Environment

Senior High

Grade 11

Teacher Guide

Standards-Based

Department of Education

'FREE ISSUE
NOT FOR SALE'

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Grade 11

Teacher Guide

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Issued free to schools by the Department of Education

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Contents

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Acronyms

AAL	Assessment AS Learning
AFL	Assessment FOR Learning
AOL	Assessment OF Learning
BOS	Board Of Studies
CDD	Curriculum Development Division
CP	Curriculum Panel
DA	Diagnostic Assessment
IHD	Integral Human Development
GoPNG	Government of Papua New Guinea
KSVA	Knowledge Skills Values and Attitudes
MTDG	Medium Term Development Goals
NDoE	National Department of Education
OBC	Outcomes-Based Curriculum
OBE	Outcomes-Based Education
PNG	Papua New Guinea
SAC	Subject Advisory Committee
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Engineering, Arts and Mathematics

Secretary's Message

The ultimate aim of Standards-Based Education (SBE) in Papua New Guinea is to prepare students for careers, higher education, and citizenship. SBE will therefore focus on providing students with careers, higher education, and citizenship preparedness knowledge, skills, values and attitudes that they can use to work, study and live in the 21st century.

Standards-Based Curriculum (SBC) in PNG is closely aligned to and is key to achieving this aim and its related operational goals. The curriculum is underpinned by four key pillars:

- morals, values and attitudes;
- cognitive, reasoning, decision-making, problem-solving, high level and 21st century skills;
- Science, Technology, Engineering, Arts and Mathematics (STEAM),
- core curriculum.

Social Science is a significant curriculum framework for teaching children and enabling them to progressively develop proficiency on fundamental ideas of Geography, History, Political Science Economics and Environment. This curriculum addresses Social Science skills and processes of geography, civic and cultural literacy, historical and economical literacy and global awareness.

Thus, students will be able to make informed decisions and will be equipped with problem–solving and management knowledge, skills, values and attitudes in Social Science. This enables them to function effectively in the work and higher education environments as productive and useful citizens of a culturally diverse and democratic society in an interdependent world.

Social Science teachers are expected to effectively plan, teach, and assess these knowledge, skills, values, and attitudes. This teacher guide describes what teachers are expected to know and do to enable all their students to effectively learn and demonstrate the expected levels of proficiency in all the grade level Social Science knowledge, skills, values and attitudes, and attain the national content standards.

I commend and approve this Social Science Teacher Guide for Grade 11 to be used in all High Schools throughout Papua New Guinea.

……

UKE W. KOMBRA, PhD.
Secretary for Education

Introduction

Social Science aims to develop and instill in students the ability to gauge views from all spectrums of life and be able to analyse and make proper judgments and statements to resonate and promote peace and harmony for all people. As individuals, they must be aware of issues of paramount importance affecting their daily lives such as their social groupings and institutions, governance and the natural world surrounding them. Thus, they are able to create and foster great cohesion within their locality which should have an impact on the world and over to sustain and maintain life.

The study of Social Science enhances students' understanding of inter-disciplinary concepts and issues in relation to geography, history, politics, economics and environment within PNG and globally.

Social Science aims to provide a meaningful pedagogical framework for teaching and learning essential and in demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st century.

Students should be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organize and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

Students' employability will be enhanced through the study and application of STEAM principles. STEAM is an integral component of the core curriculum. All students are expected to study STEAM and use STEAM related skills to solve problems relating to both the natural and the physical environments. The aim of STEAM education is to create a STEAM literate society. It is envisioned that the study of STEAM will motivate students to pursue and take up academic programs and careers in STEAM related fields. STEAM has been embedded in the Social Science curriculum. Equal opportunities should be provided for all students to learn, apply and master STEAM principles and skills.

Social Science is to be timetabled for 240 minutes per week in grade 11.

Structure of the Teacher Guide

This teacher guide comprises of three main sections that provide essential information that all teachers should know and do to effectively implement the Social Science - Environment curriculum.

1. **General Information**
    - Purpose of the teacher guide
    - How to use the teacher guide
    - Syllabus and teacher guide alignment
    - Learning and performance standards
    - Core Curriculum
    - STEAM
    - Curriculum Integration
    - Essential KSVAs

2. **Teaching and Learning**
    - Teaching and Learning Strategies
    - Units and Topics
    - Standards-Based Lesson Planning

3. **Assessment**
    - Performance Assessment
    - Performance Standards

The above components are linked and closely aligned. They should be connected to ensure that the intended learning outcomes and the expected quality of education standards are achieved. The close alignment of planning, instruction and assessment is critical to the attainment of learning standards.

