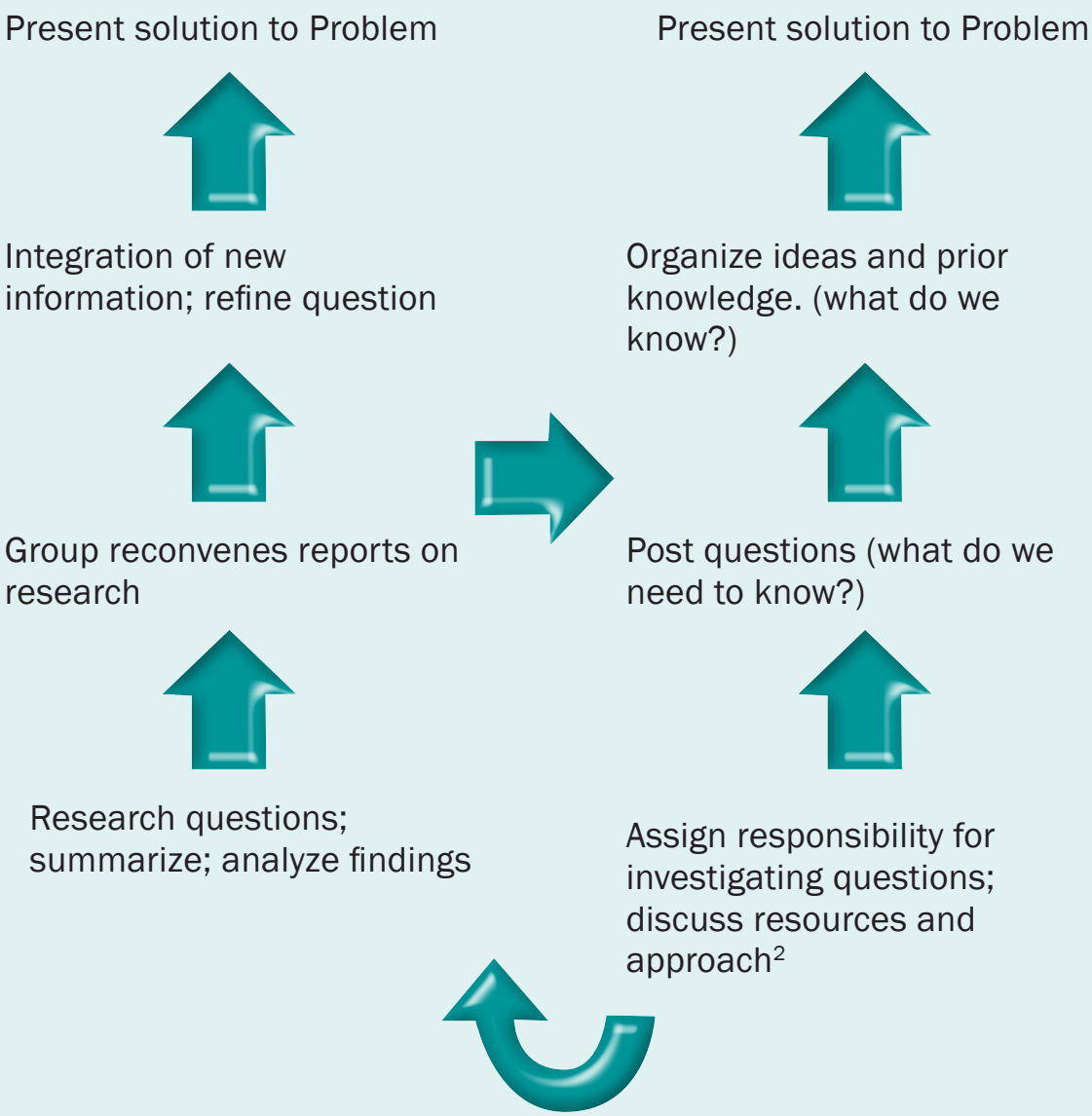
STEP 3 NARROW YOUR CHOICES

Ask the group leader to list down the possible solution/hypothesis. Sort them and rank them according to the priority the group members give to each solution. Give priority to the simplest and the easiest solutions in terms of finding the necessary resources to arrive at the solution or solutions. It is easier to go and do an observation or find information from other sources rather than buying expensive gadgets.

STEP 4 TEST YOUR SOLUTIONS

Test the first 3-5 hypotheses or possible solutions that you have listed and ranked. If all your first 5 possible solutions are eliminated, begin the cycle again: define, explore, narrow, and test. When you come across information that confirm one of your hypotheses, you may be asked to write a scientific explanation of your solution and justify it using the available evidence or information collected.

STEPS TO FOLLOW IN DENT PROCEDURE



[2] Adapted from ITUE Session, (2005)

STEPS TO FOLLOW IN DENT PROCEDURE

DEFINE

What is the problem here? What are we trying to study?

Try rephrasing the question so that it wil be understood properly.

EXPLORE

Brainstorm ideas that may contribute to a solution. Ask individuals to justify the ideas to the group. Clarify for them the science process skills in solving the problem. Have them rephrase the ideas. Listen carefully and guide the group by providing cues and ideas to the group.

NARROW

Lists down the possible solution/hypothesis. Sort them and rank them according to the priority the group members give to each solution. Give piority to the simplest and the easiest solutions in terms of finding the necessary resources to arrive at the solution or solutions.

TEST

Test the first 3-5 hypotheses or possible solutions that you have listed and ranked. If all your first 5 possible solutions are eliminated, begin the cycle again:define, explore, narow, and test. When you come across information that confirm one of your hypothesis you may be asked to write a scientific exexplanation of your solution and justify it using the available reevidence or information collected.

METHODS FOR INSTRUCTORS

1 GROUPING THE STUDENTS

Make groups of 3-5 students according to the problem to be solved. This will be left to the judgment of the teacher in charge of the class. When deciding the group size, consider the amount of work that goes into exploring the problem and the time at hand.

2 PRESENT THE PROBLEM

Present the problem to the whole class, explain and give the problem printed on card paper or emphasize to the students that they are dealing with an authentic case. Bizarre problems work best. Prior to class you should review the case history and arm yourself with data that can be released incrementally as you present the case.

3 ACITIVATE THE GROUPS

Ask the groups to brainstorm possible causes for the provided case. Each group will have to discuss, review, or investigate. This is when much learning occurs, as the students help each other understand the basic science and the process skills required in order to investigate the provided case. PBL students must reflect upon scientific mechanisms rather than just memorize facts (as might occur in some traditional classes). The teacher circulates among the groups, providing assistance but not solutions. The groups may well explore avenues unanticipated by the teacher. This is highly desirable and should not be discouraged. The instructor should avoid controlling the agenda of the groups.

At this point teacher can ask students probing questions identified at the Explore and Narrow stages.

4 PROVIDE FEEDBACK

Ask the group leader from each group to place their top priority hypothesis or data request on the board (if already entered by another group, place their second choice, etc.). If this is not practical, ask for oral suggestions from the groups, when the small group work is finalized and the class is reconvened. The small group work can be stopped and the instructor can briefly discuss the ideas with the entire class. It is important to value every contribution, to assist the students in analysis of the science involved, and to provide further information. The students can be prompted for data requests: it is not likely that the students will solve a problem on the first attempt, and the feedback from the teacher motivates the next round of small group work. The cycle of small group work and teacher feedback can be continued during the current class session or on future occasions. The key to managing a PBL session is providing continual feedback to maintain student enthusiasm while simultaneously prolonging the resolution of the problem to ensure that adequate learning occurs.

5 ASK FOR A SOLUTION

At this point the groups will likely focus providing a solution. When a reasonable number of groups have solved the problem, you might request a brief written analysis from each group describing the science involved in the case. Students may be asked to include certain key words in their reports.

PROBLEM BASED LEARNING

CASES

3.1 HABITATS OF PLANTS

LL2.1 Explores a variety of habitats and identify ways in which individuals and groups of organisms interact with each other and their environment.

a. Recognizes that each plant and animal depends on a specific habitat to meet its needs.

b. Compares the needs of a variety of living things and identify how the needs of animals change with the habitat (e.g. some living organisms live in water and some on land, some eat plants and some eat other animals).

c. Identifies how living things depend on one another (e.g. trees produce the oxygen that other living things breathe; plants such as tomatoes and apple trees and animals such as cows and fish provide food for humans and for other animals).

d. Investigates how living things are dependent on the non-living environment (e.g. using air for breathing, water for drinking, nutrients from soil for plant growth).

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. What are habitats?
2. Where do birds live?

The Problem

Afran is a very curious 11 year old boy who lives in Male' with his family. During the school holidays his parents decided to go on a family trip to a nearby uninhabited island. Afran was so excited about the trip he started planning straight away on what to take with him and what to do on the island.

The big day arrived and Afran was the first person to get ready with his backpack and his science investigation toolkit- a gift his grandmother has given him on his 11th birthday. As soon as they arrived on the island, Afran took off to explore the island. Afran walked along the beach observing the crabs and sea birds. He observed the washed up sea grass under his magnifying glass. He saw a small bird walking along the beach. He looked around and decided to catch the bird to show it to his friends back in Male'. He ran and caught it and ran off excitedly to show it to his father. His father thought it would be a nice pet for Afran and helped him put the bird in a small box so that they can bring it back to Male'.

As soon as they arrived Male', Afran took out the bird and searched on Google to find the name of the bird. He discovered that it was called *theyravaa*. He searched and learnt about the bird's diet and fed it accordingly. He lovingly fed it daily and kept him in a small box in his air-conditioned bedroom. He was so protective of the bird he never let it out of the room. After a week he understood the bird was very weak and not eating anything. He was very upset because the bird had fallen sick.

What could be the reason the *theyravaa* was not well?

TEACHER'S NOTES

CRAB PLOVER'S HABITAT

The crab plover is a peculiar wading bird of tidal mudflats around shores, coastlines and islands of the Indian Ocean. It also inhabits sandy and muddy shores on mainland coasts and islands, as well as intertidal sand flats, estuaries, lagoons and exposed coral reefs.

Crab Plover

Scientific name: *Dromas ardeola*

Family name: Dromadidae

Dhivehi name: Theyravaa (Female) / Moalha tun'bo (Male)

Distribution and Habitat: Outside the breeding season, the Crab Plover is distributed throughout the Indian Ocean. When breeding, it concentrates around the Southern Red Sea, the Gulf of Oman and the Persian Gulf. The Crab Plover inhabits sandy coastlines, intertidal mudflats, estuaries and lagoons.

Description: The Crab Plover is the only species within the family Dromadidae. It is 33 – 36 cm in length. It has white plumage on its head and under-parts and black primaries and back feathers. It has a long, black bill. It has long legs, partially webbed toes and a short tail. The diet of the Crab Plover consists of crabs, crustaceans and aquatic worms. It is commonly found foraging in small groups. Its large powerful beak protects it from its prey.

The Crab Plover is unique from other waders in that it nests in an underground burrow on sandy dunes. It nests in colonies with many burrows set close together each reaching about 1 – 2.5 meters in length. The burrow is initially angled downwards then curving up and into the nest chamber. The Crab Plover lays only one egg at a time. The chamber protects the egg from high temperatures and acts as a solar incubator. As the egg remains at an optimum temperature, very little direct incubation from the parent is needed.

Threats: The Crab Plover is vulnerable to oil spills, loss of nesting sites and predation from introduced animals on nesting islands. Nonetheless, it is currently classified under *Least Concern* in the 2009 IUCN Red List. This bird is protected under the *Environmental Protection and Preservation Act* (Law 4/93) in the Maldives.

CRAB PLOVER'S DIET

Crab plovers flock on beaches and reefs where they hunt crabs and mollusks. They catch their prey and break them up by pounding them with their heavy beaks. They will also take advantage of marine worms and mudskippers exposed to the shore by receding tides.

CRAB PLOVER'S BEHAVIOUR

Crab plovers are very tame birds.

They are also very noisy and give out frequent 'calls', particularly at their breeding sites and wintering grounds. Their usual call sounds like 'ka ka ka ka' which is repeated rapidly.

Flocks of crab plovers produce 'whinnying' sounds. During the breeding season a 'kew ki ki' can be heard. Flocks of Crab Plovers can often be observed flying in a 'V' formation.

Crab plovers are gregarious birds and generally feed in large groups of 30 – 40 individuals anytime of the day or night although flocks as many as 400 can be observed outside of the breeding season. Crab plovers are active during the day and night. This crepuscular and nocturnal behaviour is more common during the breeding season.

CRAB PLOVER'S REPRODUCTION

Crab plovers breed during the months of April to August. Breeding grounds occur around the Arabian Sea of Pakistan, Gulf of Oman and the Persian Gulf, Red Sea and Somalia. Crab plovers are colonial breeders and nest in colonies of up to 1500 breeding pairs. These dense colonies form around areas that have an abundance of crabs which can be fed to the young.

These mysterious shore birds have very unique breeding habits. Crab plovers dig deep burrows and networks of interconnected burrows measuring 1.5 – 2.5 metres in sandbanks and dunes along the coast. The burrows are angled downwards and then curve upwards ending in a nest chamber a short

distance from the surface. The chamber acts as insulation for the egg against very hot temperatures which occur during the breeding season and as incubation for the egg, keeping it at an optimum temperature and requiring minimum incubation from the parents. Nests can be left for up to 58 hours.

The female lays one large, single white egg into the burrow. The large egg provides sufficient energy for the developing chick during the 32 – 33 day incubation period. When the chick hatches, it is well developed and is able to walk quite quickly although it will remain in the nest for several days after hatching. Food is brought by the parents and is mainly live crabs. Parental care from both parents is continued for a long period of time, even after the chick has fledged.[1]

Where does the crab plover (*theyravaa*) like to live?

The teacher can pose questions such as:

- How are habitats defined?
- How is an organism's behaviour determined by its environment?
- How do organisms survive in specific environmental conditions?

Key Concepts

- Organisms live in habitats, which determine their behaviour.
- Different organisms need different environmental conditions in order to survive.
- Living things have structural features and adaptations that help them to survive in their environment.
- How can we obtain further information on crab plover?

Use the KWL chart Student Resource Sheet 1: Crab plover - KWL chart

[1] www.livelearn.org/sites/default/files/docs/Bird%20guide%20FINAL.pdf (accessed on 10th November 2015)

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding Crab Plovers. Using the ideas that have been raised (focus questions), ask the students to develop hypotheses or questions they want answered concerning crab plover. The following activity will guide the students in their investigations of the bird.

The students divide into groups (5) to investigate about the bird. In order to guide the students and immerse them more into the problem, teacher can use the following question to guide students' thinking.

What is the science process skill involved in solving this problem?

- Introduce the term hypothesis and define it as, "an idea that can be tested by an experiment or observation" (Science Saurus, 2005). As an example, show the students a picture of the Crab Plover. Ask students to make observations of its adaptive structures/behaviours as well as the environmental conditions it needs to survive.
- Ask the group leader to assign tasks to individual students in the group, for solving the problem.

Establishing Investigation Protocols

Differentiating between observation and inference:

- State that making good observations are the basis for any investigation.
- Ask students what an observation is. "Something that they see" is a common response.
- Ask students if "seeing" is the only sense they can use when making observations.
- Through discussion and questioning, define an observation as the act of examining something carefully using one or more of your five senses. Clarify that you may not need to use all of your senses to make observations all the time. Provide practice by having students share observations.
- Introduce the term inference. Explain that an inference is not an observation you actually make, but an explanation based on your observations and past experiences. For example, "The caterpillar is 3 centimeters long and 1 centimeter wide" is an observation. "The caterpillar is ready to form its chrysalis" is an inference.

STEP 3 NARROW YOUR CHOICES

Ask the group leader to list down the possible solution/hypothesis. Ask the groups to list down the solutions in priority order.

Get ready or plan for an outing to undertake observations in groups.

- Do observations only of the crab plover.
- To identify crab plover, find pictures of the bird and get ready to observe the behavior of the crab plover.
- Search other documents for information relating to crab plover.
- Focus on observing the following characteristics of the crab plover. Body, eyes, anatomy, habitat, beak and diet etc.
- After and before the observations, check to see if the group members have utilized the following science process skills.

Establishing Investigation Protocols

Sketch the bird by referring to the following:

- **Student Resource Sheet 2: Sketch of crab plover and naming the body parts**
- **Student Resource Sheet 3: Record sheet of observations**

When observing make sure that you have taken all the five senses in to consideration.

STEP 4 TEST YOUR SOLUTIONS

Test your hypotheses/solutions discussed before from the observations and from the information that you have collected in the groups.

Present the findings to the class and provide space for other groups to comment on their drawings / pictures or refute their hypothesis.

- Use the fact sheets to confirm and justify how the crab plover survives in its own habitat.
- Based on the observations make a drawing or sketch/photographs of the crab plover and come up with the solutions to the hypothesis.

ASSESSMENT

The assessments will be done in two parts.

- Skills assessment
- End-product assessment

Skill assessment rubric

Parts of this should be used to evaluate students' skills as they are using them throughout the problem solving activity.

Tick as appropriate

	ESTABLISHED	DEVELOPED	EMERGING
SUB-STRAND: OBSERVATIONS, QUESTIONS & HYPOTHESIS			
Uses appropriate tools in making observations			
Uses appropriate vocabulary to explains events/phenomena			
Describes observations by various means (e.g., sketches, drawings, tables, etc.).			
SUB-STRAND: INVESTIGATION SKILLS			
Formulates investigative questions			
Identifies variables in an investigation			
Plans procedures in carrying out simple investigations			
Collects data using appropriate tools			
Recognizes the need to take accurate measurements			
Uses appropriate units in measurement			
Organizes data in appropriate ways			
Proposes ways to improve the investigation			
Analyses data to make conclusions			

Content Assessment Criteria

- How the crab plover survives in its environment?
- Does the explanation relate with facts and observations?
- Does the drawing explain how the crab plover survives in the environment?
- Is the presentation or explanation in students' own words?

STUDENT INFORMATION SHEET 1

Name ---------- Date ----------

THEYRAVAA STORY

Afran is a very curios 11 year old boy who lives in Male' with his family. During the school holidays his parents decided to go on a family trip to a nearby-uninhabited island. Afran was so excited about the trip he started planning straight away on what to take with him and what to do on the island.

The big day arrived and Afran was the first person to get ready with his backpack and his science investigation toolkit- a gift his grandmother has given him on his 11th birthday. As soon as they arrived on the island, Afran took off to explore the island. Afran walked along the beach observing the crabs and sea birds. He observed the washed up sea grass under his magnifying glass. He saw a small bird walking along the beach. He looked around and decided to catch the bird to show it to his friends back in Male'. He ran and caught it and ran off excitedly to show it to his father. His father thought it would be a nice pet for Afran and helped him put the bird in a small box so that they can bring it back to Male'.

As soon as they arrived back to Male', Afran took out the bird and searched on Google to find the name of the bird. He discovered that it was called *theyravaa*. He searched and learnt about the bird's diet and fed it accordingly. He lovingly fed it daily and kept him in a small box in his air-conditioned bedroom. He was so protective of the bird he never let it out of the room. After a week he understood the bird was very weak and not eating anything. He was very upset because the bird had fallen sick.

What could be the reason the *theyravaa* was not well?

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

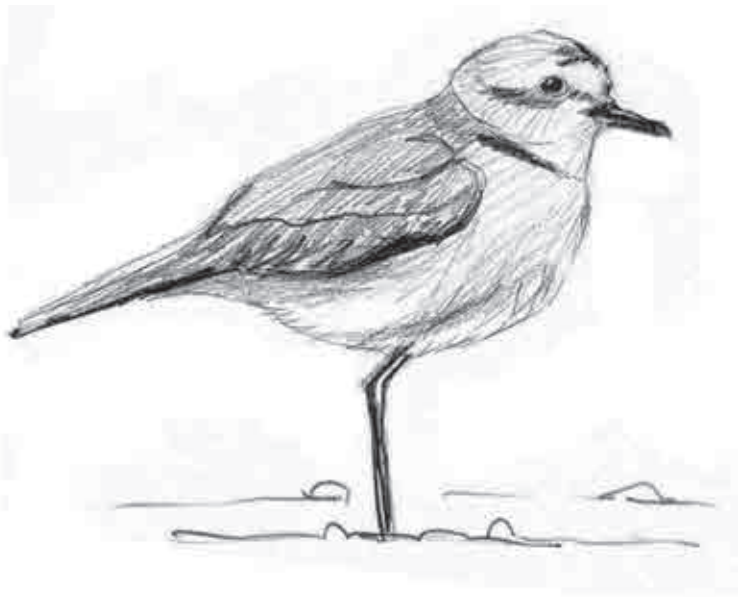
CRAB PLOVER - KWL CHART

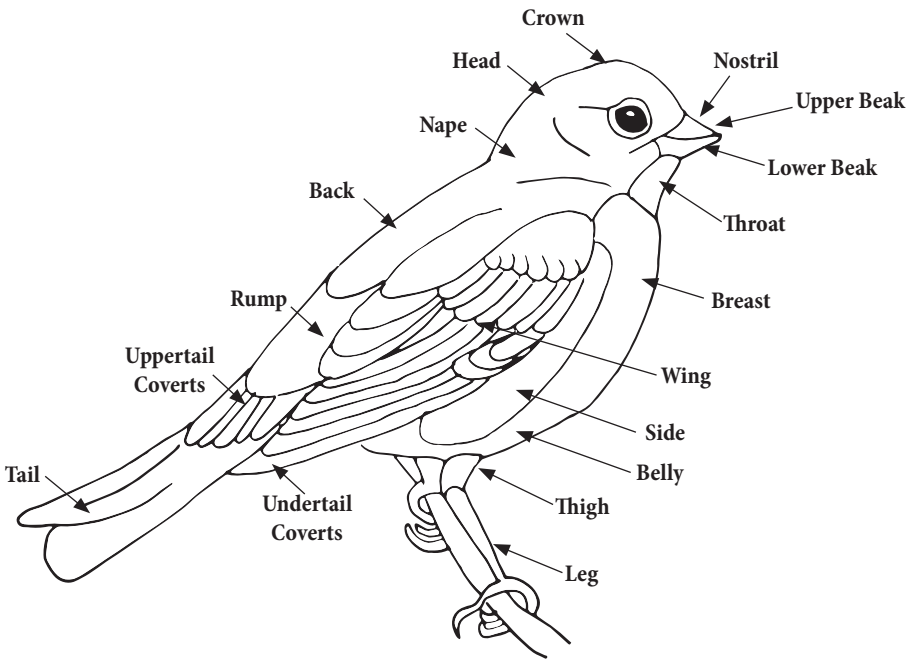
WHAT I KNOW ABOUT CRAB PLOVER	WHAT I WANT TO FIND OUT ABOUT CRAB PLOVER	HOW CAN I LEARN MORE ABOUT CRAB PLOVER

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

EXAMPLES FOR SKETCHING OF CRAB PLOVER AND IDENTIFYING THE BODY PARTS





RECORD SHEET OF OBSERVATIONS

Bird Record Sheet

Name .....

Type of bird	Date	Where was the bird?	Weather				What was the bird doing? (flying / feeding / collecting nesting materials etc.)

3.4 IMPACTS ON HABITATS

LL2.3 Explore the impact on various habitats caused by human activities and natural disasters.

a. Studies the impacts of human activity on a familiar habitat.

b. Researches on a local endangered organism and identify the reasons for it to become endangered

ST2.2 Applies the knowledge gained to make informed decisions

a. Identifies and explains events and phenomenon using their scientific knowledge (e.g., germination of seeds, spreading of germs).

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. What is a mangrove?
2. How useful is a mangrove to the environment?
3. What makes a mangrove so unique?

The Problem

Rameez and his family travelled to the island of *Huraa* on *Eid* to visit their family friends. Rameez did not know anything about *Huraa* so he asked his grandfather while travelling on the boat where they were going and his grandfather narrated the following facts to Rameez. *Huraa* is a small inhabited island lying in the North Male' *Kaafu* Atoll. Just an hour and a half boat ride from the capital. The people of *Huraa* are very nice and friendly. According to folk stories passed on from generation to generation, the very first inhabitants of *K. Huraa* were three foreigners from France. Two men and a woman. It is believed that the people of *K. Huraa* are descendants of them. Till date, the three graves, believed to be belonging to the first three inhabitants still lie near the cemetery at *Dhon Bandaara* Mosque.

Even though the original inhabitants of the island amount to just over a 1000, there are more than double that number of people from other islands living in *Huraa*. Most of them are staff from the neighbouring resorts and their families. Many tourist resorts on both sides of the island surround *Huraa*. The nearest one is Four Seasons Resort Maldives at *Kuda Huraa*, which is just across the lagoon on the southwest side of the island. Due to this proximity, every week tourists from these resorts make scheduled trips to *Huraa* to see the local island life. Huraa is famous for its mangrove swamp locally known as *Huraa Kulhi*.

This is an amazing place filled with nature's wonders and the little crabs of spectacular colours reside in this *Kulhi*. These crabs will be endangered if *Huraa Kulhi* is not preserved because these crabs are found in this *Kulhi* only. The *Kulhi* at *Huraa* is famous for its large size and deep waters during high tide. It is also one of the few mangrove swamps located close to the capital Male'.

Huraa Kulhi is home to a vast number of species of mangrove trees, tropical birds, crabs and fish. Due to these reasons the site has been declared environmentally protected by the government.

What do you think are some of the other reasons why *Huraa Kulhi* should be preserved?

TEACHER'S NOTES

Mangroves in the Maldives are normally found in depressions of islets locally known as *Kulhi*. Some species of mangroves also grow along island lagoons. Mangrove areas are highly productive ecosystem contributing to the food chains of atoll islands. They are also important to the atoll ecosystems, as they filter out silt, nutrients and sand that would otherwise go out to the house reef around the islands which will suffocate corals and encourage algal growth.

Most of the native plants in the Maldives are salt tolerant. Most of the plants that grow on the coasta vegetation belt around islands although very salt tolerant but differ that of mangroves. This was quite visible in the 2004 Asia's tsunami disaster, most of the native plants survived leaving dead all the introduced and naturalized plants in tsunami-affected islands.

Mangroves are most extensive on the southern atolls and at least 13 mangrove species are found and dominated by:

- Rhizophora mucronta *(Thakafathi/Randoo)*
- Rhizophora sp *(Thakafathi/Randoo)*
- Rhizophora sp *(Thakafathi/Randoo)*
- Bruguiera cylindrical *(Kandoo)*
- Bruguiera gymnorrhiza *(Bodavaki/Bodu Kandoo)*
- Bruguiera eriopetala *(Bodavaki/Bodu Kandoo)*
- Ceriops tagal *(Karamana)*
- Avicennia marina *(Karamana/Baru)*
- Excoecaria agallocha *(Thella)*
- Lumnitzera racemose *(Burevi)*
- Sonneratia caseolaris *(Kulhlhavah)*
- Acrostichum aureum *(Ma keha)*
- Heritiera littoralis *(Kaharuvah)*

The depression-oriented mangroves are found in less saline areas and floras are different from mangroves found along lagoons, appear to lack any visible link to saline water. The effect of the saline water penetrating into the depression through the sand during high swells and tides, lead some part of forest inundation. Although mangroves grow in salt water, they need regular flushing with freshwater. Mangrove species that grow near a salt water dominated atoll depressions in atoll islets differ that of fresh water and they are very similar to that of coastal vegetation.