Purpose of the Teacher Guide

This teacher guide describes what all teachers should know and do. The overarching purpose is to help teachers to effectively plan, teach, assess, evaluate, report and monitor students' learning and mastery of national and grade-level expectations. That is, the essential knowledge, skills, values and attitudes (KSVAs) described in the content standards and grade-level benchmarks, and their achievement of the national and grade-level proficiency standards.

Thus, the teacher is expected to:

- understand the significance of aligning all the elements of Standards-Based Curriculum (SBC) as the basis for achieving the expected level of education quality;
- effectively align all the components of SBC when planning, teaching, and assessing students' learning and levels of proficiency;
- effectively translate and align the Social Science syllabi and teacher guide to plan, teach and assess different Social Science units and topics, and the KSVAs described in the grade-level benchmarks;
- understand the Social Science national content standards, grade-level benchmarks, and evidence outcomes;
- effectively make sense of the content (KSVAs) described in the Social Science national content standards and the essential components of the content described in the grade-level benchmarks;
- effectively guide students to progressively learn and demonstrate proficiency on a range of Social Science knowledge, skills, processes, concepts, ideas, principles, practices, values and attitudes;
- confidently interpret, translate and use Social Science content standards and benchmarks to determine the learning objectives and performance standards, and plan appropriately to enable all students to achieve these standards;
- embed the core curriculum in their Social Science lesson planning, instruction, and assessment to permit all students to learn and master the core KSVAs required of all students;
- provide opportunities for all students to understand how STEAM has and continues to shape the social, political, economic, cultural, and the environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems relating to both the natural and physical (man-made) worlds as well as problems created by STEAM;
- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem-solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustaining values), and attitudes in lesson planning, instruction and assessment;

- meaningfully connect what students learn in Social Science with what is learnt in other subjects to add value and enhance students' learning so that they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content;
- formulate effective SBC lesson plans using learning objectives identified for each of the topics;
- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade-level benchmark;
- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain students' status of progress towards meeting grade-level and nationally expected proficiency standards, and use evidence from the assessment of students' performance to develop effective evidence-based intervention strategies to help students' who are making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning and performance.

How to use the Teacher Guide

Teacher Guide provides essential information about what the teacher needs to know and do to effectively plan, teach and assess students learning and proficiency on learning and performance standards. The different components of the teacher guide are closely aligned with SBC principles and practice, and all the other components of PNG SBC. It should be read in conjunction with the syllabus in order to understand what is expected of teachers and students to achieve the envisaged quality of education outcomes.

The first thing teachers should do is to read and understand each of the sections of the teacher guide to help them understand the key SBC concepts and ideas, alignment of PNG SBC components, alignment of the syllabus and teacher guide, setting of content standards and grade-level benchmarks, core curriculum, STEAM, curriculum integration, essential knowledge, skills, values and attitudes, strands, units and topics, learning objectives, SBC lesson planning, and SBC assessment. A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Grade 11 Social Science Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

Determine Learning Objectives and Lesson Topics

Topics and learning objectives have been identified and described in the Teacher Guide. Lesson objectives are derived from topics that are extracted from the grade-level benchmarks. Lesson topics are deduced from the learning objectives. Teachers should familiarise themselves with this process as it is essential for lesson planning, instruction and assessment. However, depending on the context and students' learning abilities, teachers would be required to determine additional learning objectives and lesson topics. Teachers should use the examples provided in this teacher guide to formulate additional learning objectives and lesson topics to meet the educational or learning needs of their students.

Identify and Teach Grade Appropriate Content

Grade appropriate content has been identified and scoped and sequenced using appropriate content organisation principles. The content is sequenced using the spiraling sequence principles. This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they progress further into their schooling. What students learn in previous grades is reinforced and deepens in scope with an increase in the level of complexity and difficulty in the content and learning activities. It is important to understand how the content is organised so that grade appropriate content and learning activities can be selected, if not already embedded in the benchmarks and learning objectives, to not only help students learn and master the content, but ensure that what is taught is rigorous, challenging, and comparable.

Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment

Teachers should use this teacher guide to help them integrate the core curriculum – values, cognitive and high-level skills, 21st century skills, STEAM principles and skills, and reading, writing, and communication skills in their lesson planning, instruction and assessment. All students in all subjects are required to learn and master these skills progressively through the education system.

Integrate Cognitive, High Level, and 21st Century Skills in Lesson Planning, Instruction and Assessment

Teachers should integrate the cognitive, high level and 21st century skills in their annual teaching programs, and give prominence to these skills in their lesson preparation, teaching and learning activities, performance assessment, and performance standards for measuring students' proficiency on these skills. Social Science addresses the skills and processes of geography, civic and cultural literacy, historical and economical literacy and global awareness. Thus, students will be able to make informed decisions, problem – solving and management knowledge, skills, values and attitudes in Social Science. This enables them to function effectively in the work and higher education environments as productive and useful citizens of a culturally diverse and democratic society in an interdependent world.