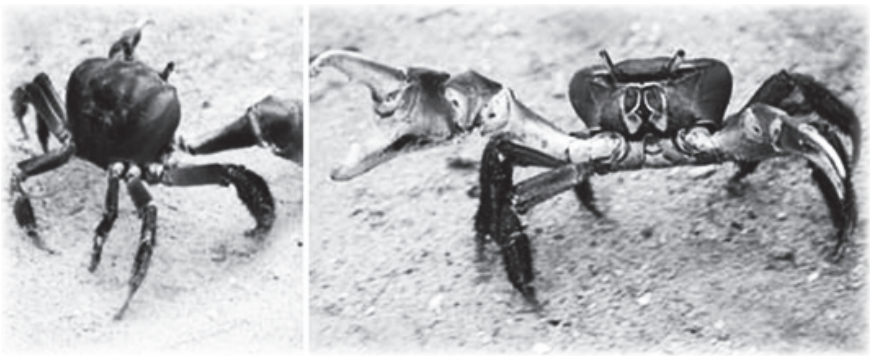

Mangroves needs to be protected in the Maldives

At least two types of mangrove crabs are found in mangrove swamps in the Maldives and local islanders do not eat or harvest them. Crabs are vital part of the mangrove ecology, influencing both nutrient cycling and forest structure by flow of water through crab holes.

Mangrove depressions or *Kulhi*, protect coastline from erosion, provide a breeding ground for crustaceans and fish. Milk fish is the common fish found in fresh water dominated mangroves swamps, on which the local population depends on as a staple food when the sea is rough and tuna and other pelagic fish is scare. Harvesting and managing of milk fish in the mangroves is done traditionally by the island community as a whole. Mangrove crabs that are found in mangrove swamps are a vital part of the mangrove ecology, influencing both nutrient cycling and forest structure by flow of water through crab holes.

Mangrove apple (Sonneratia caseolaris) juice, a favourite drink in Noonu Landhoo

This unique fragile atoll environment is not adequately protected in the Maldives, which ecologists have long recommended should enjoy special protection. Regrettably, few people in the Maldives understand the importance of mangrove forest and no proper regulatory measures are in place to conserve these vital atoll ecosystem. Except two Mangrove sites *Eidhigali kulhi*, *S. Hithadhoo* of *Addu Atoll* (5th June 2004) and *Kaafu Huraa* (14th June 2006) declared protected. Some mangrove areas across the Maldives archipelago have been destroyed by reclamation for housing, tourism, agriculture and commercial purposes. In many islands, sadly, mangrove swamps are still used for disposal of garbage, of both organic and inorganic origin. Destruction of mangroves in the Maldives has posed serious problem of intrusion of salt water into the island fresh water lens making groundwater brackish.



Mangrove crab not a favourite food in the Maldives

Mangroves are usually found on the ocean side of the islands in the Maldives. Islands with mangrove ecosystem locally known as *Kulhi* tamed furious waves of tsunami before hitting the settlements, where the power of tsunami was absorbed by layers of mangroves and through crab holes. Without these mangroves many deaths and destruction to properties could have occurred in many islands in North of Maldives. *Noonu Kedhikulhudhoo* and *Shaviyani Fonadhoo* in the North Maldives suffered less from the tsunami, and spared destructions due to the presence of large *Kulhi*. However, *Noonu Maafaru* with no distinct differences in the physical characteristic as *Noonu Kedhikulhudhoo* except presence of *kulhi*, have been badly hit by tsunami. In *Haa Dhaal Filladhoo*, mangroves played second line in defence against deadly tsunami waves.

Furious waves of tsunami opening into the mangroves in Noonu Atoll Kedhikulhudhoo

Mangroves with hanging long branches into sand and below the surface of water absorb the shock of tsunamis. Behind mangrove trees there is a second layer of native plants, which are taller and slow down the waves. Mangrove roots with aerial roots and salt-filtering tap roots not only provided support in uneven soils but held up currents and storms.[2]

[2] http://www.bluepeacemaldives.org/news2007/atoll_mangroves.htm (accessed on 18th July 2015)

The following are examples of some Focus Questions, which could guide the students in their research on the Ecological Footprints.

- Why are mangroves important?
- Who lives in mangroves?
- What makes mangroves so special and unique?
- What can people do to protect mangroves?

Use Student Resource Sheet 1: Mangroves - KWL chart

Why are mangroves important?

Mangroves, together with the mudflats and adjoining seagrass areas, form the coastal wetland system. Within this system there are numerous plants and animals whose survival depends on the continuous interaction of the different food chains.

In the Maldives, most of the mangroves grow in areas protected by a coral reef. The mangroves and the coral reefs have a special relationship. The coral breaks and reduces the force of the waves providing the mangroves with calm waters, while the mangrove roots act as a sieve filtering water and dirt, which can harm the coral reefs.

Mangrove areas are important because:

- Mangrove areas have murky muddy water that give young fish a place to hide, making it difficult for predators, like birds and big fish, to catch young animals.
- Mangrove root systems anchor soil and prevent erosion in the coastal zones.
- Mangroves act as wave breakers and thus protect the coasts and the communities from strong wind and high waves, even tsunamis.
- Mangrove tree root systems trap and reduce the amount of sediment entering the lagoon and smothering the coral (silt sedimentation).
- Mangrove areas are good for breeding, feeding and act as nursery grounds for many fish and other animals like crabs, shrimps and shellfish.
- Mangrove provides good sources of food and income for communities.
- They provide recreation areas where children play or people might fish.

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding mangroves and its various aspects.

Organizing Ourselves

The students divide into groups (4-6 students) to research about the mangroves, their features and conserving them.

Note these down on the **Student Resource Sheet 2: Understanding Our Mangroves**

Identify the steps that need to be taken for further study to occur, from the questions that have been raised by previous discussions.

Ask the group leader to assign tasks to individual student in the group for solving the problem.

- What questions do we need about mangroves?
- How are we going to conduct our enquiry?
- What sort of timeline do we need to set?
- What type of information do we need and how do we find and collect this information? (E.g. organise an excursion or locate resources).
- What is the best way of allocating tasks? (E.g. forming small groups or creating individual projects).
- How will we organise or present our findings?

Note these down on the **Student Resource Sheet 2: Understanding Our Mangroves** as well.

STEP 3 NARROW YOUR CHOICES

Discuss the individuals' results and based on this plus the information gathered, students can discuss and prioritize these information they need to find.

Establishing Protocols

One of the first activity involves going on a field trip to a mangrove.

In their groups based on the discussion before, students list down the things they want to observe in the mangrove. Teacher can assist in this discussion by guiding them to observe living things, nonliving things and environmental factors of the mangrove.

Planning for the field trip

Refer to teacher notes to plan for the trip.

In the field students will be completing activity sheets below:

Students Resource Sheet 3: What's in the mangrove?

Students Resource Sheet 4: Mangrove Climate and physical factors

Students Resource Sheet 5: Observing the organisms in the mangrove

Students Resource Sheet 6: Human Activities in the Mangrove

Students Resource Sheet 7: Rubbish in the Mangrove

Upon returning from the field trip, students can survey people's opinion about conserving mangrove habitats. The teacher may use;

Students Resource Sheet 8: What do you think of Mangroves?

Based on all these information gathered, students can summaries the findings in

Students Resource Sheet 9: Status of my Mangrove.

Use this to recommend some ways to conserve the mangroves and research can also be done to find these information.

STEP 4 TEST YOUR SOLUTIONS

The information they have listed at the end of the last step can be used to make a presentation and present to the class. The teacher can add supplemental information that will help the students consolidate their plans.

In addition to this, students can also reflect on their personal experiences to the mangroves and how they felt to see it deteriorating.

Extension Activity

Awareness posters can be produced where each single poster sends one single message to the reader on how to conserve the mangroves.

As a result of students being actively involved in decision making throughout the inquiry process, it is hoped that they will be empowered to take action which has positive personal, community and global effects. Some suggestions are listed below.

- Clean up the mangrove
- Write to the island authorities about the protection or upkeep of the local mangrove
- What would you do about mangroves if you were in government?
- Write a brochure for public distribution to raise awareness of the importance of mangroves.
- Completing an assessment of the human impacts on mangroves
- Start a Youth Environment Club

OR

Students record the features of mangroves through a choice of mediums.

For example:

Visual Art – This may be a general response or specific to the students' investigations. They may show something they saw at the mangroves or show their findings using a variety of art materials.

You may suggest some watery 'art', such as using water colours, drawing with chalk on wet paper, using weak solution of paint and water to wash over a picture done in pastel.

Use photographs to display various aspects of the mangrove area.

Make models of the mangroves that you visited. Use natural materials such as bark, grass, twigs and rocks to bring the model to life.

Language focused written reports – As a class, write a story to report on your visit to the mangrove area. Students may write individual reports on their visit[3].

[3] EDC, UNICEF(2008) adapted from Biodiversity Module

ASSESSMENT

The assessments will be done in two parts.

- Skills assessment
- End-product assessment

Skill assessment rubric

Parts of this should be used to evaluate students' skills as they are using them throughout the problem solving activity.

Tick as appropriate

	ESTABLISHED	DEVELOPED	EMERGING
SUB-STRAND: OBSERVATIONS, QUESTIONS & HYPOTHESIS			
Uses appropriate tools in making observations			
Uses appropriate vocabulary to explains events/ phenomena			
Describes observations by various means (e.g., sketches, drawings, tables, etc.).			
SUB-STRAND: INVESTIGATION SKILLS			
Formulates investigative questions			
Identifies variables in an investigation			
Plans procedures in carrying out simple investigations			
Collects data using appropriate tools			
Recognizes the need to take accurate measurements			
Uses appropriate units in measurement			
Organizes data in appropriate ways			
Proposes ways to improve the investigation			
Analyses data to make conclusions			

Content Assessment Criteria

Based on the student's experiences, students will write a reflective journal about their experiences in the field trip, what they observed, what they felt and their plan to revive it.

This can be assessed based on the following criteria.

- Narrative of the experiences. The expression of the content is accurate and relates with the experiences.
- Their feelings are expressed well and related with the experiences.
- The plan to revive it. Details, practicality and appropriateness to the targeted audience.

STUDENT INFORMATION SHEET 1

Name ---------- Date ----------

HURAA KULHI

Rameez and his family travelled to the island of *Huraa* on *Eid* to visit their family friends. Rameez did not know anything about *Huraa* so he asked his grandfather while travelling on the boat where they were going and his grandfather narrated the following facts to Rameez. *Huraa* is a small inhabited island lying in the North Male' Kaafu Atoll.

Just an hour and a half boat ride from the capital. The people of Huraa are very nice and friendly. According to folk stories passed on from generation to generation, the very first inhabitants of *K. Huraa* were three foreigners from France. Two men and a woman. It is believed that the people of *K. Huraa* are descendants of them. Till date, the three graves, believed to be belonging to the first three inhabitants still lie near the cemetery at *Dhon Bandaara* Mosque.

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Due to this proximity, every week tourists from these resorts make scheduled trips to *Huraa* to see the local island life. *Huraa* is famous for its mangrove swamp locally known as *Huraa Kulhi*.

This is an amazing place filled with nature's wonders and the little crabs of spectacular colours reside in this *Kulhi*. These crabs will be endangered if *Huraa Kulhi* is not preserved because these crabs are found in this *Kulhi* only. The *Kulhi* at *Huraa* is famous for its large size and deep waters during high tide.

It is also one of the few mangrove swamps located close to the capital Male'.

Huraa Kulhi is home to a vast number of species of mangrove trees, tropical birds, crabs and fish. Due to these reasons the site has been declared environmentally protected by the government.

Why do you think are some of the other reasons why *Huraa Kulhi* should be preserved?

Huraa Kulhi

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

MANGROVES - KWL CHART

Use this chart to organize your group's thoughts about the problem and focus on what needs to be solved.

What we know about mangroves	What we want to know about mangroves	What we have learnt about mangroves

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

UNDERSTANDING OUR MANGROVES

1. List down below the aspects you want to research about regarding mangroves. Write an aspect on each box below.

2. For each aspect identify how you are going to find the information you need. (On each box, using a different coloured pen write these).

STUDENT RESOURCE SHEET 3

Name ---------- Date ----------

WHAT'S IN THE MANGROVE?

1. Observe the mangrove for 10 minutes.
2. Note down all the things that you observe.

In The Mangrove I See

.....

.....

.....

.....

.....

.....

.....

3. Classify the things you have recorded above to the categories given.

LIVING THINGS		NON-LIVING THINGS		UNSURE THINGS
Plants present	**Animals present**	**Human structures**	**Litter**	

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

MANGROVE CLIMATE AND PHYSICAL FACTORS

WIND STRENGTH

Light Breeze **Gale**

1 2 3 4 5

LIGHT INTENSITY

Dull **Bright**

1 2 3 4 5

TEMPERATURE

Sun _____C

Shade_____C

AVERAGE ANNUAL RAINFALL

_____ cm precipitation

WATER TURBIDITY (VISUAL)

Clear **Opaque**

1 2 3 4 5

SOIL TEXTURE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Soil temp														
Bare ground														
Ground cover														
Sediment depth														

* 1-14 represents days

Note any other physical factors that you observe.

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

OBSERVING THE ORGANISMS IN THE MANGROVE

Observing Mangrove Animals

1. Write the name or draw the picture of the animals you see.
2. Describe or draw the habitat of each animal.
3. If possible, describe or draw the food eaten by each animal.

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

Observing Mangrove Plants

Write the name or draw a picture of the plants you can see.

Mangroves have many .....

but very few .....

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

Record information about the mangrove animals you observe using descriptions and illustrations.

Name and drawing of animal	Number	Description of habitat	Food source
Invertebrates			
Birds			
Mammals			
Reptiles			
Amphibians			

STUDENT RESOURCE SHEET 5

Name ---------- Date ----------

Observing Mangrove Plants

Record information about the mangrove plants you observe using descriptions and illustrations.

Name of plant	Description and drawing of plant	Number observed
Grasses		
Shrubs		
Trees		

STUDENT RESOURCE SHEET 6

Name ---------- Date ----------

HUMAN ACTIVITIES IN THE MANGROVE

1. Observe and record the different types of activities occurring in the mangrove. Include details on time of day, who or what was involved, how many people. The more detailed the better.

Time of day	Who or what involved	How many people	Description of activity

2. Divide the activities into two groups:

- Activities that might harm the mangrove
- Activities that do not harm the mangrove or may do some good for the mangrove

3. Discuss what can be done to stop or lessen the harmful activities.

STUDENT RESOURCE SHEET 7

Name ---------- Date ----------

RUBBISH IN THE MANGROVE

1. Choose a location in the mangrove, and record that location. Using a tape measure (25m) measure out a transect line that starts in the mangrove and runs towards the sea.
2. Record the type of rubbish and its location.
3. Back in the classroom, group the rubbish (e.g., plastic, styrofoam, glass, rubber, metal, paper, wood, glass, cloth, etc.).

Item & amount	Type of debris	Location

4. Discuss the possible origins of the materials collected.

- Materials from the sea (e.g. fishing floats).
- Material that came from nearby communities (e.g. household goods).
- Material that may have come from either group (e.g. rope).

STUDENT RESOURCE SHEET 8

Name ---------- Date ----------

WHAT DO YOU THINK OF MY MANGROVE SURVEY?

1. Choose THREE people (friends, parents, etc.) and ask them the following questions and note their response.

Question	Participant 1	Participant 2	Participant 3
Have you ever seen a mangrove? Or been to one?			
How did you feel in the mangrove?			
What was the most interesting thing about the mangrove you notice?			
Would you like to visit a mangrove soon?			
How do you think we should use the mangroves?			
What kind of resources do we get from mangroves?			
Would you like to help keep mangroves healthy and alive?			
How would you like to help sustainably manage the mangroves?			

STUDENT RESOURCE SHEET 9

Name ---------- Date ----------

STATUS OF MY MANGROVE.

Summarize your findings about the status of the mangrove.

1. Is there much variety of plants and animals in the mangrove?

2. What is the climate like in the mangrove?

3. How much is it being destroyed? How?

4. Is anything being done to help make the mangrove better and healthier?

5. What can be done to revive the mangrove and make people aware about keeping mangroves healthy?

MANGROVE FLORA AND FAUNA

Mangrove Species

Scientific name	Local name	Common name
Rhizophore mucronata	*Ran'doo*	Mangrove
Ceriops tagal	*Karamana*	Mangrove
Lumnitzera racemosa	*Burevi*	Mangrove
Rhizophora apiculata	*Thakafathi*	Mangrove
Avicennia marina	*Baru*	Mangrove
Bruguiera cylindrica	*Kandoo*	Mangrove
Bruguiera gymnorrhiza	*Bodavaki*	Mangrove
Excoecaria agallocha	*Thela*	Mangrove
Heritiera littoralis	*Kaharuvah*	Mangrove
Sonneratia caseolaris	*Kulhlhavah*	Mangrove

Features	Rhizophore	Ceriops	Lumnitzera
Tree trunk size and Height	It can grow to 20 m tall.	They grow to 5 m tall.	Lumnitzera racemosa grows to 6 m.
Shape of the whole tree	Oval Rough, brown to dark grey bark.	Cream coloured bark with dark brown spots.	Grey and fissured bark.
Leaves	Tips of the leaves are blunt.	Obovate (broadest above the middle of the leaf), with a rounded apex, light green in color, lighter than Rhizophora mucronata.	Small (about 7 cm long) light green, fleshy leaves with an indentation at the end.
Flowers	Small, white flowers which are pollinated by wind or insects. The propagules are 1-2 cm in diameter, 20-40 cm long and tapered at one end.	Flowers are very small (<1 cm, usually 0.5 cm). Like all mangrove trees of the family Rhizophoraceae, Ceriops tagal is also viviparous. Propagules are slender and long.	Lumnitzera racemosa has white flowers.
Seeds	Usually longer and thinner.	NA	Fruits of both species are about 2 cm long, green and capsule-shaped.
Stems	Thin and short.	NA	NA
Roots	Prop roots Mostly above the ground (Arched roots growing from the stem).	The stem of Ceriops tagal is usually buttressed and knee roots.	Above-ground roots are not usually present. However, in moist environments, small knee type above-ground roots may be present.
Where it is found	Occurs low in the intertidal zone, where its roots are submerged during high tides.	Often occurring as short, stunted trees (especially in very saline environments), they may grow to 5 m high in areas having some freshwater influence.	Landward edge of the mangroves.

MANGROVE ROOTS

The *Rhizophora* has 'prop roots'.

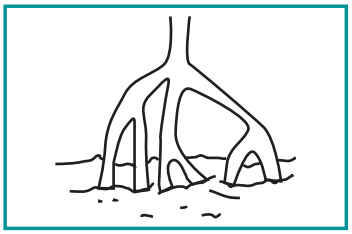
These roots can sprout from very high in the tree. The older the tree the higher the roots are located

The *Ceriops* has 'knee roots'.

These roots come in and out of the soil.

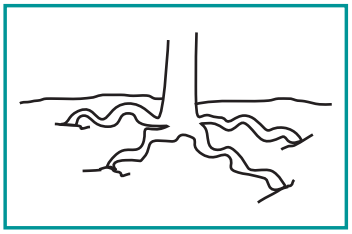
PROP ROOTS

These roots can sprout from very high in the three. The older the tree the higher the roots are located.



KNEE ROOTS

These roots come in and out of the soil.



Mangrove roots have different function.

The roots:

- Anchor the plant
- Absorb minerals
- Exchange gases (O_2 and CO_2)

Roots can only absorb water from the surroundings and excludes most of the salt.

The extensive root system slows down the wave action and water flowing through them. This reduces erosion by holding the earth together so it does not wash away from the land into the lagoon and reef, killing the coral.

As a result, mangrove shores continue to grow towards the sea.

MANGROVE LEAVES

Mangroves have a medium-sized, thick waxy leaf that helps prevent excessive water loss. Like other plants, the green leaves of the mangrove use the light of the sun to make food; this process is called photosynthesis.

When dead leaves fall into the water, they decay providing nutrients for the soil and food for animals like crabs, prawns and some fish.

The Rhisophora leaves have blunt tips while Bruguiera have pointed tips.

RHIZOPHORA

BRUGUIERA

MANGROVE SEEDS

Mangroves usually grow in flat, soft muddy ground. When the long, thin and pointed mangrove seeds fall vertically to the ground, they are able to stick upright in the soft mud.

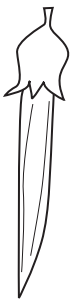
Some mangrove trees have seeds that start to grow while they are still on the tree. When the young plant is big enough to survive it falls into the water or mud. Those young plants float around until they find a muddy area to grow.

The seeds can float which help them disperse and grow in new areas.

Mangrove trees are constantly exposed to strong wind and waves. The new plants, when established in the soil, are able to withstand wave action.

The Rhizophora seed curves at the top, while the Bruguiera seed is straight.

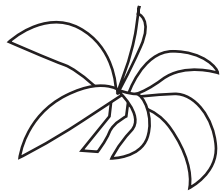
RHIZOPHORA SEED



BRUGUIERA SEED

MANGROVE FLOWERS

The flower of the Rhizophora is small and yellow, while the Bruguiera flower is bigger and pink.



RHIZOPHORA FLOWER

BRUGUIERA FLOWER

OTHER PLANTS FOUND IN THE MANGROVE

The flower of the Rhizophora is small and yellow, while the Bruguiera flower is bigger and pink.

Scientific name	**Local name**	**Common name**
Trees		
Cocos nucifera	*Ruh*	Coconut tree
Shrub		
Hibiscus tilaceous	*Dhigga*	Beach hibiscus

OTHER PLANTS FOUND IN THE MANGROVE

Scientific name	Local name	Common name
Birds[4]		
Amaurornis Phoenicurus	Kabili	Maldivian Water Hen
Anas Querquedula	Reyru	Garganey
Apus Affinis	Forikey	Common Swift
Ardea Cinerea (rectirostris)	Maakana	Eastern Grey Heron
Ardeola Grayii (phillipsi)	Huvadhoo raabodhi	Maldivian Pond Heron
Arenaria Melanocephala	Rathafai	Black Turnstone
Bubulcus Ibis (coromandus)	Iruwaa hudha	Cattle Egret
Egretta Garzetta	Kuda iagana	Little Egret
Fregata Ariel	Hoara	Lesser Frigate Bird
Gallus Gallus	Kukulhu haa	Domestic Fowl
Gygis Alba	Dhondheeni	White Tern
Numenius Phaepus	Bulhi thumbi	Wimbrel
Phoenicopterus Ruber	Gudi gudaa dhooni	Flamingo
Psittacula Upatria	Bodu guraa	Alexandrine Parakeet
Tringa Hypoleucos	Fidhana	Common Sandpiper
Protected birds of the Maldivian mangroves		

[4] Information on birds taken from ERC (n.d.) Protected Birds of the Maldivian Mangroves

Common name
Fish
Butterfly fish Dolphins Angelfish Parrotfish Flutemouth Gobey Boxfish Puffer Fish
Crustaceans
Coconut Crabs Lobsters Prawns
Reptiles
Gecko Lizard Snake
Mammals
Fruit Bat Were Mouse

WETLANDS

Wetlands are among the most important life support systems on Earth. Yet they are some of the most threatened natural environments.

Mangroves, swamps, tidal mudflats, estuaries, rivers and streams are all wetlands, whether freshwater or saline. Wetlands can be permanent but many, especially in the tropics expand and contract with the seasons.

More recently, there has been an increase in community awareness of the value and needs of wetlands. New approaches to management are being developed and work is being done to rehabilitate damaged and degraded wetlands.

Why are wetlands important?

Wetlands enable marine, aquatic, and land animals to meet and interact. They are places where:

- sediments are collected and soils and landforms are built
- wetlands moderate water quality and quantity. Acting as vast spongy filters, wetlands take up run-off, extracting sediments, recycling nutrients, oxygenating the water, and releasing these gradually back into the system.

Wetlands support an enormous variety of plants, invertebrates, fish, amphibians, reptiles, birds and mammals. Many species can survive nowhere else. Many unique, rare and endangered species are found only in wetlands.

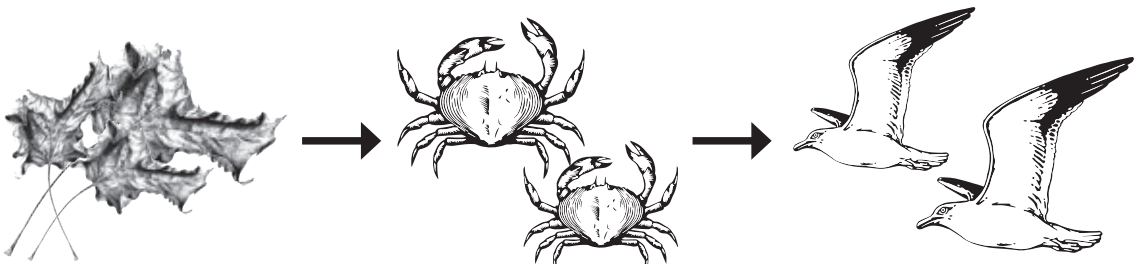
Many migratory birds depend on wetlands, which means the well-being of wetlands has implications for animals in other countries.

Wetlands are important sources of fish, crustaceans, shellfish and other food for people.

An example of a wetland on the islands of the Maldives is the mangroves habitat.

Mangroves

The mangroves together with the mudflats and adjoining seagrass areas, form the coastal wetland system. Within this system there are numerous plants and animals whose survival depends on the continuous interaction of the different food chains. A simplified diagram of a food chain to be found in the mangrove area is illustrated below.



A close examination of a basic food web within the mangrove system reveals the input of dissolved organic materials from marine and terrestrial sources. There is also an input from the plants and animals within the mangrove itself. This is in the form of excrement and decaying organic matter which mixes with the sediments (known as detritus).

Interruption of the cyclic pattern of the food web by depletion or removal of any of the components will have detrimental effects on the whole of the mangrove ecosystem.

Mangrove trees are amazing, as they are among the few trees that can grow in salty water as well as a mixture of seawater and fresh water.

In the Maldives, most of the mangroves grow in areas protected by a coral reef. The mangroves and the coral reefs have a special relationship. The coral breaks and reduces the force of the waves providing the mangroves with calm waters, while the mangrove roots act as a sieve filtering water and dirt, which can harm the coral reefs.

Mangrove areas are important because:

- They have murky muddy water that give young fish a place to hide, making it difficult for predators, like birds and big fish, to catch young animals.
- Mangrove root systems anchor soil and prevent erosion in the coastal zones.
- Mangroves act as wave breakers and thus protect the coasts and the communities from strong wind and high waves, even tsunamis.
- Mangrove tree root systems trap and reduce the amount of sediment entering the lagoon and smothering the coral (silt sedimentation).
- Mangrove areas are good for breeding, feeding and nursery grounds for many fish and other animals like crabs, shrimps and shellfish.
- They provide good sources of food and income for communities.
- They provide recreation areas where children play or people might fish.

Traditional Uses Of Mangroves

- Mangrove wood can be used in cooking, heating and constructing shelters. Mangrove wood can be used to produce charcoal, tannins for dying and leather protection, medicinal products, furniture, construction of fishing gear, some food and drinks, and many other products.
- Abundance of food available in the form of fish, crabs and mussels from the mangrove waters. Vinegar, cooking oil, cigarette wrappers could also be obtained from the mangrove plants.
- Bridges and poles for fish traps are also made using the mangrove timber.

Mangrove Threats

Mangroves are an important part of our island environment. Many plants and animals live in them and depend on them. Sadly, many people consider the mangroves to be dirty, useless and mosquito ridden places, without understanding that the destruction of these areas endangers our way of life.

Threats to the Mangroves include:

- Poor land management – when land is cleared for construction or agricultural purposes the soil is easily washed away during heavy rains. If this dirt and sediment reaches the mangrove forest, it can cover the roots and kill the trees, which in turn will affect the animals that live in the water. Cutting of trees leads to physical damage to trees.
- Cutting the mangrove forest – large areas of mangroves are being cleared and filled. These reclaimed areas alter or stop the amount of fresh water entering the mangroves. Mangroves need a mixture of fresh and sea water to grow, any changes in this mixture will affect the growth and health of the trees.
- Water pollution and rubbish – oil from boats and spills create a thin film that sticks to the mangrove roots. Household waste like plastic bags and containers cover the mangrove areas endangering the wildlife that lives there. In some areas sewage is disposed in the mangroves, which results in excess algal growth that kills the other marine life.
- Dredging in marine areas – leads to increased sedimentation in mangroves.

Taking care of the Mangroves

One of the greatest challenges we face in taking care of mangroves is to balance the needs of people that use it or live nearby, and the future of the mangroves as a habitat for plants and animals.

One of the most important things that we can do for the mangroves is to take responsibility for them and get involved with caring for them. Teachers, students and communities can help restore and maintain mangrove areas.

We need to focus on long term strategies for sustainability of the mangroves but also develop and carry out short term projects to address the immediate needs of the mangrove.

Some suggestions for taking care of the Mangroves

The following are some suggestions on how to take care of mangroves.

- **Education** – visit the mangrove, invite people to speak to the class, give the students awareness projects that involve people in their homes and the community, such as posters or information pamphlets.
- **Monitoring** – this means keeping an eye on the health and wellbeing of the mangrove forest and its animals. Check the way people are using it. Observe if the trees and other plants and animals are healthy, or if the numbers have changed. If possible keep a record of the data in the island office.
- **Awareness** – community awareness activities can be done in schools, in meetings with different groups and the local authorities. You can teach with your actions and provide a good example by the way you use and respect the mangroves.
- **Reforestation** – many mangrove areas have been destroyed. Replanting mangroves can be an interesting and good teaching and learning activity. Cuttings can be taken of the plants and grown in a nursery area in the school to be replanted in the mangrove.
- **Mangrove reserves** – by creating areas of the mangrove as a reserve will ensure protection of the mangrove for the future.
- **Protection of endangered species** – healthy mangroves provide a home for endangered and protected species.[5]

[5] EDC, UNICEF (2008) adapted from Biodiversity Module

PREPARATION FOR THE FIELD TRIP

Ensure that all necessary preparation and arrangements are made before the field trip.

It is important that the SAFETY of the students is ensured at all times.

Below are some suggestions to ensure your trip is safe, successful and enjoyable.

Setting a Date

- Ask permission from the Head Teacher. Ensure the timetable is covered to release the students and teachers to spend time at the mangroves.
- Check if you need to ask permission from the Island Office to access the mangrove area.
- Check the Tide Chart – it is important that you get there during or just before low tide. Choose a day when the low tide is around 9.00 am.
- You will need extra helpers, such as voluntary parents or school committee members, to accompany and supervise the groups during field activities.
- Invite a local expert on the flora and fauna of the island's mangroves, to assist with identification, such as fisherman, field officers for the Ministry of Environment, Water and Energy.

Introduction to the Mangroves

- Invite people to speak to your class about the importance and marvels of the mangrove trees and environment.
- Have students predict what they will see, hear and touch at the mangroves, in the form of a y-chart.
- Emphasise the importance of disturbing as little of the area as possible.
- Check with the Island Office whether they have aerial photos of your island. If you can get photos at different times you can compare the changes over time.

Teacher's Responsibilities

- Seek permission from the Head Teacher.
- Seek permission if required to access the area for the field trip.
- Book transport if required.
- Organise equipment and any other resources such as paper and pencils for the clipboards, and copies of activity sheets that may be prepared by you.
- Prepare a first aid kit to be taken on the trip. Ensure it has band-aids, antisceptic cream, spray for stings and bites, mosquito repellent.
- Ensure the students bring proper clothing and shoes.

- Prepare a list of materials that students will need during the trip.
- Send this list to the parents together with a letter requesting permission for their children to join the field trip.
- Check the weather forecast prior to departure in case new arrangements need to be made.
- Check students have enough water to drink.
- Take the roll and do a headcount before you leave and once you return from the mangroves.
- Clean the area of litter at the end of the field trip. Ensure no personal belongings are left behind.
- Ensure all students reach home safely.
- Divide the class into working groups. (About three students per group.) Try to arrange class assistants to assist with supervision of these groups.
- Check with local experts which parts of the mangrove might have mud that students might sink too deeply into. Remember to make students aware of that area and to stay away from it.

8.2 GREENHOUSE EFFECT

EB1.5 Explores the greenhouse effect and its impact.

a. Identifies the greenhouse gases that exist naturally in the environment.

b. Explains greenhouse effect.

c. Identifies the factors that contribute to the increase of greenhouse gases and its impact on lives.

d. Discusses ways to reduce greenhouse gases.

WS2.1 Conducts simple investigations

a. Formulates investigative questions

b. Identifies variables in an investigation.

c. Plans procedures in carrying out simple investigations

d. Collects data using appropriate tools.

e. Recognizes the need to take accurate measurements.

f. Uses appropriate units in measurements

g. Organizes data in appropriate ways.

h. Proposes ways to improve the investigation.

i. Analyses data to make conclusions.

GRADE 6

7.2 EFFECTS OF CLIMATE CHANGE

EB1.5 Recognises the causes and their effects on climate change and how it affects the living and non- living environment.

a. Identifies how humans contribute to enhanced greenhouse effect.

b. Relates enhanced greenhouse effect to global warming.

c. Identifies causes of climate change (e.g., burning of fossils fuels and deforestations).

d. Recognises the likely impact of climate change globally and to our local environment (e.g., coral bleaching, ocean acidification, coastal erosion, and food and water security).

EB3.2 Explores the importance of ozone layer to sustain life on Earth

a. Recognises that ozone layer protects the Earth from harmful radiation.

b. Discusses the causes of ozone layer depletion and its effects.

c. Identifies ways in which damage to ozone layer can be reduced.

WS3.1 Take care of themselves, others and respects others viewpoints

a. Demonstrates and advocates the shared responsibility for addressing environmental issues (e.g., reducing consumption, use durable products/ecofriendly products, save money, etc.).

WS2.1 Conducts simple investigations

a. Collects data using appropriate tools.

b. Organizes data in appropriate ways.

c. Analyses data to identify trends and make conclusions.

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. How does our Earth remain so ideal for life?
2. What is the Greenhouse effect? What do we understand by this term?
3. How do we humans contribute to the Greenhouse effect?

The Problem

Haseena and Sakeena were both 11 years old and have been best friends since grade 1. Both share a love for plants and gardening. In their science class they have learnt about what plants need to grow. On their school holiday both girls decided to make a small home garden. Haseena thought it was best to start with few plants and Sakeena agreed. So they both got *asuruma* seeds and some chilli seeds.

Sakeena decided to make small fenced area in her home backyard and to plant the seeds. Haseena decided she wanted to do it fenced, but covering her seedlings with a transparent polythene sheet, as roof would be best.

HASEENA'S DESIGN

SAKEENA'S DESIGN

Both girls planted the seeds on a Friday evening and was so excited that they decided to take pictures of their seedlings every day. Both used the same type of soil, same amount of fertilizers and watered the plants every morning and evening.

One week after, both girls observed that the seedlings has just come out from almost all their seeds. Two weeks after Haseena's plants were very healthy and growing well, while Sakeena's did not look very healthy. Sakeena was very upset and asked Haseena if it was to do with their overall design of the plots.

Sakeena's mother overheard the girls discussing this and responded, "My dear girls what you are seeing is a natural phenomenon happening and that keeps life on Earth possible, but that phenomena is now getting out of control and rather than doing good, it is harming our Earth".

Why do you think there were differences in the growth?

What do you think is the phenomena that Sakeena's mother is talking about and how is it affecting the environment?

HOW DOES A GREENHOUSE WORK?

HOW DOES A GREENHOUSE WORK SCIENTIFICALLY?

The greenhouse works by collecting light and converting it to heat. That is a simplistic view of how a greenhouse works. In addition to capturing light, the greenhouse also stores thermal energy and releases that energy properly. It can help moderate temperature and produce a controlled environment for plants to grow and thrive in. Further, a greenhouse offers protection from wind, rain, snow and other weather elements while also keeping your fruits from invading pests and animals.

The greenhouse captures light through its walls and converts it to heat. The effect is similar to that of a vehicle with the windows up. It takes only a few minutes for light coming in a window to warm up the vehicle to a temperature significantly higher than the outside temperature. Greenhouses work the same way. The darker material within the greenhouse helps to store heat, keeping the surrounding air warmer.

The greenhouse is a closed-in environment, which means there are no breezes to push the heat away. The structure is often made of glass, or glass-like material that helps to attract the sun's rays. Without a breeze, the air within the greenhouse heats up quickly and remains warm. This creates the ideal area for plants to grow.

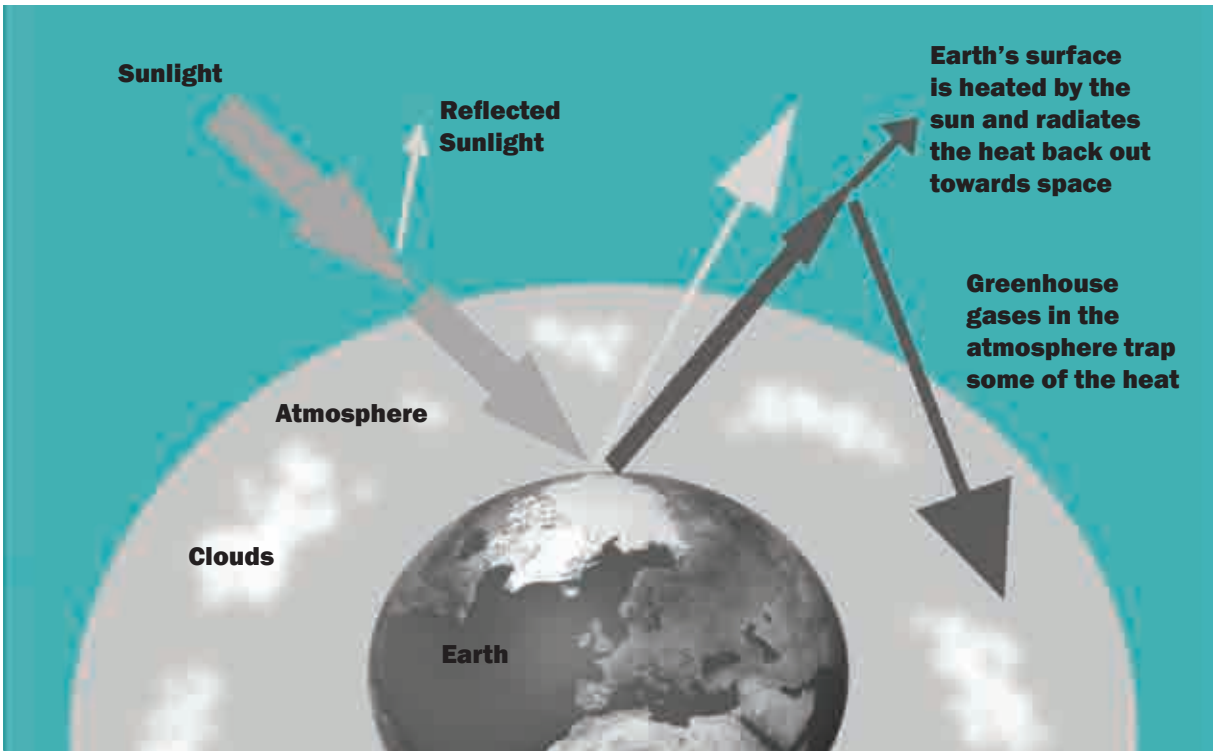
As the greenhouse draws in and collects sunlight, it warms the air within. This occurs naturally. The process is releasing thermal energy. The matter within the greenhouse, such as the soil and water, will absorb the heat drawn in. Even when the sun goes down, the warmth in the soil and water continue to protect the plants because these materials release the warmth slowly.[6]

Websites for reference: http://home.howstuffworks.com/lawn-garden/professional-landscaping/alternative-methods/greenhouse.htm/printableGood
http://www2.gi.alaska.edu/ScienceForum/ASF8/817.html

[6] http://garden.lovetoknow.com/wiki/How_Does_a_Greenhouse_Work (accessed on 10th November 2015)

Enhanced Greenhouse Effect & The Environment

Some gases in the atmosphere (the so called greenhouse gases: such as carbon dioxide, water vapour, methane, etc.) absorb the infra-red radiation (heat) which is converted into kinetic and potential energy. Eventually these molecules then emit heat back into the atmosphere as infrared radiation. Some of this infrared radiation is absorbed by other greenhouse gases and some is absorbed at the Earth's surface and the cycles of absorption, conversion and emission are repeated. Essentially this process slows the loss of heat to space, keeping the Earth's surface warmer than it would be without the greenhouse gases. Without this "greenhouse" the Earth's atmosphere would be an average of about 30-35°C cooler and life as we know it would not exist.

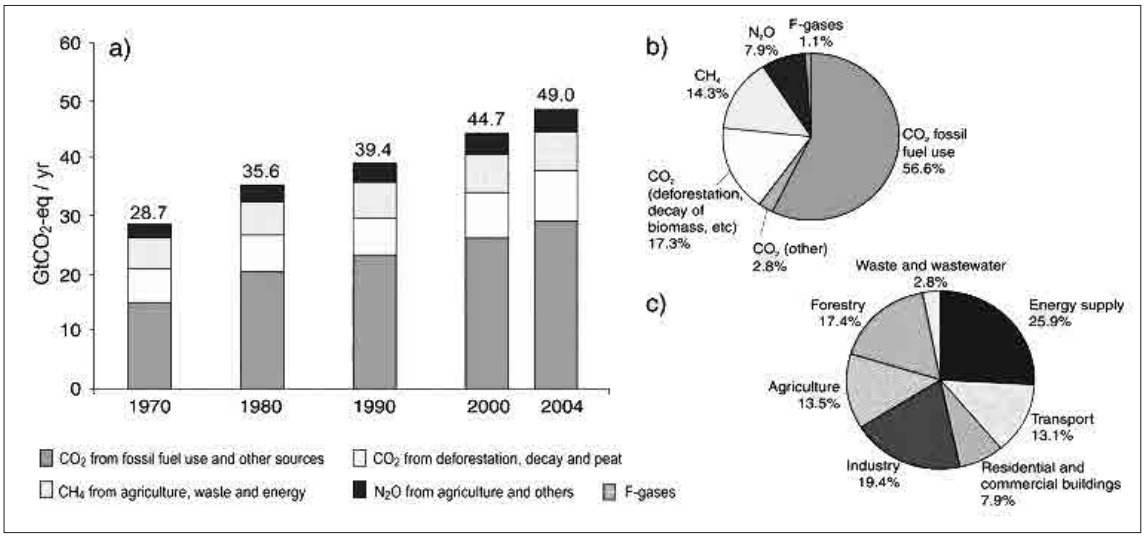


An overview of the Greenhouse Effect

The enhanced greenhouse effect, sometimes referred to as climate change or global warming, is the impact on the climate from the additional heat retained due to the increased amounts of carbon dioxide and other greenhouse gases that humans have released into the Earth's atmosphere since the industrial revolution.

What is causing the enhanced greenhouse effect?

Since the mid 1800's the average concentration of CO_2 in the Earth's atmosphere has risen from about 280 parts per million (ppm) to just over 383 ppm in 2007, and methane from about 800 part per billion (ppb) to around 1790 ppb in 2008. See the figure below.



Global atmospheric concentrations of four greenhouse gases. From the IPCC 2007 4th Assessment Report [2].

While these changes represent only a very small change to the overall composition of the Earth's atmosphere, it is a significant change to its capacity to absorb and emit heat. The main contributors are changes to the carbon cycle that have led to increased levels of carbon dioxide in the earth's atmosphere in the last 200 years. These include reduced CO_2 removal and storage through deforestation; direct CO_2 production from the burning of fossil fuels and CO_2 released from cement production.

The increased release of nitrogen oxides (NO_x) from burning fossil fuels and soil denitrification (particularly with the introduction of high nitrogen fertilizers) and intensive production of livestock such as cows and pigs which produce methane have also contributed to the enhanced greenhouse effect.[7]

[7] http://www.ozcoasts.gov.au/indicators/greenhouse (accessed on 10th November 2015)

The following are some Focus Questions, which could guide the students in their research on the greenhouse effect.

- What is greenhouse effect? What is the enhanced greenhouse effect?
- What and how is greenhouse effect happening in the problem here?
- Is greenhouse effect a good thing or not?
- When does greenhouse effect start to harm the environment?
- How can we act to decrease the enhanced greenhouse effect?

Use the Student Resource Sheet 1: Greenhouse effect - KWL chart

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding (enhanced) greenhouse effect and its various aspects including ways to minimize it.

Organizing Ourselves

The students divide into groups of 4-6 students to study about the greenhouse effect, enhanced greenhouse effect and how to reduce this.

They start by exploring greenhouse effect practically. To do this they are given the Resource Sheet 2: Understanding and Exploring about greenhouse effect. Students

In order to understand the situation of the enhanced greenhouse effect students can identify a list of questions that they want to find answers to. List these questions and together with the Resource Sheet 3: Researching on Greenhouse Effect and the Environment students can gather more information about the enhanced greenhouse effect

These questions can be divided among the group members so that different members will research on different aspects of the greenhouse effect.

As part of the problem is also to understand the community's perception of this effect, after researching the students can conduct interviews on finding out people's perception about the threat caused due to enhanced greenhouse effect.

Use Student Resource Sheet 4: Greenhouse effect knowledge questionnaire

STEP 3 NARROW YOUR CHOICES

After the interviews have been completed, convene the groups back and summarize the group's data in Student Resource Sheet 5: Summary of awareness interview findings

Establishing Protocols

Based on the data gathered on Resource Sheet 5: Summary of awareness interview findings students in the groups narrow down the most important things that needs to be done regarding reductions of greenhouse gas emission.

They should also discuss practical solutions that can be done and also ways to do it.

These ideas that they brainstorm can be entered into the idea wheel on Resource Sheet 6: Consuming or Conserving? So several solutions would now have been proposed by the group.

Each group member can then study one of these measures in detail and note down how that particular method can help reduce greenhouse gas emission.

STEP 4 TEST YOUR SOLUTIONS

The information they have listed at the end of the last step can be verified by teacher provided information.

Here teacher can provide information provided from Intergovernmental Panel on Climate Change (IPCC), on what they are doing to reduce greenhouse gas emission globally.

Student can present their proposed solutions and also individual action plans as solutions to mitigate this problem.

Extension Activity

As an extension activity students can plan an activity day for the whole school where everybody in the school do something to do an activity that will reduce their greenhouse gas emission (e.g., walk to school, plant a tree, not use the air conditioning, etc.).

ASSESSMENT

The criteria for the group presentation are:

- Definition and explanation of greenhouse effect
- Definition and explanation of the enhanced greenhouse effect
- Explanation of what will happen to the Earth if there are more greenhouse gases emitted.

- What are some proposed solutions that can be used to reduce the emission of these greenhouse gases?

Presentation will be both teacher assessed and peer assessed.[8]

PRESENTATION RUBRIC

Circle the appropriate number based on performance, 4 being exceptional and 1 being not acceptable.

Presence					
• Body Language & Eye contact	4	3	2	1	0
• Poise	4	3	2	1	0
• Contact and interaction with the audience	4	3	2	1	0
Language Skills					
• Correct usage of language	4	3	2	1	0
• Appropriate vocabulary & Grammatical usage	4	3	2	1	0
• Voice modulation	4	3	2	1	0
Organization					
• Clear Objectives	4	3	2	1	0
• Logical Structure of the presentation	4	3	2	1	0
• Sign-posting used	4	3	2	1	0
Mastery of the content					
• Content is focused and main points addressed	4	3	2	1	0
• Depth of commentary showing understanding of content	4	3	2	1	0
• Presentation is spoken, not read (showing confidence in content)	4	3	2	1	0
• Able to answer questions	4	3	2	1	0
Visual Aids					
• Use of presentation materials (slides, transparencies posters, etc.)	4	3	2	1	0
• Hand-outs given to peers are informative	4	3	2	1	0
• Visuals are used	4	3	2	1	0

[8] Assessment activities for this PBL case study is developed by Aminath Adam & Aishath Niyaza

STUDENT INFORMATION SHEET 1

Name ---------- Date ----------

The Case of Two Farmer's Dilemma

Haseena and Sakeena were both 11 years old and have been best friends since grade 1. Both share a love for plants and gardening. In their science class they have learnt about what plants need to grow. On their school holiday both girls decided to make a small home garden. Haseena thought it was best to start with few plants and Sakeena agreed. So they both got *asuruma* seeds and some chilli seeds.

Sakeena decided to make small fenced area in her home backyard and to plant the seeds. Haseena decided she wanted to do it fenced, but covering her seedlings with a transparent polythene sheet, as roof would be best.

HASEENA'S DESIGN

SAKEENA'S DESIGN

Both girls planted the seeds on a Friday evening and was so excited that they decided to take pictures of their seedlings every day. Both used the same type of soil, same amount of fertilizers and watered the plants every morning and evening.

One week after both girls observed that the seedlings has just come out from almost all their seeds. Two weeks after Haseena's plants were very healthy and growing well, while Sakeena's did not look very healthy. Sakeena was very upset and asked Haseena if it was to do with their overall design of the plots.

Sakeena's mother overheard the girls discussing this and responded, "My dear girls, what you are seeing is a natural phenomenon happening and that keeps life on Earth possible, but that phenomena is now getting out of control and rather than doing good, it is harming our Earth".

Why do you think there were the differences in the growth?

What do you think is the phenomena that Sakeena's mother is talking about and how is it affecting the environment?

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

GREENHOUSE EFFECT - KWL CHART

Use this chart to organize your group's thoughts about the problem and focus on what needs to be solved.

What we know about greenhouse effect	What we want to know about greenhouse effect	What we have learnt about greenhouse effect

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

GREENHOUSE EFFECT

The aim of this experiment is to demonstrate how greenhouse gases contribute to warming of the Earth.

QUESTION 1

Before you begin, write a short description or draw a diagram of how you think the greenhouse effect works.

MATERIALS

- 2 clear 2 litre plastic bottles (empty)
- 500ml beaker
- 2 cans of Coca-Cola at room temperature
- 2 stirring rods
- 2 thermometers
- 1 funnel
- 2 rubber stoppers or plasticine to seal the bottle top timer

METHOD

1. Label each bottle 1 and 2.

Bottle 1:

- Pour a full can of Coca-Cola into the 500ml beaker.
- Stir vigorously with a stirring rod for 2 minutes to make the liquid fizzy.
- Pour into bottle 1 using the funnel.
- Place the bung in the neck of the bottle and adjust the thermometer so the bulb is in the atmosphere of the bottle and you can read the temperature. Make sure the thermometer is not touching the side of the bottle.
- Ensure the stopper is airtight.

Name ---------- Date ----------

QUESTION 2

What does shaking the Coca-Cola do? Think about why the liquid becomes fizzy.

Bottle 2:

- Pour a full can of Coca-Cola into the bottle using the funnel.
- Now shake the bottle for 2 minutes to make the liquid fizzy.
- Place the stopper in the neck of the bottle and adjust the thermometer so the bulb is in the atmosphere of the bottle and you can read the temperature. Make sure the thermometer is not touching the side of the bottle.
- Ensure the stopper is airtight.

QUESTION 3

What is the difference between Bottle 1 and Bottle 2? Think about the different gases (representing the atmosphere) in the bottles.

2. Place both bottles outside in the sun so they receive the same amount of sunlight. (If the day is not warm or sunny enough, your teacher may give you a heating lamp to warm the bottles. In this case place the bottles in front of the lamp so they receive the same amount of heat.)
3. Record the temperature from both bottles using the given table. Repeat this every minute for 20 minutes.

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

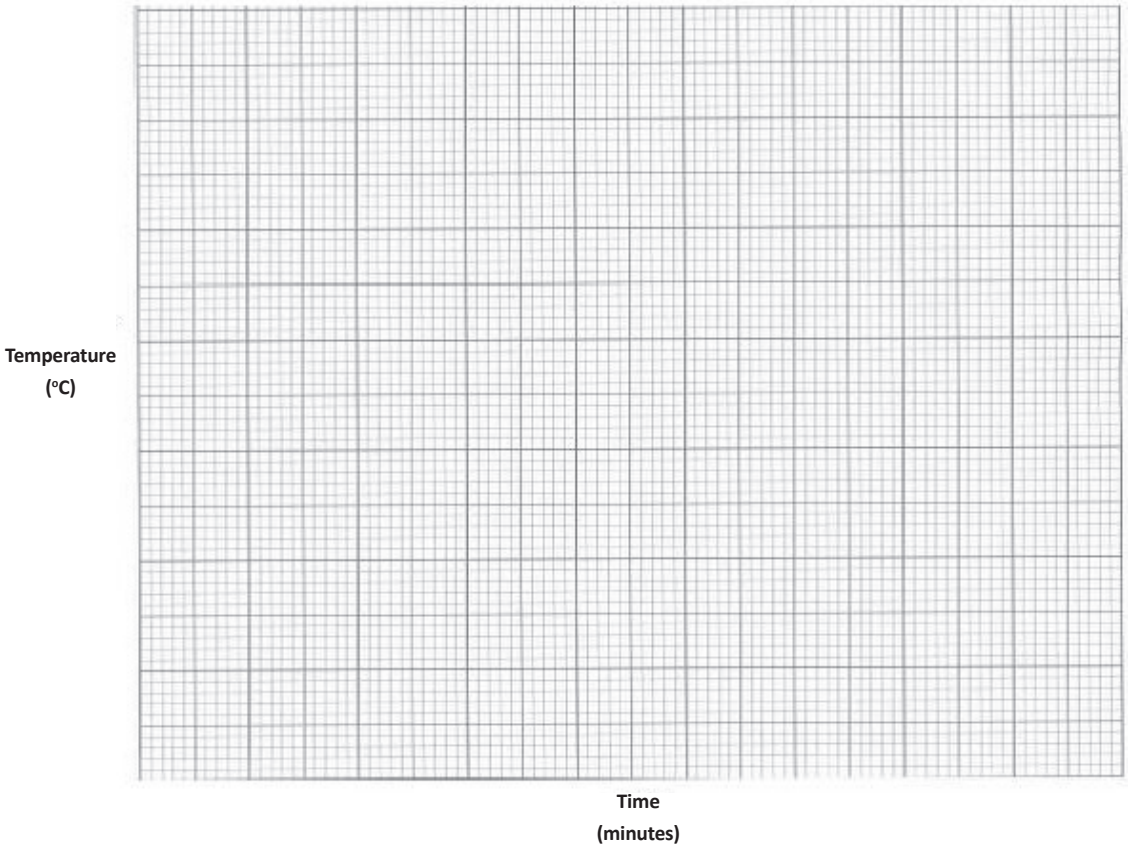
RESULTS

Table of time and temperature.

Time (mins)	Bottle 1 temperature (°C)	Bottle 2 temperature (°C)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Name ---------- Date ----------

Draw a graph of your results. Remember to: 1) include a title for your graph, and 2) a legend showing the different results for Bottle 1 and Bottle 2.



QUESTION 4

Describe three patterns that your graph shows.

QUESTION 5

Can you think of any possible sources of error in this experiment?

QUESTION 6

How do these bottles represent the Earth's atmosphere and the greenhouse effect? Draw a diagram to help with your explanation.[9]

[9] UWA (2014) Climate Change & The Greenhouse Effect Module

GREENHOUSE EFFECT

This experiment demonstrates that an atmosphere high in carbon dioxide increases in temperature more rapidly and remains at a higher temperature than an atmosphere low in carbon dioxide. The experiment works well in groups of 4, however, can also be done as a demonstration with groups of students being called every five minutes to read the temperature of the bottles and to write the results on the board.

The demonstration of the greenhouse effect is achieved by using two 2 litre plastic bottles and two cans of Coca Cola.