In addition, it envisages all students attaining expected proficiency levels in these skills and will be ready to pursue careers and higher education academic programs that demand these skills, and use them in their everyday life after they leave school at the end of Grade 12. Teachers should use the teacher guide to help them to effectively embed these skills, particularly in their lesson planning and in the teaching and learning activities as well as in the assessment of students' application of the skills.

Integrate Social Science Values and Attitudes in Lesson Planning, Instruction and Assessment

In Social Science, students are expected to learn, promote and use work, relationship, peace, health, social, personal, family, community, national and global values in the work and study environments as well as in their conduct as community, national and global citizens. Teachers should draw from the information and suggestions provided in the syllabus and teacher guide to integrate values and attitudes in their lesson planning, instruction, and assessment. They should report on students' progression towards internalizing different values and attitudes and provide additional support to students who are yet to reach the internalization stage to make positive progress towards this level.

Integrate Science, Technology, Engineering, Arts and Mathematics (STEAM) Principles and Skills in Lesson Planning, Instruction and Assessment

Teachers should draw from both the syllabus and teacher guide in order to help them integrate STEAM principles and skills, and methodologies in their lesson planning, instruction and assessment. STEAM teaching and learning happens both inside and outside of the classroom. Effective STEAM teaching and learning requires both the teacher and the student to participate as core

investigators and learners, and to work in partnership and collaboration with relevant stakeholders to achieve maximum results. Teachers should use the syllabus, teacher guides and other resources to guide them to plan and implement this and other innovative and creative approaches to STEAM teaching and learning to make STEAM principles and skills learning fun and enjoyable and, at the same time, attain the intended quality of learning outcomes.

Identify and Use Grade and Context Appropriate, Innovative, Differentiated and Creative Teaching and Learning Methodologies

SBC is an eclectic curriculum model. It is an amalgamation of strengths of different curriculum types, including behavioural objectives, outcomes, and competency. Its emphasis is on students attaining clearly defined, measurable, observable and attainable learning standards, i.e., the expected level of education quality. Proficiency (competency) standards are expressed as performance standards/criteria and evidence outcomes, that is, what all students are expected to know (content) and do (application of content in real life or related situations) to indicate that they are meeting, have met or exceeded the learning standards. The selection of grade and contextually appropriate teaching and learning methodologies is critical to enabling all students to achieve the expected standard or quality of education. Teaching and learning methodologies must be aligned to the content, learning objective, and performance standard in order for the teacher to effectively teach and guide students towards meeting the performance standard for the lesson. They should be equitable and socially inclusive, differential, student-centred, and lifelong. They should enable STEAM principles and skills to be effectively taught and learned by students. Teachers should use the teacher guide to help them make informed decisions when selecting the types of teaching and learning methodologies to use in their teaching of the subject content, including STEAM principles and skills.

Plan Standards-Based Lessons

SBC lesson planning is quite difficult to do. However, this will be easier with more practice and experience over time. Effective SBC lesson plans must meet the required standards or criteria so that the learning objectives and performance standards are closely aligned to attain the expected learning outcomes. Teachers should use the guidelines and standards for SBC lesson planning and examples of SBC lesson plans provided in the teacher guide to plan their lessons. When planning lessons, it is important for teachers to ensure that all SBC lesson planning standards or criteria are met. If standards are not met, instruction will not lead to the attainment of intended performance and proficiency standards. Therefore, students will not attain the national content standards and grade-level benchmarks.

Use Standards-Based Assessment

Standards-Based Assessment has a number of components. These components are intertwined and serve to measure evaluate, report, and monitor students' achievement of the national and grade-level expectations, i.e., the essential knowledge, skills, values and attitudes they are expected to master and demonstrate proficiency on. Teachers should use the information and examples on standards-based assessment to plan, assess, record,

evaluate, report and monitor students' performance in relation to the learning standards.

Make informed Judgments About Students' Learning and Progress Towards Meeting Learning Standards

Teachers should use the teacher guide to effectively evaluate students' performance and use the evidence to help students to continuously improve their learning as well as their classroom practice.

It is important that teachers evaluate the performance of students in relation to the performance standards and progressively the grade-level benchmarks and content standards to make informed judgments and decisions about the quality of their work and their progress towards meeting the content standards or components of the standards. Evaluation should not focus on only one aspect of students' performance. It should aim to provide a complete picture of each student's performance. The context, inputs, processes, including teaching and learning processes, and the outcomes should be evaluated to make an informed judgment about each student's performance, Teachers should identify the causal factors for poor performance, gaps in students learning, gaps in teaching, teaching and learning resource constraints, and general attitude towards learning. Evidence-based decisions can then be made regarding the interventions for closing the gaps to allow students to make the required progress towards meeting grade-level and national expectations.