For Bottle 1, the Coca Cola is agitated in a beaker before being poured into the bottle. This releases the carbon dioxide into the air, meaning that when the liquid is poured into the bottle, the atmosphere will have much less carbon dioxide than Bottle 2.

In Bottle 2 the Coca Cola is poured into the bottle using a funnel and then agitated by shaking the bottle for approximately 2 minutes. This releases the carbon dioxide into the air inside the bottle, creating an atmosphere high in carbon dioxide.

A thermometer is placed inside each bottle and students then place the two bottles outside in the sunshine. Students will take measurements of the temperature in each bottle every minute for 20 minutes.

Equipment Cola brands - Two cans of cola are required and even though different brands can be used, Coca Cola brand has been shown to work best.

All of the equipment including the cans of cola need to be at room temperature. If the cola liquid has been in the fridge, less carbon dioxide will be released and the temperatures inside the bottles will take longer to heat up.

Thermometer

A stopper which tightly fits the top of the bottle and can hold a thermometer inside the bottle should be used.

If this is not available, then use plasticine or playdough to hold the thermometer in place and to form an airtight seal.

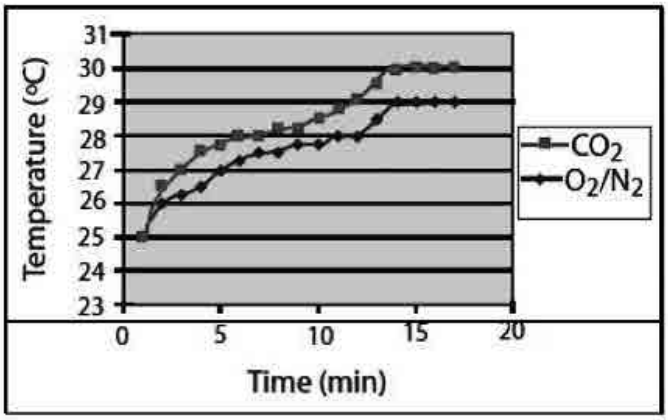
A digital thermometer or probe gives the most accurate results. An alcohol thermometer can also be used, however, it will give less precise results.

Weather

This experiment works best on a warm and sunny day. If the temperature is below 25^0C and/or is cloudy, then the experiment can also be performed using a heat lamp. It is imperative that both bottles receive the same amount of heat. Even placing one bottle in the shadow of the other bottle can affect the results.

Method

- Because both bottles appear the same, they need to be clearly labelled as Bottle 1 and Bottle 2.
- Students need to agitate the Coca Cola for Bottle 1 vigorously for two minutes. If this is not done effectively then both atmospheres will be high in carbon dioxide.
- Ensure the stoppers used are airtight, otherwise as the gases heat up they will escape out the top of the bottles.
- The temperature reading is affected (raised) if the bulb or sensor is touching the sides of the plastic bottle.
- Both thermometers need to be at the same level in each bottle for a fair comparison. What to expect within the first five minutes Bottle 2 (with a higher carbon dioxide content) should rise to a higher temperature than Bottle 1. It should remain at a higher temperature for the duration of the experiment. As the example of typical results take from Keating (2007) demonstrates, the stable temperature is reached at about 15 minutes



Example of results on a sunny day, using a digital thermometer

Explanation of the results

Bottle 1 represents an atmosphere with a lower concentration of carbon dioxide and is made up mostly of oxygen (O_2) and nitrous oxide (N_2O). The agitation of the Coca Cola in the beaker outside the bottle, releases the carbon dioxide into the air. Some carbon dioxide will remain in the cola liquid and still be present in the air inside the bottle, however, it will be considerably less than in Bottle 2. Bottle 1 is used for comparison.

Bottle 2 represents the Earth's atmosphere with a higher concentration of carbon dioxide. The agitation of the Coca Cola inside the bottle releases carbon dioxide into the air inside the bottle which is sealed inside by the lid. Due to the higher amount of carbon dioxide, this atmosphere retains more heat than Bottle 2, allowing it to heat up faster and stay at a warmer temperature than Bottle 1. Bottle 2 demonstrates the greenhouse effect on Earth.

ANSWERS TO THE ACTIVITY IN STUDENTS RESOURCE SHEET 2

QUESTION 1

Before you begin, write a short description or draw a diagram of how you think the greenhouse effect works. Light from the sun passes through the atmosphere and warms the surface of the Earth. This heat is released back into the air and greenhouse gases in the atmosphere such as carbon dioxide, methane and water absorb this heat. This keeps the planet warmer than it would be and allows life to exist.

QUESTION 2

What does shaking the Coca-Cola do? Think about why the liquid becomes fizzy. Shaking the Coca Cola releases the carbon dioxide from the liquid into the air inside the bottle.

QUESTION 3

What is the difference between Bottle 1 and Bottle 2? Think about the different gases (representing the atmosphere) in the bottles. Bottle 1 had the Coca Cola released into the air outside, so the air inside the bottle is similar to the air outside. This atmosphere will be mostly oxygen and nitrous oxide. Bottle 2 has had the Coca Cola released into the air inside the bottle creating an atmosphere high in carbon dioxide.

QUESTION 4

Describe three patterns that your graph shows.

1. The temperature of Bottle 2 increased faster than Bottle 1.
2. The temperature of Bottle 2 reached a higher temperature than Bottle 1.
3. The temperature of Bottle 2 remained at a higher temperature than Bottle 1 once the temperatures were stable.

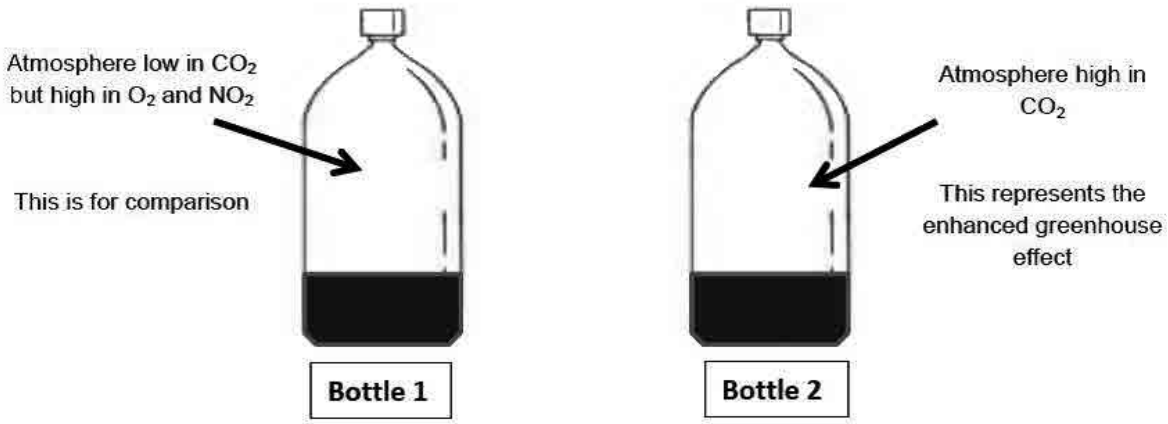
QUESTION 5

Can you think of any possible sources of error in this experiment?

- The Coca Cola was not shaken or stirred enough to release the carbon dioxide.
- The bottles did not receive the same amount of sunlight/heat.
- The bottles were placed on different surfaces.
- The lids were not completely airtight.
- The thermometers were read incorrectly (if using alcohol thermometers).
- Either of the thermometers were touching the side of the bottle.
- The thermometers may have been at different levels in the bottles.

QUESTION 6

How do these bottles represent the Earth's atmosphere and the greenhouse effect? Draw a diagram to help with your explanation.



QUESTION 7

Look at your previous explanation of the greenhouse effect. Did you learn anything new or different about the greenhouse effect from doing this experiment? Please explain. Solar radiation passes through the atmosphere and warms the surface of the Earth. This heat is released back into the air and greenhouse gases in the atmosphere such as carbon dioxide, methane and water absorb this heat. This keeps the planet warmer than it would be and allows life to exist. Increasing levels of greenhouse gases, cause more heat to be absorbed, which raises the temperature of the Earth's surface. This is called global warming.

RESEARCHING ON GREENHOUSE EFFECT AND THE ENVIRONMENT

Complete the following table through your research conducted

Aspects studied	Your research findings
What is greenhouse effect and enhanced greenhouse effect?	
What are the substances that helps in heating up the Earth?	
What happens if these 'Earth Heating Gases" increase in our atmosphere?	
What are some possible solutions to decrease these greenhouse gases emission? (List this in any order as later in the group you will rank them in what you can do easily).	

GREENHOUSE EFFECT KNOWLEDGE QUESTIONNAIRE

Interview 4 people from outside the school. You can ask a family member, a relative, etc.

1. Do you know what greenhouse effect is?

2. Have you heard about it and from where?

3. Are you concerned about greenhouse effect harming the environment? (tick only one)

   ☐ Not concerned

   ☐ Little concerned

   ☐ Very concerned

   ☐ Does not care

   Why?

4. What are you doing to reduce it?

5. What will you advise youths to reduce the greenhouse gas emission?

SUMMARY OF AWARENESS/INTERVIEW FINDINGS

Based on the information collected, in your groups, now combine the results and present your findings.

1. Does the majority of the people interviewed know about greenhouse effect?

2. How are people's reaction to the greenhouse effect harming the environment? For each category calculate the percentage.

   [%] Not concerned

   [%] Little concerned

   [%] Very concerned

   [%] Does not care

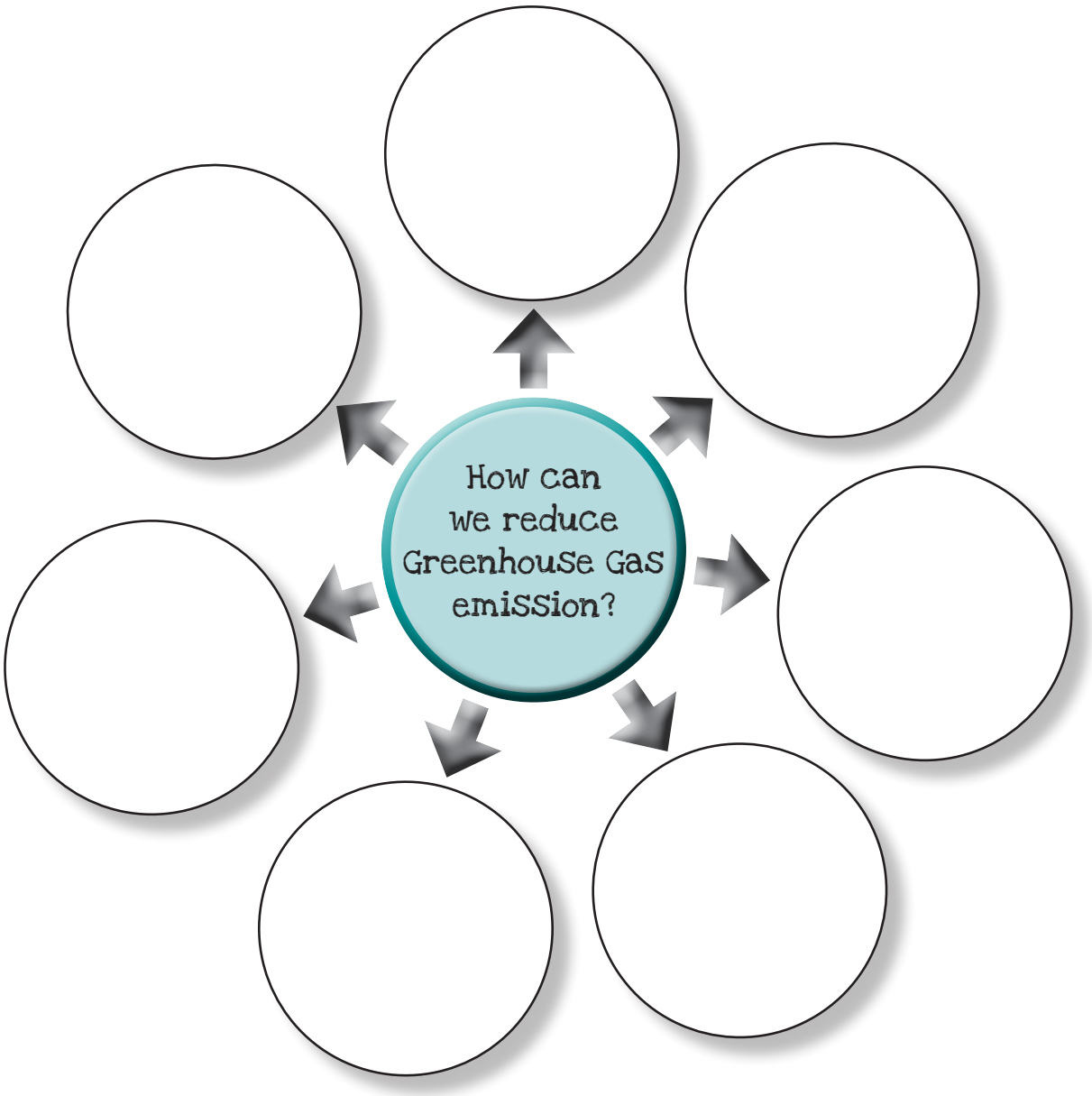
   Why?

3. How do they plan to reduce the greenhouse gas emission?

4. Do people generally want to help the environment reduce the greenhouse effect? Do they want to advocate reduced greenhouse emission?

PROPOSED WAYS WE CAN REDUCE GREENHOUSE GAS EMISSION

Based on your research and other ways of knowing, identify ways in which you can reduce greenhouse gas emission.



Each group member can now develop a poster representing a chosen method and in the poster day, present it to the class or school.

STUDENT'S NOTES

ENHANCED GREENHOUSE EFFECT AND THE ENVIRONMENT

The greenhouse effect is a vital natural phenomenon, intensified by human activity

The greenhouse effect happens when certain gases—known as greenhouse gases—collect in Earth's atmosphere. These gases include carbon dioxide (CO_2), methane, nitrous oxide (N_2O), fluorinated gases, and ozone.

Greenhouse gases let the sun's light shine onto the Earth's surface, but they trap the heat that reflects back up into the atmosphere. In this way, they act like the glass walls of a greenhouse. This greenhouse effect keeps the Earth warm enough to sustain life. Scientists say that without the greenhouse effect, the average temperature of the Earth would drop from 14˚C (57˚F) to as low as –18˚C (–0.4˚F).

Some greenhouse gases come from natural sources. Evaporation adds water vapour to the atmosphere. Animals and plants release carbon dioxide when they respire, or breathe. Methane is released naturally from some low-oxygen environments, such as swamps. Nitrous oxide is produced by certain processes in soil and water. Volcanoes—both on land and under the ocean—release greenhouse gases, so periods of high volcanic activity tend to be warmer.

Since the Industrial Revolution of the late 1700s and early 1800s, people have been releasing large quantities of greenhouse gases into the atmosphere. That amount has skyrocketed in the past century. Greenhouse gas emissions increased 70 percent between 1970 and 2004. Emissions of CO_2, the most important greenhouse gas, rose by about 80 percent during that time. The amount of CO_2 in the atmosphere today far exceeds the natural range seen over the last 650,000 years.

Most of the CO_2 that people put into the atmosphere comes from burning fossil fuels. Cars, trucks, trains, and planes all burn fossil fuels. Many electric power plants do, as well. Another way humans release CO_2 into the atmosphere is by cutting down forests, because trees contain large amounts of carbon.

People add methane to the atmosphere through livestock farming, landfills, and fossil fuel production such as coal mining and natural gas processing. Nitrous oxide comes from agriculture and fossil fuel burning. Fluorinated gases include chlorofluorocarbons (CFCs), hydro chlorofluorocarbons (HCFCs), and hydrofluorocarbons (HFCs). These gases are used in aerosol cans and refrigeration.

All of these human activities add greenhouse gases to the atmosphere. As the level of these gases rises, so does the temperature of the Earth. The rise in Earth's average temperature contributed to by human activity is known as global warming.

The Greenhouse Effect and Climate Change

Even slight increases in average global temperatures can have huge effects. Perhaps the biggest, most obvious effect is that glaciers and ice caps melt faster than usual. The meltwater drains into the oceans, causing sea levels to rise.

Glaciers and ice caps cover about 10 percent of the world's landmasses. They hold about 75 percent of the world's freshwater. If all of this ice melted, sea levels would rise by about 70 meters (230 feet). The Intergovernmental Panel on Climate Change states that the global sea level rose about 1.8 millimeters per year from 1961 to 1993, and 3.1 millimeters per year since 1993.

Rising sea levels could flood coastal cities, displacing millions of people in low-lying areas such as Bangladesh, the U.S. state of Florida, and the Netherlands.

Millions more people in countries like Bolivia, Peru, and India depend on glacial meltwater for drinking, irrigation, and hydroelectric power. Rapid loss of these glaciers would devastate those countries.

Greenhouse gas emissions affect more than just temperature. Another effect involves changes in precipitation, such as rain and snow. Over the course of the 20th century, precipitation increased in eastern parts of North and South America, northern Europe, and northern and central Asia. However, it has decreased in parts of Africa, the Mediterranean, and southern Asia.

As climates change, so do the habitats for living things. Animals that are adapted to a certain climate may become threatened. Many human societies depend on specific crops for food, clothing, and trade. If the climate of an area changes, the people who live there may no longer be able to grow the crops they depend on for survival. Some scientists also worry that tropical diseases will expand their ranges into more temperate regions if the temperatures of those areas increase.

Most climate scientists agree that we must reduce the amount of greenhouse gases released into the atmosphere. There are lots of ways to do this, including:

- Drive less. Use public transportation, carpool, walk, or ride a bike.
- Fly less. Airplanes produce huge amounts of greenhouse gas emissions.
- Reduce, reuse, and recycle.
- Plant a tree. Trees absorb carbon dioxide, keeping it out of the atmosphere.
- Use less electricity.
- Eat less meat. Cows are one of the biggest methane producers.
- Support alternative energy sources that don't burn fossil fuels.[10]

[10] http://education.nationalgeographic.com/encyclopedia/greenhouse-effect/ (accessed on 10th November 2014)

The Enhanced Greenhouse Effect and Global Warming

The enhanced greenhouse effect describes the increase in concentration of heat absorbing gases such as carbon dioxide (and other greenhouse gases) in the Earth's atmosphere. Scientific data shows an increase in carbon dioxide levels in the atmosphere in the last 150 years, mostly due to the burning of fossil fuels for energy. Scientific data also shows that the last 30 years until 2012 were the warmest in 1,400 years. Scientists have theorised that this increase in carbon dioxide has caused the increase in global temperatures, but this cannot be scientifically proven. Because it cannot be proven, there are many people who believe global warming is part of a natural cycle of the Earth and not caused by humans.[11]

[11] http://spice.wa.edu.au/wp-content/uploads/2014/12/Climate-change-and-the-greenhouse-effect.pdf (accessed on 10th November 2014)

8.4 NATURAL DISASTERS

EB1.6 Recognizes natural disasters that are likely to occur in the Maldives and identifies preventive measures.

a. Identifies some natural disasters that are likely to happen in the Maldives (e.g., flood, tsunami, sea swell, tornado and tidal surge and coastal erosion).

GRADE 6

7.1 WEATHER AND CLIMATE

EB1.4 Studies factors that influence weather and climate systems.

a. Identifies factors that influence weather and climate systems (e.g., temperature, wind, air, moisture, pressure and the sun).

b. Studies local weather patterns over a period of time.

c. Explain features of the local weather system.

WS3.1 Take care of themselves, others and respects others viewpoints.

d. Demonstrates and advocates the shared responsibility for addressing environmental issues (e.g., reducing consumption, use durable products/ecofriendly products, save money, etc.).

ST1.1 Explores the contributions to science made by people around the world

b. Studies major breakthroughs by scientists who have contributed to scientific developments (e.g., discovery of penicillin, electric bulb, etc.).

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. What is a tsunami hazard?
2. What is a storm hazard?
3. What are tidal waves?
4. What is sea swells?
5. What is coastal erosion?
6. What are the preventive measures planned for R. Dhuvaafaru?

TEACHER'S NOTES

The disaster risk scenario for Maldives can be described as moderate in general. Despite this, Maldives is among the most severely affected countries hit by the Asian tsunami on December 26th, 2004. Maldives experiences moderate risk conditions due to a low probability of hazard occurrence and high vulnerability from exposure due to geographical, topographical and socio-economic factors. It is crucial to address this context of Maldives high level of vulnerability in order to avoid the present scale of losses and damages in the future.[12]

[12] UNDP (2006) Developing a disaster risk profile for Maldives

The Problem

Before the Tsunami of 2004, Idhrees and his family lived in *R. Kadholhudhoo*. However, the Tsunami of 2004 destroyed all the houses in *Kadholhudhoo.* Neighbouring islanders came to the rescue of *Kandholhudhoo* natives during the Tsunami and provided shelter to the Tsunami victims until the government built temporary shelters for the Tsunami victims. *Dhuvaafaru* was finalized as the new home for the *Kandholhudhoo* people who were scattered across at least five different islands of the atoll, some lived in islands even further away like *Hulhumale*.

All together 600 houses were constructed in *Dhuvaafaru*; for *Kadholhudhoo* residents with the assistance of the International Federation of Red Cross and Red Crescent Societies 38 of which were funded by the government. Idhrees and his family now lives in *Dhuvaafaru* in a three bedroom house given by the government and enjoys the luxury of a pre-school, primary school and secondary school, an auditorium, water supply and sewage systems, a sports complex, roads, mosque, and a power supply system. Currently, there are two mosques in the island, one funded by the government.

In the local dhivehi language, the island name of *Dhuvaafaru* is literally translated as "running reef". It is suggested that this name may have been derived from the ever-shifting shape of the island's beach in different monsoons. Even today the shape of the beach and shoreline keeps changing consistently, especially during the rainy season.

There is historical evidence that *Dhuvaafaru* was populated around 15th Century and it may have been populated as late as 200 years ago. A famous associate of the Maldivian national hero *Muhammad Thakurufaanu Al Auzam* hails from *Dhuvaafaru*. This associate is popularly known as *Dhuvaafaru Dhandahelu*. According to Maldivian historical sources, *Dhuvaafaru Dhandahelu* was a young boy from the island of *Dhuvaafaru* who fought with *Muhammad Thakurufaanu Al Auzam* to free Maldives from the occupation of Portuguese. In traditional stories, *Dhuvaafaru Dhandahelu* is portrayed as a vigilant and a valiant person.

Idhrees believes that the previous residents of *Dhuvaafaru*, left the island due to soil erosion and its less proximity to fishing grounds. Some folktales claim that *Dhuvaafaru* was abandoned because the island was haunted. Idhrees says that elders of *Kandholhudhoo* claim that their ancestors were from *Dhuvaafaru* and other such islands across the atoll. They migrated to *Kandholhudhoo* because it was closer to the wider sea where fish is abundant.

The teacher can pose questions like,

- **What are some of the preventive measures that the residents of *Dhuvaafaru* can take to prevent future disasters?**
- **What are the preventive measures planned and implemented for *Dhuvaafaru* after the Tsunami?**

Use Student Resource sheet 1: Disasters - KWL chart

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding the waste management in the island. Using the ideas that have been raised in the previous activity (focus questions), ask the students to develop hypotheses or questions they want answered concerning the weather and the hazards faced by travellers and islanders during the *hulhangu* season in the Maldives. Give a copy of the following news and the picture to generate interest and discuss about the hazards.

BAD WEATHER CONTINUED TO HAMPER EID HOLIDAY GOERS AS SEVERAL VESSELS WERE FORCED TO RETURN TO MALE DUE TO ROUGH SEAS.

SEPTEMBER 19 2015

"Our trip had to be postponed until Sunday because we couldn't reach Male' due to rough sea. But as the weather is slightly better today we have resumed our journey," a ferry operator between Baa Atoll *Eydhafushi* and capital Male' said.

The coast guard said no travel bans had been issued thus far. But the coast guard was quick to urge the public to be weary of the weather before undertaking sea travel.

Coast guard has launched a special operation to carry out safety checks on marine vessels.

Several marine accidents have been reported in the past few days.

On Tuesday morning, a ferry carrying 80 passengers and millions in cargo sank near Kaaf Atoll *Vaagali*. In another incident a speedboat with 43 people on-board hit a reef near Full Moon resort on Wednesday while a vessel carrying construction sand had capsized near Anantara Resort with five crew on-board.

But there had been no casualties and all passengers had been rescued.

Meteorology department had issued white alerts in several regions of the archipelago. The department said the southern Atolls would experience wind speeds of between 7-15 miles per hour for the next 24 hours.[13]

[13] Muizzu Ibrahim, Haveeru Online (accessed on 25th September 2015)

What are sea swells and what is the effect of sea swells in Male' and other islands?

Student Resource Sheet 2 : Examples of sea swells

Student Resource Sheet 2 : Ideas wheel

Encourage students to develop a list of disasters faced by the islanders and residents of Male'. Allow time for students to discuss and enter responses on to the Ideas Wheel. Using this approach helps in prioritizing the most important for the group. As a group develops a priority list of ideas, which may focus on categories such as making the community aware of the disasters.

Organizing Ourselves

From the questions that have been raised by previous discussions around disasters, identify the steps that need to be taken for further study to occur. The following may need to be considered:

Discuss in the groups:

1. What they feel about disasters.
2. How it is impacting the environment.
3. Ask students to think about their island, and the disasters encountered.
4. Make a time line of disasters as per guideline in resource sheet 4.

Student Resource Sheet 3 : Timeline of disasters encountered in the islands

STEP 3 NARROW YOUR CHOICES

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

JANUARY 13TH 2013

A house near the beach in Holhudhoo: People of two houses have been moved due to erosion –Sun photo by a reader

"It has recently come to light that fifteen islands have seen drastic erosion of shores due to climate change, and people from three of these islands need to be migrated to other islands.

"Statistical Year Book" updated and published by the Planning Department last Thursday shows that at the end of 2011, fifteen of the 191 inhabited islands had faced severe erosion. The people of the islands affected worst were changed to other islands. People of *Haa Alif Hathifushi* were migrated to *Haa Dhaalu Hanimaadhoo* while *Laamu Kalhaidhoo* people were migrated to *Laamu Gan* and *Gaafu Alif Dhiddhoo* people were migrated to *Gaafu Alif Gemanafushi*. *Baa* Atoll is the worst affected out of all 20 atolls where three of the 13 islands are facing severe erosion. Two islands in *Haa Alif* Atoll and two from *Meemu* atoll are also facing the problem while islands in atolls *Haa Dhaalu, Noonu, Lhaviyani, Alif Alif, Vaavu, Meemu* and *Gaafu Dhaalu* are also facing the dangers of erosion. With island heights averaging at about 1.5 above sea level, Maldives tops the list of countries facing the dangers of sea level rise. People of two houses in *Noonu Holhudhoo* were forced to abandon their homes and move to other houses last year. Those two houses now sit in the sea. There is much talk about the dangers of climate change, but little action is seen to be taken".[14]

[14] http://www.sun.mv/english/8464 (accessed on 9th September 2015)

Pose the challenge of how can we prevent houses like this to be taken away by beach erosion.

Ask students:

- **What they think they would need to do first in a project such as this?**
- **What are the reasons for the destruction of houses?**
- **What can we do to prevent such disasters?**

Student Resource Sheet 4 : Ways to prevent disasters.

In groups, fill in the form so that students are very familiar with what is required.

Discuss student responses as a group. Focus on common themes or ideas asking students to justify their ideas.

Student Resource Sheet 5 : *Dhuvaafaru* land use plan.

Invite students to make suggestions on the best way to represent the data to others. For instance, drawing a map of the school with symbols and with annotated information chart.

STEP 3 TEST YOUR SOLUTIONS

Students at this stage will be collating, processing, analyzing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be opportune time to revisit some of the initial activities from the information sought on the ideas wheel, the timeline of disasters encountered and some ways to prevent the disasters and present the information on a story board using resource sheet 4.

Ensure that students include in their story board:

- How will it work?
- Who will be involved?
- When will it happen?
- What resources are needed?
- How it will be monitored?
- How will it be reported?

ASSESSMENT

The story board students develop will be presented to the class and will be evaluated on the following criteria.[15]

Criteria	Well-done	Average	Needs improvement
Correct definitions of different types of natural disasters Maldives is susceptible to. (Here the use of own words to explain this is important).			
Examples of at least TWO natural disasters that happened in our locality explained. (The case, how and where it happened, the people and assets affected).			
Suggestions of at least TWO preventative measures to reduce the damages that can happen due to natural disasters.			
Creativity of the overall story-board.			
The overall flow and structure and presentation of the story board.			
Language usage (correct grammar and vocabulary used).			
Use of images (pictures and drawings).			

[15] Assessment activities for this PBL case study is developed by Mohamed Hussain & Aishath Hassan

STUDENT INFORMATION SHEET 1

Name ---------- Date ----------

Natural Disaster Reduction Plan

Image from: http://www.vaguthu.mv/en/29402

Before the Tsunami of 2004, Idhrees and his family lived in *R. Kadholhudhoo*. However, the Tsunami of 2004 destroyed all the houses in *Kadholhudhoo*. Neighbouring islanders came to the rescue of *Kandholhudhoo* natives during the Tsunami and provided shelter to the Tsunami victims until the government built temporary shelters for the Tsunami victims. *Dhuvaafaru* was finalized as the new home for the *Kandholhudhoo* people who were scattered across at least five different islands of the atoll, some lived in islands even further away like *Hulhumale*.

All together 600 houses were constructed in *Dhuvaafaru*; for *Kadholhudhoo* residents with the assistance of the International Federation of Red Cross and Red Crescent Societies 38 of which were funded by the government. Idhrees and his family now lives in *Dhuvaafaru* in a three bedroom house given by the government and enjoys the luxury of a pre-school, primary school and secondary school, an auditorium, water supply and sewage systems, a sports complex, roads, mosque, and a power supply system. Currently, there are two mosques in the island, one funded by the government.

In the local Dhivehi language, the island name of *Dhuvaafaru* is literally translated as "running reef". It is suggested that this name may have been derived from the ever-shifting shape of the island's beach in different monsoons. Even today the shape of the beach and shoreline keeps changing consistently, especially during the rainy season.

There is historical evidence that *Dhuvaafaru* was populated around 15th Century and it may have been populated as late as 200 years ago. A famous associate of the Maldivian national hero *Muhammad Thakurufaanu Al Auzam* hails from *Dhuvaafaru*. This associate is popularly known as *Dhuvaafaru Dhandahelu*. According to Maldivian historical sources, *Dhuvaafaru Dhandahelu* was a young boy from the island of *Dhuvaafaru* who fought with *Muhammad Thakurufaanu Al Auzam* to free Maldives from the occupation of Portuguese. In traditional stories, *Dhuvaafaru Dhandahelu* is portrayed as a vigilant and a valiant person.

Idhrees believes that the previous residents of *Dhuvaafaru*, left the island due to soil erosion and its less proximity to fishing grounds. Some folktales claim that *Dhuvaafaru* was abandoned because the island was haunted. Idhrees says that elders of *Kandholhudhoo* claim that their ancestors were from *Dhuvaafaru* and other such islands across the atoll. They migrated to *Kandholhudhoo* because it was closer to the wider sea where fish is abundant.

What are some of the preventive measures that the residents of *Dhuvaafaru* can take to prevent future disasters?

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

DISASTERS - KWL CHART

What do we know about the disasters	What do we want to learn about disasters	What have we learned about disasters

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

SEA SWELLS AND TIDAL WAVES

DISASTER MANAGEMENT ADVISES PUBLIC TO PREPARE AND BE CAUTIOUS BEFORE TIDAL FLOODING

22 SEPTEMBER 2015

The National Disaster Management Centre has advised the general public to be on alert, and prepare before the tidal flooding expected in the next week due to the 'Supermoon'.

Indian National Center for Ocean Information Services (INCOIS) has issued a tidal wave flooding alert to Maldives on the 28th of this month due to the 'Supermoon'.

The alert issued by Indian scientists say that sea swells are expected on the 28th of month in Maldives and the Indian Ocean. However, this alert is mainly targeted to India.

While INCOIS has said that the effects of tidal wave flooding will last from the 25th to 30th of this month, Maldives is expected to face the the sea swells on the 28th of this month.

However, the alert also says that the coming Monday will experience the maximum tide induced phenomena for the year 2015.

The urges of the Disaster Management includes:

- Prepare for any floods inside the island due to sea swells
- To protect the household items and other public and private properties which may get damaged due to flooding
- To protect and barricade shops, cafe's petrol sheds and such buildings near the shore from the flooding
- To park motorcycles and other vehicles away from the shore or any areas imminent to be affected from the sea swells.[16]

[16] http://www.vaguthu.mv/en/29402 (accessed on 25th of September 2015)

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

STRONG SEA SWELLS ARE LIKELY TO HIT CAPITAL CITY MALE' DURING HIGH TIDES ON THURSDAY AND FRIDAY, THE MALDIVES METEOROLOGICAL CENTER, COMMONLY REFERRED TO AS THE MET OFFICE, SAID.

Swells hit near *Nasandhura Palace* hotel and had spread up to *Hulhumale* ferry terminal on Wednesday. A statement from MET said that high tides to the west could lead to similar swells as well; high tides happen at around 12:49 pm to midnight.

"I've never seen such swells ever in my life," an onlooker told Haveeru, while some now describe it as a 'mini-tsunami'. When the swells first began to hit earlier this year, the *Lily's Restaurant* had removed the tables near the sea and reinforced the area with bags of sand. When Wednesday night's large swells hit, they had risen beyond the sand bags and spread to the entire restaurant. The water had washed away tables, refrigerators, and other fixtures at the restaurant. Eye witnesses claim to have seen fish washed up as well.

"The waves were huge. They cleared the sea wall by over one and a half feet, the biggest waves I have seen since the 2004 tsunami" said an employee at the restaurant. Employees and customers, sitting at the restaurant when the wave hit, had suffered minor injuries as well. According to eyewitnesses, the first large wave, strong enough to move a truck parked outside the restaurant, and was followed by a smaller one and spilled onto *Bodu Thakurufaanu Magu*. Water in the area reached up to three feet.[17]

[17] www.haveeru.com.mv, August 13 2015 (accessed on 25th of September 2015)

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

Ahmed Shafeeq, Supervisor at two of *Lemongrass café* at the carnival lot in *Henveiru*; *Citron and Seaview*, said that the waves were a minor tsunami. He said that waves hit their restaurants as strong as it hit *Lily's*, a likely prospect given that the outlets are adjacent to each other. Shafeeq said that the waves had surrounded the restaurant's counter, which has a wall built around it.

"Our customers had reacted quickly and bravely, it is because of them that we were able to avoid any serious damage" he added. The waves that hit *Citron* were so strong that the only reason the restaurant was not flooded, because the water that entered had spilled out of the main entrance.

Sea swells usually hit the eastern side of Male' near surf point, north east side and west side near IGMH.

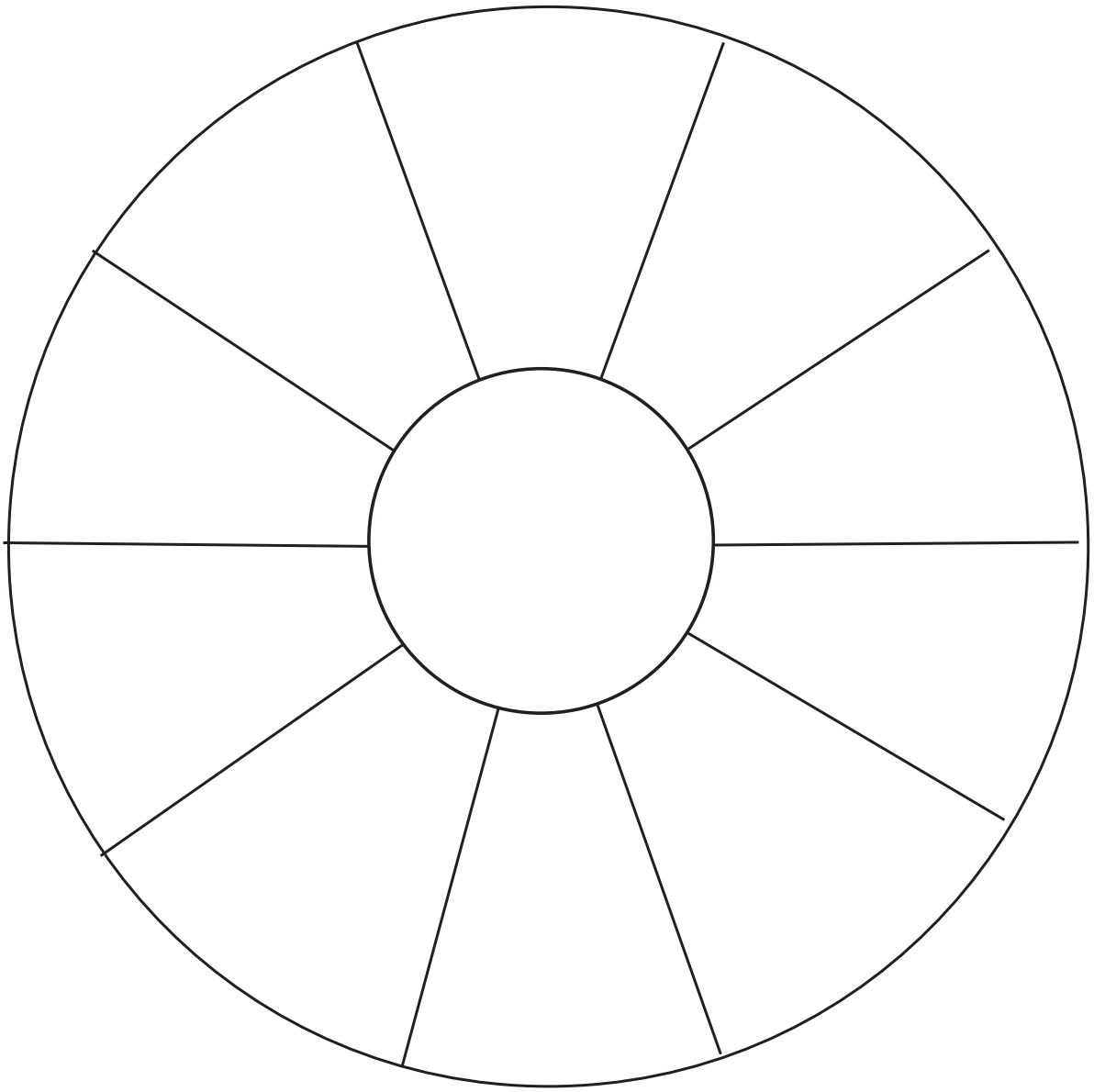
STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

IDEAS WHEEL FOR DISASTERS

Complete the ideas wheel.[18]

MY FOCUS WHEEL



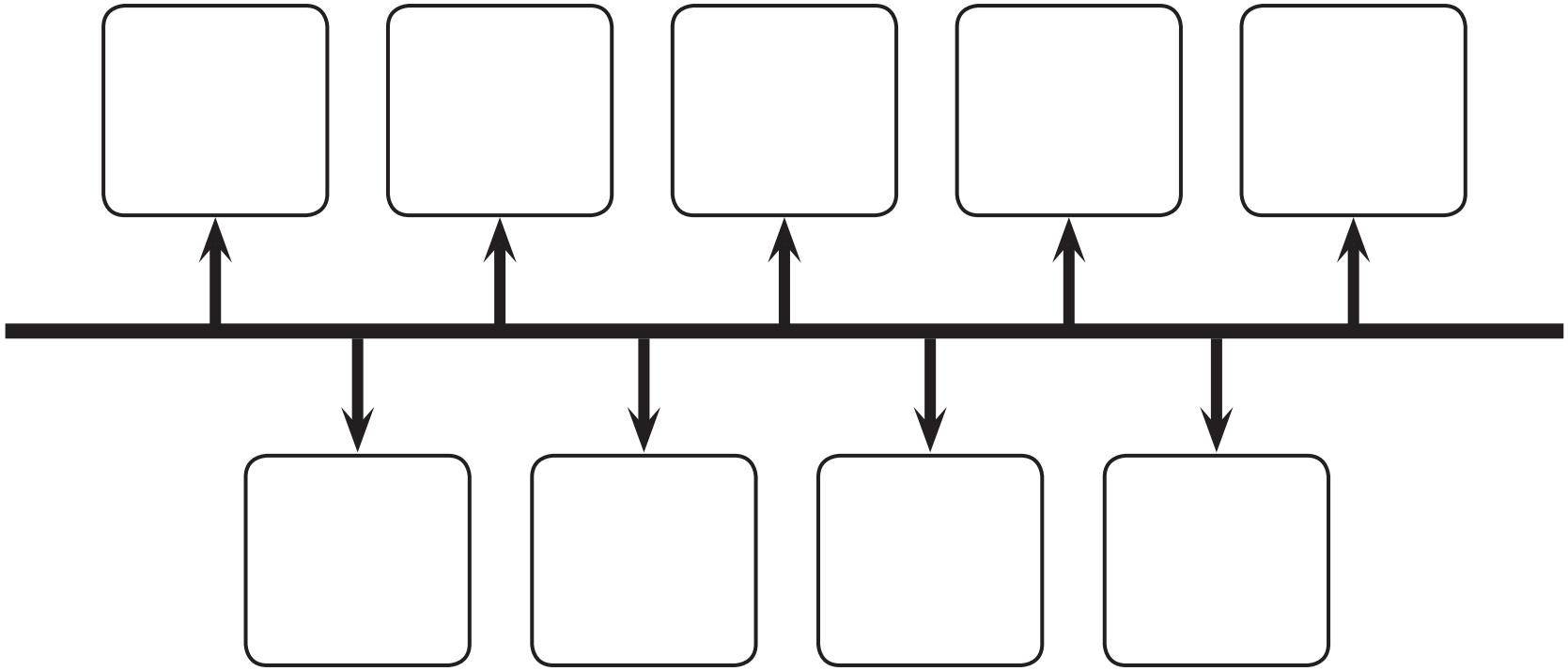
[18] Adapted from: www.travelingnatural.com

STUDENT RESOURCE SHEET 3

Name ----------

Date ----------

TIMELINE OF DISASTERS ENCOUNTERED IN THE ISLANDS



STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

WAYS TO PREVENT DISASTERS

STORYBOARD YOUR IDEAS!

In each box, sketch what your audience will see, based on your story.

1	2
.....	.....
.....	.....
.....	.....

3	4
.....	.....
.....	.....
.....	.....

Name ---------- Date ----------

R.DHUVAAFARU

Raa Dhuvaafaru is a new island chosen to resettle the community of *Raa Kandholhudhoo,* one of the islands that were severely affected by the Tsunami that hit Maldives on the 26th of December 2004, with the entire infrastructure and 80% of the housing destroyed. Given the sizable existing population compared to the small land area of *Raa Kandholhudhoo*, it was decided to relocate the entire community to Raa Dhuvaafaru.

Dhuvaafaru is planned as per the 'safe island' concept, with a 40m wide Environmental Protection Zone (EPZ) and accessible evacuation points. A total land area of 15.1Ha will be reclaimed which includes the land area around the harbour and a 20m wide belt around the island which would eventually form part of the EPZ. This island has been planned for a population of 4,500.

Extensive consultations were carried out prior to, during and after the proposed land use plan was drafted. Consultations were carried out with:

- Government ministries and other relevant bodies
- *Kandholhudhoo* community

A meeting was held to consult with the community of *Raa Kandholhudhoo* temporarily accommodated in *Raa Ungoofaaru*, on 27th March 2005.

A second meeting was held with the displaced people of *Raa Kandholhudhoo* sheltered in *Raa Hulhudhufaaru,* on 28th March 2005.

Land Use Plan

Various land uses have been planned for the island. These include:

- Residential
- A total of 766 (2000 sq.ft each) residential plots have been allocated
- Institutional and Community Zone
- Schools

STUDENT RESOURCE SHEET 5

Name ---------- Date ----------

- A new Secondary School is located in the central area of the island, 2 Primary Schools and 2 Pre-Schools
- Health Centre
- 1 Friday Mosque, and 2 neighbourhood Mosques
- Community Centre and Bank
- Fire / Coastguard

Commercial Zone

- Fish Market, Local Market
- Fuel storage and retail
- Ice plant and water supply for vessels

Industrial Zone

- Boat repair yard
- Fish processing
- Light industrial (workshops, etc.)
- Storage and Warehousing
- Sport and Recreation Zone
- One FIFA size football ground, a recreational park area north of this football ground, and small neighbourhood parks have been provided.

Name ---------- Date ----------

Utility and Municipal Zone

- Cemetery
- Power House
- Desalination Plant
- Solid waste management

Environmental Protection Zone

- A 40m wide EPZ, consisting of a 20m wide raised area (1.4m above mean sea level) with revetment on the outer edge and a 20m wide drainage area, is provided around the island, most prominently on the eastern side facing the outer reef side. A detail cross section drawing of the EPZ is attached.[19]

[19] Ministry of housing and urban development, (n.d.) http://www.tsunamimaldives.mv (accessed on 20th August 2015)

9.1 ECOLOGICAL FOOTPRINT

EB3.1 Identifies Earth's available resources are limited and that living things depend on them.

a. Identifies one's own needs and wants and relates to the needs of the whole community.

b. Identifies ways to reduce ecological footprint and advocates the importance of reducing consumption.

c. Appreciates that Allah creates all the resources for the benefit of living things.

ST2.2 Applies the knowledge gained to make informed decisions

a. Identifies and explains events and phenomenon using their scientific knowledge (e.g., germination of seeds, spreading of germs).

45 minutes X 2 periods

Instruct students to follow the (DENT) (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. What is an ecological footprint?
2. What does it measure and how does that help the environment?

The Problem

Hassan was walking on the beach with his father one day and asked his father that in class the teacher was talking about ecological footprints. This is the first time he has heard about an ecological footprint and he thought it was just like his footprint on the beach he is making now. Hassan's father explained that footprint on the beach can be taken as an example to the footprint we leave on the Earth which impact on the natural world – their footprints can be seen just about everywhere on the planet. Everywhere we go, and in everything we do, we leave an impression, an effect, like footprints on the beach you are making. Each time we take a breath, a meal, wash, go to school, play a game, comb our hair, buy a new T-shirt – everything we do changes our physical world just a tiny little bit. If you could add together all the tiny changes, or footprints, we create every day, we would understand our own, individual ecological footprint. If we could then add together all the other footprints for the other people living in the world, we would find that humanity's ecological footprint is over 23% larger than what the planet can support. In other words: We now need 1.23 planet Earth's' to support the lifestyle of the human race. It now takes more than one year and two months for the Earth to regenerate what we use in a single year. This is the same as spending 23% more money than you have. Although populations and economies continue to grow each year, planet Earth remains the same size (WWF, 2005). Therefore we are living beyond our ecological means on Earth.

How can you make your footprint smaller?

TEACHER'S NOTES

Unless we make changes to the way we live, we will continue to use the natural resources on Earth and our ecological footprint will get bigger and bigger. The footprint of a country is the total area required to produce the food, fibre and timber that it consumes, absorb its waste and provide space for its infrastructure. In general, Ecological Footprints decrease with a smaller population size, lower consumption per person, and higher resource efficiency. Once the footprint is calculated it is compared against biological capacity- the ability of nature to produce these resources that we depend on (WWF, 2005). The Maldives is located within the Indian Pacific region, one of the most populous on the planet. In fact the Asia Pacific region includes 55% of the world's population. In 2005 the footprint of this region was 1.7 times as large as its own biological capacity. This means that, at its current rate of consumption, the region needs more than one and a half times its own land and sea space to support its resource demands (WWF, 2005). The ecological footprint of the Maldives has not been calculated, however, Table below shows the respective footprints for some other countries. As can be seen from the table the average footprint of an Asian resident is still far smaller than the average footprint of people living in Europe, North America, Australia or Japan. People living in these countries have very high ecological footprints and will need to make major changes in order to live sustainably on Earth. Countries in Asia Pacific also need to manage ecological resources effectively. We all need to be aware of our ecological footprint and reduce it where possible. If we do not act promptly to reduce our ecological footprint, 'critical ecosystems' will be eroded beyond the point at which they can easily recover (WWF, 2005) and as time moves on we will become more and more dependent on fewer and fewer ecological resources.

Country	**Ecological Footprint (global hectares per person)**
India	0.8
Malaysia	3.0
France	5.8
Bangladesh	0.5
Sri Lanka	1.1
Japan	4.3
Australia	7.7
USA	9.5

Sustainable Living

We cannot move to another planet once Earth is exhausted, so we must learn to live more gently now. We can all make changes to how we live in order to live more sustainably on Earth. Some suggestions from WWF (2005) include:

1. **Bio capacity.** We need to increase or at least maintain our ecological resources. This means protecting soil from erosion and degradation, protecting wetlands and mangroves, protecting the quality of ground water, and maintaining healthy fisheries. It includes taking action to protect ecosystems from climate change and eliminating the use of toxic chemicals that degrade ecosystems. In the Maldives we can protect our environment by disposing of waste carefully (e.g. not disposing of oil/chemicals in the ocean), by reducing the amount of plastic bags we bring home and reducing the amount of electricity used (e.g. turning off the fan or air conditioner when you are no longer in the room).

2. **Resource efficiency in producing goods and services.** Nowadays technology allows us to produce goods and services very efficiently from a given amount of ecological resources. As a result, the average Ecological Footprint per person has stayed relatively constant. In the Maldives we can buy "Eco-friendly" products that have been produced in a more environmentally friendly way (e.g. recycled paper, phosphate free detergents).

3. **Consumption of goods and services per person.** The potential for reducing per person consumption depends in part on the person's income level. People living at or below subsistence may need to increase their absolute consumption levels to move out of poverty. Wealthy individuals could cut their consumption levels of goods and services, thus reducing their footprints, without seriously compromising the quality of their lives. In the Maldives people have become more affluent in recent times. When we go to the shop we can buy a tin of biscuits in bulk, rather than in small individual plastic packets. Or instead of upgrading to a new mobile phone each year, we can buy one phone that is used for many years. By doing either of these things we can reduce how much we consume each year.

4. **Size of the population.** Addressing population growth will be especially critical for the Asia-Pacific region, which is already home to half the world's people. Supporting measures that lead to families choosing to have fewer children can reduce population growth. Offering women better education, economic opportunities and health care are three proven approaches. In the Maldives the size of the population is quite small, however as the islands in the Maldives are quite small and fragile, population densities on an island level need to be considered. People living in Male' have a larger ecological footprint than people who live in the other atolls.[20]

[20] EDC, UNICEF (2006) Biodiversity flip chart

The following are examples of some Focus Questions, which could guide the students in their research on the Ecological Footprints.

FOCUS QUESTIONS

1. What is an Ecological Footprint and why is it important?
2. What is my Ecological Footprint?
3. What is the effect of this?
4. How can I reduce my Ecological Footprint?

Student Resource Sheet 1: Ecological footprint - KWL chart

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding ecological footprint and its various aspects including ways to minimize it.

Organizing Ourselves

The students divide into groups of 4-6 students to research about the concept of ecological

Note these down on the Student Resource Sheet 2: Understanding about Ecological Footprints.

Brainstorm on how we contribute to the sage of resources around us. As you discuss, complete the Idea Wheel on Student Resource Sheet 3: Our Usage of Natural Resources.

In order to understand individual's ecological footprint, students can answer the questions on Student Resource Sheet 4: My Ecological Footprint Quiz.

From the questions that have been raised by previous discussions, identify the steps that need to be taken for further study to occur. The following may need to be considered:

Research information on how to help reduce the ecological footprint

- What are some individual measures that can be made?
- What are some national and global measures that can be made?

If computer access is available, students could use the on-line calculator found at:

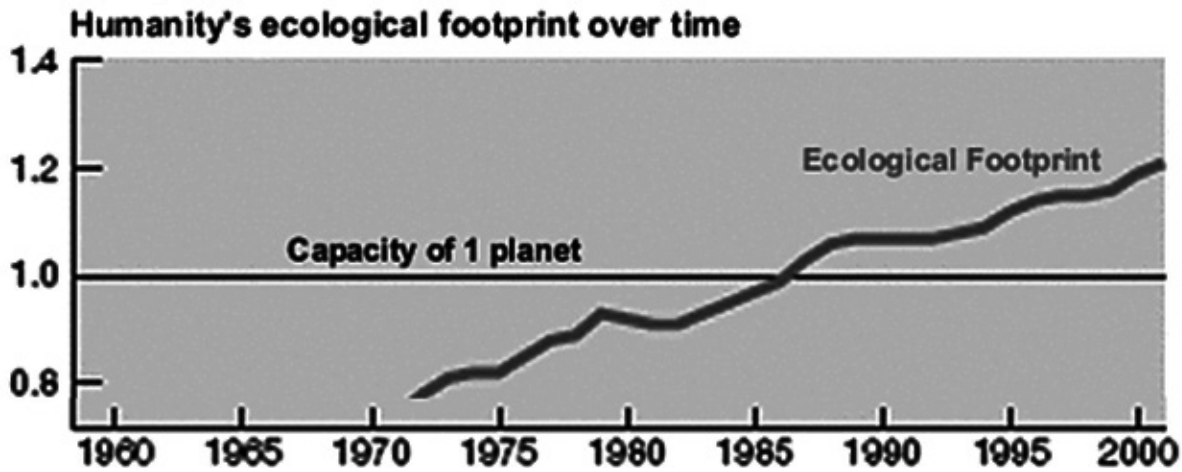
- *http://www.powerhousemuseum.com/education/ecologic/bigfoot/low/*. This is a very interactive game based upon Ecological Footprints. Students take the role of contestants in a TV Quiz show.
- *www.myfootrpint.org*. This multi-language calculator presents an extended form of the questionnaire in and is tailored to suit the situation in different countries.

Make a frequency table on the board of the scores of all the students in the class and calculate an average.

STEP 3 NARROW YOUR CHOICES

Discuss the individuals' results and based on this plus the information gathered, students can discuss how big a problem is and list down more specific issues that needs to be address, at all levels. (Individual, community, national and international).

The resource below can be provided when students are discussing this.



If we could then add together all the other footprints for the other people living in the world, we would find that humanity's Ecological Footprint is over 23% larger than what the planet can support. In other words:

- We now need 1.23 Planet Earth's to support the lifestyle of the human race.
- In other words, it now takes more than one year and two months for the Earth to regenerate what we use in a single year.
- This is the same as spending 23% more money than you have.
- At least that is the figure for the whole world.

Establishing Protocols

Narrow down the discussion to what type of a society we are in: “consuming society” or “conversing society”.

This idea can be studies by completing the Student Resource Sheet 5: Consuming or Conserving?

Based on the previous steps, students in groups can complete Student Resource Sheet 6: Essential and non-Essential.

These activities will help students list a set of actions that they can take to reduce their ecological footprint. Student Resource Sheet 7: Essential and non-Essential.

STEP 4 TEST YOUR SOLUTIONS

The information they have listed at the end of the last step can be used to make a presentation and present to the class.

Aspects to present include:

- What is ecological footprint?
- What is its status in your group?
- How has the group planned and pledged to reduce their ecological footprint?

Extension Activity

Awareness posters can be produced where each single poster sends one single message to the reader on how to reduce their ecological footprint and that we all are responsible for it.

ASSESSMENT

RUBRIC FOR ASSESSING AWARENESS POSTER

Trait	Very Good (10-7 points)	Adequate (6-4 points)	Limited (3-0 points)	Score
Layout	Creatively enhances information	Balanced, tidy and adequate white space	Not balanced, untidy and insufficient white space	
Graphics / Photos	All graphics are engaging, enhance text	Graphics enhance text	Graphics do not enhance text	
Titles and Subtitles	All titles and subtitles are clear, enhance readability	Most titles and subtitles are clear, enhance readability	Graphics do not enhance text	
Content	Product description is clear, complete and concise	Product description is mostly clear, could be a little concise	Product description is not clear and concise	
Writing	Well written and organized, clear, easy to follow	Adequately written and organized, clear, reasonably easy to follow	Poorly written and organized, unclear, hard to follow	
Grammar and Spelling	No grammar or spelling error	One grammar or spelling error	Many grammar and spelling error	
Total				

Self-Reflection

Consider the following points and write a reflection for the lesson on "Ecological footprint"

1. What did you learn in this topic?
2. What were the things you did really well in this topic?
3. What were the challenges you came across while you studied this topic?
4. What was your role in the activities carried out throughout the lesson?
5. What would you like to learn more about this topic?[21]

[21] Assessment activities for this PBL case study is developed by Khadeeja Ibrahim & Ramiza Ibrahim

STUDENT INFORMATION SHEET 5

Name ---------- Date ----------

The Case of the Growing Footprint

Image from: EDC and UNICEF Interdependence Module

Hassan was walking on the beach with his father one day and asked his father that in class the teacher was talking about ecological footprints and this is the first time he has heard about an ecological footprint and he thought it was just like his footprint on the beach he is making now. Hassan father explained that footprint on the beach can be taken as an example to the footprint we leave on the Earth which impact on the natural world – their footprints can be seen just about everywhere on the planet. Everywhere we go, and in everything we do, we leave an impression, an effect, like footprints on the beach you are making. Each time we take a breath, a meal, wash, go to school, play a game, comb our hair, buy a new T-shirt – everything we do changes our physical world just a tiny little bit. If you could add together all the tiny changes, or footprints, we create every day, we would understand our own, individual ecological footprint. If we could then add together all the other footprints for the other people living in the world, we would find that humanity's ecological footprint is over 23% larger than what the planet can support. In other words: We now need 1.23 Planet Earth's' to support the lifestyle of the human race. It now takes more than one year and two months for the Earth to regenerate what we use in a single year. This is the same as spending 23% more money than you have. Although populations and economies continue to grow each year, planet Earth remains the same size (WWF, 2005). Therefore we are living beyond our ecological means on Earth.

How can you make your footprint smaller?

Your teacher will guide you in the process.

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

ECOLOGICAL FOOTPRINT - KWL CHART

Use this chart to organize your group's thoughts about the problem and focus on what needs to be solved.

What we know about ecological footprints	What we know about ecological footprints	What we have learnt about ecological footprints

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

RESEARCHING ABOUT THE ECOLOGICAL FOOTPRINTS

Complete the following table through your observation field trip and other information you gathered

Aspects studied	Interesting features and details
What is ecological footprint?	
Why is this a cause for concern?	
Why should countries and individuals worry about this?	
What factors lead to an increase in the ecological footprint??	
What are some current actions internationally and nationally that are done to address the issues of increasing ecological footprints?	
What are global trends on ecological footprints?	
How can I, as a student, help or what can I do to reduce the footprint?	
Any other interesting aspects of this?	

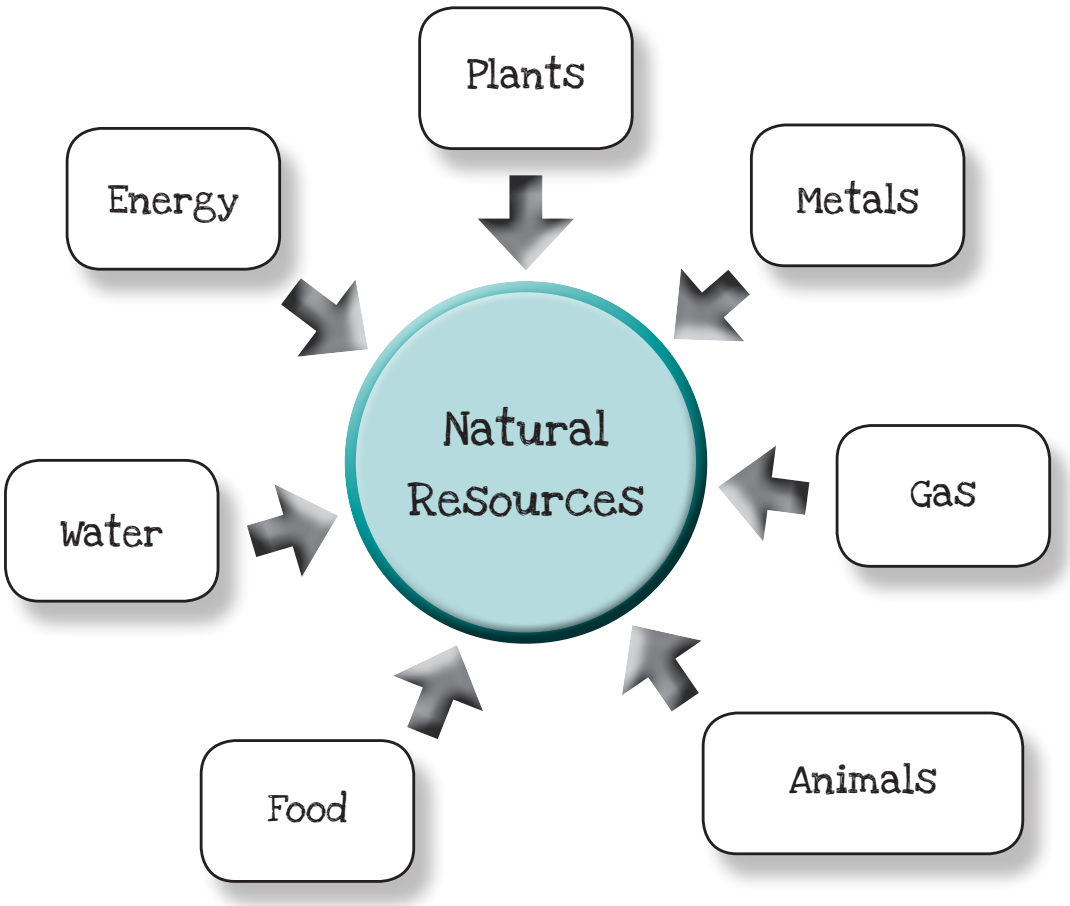
STUDENT RESOURCE SHEET 3

Name ---------- Date ----------

OUR USAGE OF NATURAL RESOURCES

Write down the ideas you brainstorm about how we use the Natural Resources around us.

On each aspect identified write around it how you use that resource.



STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

HOW LARGE IS MY ECOLOGICAL FOOTPRINT?

Ecological Footprint Quiz

Find out by answering the quiz below. Circle the number (either 1, 2 or 3) next to the answer that best fits your lifestyle.

FOOD						
1. How much fish do you eat?	Vegetarian (no fish)	1	Fish 1 to 4 days a week	2	Fish almost every day	3
2. How much food is wasted in your household?	Most is eaten	1	Occasional wastage as rotten or uneaten food	2	Uneaten food thrown away most days	3
3. Where does your food come from?	Grown at home or bought from local markets - no plastic packaging	1	Local produce from market packaged in plastic	2	Mostly imported food from market packaged in plastic	3
TRAVEL						
4. How far does you family travel each week (on your island and between islands)?	Less than 5 km per week	1	Less than 8 km per week	2	Less than 10 km per week	3
5. Where do you go for holidays each year?	Not far from home	1	Within my country	2	Fly overseas	3
6. How do you travel to school each day?	Walk	1	Cycle/car/bus	2	Dhoani	3
7. Does your family have a boat?	No	1	One with small motor	2	One with large motor	3

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

HOUSING						
8. How big is your house?	Small - 1 to 3 rooms	1	Medium - 4 to 7 rooms	2	Large - over 7 rooms	3
9. What power source does your house have?	Some or all solar/wind power	1	Only electricity	2	Wood/coal/ paraffin	3
10. How much electricity does your household use? Check your electricity bill (based on STELCO bill).	Small (usage 0-100 units for 30 days)	1	Medium (usage 101-200 units for 30 days)	2	Large (usage 201-300 units for 30 days)	3
11. How much water does your household use?	Small (eg 30-50 litres per person per day)	1	Medium (50-100 litres per person per day)	2	Large (125+litres per person per day)	3
12. How many of these waterwise activities does your family do? Turns off taps; recycle used water on garden; use water tank	All 3 of these	1	1-2 of these	2	None of these	3
13. Do you reuse paper, plastic bottles and glass and make compost?	All 4 of these	1	2-3 of these	2	0-1 of these	3
POPULATION						
14. How many brothers and sisters do you have?	None	1	One	2	Two or more	3

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

- Now add up all your circled points to find the Grand Total.
- What your grand total means.
- Check your quiz grand total below to find out how much your particular lifestyle affects our planet.

LESS THAN 16

You tread softly on our Earth and have a small footprint compared to others. Wish there were more of you around!

17 TO 30

You have a medium footprint and your passage on Earth is damaging - the natural environment won't be able to support very many like you.

In fact, if everyone in the world lived like you, we would need two Planet Earths - not one – to meet everyone's lifestyle needs

OVER 30

Lighten up! If everyone had footprints like this, we would need several more Earths to have enough resources to meet all these demands!

In fact, if everyone in the world lived like you, we would need two Planet Earths - not one – to meet everyone's lifestyle needs.[22]

[22] EDC, UNICEF (2008) Interdependence Module

STUDENT RESOURCE SHEET 5

Name ---------- Date ----------

CONSERVING OR CONSUMING

Cut up the slips on this page.

Uses up the energy and resources as if an unlimited source with no worries of their waste or renewal.	Uses only as much energy and resources as it needs to. Always uses renewable sources where possible and minimises waste.
Makes/buys cheap and convenient goods that don't last long.	Tries to make/buy long lasting goods that can be maintained and repaired.
Produces goods in large quantities. Often considers cash cost but not the effects on people (at home or abroad) and the environment.	Carefully considers and balances all costs - people (at home and abroad), environment and cash - involved in making goods.
Concentrates on short-term cash benefits and short-term goals.	Tries to show concern for the future, by looking at long - term benefits and goals - cash, people, environment.
Avoids responsibility - often relies on someone else (government) paying to develop the technology to clear up the mess.	Takes responsibility - individuals, communities, businesses and industry as well as government try to save energy and resources, and dispose of their wastes carefully.

STUDENT RESOURCE SHEET 5

Name ---------- Date ----------

Paste the cut up slips under the heading that you think each cut up slip fits best under.

Consuming society	Conserving society

STUDENT RESOURCE SHEET 6

Name ---------- Date ----------

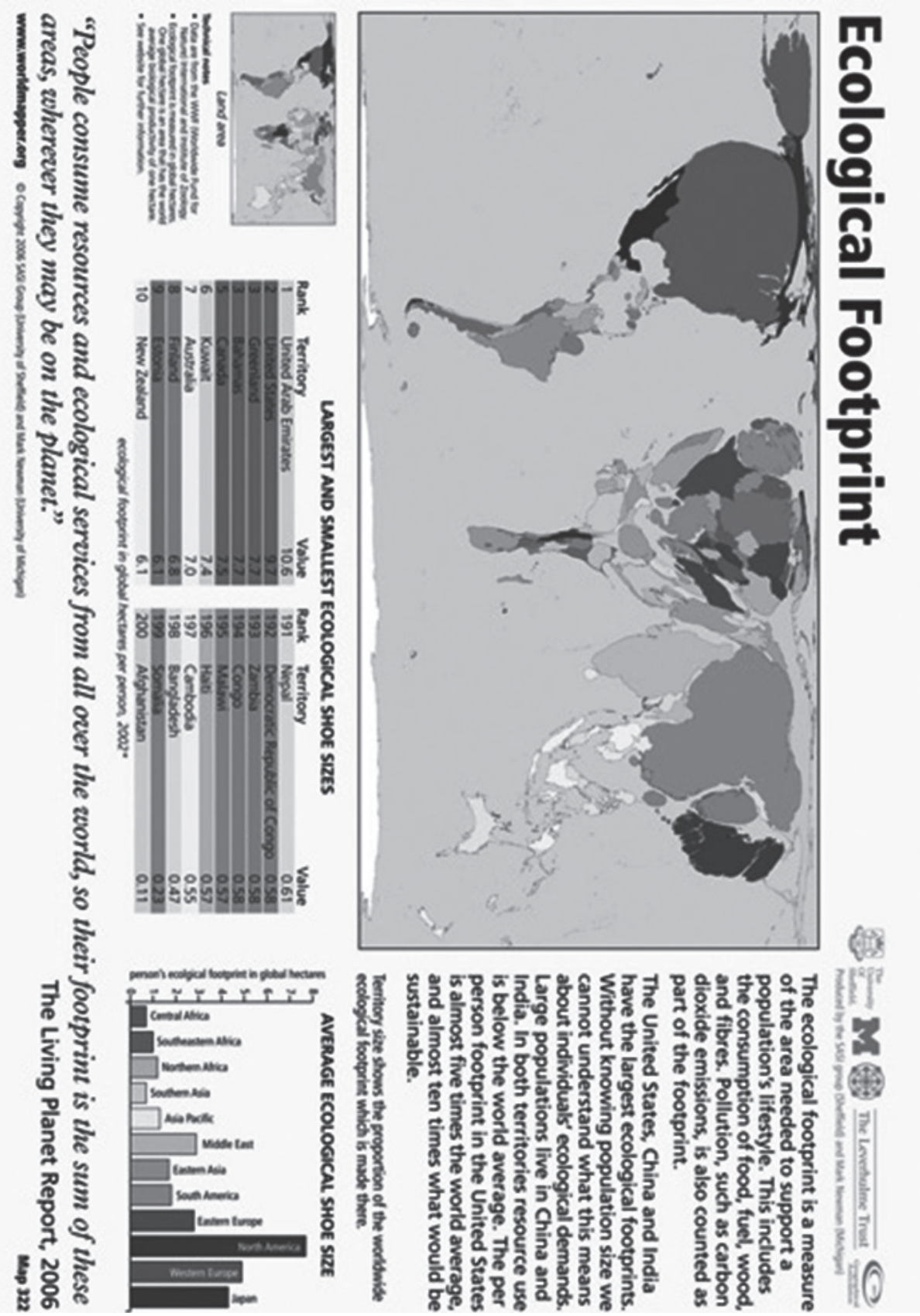
ESSENTIALS AND NON-ESSENTIALS

"Essentials" that satisfy my needs	"Non - essentials" that satisfy my wants	what i might do to reduce my footprint
eg : Fresh water for drinking		eg : Make sure that no water is wasted
	eg : Plastic bag	eg : Use a woven or cloth bag when shopping

STUDENT RESOURCE SHEET 6

Name ---------- Date ----------

EXTRA NOTES



Ecological Footprint

The University of Sheffield. The Leverhulme Trust

Produced by the SASI group (Sheffield) and Mark Newman (Michigan)

The ecological footprint is a measure of the area needed to support a population's lifestyle. This includes the consumption of food, fuel, wood, and fibres. Pollution, such as carbon dioxide emissions, is also counted as part of the footprint.

The United States, China and India have the largest ecological footprints. Without knowing population size we cannot understand what this means about individuals' ecological demands. Large populations live in China and India. In both territories resource use is below the world average. The per person footprint in the United States is almost five times the world average, and almost ten times what would be sustainable.

Territory size shows the proportion of the worldwide ecological footprint which is made there.

AVERAGE ECOLOGICAL SHOE SIZE

LARGEST AND SMALLEST ECOLOGICAL SHOE SIZES

Rank	Territory	Value	Rank	Territory	Value
1	United Arab Emirates	10.6	191	Nepal	0.61
2	United States	9.7	192	Democratic Republic of Congo	0.58
3	Greenland	7.7	193	Zambia	0.58
3	Bahamas	7.7	194	Congo	0.58
5	Canada	7.5	195	Malawi	0.57
6	Kuwait	7.4	196	Haiti	0.57
7	Australia	7.0	197	Cambodia	0.55
8	Finland	6.8	198	Bangladesh	0.47
9	Estonia	6.1	199	Somalia	0.23
10	New Zealand	6.1	200	Afghanistan	0.11

ecological footprint in global hectares per person, 2002*

Land area

Technical notes
- Data are from the WWF (Worldwide Fund for Nature) International and Institute of Zoology.
- Ecological footprint is measured in global hectares. One global hectare is an area that has the world average biological productivity of one hectare.
- See website for further information.

"People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet."

The Living Planet Report, 2006

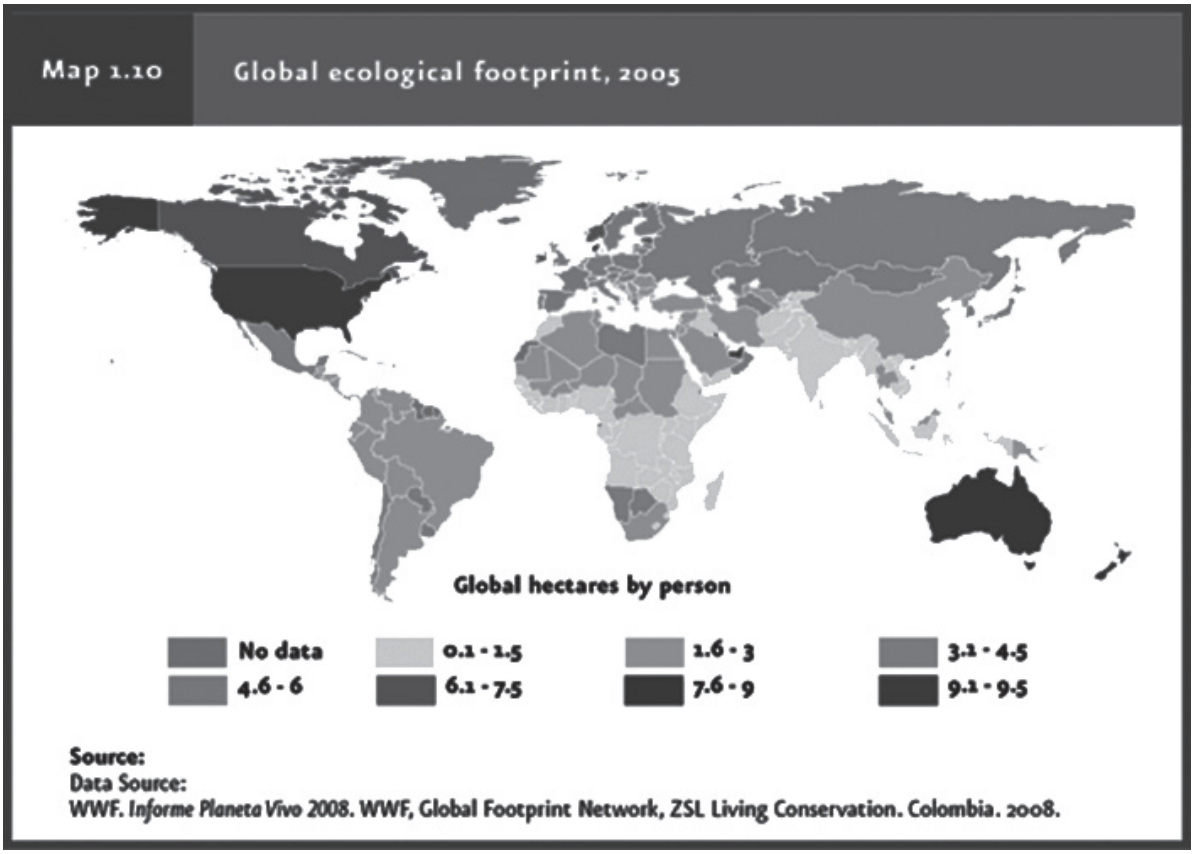
www.worldmapper.org © Copyright 2006 SASI Group (University of Sheffield) and Mark Newman (University of Michigan)

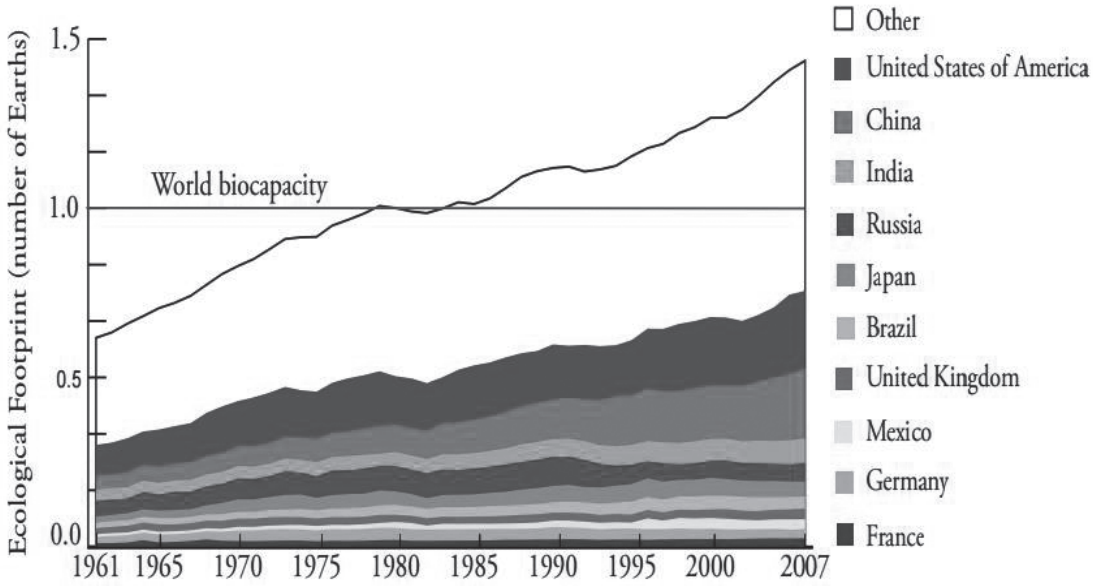
Map 322

STUDENT RESOURCE SHEET 6

Name ---------- Date ----------

Information for students.[23]





Humanity's Ecological Footprint by country, 1961-2007

[23] http://www.footprintnetwork.org/images/uploads/Ecological_Footprint_Atlas_2010.pdf (accessed on 10th November 2015)

10.2 CONSERVING WATER

EB3.3 Describes ways to manage and preserve water

a. Surveys to find out the availability of water / its sources within their locality.

b. Describes ways how people manage water in their community especially focusing on harvest.

EB3.3 Describes ways to manage and preserve water

c. Studies some ways water can be conserved (e.g., conducts a water usage audit and takes necessary actions to minimise water wastage).

ST2.2 Applies the knowledge gained to make informed decisions

a. Identifies and explains events and phenomenon using their scientific knowledge (e.g., germination of seeds and spreading of germs).

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. What type of a resource is water?
2. Will we ever run out of water?
3. How important a recourse is this?
4. How can we make sure we use water so that it is used wisely and sustainably?

The Problem

It is almost at the end of November and Yafaa was planning her visit to her grandmother's island in December. Herself, her mother and little sister would be travelling on a sea-plane to visit her grandmother who lives in *Raa Atoll*.

Two days before their departure, Yafaa was helping her mother wash the dishes after lunch. She turned on the tap and there was no water. She thought her sister was playing a trick and checked the main taps and there was no water from those taps either. She ran into the living room and heard the news: "There had been a fire in the water purification plant in Male' and water was completely cut off from Male' until further notice!" Yafaa was horrified! How could we go on without water for our daily needs? She wondered. Her father came from work and gathered her family and informed that the government has decided that every day for two hours they will get water. This means during those two hours they have to collect as much water they can and use them wisely and conserve as much water as possible. Yafaa had never experienced such water shortage and she wondered what can they all do now to conserve water.

TEACHER'S NOTE

WATER

Water covers two thirds of the planet, but only 2.5% of that amount is fresh water. Most of that is locked into ice caps and glaciers, leaving only 0.08% of the earth's water available for human use. Water must be used wisely if there is to be enough to meet the needs of future generations. An awareness about the amount of water used in everyday tasks is the first step in developing a responsible approach to water use. Alternative ways of carrying out day to day tasks using less water can then be explored.

In the Maldives, the Maldives Water and Sanitation Authority is responsible for the treatment and distribution of desalinated water to Male', *Villingili* and *Hulhumale* for public consumption. In the islands, the island communities have their own sources of drinking water, such as wells and rainwater tanks. Unlike in Male' the island communities do not have experts regularly checking the water quality and wastewater is not treated or used for any purpose.

HOW WE USE WATER

We all use water in many ways that include drinking, bathing, washing and watering our plants, but water is a limited resource. That is why it is important that we all find ways to conserve water every day in every way. Children play an important role in making sure that every drop counts and there are things you can do to help your family save water. If everyone saves a little we can save a lot.

SAVING WATER MAKES GOOD SENSE

The average person uses 190 liters of water a day. If you obtain water from a public water supply, your water bill lets you know that each drop wasted costs you money. Those of us who get our water from private wells are concerned about wells going dry. These simple tips can help us all save money and preserve precious water supplies.

WHAT YOU CAN DO INDOORS TO SAVE WATER

Bathroom

- Turn the tap off when you brush your teeth. If you brush your teeth twice a day, for two minutes each time, and leave the tap running, you could be wasting around 12 litres (or just over a bucket) of water a day. That's over 4,300 litres per person, per year.
- Reduce your showering time. Every minute you cut from your shower time could save up to nine litres of water if you have a water-efficient showerhead, and up to 20 litres if you have an older style, conventional showerhead.
- Use the half flush option when possible on dual flush toilets.
- Install a displacement device in the cistern (tank) of single flush toilets, as it can save you a litre of water every flush. You can do this by removing the lid of your cistern and carefully placing a one litre sealed plastic bottle filled with pebbles and water inside in a way that won't interfere with the flushing mechanism.
- Check for toilet leaks by placing a few drops of biodegradable food colouring into the cistern, and wait for 30 minutes. If you have a leaking toilet, you will see coloured water in the toilet bowl and need to contact a plumber. A slow, barely visible leak into your toilet bowl can waste more than 4,000 litres of water a year. Visible, constant leaks (with a hissing sound) can waste 95,000 litres a year.

Laundry

About 13 per cent of household water is used in the laundry. Conventional top loading washing machines use an average of 120 to 150 litres of water each load. Wash only full loads laundry. Reduce the number of washing loads in a week and save water by combining smaller loads and only washing when you have a full load.

- Adjust the water level to suit the size of your load and use the economy cycle, if your machine has one.
- If you are buying a new washing machine, choose a water-efficient model with a water conservation rating of AAA (or greater). Front loading machines and some water efficient top loaders will save approximately 50 litres of water per load. They are also gentler on your clothes and require less detergent.

Kitchen

- Defrost frozen food in the refrigerator.
- Rinse vegetables in a full sink or bucket of water.
- Rinse dishes in a full sink or bucket of water.

TIPS ON SAFEGUARDING WATER

All of us need clean water to drink. We can go for weeks without food, but only days without water. Contaminated water can be a threat to anyone's health, but especially to young children.

Use Household Products Properly: BE CAREFUL. Many things around the home like paint or cleaners can harm you and cause water pollution if they are not handled and disposed of properly.

- Care For Your Vegetables: Everyone needs to use fertilizers carefully. If too much fertilizer is used, the fertilizer can wash into the sea and cause water pollution.
- Plant Trees and Shrubs: Trees and shrubs help prevent water pollution by soaking up extra fertilizer (nutrients). Plants also prevent erosion by keeping the soil where it belongs on the land and out of the water. Use mulch around shrubs and garden plants to save soil moisture and reduce evaporation.
- Control Bugs Carefully: Not all bugs are bad. It's important to read labels and follow directions when using pesticides (bug sprays). Some pesticides can cause water pollution and even kill friendly insects like ladybugs. Staff at your local Health Centre or other relevant authority can teach your family safe, new ways to control pests.
- Control Rainwater: When lots of rain falls on hard surfaces like paved sidewalks and streets it can run off carrying leaves, waste and car oil into drains. The drains eventually seep into the water lens causing water pollution.[24]

The teacher can pose questions like,

Why is it important to save water?

What type of a resource is water?

What can we do to save water?

How much water do we really use daily?

How much do we waste water?

Use Student Resource Sheet 1: Conserving water - KWL chart.

[24] EDC, UNICEF (2006) Weather, Water, Waste & Energy flipchart

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding water conservation.

Organizing Ourselves

In groups of 4-6 students can discuss why conserving water is important and list down how to go about finding the status of the problem in their families and schools.

Conduct the water Audit Student Resource Sheet 2: How I Use Water.

(They can do the interactive one as well) and calculate their monthly score and determine how water wise they are.

As an optional activity they can do Student Resource Sheet 3: Drinking Water Audit.

STEP 3 NARROW YOUR CHOICES

Based on the findings students plan several areas and ways in which water can be conserved and discuss how they can raise awareness in their family and school to do the same.

These can be noted on: Student Resource Sheet 4; Water Usage Reduction Plans

They can carry out the Extension Activity in Student Resource Sheet 5; Research Project and find out the water wastage in the school as well.

STEP 4 TEST YOUR SOLUTIONS

Students at this stage will be collating, processing, analyzing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have risen when they were investigating.

To verify and add more to the list of water conservation methods, students can be shown the video at the link:

http://wateruseitwisely.com/100-ways-to-conserve/home-water-challenge/

Here, as students watch the video, they can affirm or add more ideas to the list of water conservation methods that they have identified.

(If the link does not work or resources for this is not available, the list in Students Information Sheet2: Water conservation methods, can be given).

Extension Activity

Students will be presenting their poster (10 minutes) to the class and teacher and peers will use the rubric below to assess.[25]

RUBRIC FOR ASSESSING AWARENESS POSTER

	10-8 (Very Good)	**7-5 (Good)**	**4-3 (Satisfactory)**	**2-0 (Not acceptable)**
Graphics	Several graphics used on the poster reflect an exceptional degree of student creativity in the creation and display	One or two of the graphics used on the poster reflect student creativity in the creation and display	The graphics are made by students, but are based on the design or ideas of others	No graphics made by the students included
Required elements	The poster includes all required elements as well as additional and relevant information	All elements required are included in the poster	All but one of the required elements in the posters are included	Several required elements in the poste are missing
Title	Title is easy to read and describes the content very well and is creative too	Title can be read and describes the content well	Title can be read but its too small and does not describe the content too well	Title is too small to read and does not describe the content
Content	At least 5 content aspects are focused and they are accurate and precise	3-4 accurate facts are presented	2 accurate facts are displayed	Less than 2 accurate facts are displayed
Time management	Use time well and focused well on the topic	Usually focused on getting the project done	Use some of the time well, but occasionally distracted by others	Did not use the time to focus on the topic and often distracted

[25] Assessment activities for this PBL case study is developed by Mohamed Riyaz & Hussain Ali

ASSESSMENT FOR GRADE 6

COMMUNITY BASED SURVEY ON WATER USAGE

Set-up

1. For your island, identify and collect samples of water from different sources.
2. For each sample complete the table below.

Sample source	Use	Threat(s)	Recommended ways to sustain this source

3. Collect demographic data about the island population (e.g., total number of males, females, people in the age category of >60yrs, 40-60yrs, 20-40yrs, 10-20yrs and <10yrs).
4. Collect data from the health post or hospital about the common water borne diseases in the island and its occurrences in the past 6 months.
5. Conduct a survey on household daily consumption of water (this can be done for few selected households in the island).
6. Collect information about maximum water availability of water in the island in the form of rain water, well water, etc. (Can focus on the sources identified in step 2 above).[26]

[26] Assessment activities for this PBL case study is developed by Ahemd Asim & Aishath Suraiya

Product

Your final product needs to focus on the following:

1. Evidence of data collection (e.g., data forms, interview questions, etc.).
2. Write a report including the following:
   - The sources of water identified and their potential threats
   - Potential and risk for water borne diseases in the island
   - Recommendation for improvement for water quality
   - Does the island have sufficient potable water for use?
3. Groups will give a 10 minute presentation about their process of data collection and the research they have done.
4. Students should also be ready for answering questions from their peers after the presentation.

	OUTSTANDING	VERY GOOD	SATISFACTORY	POOR	NEED IMPROVEMENT
Validity of the tools used for data collection and the methods used to collect data					
Ability to evaluate the survey data and related to the theoretical concept and explain it in simple and logical manner					
Quality of arguments and justification used (in the recommendations section)					
Overall quality of the presentation of the report (formatting, graphics and animation used)					

STUDENT INFORMATION SHEET 1

The Case of Water Treasure

It is almost at the end of November and Yafaa was planning her visit to her grandmother's island in December. Herself, her mother and little sister would be travelling on a sea-plane to visit her grandmother who lives in Raa Atoll.

Two days before their departure, Yafaa was helping her mother wash the dishes after lunch. She turned on the tap and there was no water. She thought her sister was playing a trick and checked the main taps and there was no water from those taps either.

She ran into the living room and heard the news:

"There had been a fire in the water purification plant in Male' and water was completely cut off from Male' until further notice!"

Yafaa was horrified! How could we go on without water for our daily needs? She wondered. Her father came from work and gathered her family and informed that the government has decided that every day for two hours they will get water. This means during those two hours they have to collect as much water they can and use them wisely and conserve as much water as possible. Yafaa had never experienced such water shortage and she wondered what they all can do now to conserve water.[27]

[27] Image from: http://www.dropbydrop.eu/37938

Water Conservation Methods

INDOOR TIPS

Kitchen

1. When washing dishes by hand, don't let the water run. Fill one basin with wash water and the other with rinse water.
2. Dishwashers typically use less water than washing dishes by hand. Now, Energy Star dishwashers save even more water and energy.
3. If your dishwasher is new, cut back on rinsing. Newer models clean more thoroughly than older ones.
4. Designate one glass for your drinking water each day, or refill a water bottle. This will cut down on the number of glasses to wash.
5. Soak pots and pans instead of letting the water run while you scrape them clean.
6. Use the garbage disposal sparingly. Instead, compost vegetable food waste and save gallons every time.
7. Wash your fruits and vegetables in a pan of water instead of running water from the tap.
8. Don't use running water to thaw food. For water efficiency and food safety, defrost food in the refrigerator.
9. Install an instant water heater near your kitchen sink so you don't have to run the water while it heats up. This also reduces energy costs.
10. Keep a pitcher of drinking water in the refrigerator instead of running the tap. This way, every drop goes down you and not the drain.
11. Reuse leftover water from cooked or steamed foods to start a nutritious soup. It is one more way to get eight glasses of water a day.[28]

[28] http://wateruseitwisely.com/100-ways-to-conserve/ (accessed on 10th November 2015)

Water Conservation Methods

12. Cook food in as little water as possible. This also helps it retain more nutrients.
13. Select the proper pan size for cooking. Large pans may require more cooking water than necessary.
14. If you accidentally drop ice cubes, don't throw them in the sink. Drop them in a house plant instead.
15. Collect the water you use while rinsing fruit and vegetables. Use it to water house plants.

Laundry Room

1. When doing laundry, match the water level to the size of the load.
2. Washing dark clothes in cold water saves water and energy, and helps your clothes retain their color.
3. When shopping for a new washing machine, compare resource savings among Energy Star models. Some can save up to 20 gallons of water per load.

Bathroom

1. If your shower fills a one-gallon bucket in less than 20 seconds, replace the showerhead with a WaterSense labeled model.
2. Shorten your shower by a minute or two and you'll save up to 150 gallons per month.
3. Time your shower to keep it under 5 minutes. You'll save up to 1,000 gallons per month.
4. Toilet leaks can be silent! Be sure to test your toilet for leaks at least once a year.[29]

[29] http://wateruseitwisely.com/100-ways-to-conserve/ (accessed on 10th November 2015)

Water Conservation Methods

5. Put food colouring in your toilet tank. If it seeps into the bowl without flushing, there's a leak. Fix it and start saving gallons.
6. When running a bath, plug the bathtub before turning on the water. Adjust the temperature as the tub fills.
7. Upgrade older toilets with water-saving WaterSense labeled models.
8. If your toilet flapper doesn't close properly after flushing, replace it.
9. Use a WaterSense labeled showerhead. They're inexpensive, easy to install, and can save you up to 750 gallons a month.
10. Turn off the water while you brush your teeth and save up to 4 gallons a minute. That's up to 200 gallons a week for a family of four.
11. If your toilet was installed before 1992, purchasing a WaterSense® labeled toilet can reduce the amount of water used for each flush.
12. Consider buying a dual-flush toilet. It has two flush options: a half-flush for liquid waste and a full-flush for solid waste.
13. Plug the sink instead of running the water to rinse your razor and save up to 300 gallons a month.
14. Turn off the water while washing your hair and save up to 150 gallons a month.
15. When washing your hands, turn the water off while you lather.
16. Take 5-minute showers instead of baths. A full bathtub requires up to 70 gallons of water.
17. Install water-saving aerators on all of your faucets.
18. Drop tissues in the trash instead of flushing them and save water every time.
19. Look for WaterSense labeled toilets, sink faucets, urinals and showerheads.[30]

[30] http://wateruseitwisely.com/100-ways-to-conserve/ (accessed on 10th November 2015)

Water Conservation Methods

20. One drip every second adds up to five gallons per day! Check your faucets and showerheads for leaks.
21. While you wait for hot water, collect the running water and use it to water plants.[31]

[31] http://wateruseitwisely.com/100-ways-to-conserve/ (accessed on 10th November 2015)

Water Conservation Methods

General Indoor

1. Turn off faucets tightly after each use.
2. Watch the Home Water Challenge video or use the Home Water Audit Calculator to see where you can save water.
3. Monitor your water bill for unusually high use. Your bill and water meter are tools that can help you discover leaks.
4. Learn how to use your water meter to check for leaks.
5. Avoid recreational water toys that require a constant flow of water.
6. Grab a wrench and fix that leaky faucet. It's simple, inexpensive, and you can save 140 gallons a week.
7. Be a leak detective! Check all hoses, connectors, and faucets regularly for leaks.
8. We're more likely to notice leaky faucets indoors, but don't forget to check outdoor faucets, pipes, and hoses.
9. See a leak you can't fix? Tell a parent, teacher, employer, or property manager, or call a handyman.
10. At home or while staying in a hotel, reuse your towels.
11. Make suggestions to your employer or school about ways to save water and money.
12. Run your washer and dishwasher only when they are full. You can save up to 1,000 gallons a month.[32]

[32] http://wateruseitwisely.com/100-ways-to-conserve/ (accessed on 10th November 2015)

STUDENT INFORMATION SHEET 1

Water Conservation Methods

Water conservation in the kitchen[33]

[33] Image from: http://cache4.asset-cache.net/gc/200460328-001-dishes-in-sink-with-water-and-suds-gettyimages.jpg

Water Conservation Methods

Water conservation in the bathroom[34]

[34] Image from: http://www.awarenessideas.com/AI-wp360-Turn-off-the-water-while-you-brush-you-p/ai-wp360.htm

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

CONSERVING WATER - KWL CHART

What I know about conserving water	What I want to find out about conserving water	How can I learn more about conserving water

Name ---------- Date ----------

WATER USE AUDIT

How to use this survey

Filling out this survey is intended to give you a general idea of how much water you use each day in and around your home. More detailed information is available on the District's website at floridaswater.com.

In this printed survey, fill in the requested information in each box that applies to your home. Tally the numbers for your indoor use, placing your total in the box provided on page 140. Then do the same on page 141 to record your outdoor water use. Place your indoor water use number and your outdoor water use number in the spaces provided and add together to get your total daily household use. You can also determine daily household water use from a monthly water bill. Divide the number of gallons used (shown on the bill) by the number of days in the billing month.

From either this survey or from your water bill, you can determine the per person water use by taking the daily water use number and dividing by the number of people living in your house.[35]

[35] An interactive version of this survey can be found @ floridaswater.com/waterconservation/survey.html. http://wateruseitwisely.com/100-ways-to-conserve/home-water-audit/

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

INDOOR WATER USE

Showers				
No of people in the household (A)	Total Numbre of showers (B)	Number of minutes on average used (C)	Gallons per minute (D)	Gallons used (A×B× C× D)
			2.5	
Toilet Flushing				
No of people in the household (A)	No of flushes per person in a day (B)		Gallons per flush (C)	Gallons used (A×B× C)
			3.5	
Handwashing				
No of people in the household (A)	Total Numbre of times per day (B)	Minutes on average use (C)	Gallons per minute (D)	Gallons used (A×B× C× D)
			4	
Dishwashing by hand				
No of times washed (A)	Total no of minutes water runs on average use (B)		Gallons per minute (C)	Gallons used (A×B× C)
			4	
Clothes washer				
No. of times used in a week (A)	Gallons per load (Average)(B)		Gallons used ((A/7) × B)	
	30			
Other indoor uses per day			**Gallons used**	
Total Indoor Used				

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

OUTDOOR WATER USE

Outdoor uses per day	Gallons used
Total Indoor Used	

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

JUDGE YOUR SCORE

Determine your monthly score and use the chart below to judge how much water you use.[36]

Total family water use per day

Indoor daily total		Outdoor daily total		Gallons used
	+		=	

	Gallons used this month		Number of people in household		Number of days in month		Gallons per person every day
If in CCF units	18 ccf 18 x 748= 13,464	÷	4 people 13,464÷ 4= 3,366	÷	30 days 3,366÷30= 112.2	=	112 gal. per person/day
If in 1000 gal. units	14 units 14 x 1000= 14,000		4 people 14,000÷ 4= 3,500		30 days 3,500 30= 116		116 gal. per person/day
Insert your numbers							

Rating Your Results

Excellent: 30-80 gallons per person/day
Good: 81-150 gallons per person/day
Fair: 151-300 gallons per person/day
You Need Help! 300 or above

[36] http://wateruseitwisely.com/toolkit/ (accessed on 10th November 2015)

STUDENT RESOURCE SHEET 3

Name ---------- Date ----------

DRINKING WATER AUDIT (OPTIONAL)

	DATE:		DATE:		DATE:	
	NUMBER OF TIMES	LITRES USED	NUMBER OF TIMES	LITRES USED	NUMBER OF TIMES	LITRES USED
Cooking						
Drinking (yourself)						
	TOTAL:		TOTAL:		TOTAL:	
AVERAGE LITRES OF WATER USED A DAY:						

SOME WATER FACTS:

- Cooking a meal uses around 10 litres of water.
- Washing dishes in a sink uses about 9 litres of water.
- Washing clothes by hand can use up to 60 litres, washing machines can use 155 litres per cycle.
- A 2 minute shower can use 30 litres of water.
- Flushing a toilet needs 11 litres of water.[37]

[37] EDC, UNICEF (2008) Water Modules

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

WATER USAGE REDUCTION PLANS

Based on these students list areas of water use where they can minimize the amount used. For each identify how it will be done.

Areas of water use that can be minimized	How can it be done

Name ---------- Date ----------

RESEARCH PROJECT – EXTENSION (OPTIONAL)

BE A WATER WISE DETECTIVE AND CHECK OUT WATER WASTAGE AT YOUR SCHOOL

In groups, go through the school and make a list of the following:

- The number of leaking taps.
- The number of taps left open after break.
- The number of broken and constantly running toilets.
- The number of sprinklers and hosepipes used to water plants all day.
- How water is used to clean, for example, are cleaners wasting water by hosing down corridors or quads?
- The plants at your school that are not indigenous and so require a lot more water than indigenous plants.
- Any other water wastage that you notice.
- Write up all the water wastage problems you discover.
- Suggest solutions to water wastage to help your school use water and money wisely. As a class, put your solutions into action!

11.2 CONSERVING ENERGY

EC1.2 Classifies energy types as renewable and non-renewable and understands the impacts of using both types.

a. Discusses practices designed to conserve energy.

45 minutes X 2 periods

Instruct students to follow the DENT (Define, Explore, Narrow and Test).

STEP 1 DEFINE THE PROBLEM

Explain the steps in problem based learning approach (DENT) and introduce the problem.

FOCUS QUESTIONS

1. How do we use energy?
2. How can we use it more efficiently?

TEACHER'S NOTES

In the past the Maldives relied mainly on renewable energy sources. All traditional fishing boats were sailboats, the sun helped to dry the tuna and the trees available on the island provided firewood. However, with the development of the Maldives as a major tourist destination, increased standards of living and changes in lifestyle, the Maldives is now a very different place. Now the Maldives uses diesel fuel, a fossil fuel, for transport and electricity generation. However, diesel fuel is made from oil and the price of oil continues to get higher and higher. So the more fuel we use the more expensive it is becoming. Also, the more fuel we burn can cause local air pollution and contribute to global issues, such as global warming.

With the increase in the number of high-rise buildings with air-conditioners and other appliances (such as TVs, refrigerators, hot water systems, washing machines, ovens, etc.) the demand for electricity has been going up significantly in recent years. However, it is not just our homes that consume electricity- it is also nonresidential buildings such as schools and offices that use a lot of energy. This is partly due to the use of air-conditioning throughout such buildings.

Also in the Maldives transport consumes a lot of diesel because we need to transport people, food and materials long distances by boat or plane. Also on many islands, especially Male' there has been a huge jump in the number of bikes and cars on the island which has increased local air pollution, energy use and congestion. In 1990 there were only 3000 motorcycles in the Maldives, but by 2003, there were 17,000 motorcycles and 2100 cars! [38]

The Problem

Haa Alif Uligamu have relied on diesel generated power for all their electricity needs. Imported diesel is very costly, and inefficient because most generators operate under or over capacity. Poor fuel efficiency translates into more fuel burned and elevated greenhouse gas emission. This also means that electricity bills for these islanders are very high.

Due to high costs, availability and transportation costs, diesel consumption on remote island communities continues to pose a large issue. Many such islands cannot afford 24 hour power.

In order to address this issue, the government and with help of other donors, a wind and solar based renewable energy system was established in three islands, inducing *Haa Alif Uligamu*. It is said that this system will save approximately 120,000 liters of diesel in the three pilot study islands and a corresponding reduction of 200 tons of CO_2 per year," says Dr. Chem Nayar, professor of electrical engineering at Australia's Curtin University, an authority renewable energy electronics systems and designer of the system. "If the project is extended to 80 remote islands, the Maldives will save 10 million liters of imported diesel fuel."

Explore more about these three island's experiences with the renewable energy source usage.

How would you advocate more utilization of such energy sources in the Maldives? [39]

HA Uligamu Solar Energy Wind Mills

[38] Ministry of Environment, Energy and Water, (2005)

[39] windup.pt/resources/Skystream_Case%20Study_Maldives.pdf (accesed on 10th August 2015)

TEACHER'S NOTES

Good websites for teachers for background referencing:

- www.globalislands.net/userfiles/Maldives4.pdf
- ww.environment.gov.mv/.../20131212-Pub-Maldives-20131212-Pub-Maldives-National-Energy-Policy-and-Strategy-2010.pdf

OR

It was a very sunny afternoon and Zahura was watching TV in the sitting room. She was sweating and decide to turn on the AC and set it at 16°C. It still was not cooling her as fast as she wanted to. So she opened the window hoping to catch a wind breeze. It was at this instance her father came back from work. "Zahura, what are you doing", her father tapped her on the shoulder and asked. Zahura smiled and replied that it was too hot and she wanted to cool off.

Zahura's father sat beside her said "My dear daughter, we need to be more careful in how we use electricity. We need to use it wisely. Think about the electricity bill we get every month. It is rising month by month and if we are to spend most of my and your mother's hard earned money on electricity bills, how can we afford all our other expenses? So my dear you need to be a bit more careful in how you use electricity".

Zahura looked up at her father and replied, "Daddy, I promise I will try and use electricity wisely in the future. What should I do to reduce the electricity bills and make sure I use energy wise?"

Let us explore and try to answer Zahura's question and come up with ways to minimize electricity use.

The teacher can pose questions like,

- **What is energy?**
- **Where do you think energy comes from?**
- **What are some things you can think of that use energy?**
- **Which appliances do you use the most?**
- **Which energy uses are essential and which ones could be reduced?**
- **What predictions can we make about the most energy intensive items and practices in our homes?**
- **How can we check our predictions? Use this question to lead into the idea of conducting an energy audit.**

Use Student Resource Sheet 1: Energy - KWL chart.

STEP 2 EXPLORE POSSIBLE SOLUTIONS

The following activities will assist students to decide on exploring the aspect that they wish to research regarding the waste management in the island. Using the ideas that have been raised in the previous activity (focus questions), ask the students to develop hypotheses or questions they want answered concerning the energy use in school and at home. The following activity will guide the students in their investigations of energy use in school and at home.

How do we use energy in our homes?

Ask groups to complete a four square sheet to answer the question 'How do we use energy in our homes?' Ask students to fold an A4 piece of paper to create 4 boxes. Students will then ask 4 other students in the group to help them answer the question by writing or drawing one possible answer in one of the boxes. Students should write their name under their text or drawing.

Next, ask students to cut the 4 boxes on their sheet apart. As a whole class create a pictograph of the variety of answers (Refer Teacher Information Sheets for details).

Encourage students to analyze the information represented on the pictograph. To prompt this analysis, ask questions such as:

- What are the most common responses?
- What are the least common responses?
- What answers to the question did you not think of?
- Were people who provided one answer more or less likely to also provide another specific answer? (Use the names on the bottom of the pictures to conduct this kind of comparison).

Once the graph, as a whole has been discussed in this way, change the focus of the discussion to look at the specific themes represented. Ask questions such as the following to help students think more deeply about the role of energy in our lives:

- Can we do this activity without electricity?
- How has electricity changed the way we do this activity?
- How did our grandparents do this?
- If they couldn't do an activity without electricity, what did they do instead? (E.g. what did they do before the introduction of TV)?

Encourage students to talk to their parents and grandparents about these issues. Provide time for students to construct a list of the kinds of things they would like to ask. Questions might include:

- How did you cook?
- How did you light your house?
- What did you do without a TV?
- Would you be happy to live without electricity again?
- What are the best and worst things about living without electricity?
- What are the best and worst things about living with electricity?

Provide time for students to share the answers their families have given with each other. This could happen in small group discussions, or could take the form of story writing or drawings.

Student Resource Sheet 2: Answers provided by parents

Organizing Ourselves

From the questions that have been raised by previous discussions on how do we use energy at home identify the steps that need to be taken for further study to occur. The following may need to be considered: Discuss about ways of conducting a classroom audit.

STEP 3 NARROW YOUR CHOICES

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

Classroom energy audit

Explain the concept of an audit as a monitoring and counting up of something specific in a certain location. In this case it is looking at how many things in our house or classroom use energy and for how long each day. The audits will make clear the context for energy use.

Guide a group discussion about how to conduct an audit of the classroom using the following questions (and others as appropriate):

- What are the most common ways we use energy in our classroom?
- How many lights are there in our classroom? How long are they on for? Who turns them on and off?
- Do we use any appliances (e.g., Computer, Radio or TV)? How often? How long are they on for? Who turns them on and off?

Have students complete Student **Resource Sheet 3 – Classroom energy audit** and compare results. Ensure that everyone is clear on what to count and how to record the information. Ask students about how they estimated how long lights and fans are left on for each day. Talking about this will help students when they come to audit their homes individually.

In small groups, have students graph the findings of the classroom audit. Display these graphs and give the students time for a Gallery Walk (see Teacher Information for details on this) in which everyone can view the graphs made by other groups.

School energy audit

Next, ask students to conduct an audit of the school in small groups. Give each group a copy of Student Resource Sheet 4 (school energy audit) to fill in. Findings can be similarly graphed and tabled to give students more practice with these forms of visual presentation of information.

Home energy audit

Students are now prepared to conduct individual household audits. Student Resource Sheet 3 provides a form to guide a home energy audit. Older students can create their own format for a household audit, or can modify the form provided.

If creating their own audit form, encourage students to consider the following:

- What kinds of things will you be looking at? Use ideas generated in the 'tuning in' activity as a starting point.
- What kinds of appliances will you need to look at?
- What kind of measures will indicate the amount of energy we use (e.g. how many lights in the house and how long are they on for each day)?

Students can then graph their home audit information and display for others to see. Class tallies can be made which will allow comparisons between the different households represented to be made. You can use the audit form in Student Resource Sheet 5 (Home energy audit) to facilitate the tallying process. Questions such as the following may help you guide this discussion:

- What is the most popular time of day for lights to be on?
- What kind of lights do most homes use?
- What are the most commonly used appliances?
- What is the least used appliance?

- What is the appliance that is on for more hours than any other appliance?
- What appliances are least likely to be turned off properly?
- What mode of transport do most people use?

How do we use energy?

Group discussion of the following questions and activities should lead to students being able to recognize differences in energy use between different homes, reasons for these differences and, in some instances, how energy use might be reduced through behaviour change.

What did you find? Did your family use more or less energy than you anticipated?

Compare the graphs of different students' homes. What are some of the factors in each of our lives that contribute to different levels of energy use (e.g., number of people in the family, age of people in the family, number of appliances different families have, etc.)? Talk through the differences in different families that result in different patterns of energy use.

Why are some appliances used more than others?

Encourage students to think about what impacts on our energy use. Compare energy use at school and home and help students think about what the differences are between how we use energy in these two locations. Topics to cover in discussions may include:

- Energy helps us create good studying conditions at school.
- We don't eat at school so don't need cooking facilities or a fridge.
- At home we use energy for entertainment – e.g. TV, stereo.
- More people benefit from the energy used at school as there are more people in the classroom.
- I have more individual control over my energy use at home as it is often only me that is affected by my energy use decisions.

STEP 4 TEST YOUR SOLUTIONS

Students at this stage will be collating, processing, analyzing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be opportune time to revisit some of the initial activities from the information sought on the energy use in school and at home by referring to the energy audits. Brainstorm on how we use less energy.

As a group, discuss ideas for reducing energy use in the classroom. Develop a list of possibilities and conduct a class vote on which changes students would like to make (e.g. voting about turning on lights rather than automatically turning them on).

To support these actions, create an energy reduction ideas chart for display in the classroom.

In groups students can create signs, prompts and posters for school and home to help each other remember which energy saving actions they are trying to take. These prompts might be signs to be stuck on light switches to remind people to turn them off, prompts on fan controls to check the temperature before turning it on (have a temperature agreed to), prompts to remind people to turn off appliances, etc.

This can be followed up a week or so later with a discussion about how the process of change is going. Consider questions such as:

- Is it easy to use less energy?
- Do you often forget to ask others before you turn the lights on?
- Have the prompting signs helped?

You could consider appointing a rotating energy monitor to check that things are turned off if students feel they need more support in making the changes agreed to.

Encourage students to have similar conversations with their families about using less energy at home as appropriate.

Provide opportunities in class for students to share stories of energy savings at home as a way to celebrate changes. (Be careful not to 'penalize' those whose homes are not participating.)

Additional celebration and ongoing reinforcement could be carried out by follow up monitoring of classroom energy use to see if reductions have been made or sustained one or two months later. This would also provide ongoing practice with and reinforce use of charts/graphs/tables as useful tools for comparative purposes when follow up monitoring is undertaken.

- What would students like to add to the ideas they had at the beginning?
- What things would they like to change?[40]

[40] EDC, UNICEF (2008) Module on schools for a healthy environment

ASSESSMENT

As assessment students in their groups will conduct a survey about the use and awareness of renewable and non-renewable sources of energy consumption in their islands, schools and home.

This will be presented to the class.[41]

CRITERIA	5	4	3	2	1
Achievement of the objectives of the task	Objectives of the task fully achieved	Most of the objectives of the task achieved	Objectives of the task achieved to some extent	Few objectives of the task achieved	Objectives of the task not achieved
Content	All the information presented is clear, accurate and thorough	Most of the information presented is clear, accurate and thorough	Most of the information presented in the project was clear, and accurate, but not thorough	Information has several inaccuracy or was usually not clear	Information is irrelevant and not clear at all
Organization	Information is presented in a logical order and easy to follow	Information is presented in a logical order, but is still not generally easy to follow	Information is not presented in a logical order, making it difficult to follow occasionally	Information is not presented in a logical order, making it difficult to follow to a great extent	Information is not presented in a logical order, making it unable to follow
Creativity	A lot of thought was put into making the poster presentation and is interesting and informative	Some thought was put into making the poster presentation and is interesting and informative	Some thought was put into the effort of making the presentation informative, but some of the things in it made it harder to understand	Little thought was put into the effort of making the presentation interesting and informative	Not able to put any thought into making the presentation and is not interesting nor informative

[41] Assessment activities for this PBL case study is developed by Abdulla Adam & Hussain Shareef

Time management	Use time well and focused on the topic	Usually focused on time and presenting the paper work	Some of the parts are covered in the given time	Little or few parts are covered in the given time	Time management is very poor

STUDENT INFORMATION SHEET 1

Name ---------- Date ----------

The Story of Haa Alif Uligamu

Rural islands in the Maldives such as *Haa Alif Uligamu* have relied on diesel generated power for all their electricity needs. Imported diesel is very costly, and inefficient because most generators operate under or over capacity. Poor fuel efficiency translates into more fuel burned and elevated greenhouse gas emission. This also means that electricity bills for these islanders are very high.

Due to high costs, availability and transportation costs, diesel consumption on remote island communities continues to pose a large issue. Many such islands cannot afford 24 hour power.

In order to address this issue, the government and with help of other donors, a wind and solar based renewable energy system was established in three islands, inducing *Haa Alif Uligamu*. It is said that this system will save approximately 120,000 liters of diesel in the three pilot study islands and a corresponding reduction of 200 tons of CO_2 per year," says Dr. Chem Nayar, professor of electrical engineering at Australia's Curtin University, an authority renewable energy electronics systems and designer of the system. "If the project is extended to 80 remote islands, the Maldives will save 10 million liters of imported diesel fuel."

Explore more about these three island's experiences with the renewable energy source usage.

How would you advocate more utilization of such energy sources in the Maldives?[42]

HA Uligamu Solar Energy Wind Mills

[42] windup.pt/resources/Skystream_Case%20Study_Maldives.pdf (accessed on 10th August 2015)

STUDENT RESOURCE SHEET 1

Name ---------- Date ----------

ENERGY - (KWL CHART)

What I know about energy	What I want to find out about energy	How can I learn more about energy

STUDENT RESOURCE SHEET 2

Name ---------- Date ----------

Answers provided by parents

Kinds of activities	**What was done by parents and grandparents**
How did you cook?	
How did you light your house?	
What did you do without a TV?	
Would you be happy to live without electricity again?	
What are the best and worst things about living without electricity?	
What are the best and worst things about living without electricity?	

STUDENT RESOURCE SHEET 3

Name ---------- Date ----------

CLASSROOM ENERGY AUDIT

WHAT USES ENERGY IN OUR CLASSROOM?	HOW MANY ARE THERE IN THE CLASSROOM?	WHEN ARE THER TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
Lights	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
Fans	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day

STUDENT RESOURCE SHEET 3

Name ---------- Date ----------

EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET 3 – CLASSROOM ENERGY AUDIT

WHAT USES ENERGY IN OUR CLASSROOM?	HOW MANY ARE THERE IN THE CLASSROOM?	WHEN ARE THER TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
Lights	☐ none ☐ 1 ☐ 2 ☑ 3+	☑ morning ☐ lunchtime ☑ afternoon ☐ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Fans	☐ none ☐ 1 ☑ 2 ☐ 3+	☐ morning ☐ lunchtime ☑ afternoon ☐ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day

Name ---------------------------------- Date ------------------------------

ENERGY AUDIT

1. LIGHTING

ROOMS IN MY HOME	HOW MANY LIGHTS IN EACH ROOM?	WHAT KIND OF LIGHTS ARE USED?	WHEN ARE THEY TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ ________	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day

STUDENT RESOURCE SHEET 4

Name ----------------------------------- Date ------------------------------

2. TRANSPORT

REASON FOR TRAVEL	MODE OF TRANSPORT	LENGTH OF TRIP	ALTERNATIVE
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice

Name ----------------------------------

Date -----------------------------

3. APPLIANCES

WHAT APPLIANCES ARE USED IN YOUR HOUSE?	WHEN ARE THEY TURNED ON? (TICK ALL THAT APPLY)	HOW LONG ARE THEY USED FOR? LESS THAN 1 HOUR, 1-4 HOURS, ALL THE TIME	ARE THEY TURNED OFF PROPERLY AFTER USE?
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET 4 – SCHOOL ENERGY AUDIT

1. LIGHTING

ROOMS IN MY HOME	HOW MANY LIGHTS IN EACH ROOM?	WHAT KIND OF LIGHTS ARE USED?	WHEN ARE THEY TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
Living Room	☐ none ☐ 1 ☐ 2 ☑ 3+	☑ light bulb ☐ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Kitchen	☐ none ☑ 1 ☐ 2 ☐ 3+	☐ light bulb ☑ strip lamp other ☐ _____	☑ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Bedroom 1	☐ none ☑ 1 ☐ 2 ☐ 3+	☑ light bulb ☐ strip lamp ☐ other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day
Bedroom 2	☐ none ☑ 1 ☐ 2 ☐ 3+	☑ light bulb ☐ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Bathroom	☐ none ☑ 1 ☐ 2 ☐ 3+	☐ light bulb ☑ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day
Other Rooms				

Name ---------- Date ----------

2. TRANSPORT

REASON FOR TRAVEL	MODE OF TRANSPORT	LENGTH OF TRIP	ALTERNATIVE
	☑ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☑ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☑ could have ridden bicycle ☐ no choice
	☑ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☑ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☑ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☑ rode scooter ☐ went by car/ taxi ☐ went by boat	☑ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☑ could have walked ☑ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☑ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☑ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☑ no choice

STUDENT RESOURCE SHEET 4

Name ---------- Date ----------

3. APPLIANCES

WHAT APPLIANCES ARE USED IN YOUR HOUSE?	WHEN ARE THEY TURNED ON? (TICK ALL THAT APPLY)	HOW LONG ARE THEY USED FOR? LESS THAN 1 HOUR, 1-4 HOURS, ALL THE TIME	ARE THEY TURNED OFF PROPERLY AFTER USE?
TV	☐ morning ☐ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☑ no, they are left on stand by mode
Radio	☑ morning ☑ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Stereo	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☐ yes ☑ no,they are left on ☐ no, they are left on stand by mode
Fridge	☑ morning ☑ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☐ 2-4 hours ☑ all day	☐ yes ☑ no,they are left on ☐ no, they are left on stand by mode
Electric stove	☐ morning ☐ lunchtime ☑ afternoon ☐ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Fan	☐ morning ☐ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Other	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode

STUDENT RESOURCE SHEET 5

Name ----------------------------------- Date ------------------------------

HOME ENERGY AUDIT

1. LIGHTING

ROOMS IN MY HOME	HOW MANY LIGHTS IN EACH ROOM?	WHAT KIND OF LIGHTS ARE USED?	WHEN ARE THEY TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day
	☐ none ☐ 1 ☐ 2 ☐ 3+	☐ light bulb ☐ strip lamp other ☐ _______	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day

STUDENT RESOURCE SHEET 5

Name ---------------------------------- Date -------------------------------

2. TRANSPORT

REASON FOR TRAVEL	MODE OF TRANSPORT	LENGTH OF TRIP	ALTERNATIVE
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice
	☐ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☐ could have ridden bicycle ☐ no choice

Name ---------------------------------   Date ------------------------------

3. APPLIANCES

WHAT APPLIANCES ARE USED IN YOUR HOUSE?	WHEN ARE THEY TURNED ON? (TICK ALL THAT APPLY)	HOW LONG ARE THEY USED FOR? LESS THAN 1 HOUR, 1-4 HOURS, ALL THE TIME	ARE THEY TURNED OFF PROPERLY AFTER USE?
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode
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STUDENT RESOURCE SHEET 5

Name ---------- Date ----------

EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET 4 – HOME ENERGY AUDIT

1. LIGHTING

ROOMS IN MY HOME	HOW MANY LIGHTS IN EACH ROOM?	WHAT KIND OF LIGHTS ARE USED?	WHEN ARE THEY TURNED ON?	HOW LONG ARE THEY LEFT ON FOR?
Living Room	☐ none ☐ 1 ☐ 2 ☑ 3+	☑ light bulb ☐ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Kitchen	☐ none ☑ 1 ☐ 2 ☐ 3+	☐ light bulb ☑ strip lamp other ☐ _____	☑ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Bedroom 1	☐ none ☑ 1 ☐ 2 ☐ 3+	☑ light bulb ☐ strip lamp ☐ other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day
Bedroom 2	☐ none ☑ 1 ☐ 2 ☐ 3+	☑ light bulb ☐ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day
Bathroom	☐ none ☑ 1 ☐ 2 ☐ 3+	☐ light bulb ☑ strip lamp other ☐ _____	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day
Other Rooms				

Name ---------- Date ----------

2. TRANSPORT

REASON FOR TRAVEL	MODE OF TRANSPORT	LENGTH OF TRIP	ALTERNATIVE
	☑ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☑ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☑ could have ridden bicycle ☐ no choice
	☑ walked ☐ rode bicycle ☐ rode scooter ☐ went by car/ taxi ☐ went by boat	☐ under 5 minutes ☑ 5-10 minutes ☐ 10-15 minutes ☐ more than 15 minutes	☐ could have walked ☑ could have ridden bicycle ☐ no choice
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STUDENT RESOURCE SHEET 5

NAME ---------- DATE ----------

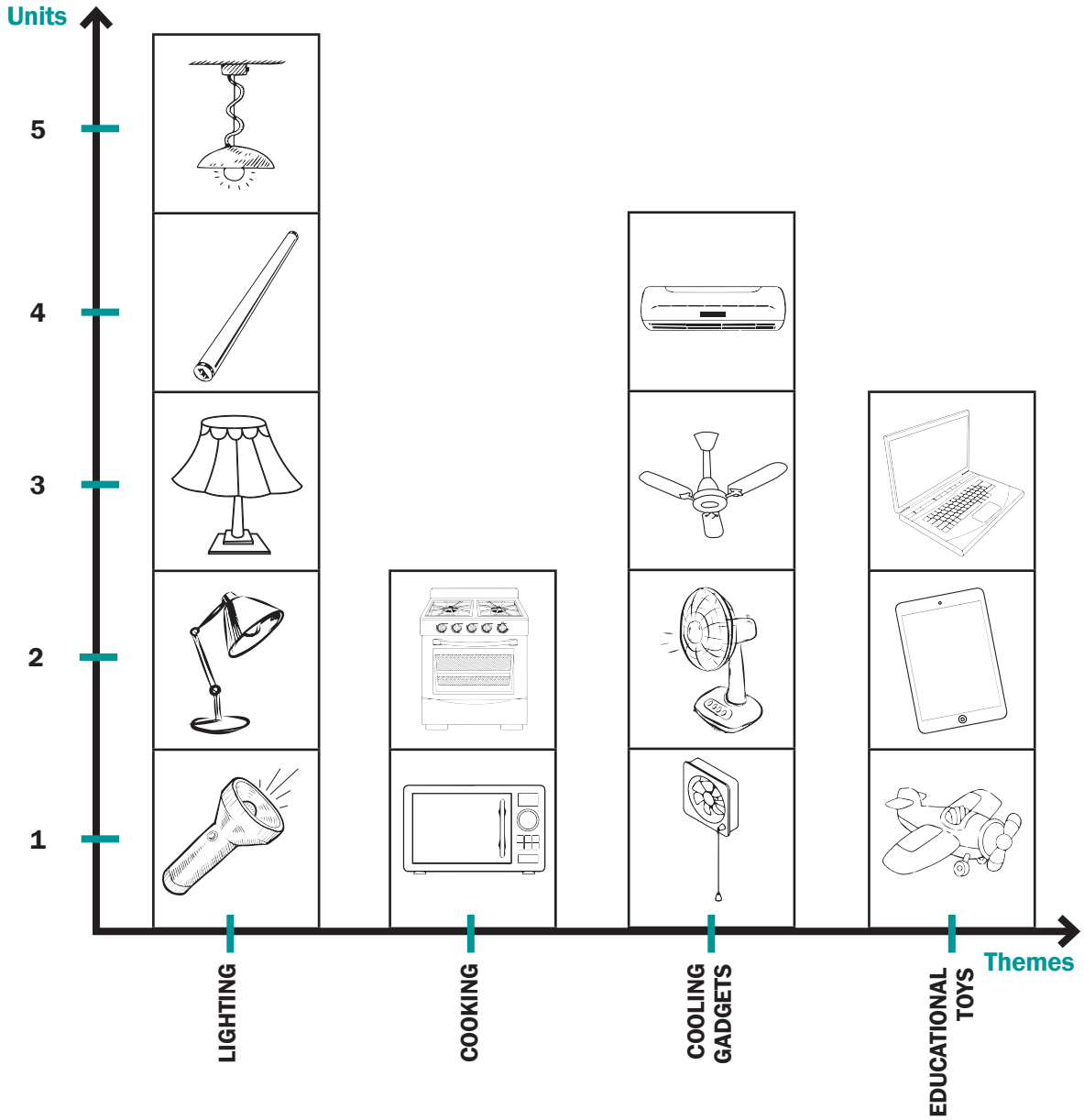
3. APPLIANCES

WHAT APPLIANCES ARE USED IN YOUR HOUSE?	WHEN ARE THEY TURNED ON? (TICK ALL THAT APPLY)	HOW LONG ARE THEY USED FOR? LESS THAN 1 HOUR, 1-4 HOURS, ALL THE TIME	ARE THEY TURNED OFF PROPERLY AFTER USE?
TV	☐ morning ☐ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☑ no, they are left on stand by mode
Radio	☑ morning ☑ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Stereo	☐ morning ☐ lunchtime ☐ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☐ yes ☑ no,they are left on ☐ no, they are left on stand by mode
Fridge	☑ morning ☑ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☐ 2-4 hours ☑ all day	☐ yes ☑ no,they are left on ☐ no, they are left on stand by mode
Electric stove	☐ morning ☐ lunchtime ☑ afternoon ☐ evening	☑ up to 1 hour ☐ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Fan	☐ morning ☐ lunchtime ☑ afternoon ☑ evening	☐ up to 1 hour ☑ 2-4 hours ☐ all day	☑ yes ☐ no,they are left on ☐ no, they are left on stand by mode
Other	☐ morning ☐ lunchtime ☐ afternoon ☐ evening	☐ up to 1 hour ☐ 2-4 hours ☐ all day	☐ yes ☐ no,they are left on ☐ no, they are left on stand by mode

PICTOGRAPH

A pictograph is a way of representing quantities by using pictures. In this context, a graph framework is used in which the vertical axis marks the number of times a theme is depicted and the horizontal axis marks the different themes that are represented. The bars on the graph are made up of the boxes students have written or drawn on for each other, which depict answers to the question 'How do we use energy in our homes?'

The columns along the horizontal axis could be lighting, cooking, cooling, electrical home appliances. The vertical axis should count each box as 1 unit. Each box will have a different student's writing or drawing that relates to the theme of the column (e.g. column 1 is lighting so the boxes may have pictures of overhead lights, lamps, fluorescent tubes, or the word 'lights' written in English or *Dhivehi*).



GALLERY WALK

A gallery walk is an opportunity for students to view each other's work. When students have visually presented what they have learnt, posters, graphs, concept maps, etc. can be put up on the wall and students given time to walk around the room looking at each other's work.

INTRODUCTION TO ENERGY

Where does energy come from?

Energy comes from a variety of sources including:

- Food for people and animals.
- Electricity is made from burning petrol and oil, coal, natural gas. These are non-renewable sources.
- Electricity can also be made from the movement of water (hydro) and wind, from biomass or from the sun (solar) directly. These are all renewable sources.
- Nonrenewable sources of energy will run out. Renewable sources will not. Currently most of the world is reliant on non-renewable sources. We need to develop our ability to generate electricity from renewable sources.

In the Maldives there are no known reserves of oil, natural gas or coal, so all non-renewable energy producing resources must be imported. Diesel is the most commonly imported source, but petrol, kerosene and LPG are also imported.

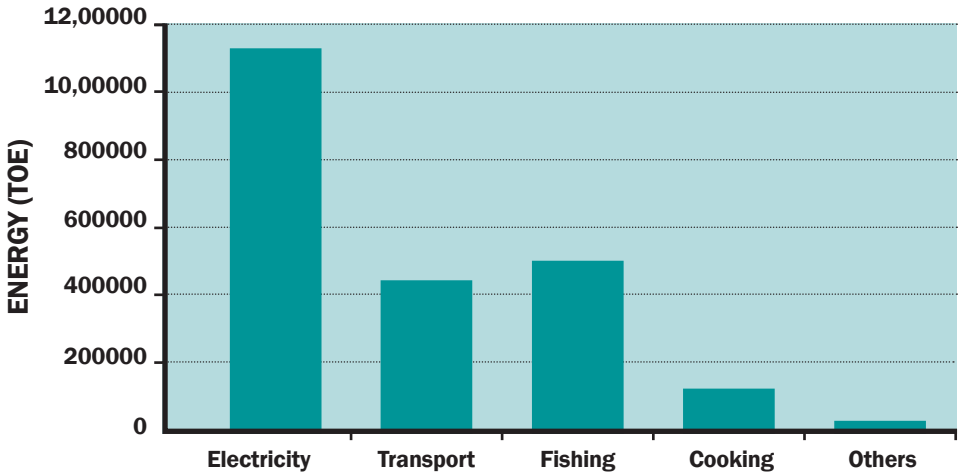
Electricity in the Maldives is primarily produced by diesel generators.

Wind, solar and biogas sources are beginning to be used in pilot locations such as Baa Atoll Goidhoo and Raa Atoll Fainu.

Firewood is also burned for energy – cooking, combating mosquitoes, etc.

How do we use energy?

The most common ways of using energy in the Maldives are shown in the table below. Almost 50% of energy is used to make electricity. 43% is used for transport and fishing combined.[43]



[43] Primary energy usage for different sectors in the Maldives (2002). Graph taken from http://www.meew.gov.mv/energy/

Different atolls use and generate energy differently, as the following table showing types of energy used for cooking reveals.

TYPE OF ENERGY USED FOR COOKING 2004			
ATOLL	**WOOD**	**KEROSENE**	**GAS**
Haa Alif	39	51	20
Haa Dhaal	50	42	28
Shaviyani	37	33	30
Noonu	40	40	33
Raa	42	43	34
Baa	43	58	38
Lhaviyani	47	70	24
Kaafu	29	24	61
Alif Alif	33	25	60
Alif Dhaal	43	32	79
Vaavu	14	65	38
Meemu	47	57	44
Faafu	33	32	35
Dhaalu	23	26	50
Thaa	16	53	41
Laamu	73	48	42
Gaafu Alif	10	42	43
Gaafu Dhaal	49	51	39
Gnaviyani	0	66	62
Seenu	0	59	59
Male	0	25	77

TRANSPORT

Marine transport is the most significant form of transport in the Maldives and can be broken down into 4 categories – fishing, transfer of tourists, passenger ferries and cargo, and pleasure craft and others. These all use either diesel or petrol to power them.

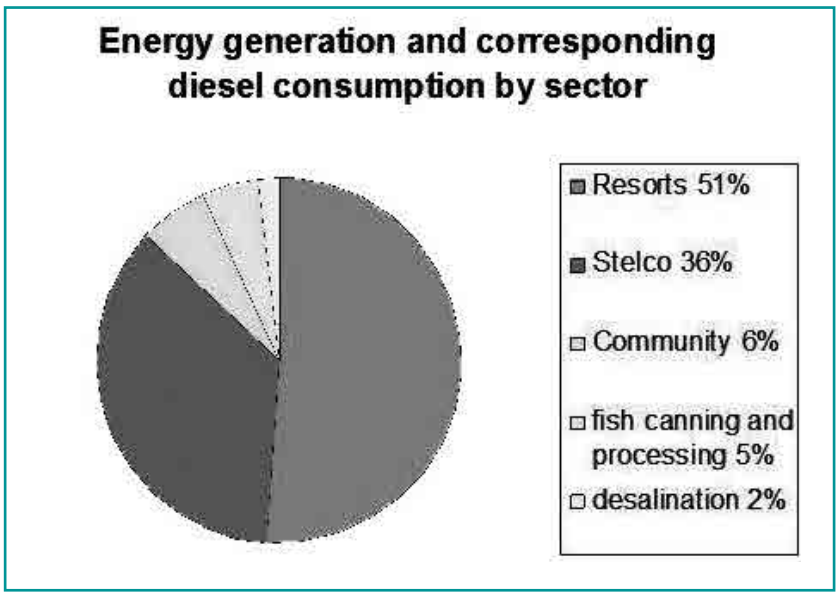
More than 95% of all registered vehicles are in Male.

Vehicle ownership, especially motorcycles, has increased rapidly in recent years. The following table shows how many cars and motorcycles were owned in 2002 compared to 2004.[44]

TYPE OF VEHICLE	2002	2004
Motorcycle	8889	14448
Car	1361	1757

The community uses only 6% of all the energy generated in the Maldives, but everyone needs to be more careful about energy use, as it is expensive to produce. The diagram below shows how much energy different sectors use in the Maldives.

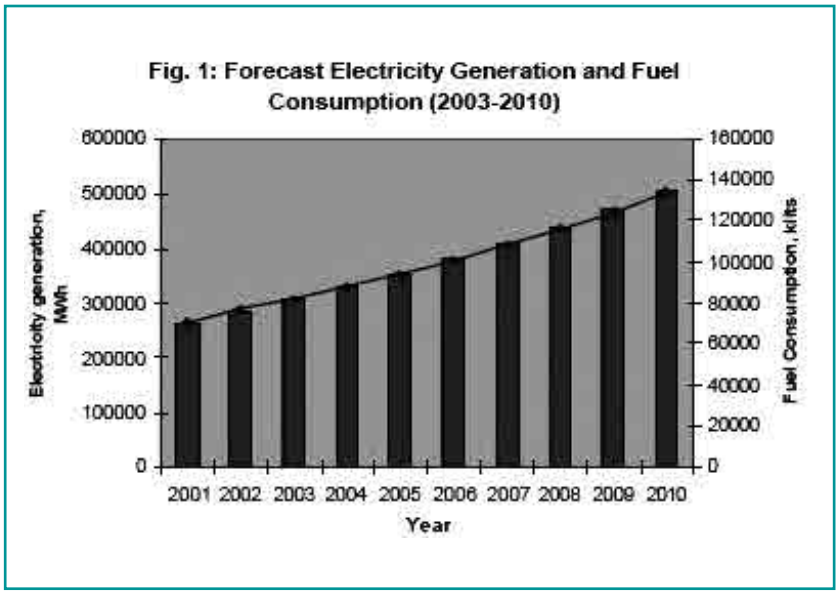
WHY DO WE NEED TO USE ENERGY MORE EFFICIENTLY?



We need to use energy more efficiently as it is expensive to produce. All fossil fuels have to be imported into the Maldives and renewable energy sources are still being developed. If energy consumption continues to grow, as is predicted (see graph below), it will be more difficult to everyone's needs.

[44] Ministry of Environment, Energy and Water Report, (August 2006) Development of a Technology Needs Assessment Resource Kit: Data for Estimation of GHG Emissions

Using fossil fuels to generate energy creates greenhouse gases, which contribute to climate change.



ENERGY USE AND GLOBAL WARMING

The atmosphere acts as a natural greenhouse trapping the Sun's heat near the Earth's surface keeping our planet at the right temperature. Without this 'Greenhouse Effect' we would not be able to survive on Earth. However, our modern life and the growth in the global population are causing huge changes to this natural 'Greenhouse Effect'. Whenever we use energy in our cars and boats, we use fossil fuels such as diesel and this adds large amounts of greenhouse gases, especially carbon dioxide, to the atmosphere. These gases are trapping more heat on Earth causing the Earth to heat up- this is known as Global Warming. Many scientists are concerned that increased temperatures will lead to sea level rises and changes to our climate (e.g. some countries may experience drier climates).

In the Maldives such changes may lead to changes in fisheries, as tuna may migrate to places with more favourable temperatures (MoEC, 2004). Also, corals have a limited range of temperatures that they can survive in, so if temperatures rise, the coral reefs may also be affected. This is a major concern for the Maldives.

Although the Maldives is a small country and contributes very little to global greenhouse emissions (0.01%) it is very susceptible to the impacts of global warming (MoEC, 2004). However, the Maldives has played a major role in raising awareness about this issue. In fact the Maldives was the first country to sign the Kyoto Protocol, which is an agreement that 169 of the world's countries have signed showing their commitment to reducing the emission of greenhouse gases.

HOW TO REDUCE YOUR ENERGY USE

Looking to the future it will be important to design houses and buildings that use less energy. Also, where possible we should be using public transport systems and installing alternative energy sources such as wind power and solar power. Some islands in the Maldives already are experimenting with alternative energy sources. Many houses use solar hot water systems and some islands are using wind turbines.

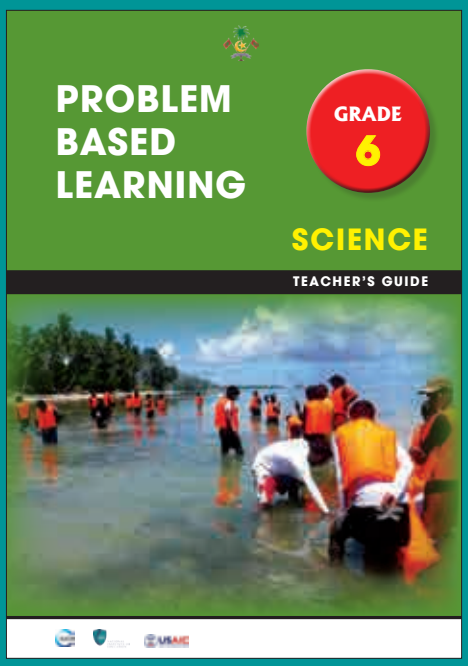
But right now there are many things you can do to reduce your energy use and limit emissions of greenhouse gases. When you buy a new appliance (like a washing machine/fridge/air conditioner) have a look to see if it has an energy efficiency rating and try and buy the most energy efficient appliance available.

Also, don't forget to switch off appliances (e.g., TVs, lights and stereos) when you are not in the room. Remember to switch off your appliances at the plug, as they are still using electricity in the standby mode. For air-conditioners, it is important to choose the right size for your needs. Also, temperature control is important to reduce electricity use- most people are comfortable around 24°C. Also don't forget to clean the air filters regularly so the air-conditioner operates efficiently.

You can also dry your clothes in the sun, instead of using a dryer, sit in the shade of a tree instead of turning on the fan or air-conditioner, or walk up the stairs instead of taking a lift. Lastly, don't forget that you can ride a bicycle or walk to school instead of catching a taxi or motorbike. With every decision that you make you can choose to be a high energy user or a low energy user! Help to save the environment and save money! Remember it's up to you![45]

[45] EDC, UNICEF (2006) Weather, Water, Waste & Energy flipchart

BOOKS IN THIS SERIES ARE:



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