Prepare Students' Performance Reports

Reporting of students' performance and progress towards the attainment of learning standards is an essential part of SBC assessment. Results of students' performance should be communicated to particularly the students and their parents to keep them informed of students' academic achievements and learning challenges as well as what needs to be done to ensure the students' make positive progress towards meeting the proficiency standards and achieving the desired level of education quality. Teachers should use the information on the reporting of students' assessment results and the templates provided to report the results of students' learning.

Monitor Students' Progress Towards Meeting the National Content Standards and Grade-Level Benchmarks

Monitoring of students' progress towards the attainment of learning standards is an essential component of standards-based assessment. It is an evidence-based process that involves the use of data from students' performance assessments to make informed judgments about students' learning and proficiency on the learning standards or their components, identify gaps in students' learning and the causal factors, set clear learning improvement targets, and develop effective evidence-based strategies (including preplanning and re-teaching of topics), set clear timeframes, and identify measures for measuring students' progress towards achieving the learning targets.

Teachers should use the teacher guide to help them use data from students' performance assessments to identify individual students' learning weaknesses and develop interventions, in collaboration with each student and his/her

parents or guardians, to address the weaknesses and monitor their progress towards meeting the agreed learning goals.

Develop Additional Benchmarks

Teachers can develop additional benchmarks using the examples in the teacher guide to meet the learning needs of their students and local communities. However, these benchmarks will not be nationally assessed as these are not comparable. They are not allowed to set their own content standards or manipulate the existing ones. The setting of national content standards is done at the national level to ensure that required learning standards are standardised, maintained and monitored to sustain the required level of education quality.

Avoid Standardisation

The teaching and learning strategies by means of lesson plans, lesson objectives and assessment should not be standardised when implementing the Social Science curriculum. SBC does not mean that the content, lesson objectives, teaching and learning strategies, and assessment are standardised. This is a misconception and any attempt to standardise the components of curriculum without due consideration of the teaching and learning contexts, children's backgrounds and experiences, and different abilities and learning styles of children will be counterproductive. It will hinder students from achieving the expected proficiency standards and hence, high academic standards and the desired level of education quality. That is, they should not be applied across all contexts and with all students, without considering the educational needs and the characteristics of each context. Teachers must use innovative, creative, culturally relevant, and differentiated teaching and learning approaches to teach the curriculum and enable their students to achieve the national content standards and grade-level benchmarks. And enable all students to experience success in learning the curriculum and achieve high academic standards.

The teaching and learning and assessment strategies provided in this teacher guide are not fixed and can be changed. Teachers should use the information and examples provided in the teacher guide to guide them to develop, select, and use grade, context, and learner appropriate content, learning objectives, teaching and learning strategies, and performance assessment and standards. SBC is evidence-based hence decisions about the content, learning outcomes, teaching and learning strategies, students' performance, and learning interventions should be based on evidence. Teaching and learning should be continuously improved and effectively targeted using evidence from students' assessment and other sources.

Syllabus and Teacher Guide Alignment

A teacher guide is a framework that describes how to translate the content standards and benchmarks (learning standards) outlined in the syllabus into units and topics, learning objectives, lesson plans, teaching and learning strategies, performance assessment, and measures for measuring students' performance (performance standards). It expands the content overview and describes how this content identified in the content standards and their components (essential KSVAs) can be translated into meaningful and evidence-based teaching topics and learning objectives for lesson planning, instruction and assessment. It also describes and provides examples of how to evaluate and report on students' attainment of the learning standards, and use evidence from the assessment of students' performance to develop evidence-based interventions to assist students who are making slow progress towards meeting the expected proficiency levels to improve their performance.

Grade 11 Social Science comprises of the Syllabus and Teacher Guide. These two documents are closely aligned, complimentary and mutually beneficial. They are the essential focal points for teaching and learning the essential Social Science knowledge, skills, values and attitudes.

Syllabus and teacher guide alignment	
Syllabus Outlines the ultimate aim and goals, and what to teach and why teach it	**Teacher Guide** Describes how to plan, teach, and assess students' performance
- Overarching and SBC principles - Content overview - Core curriculum - Essential knowledge, skills, values and attitudes - Strands and units - Evidence outcomes - Content standards and grade-level benchmarks - Overview of assessment, evaluation, and reporting	- Determine topics for lesson planning, instruction and assessment - Formulate learning objectives - Plan SBC lesson plans - Select teaching and learning strategies - Implement SBC assessment and evaluation - Implement SBC reporting and monitoring

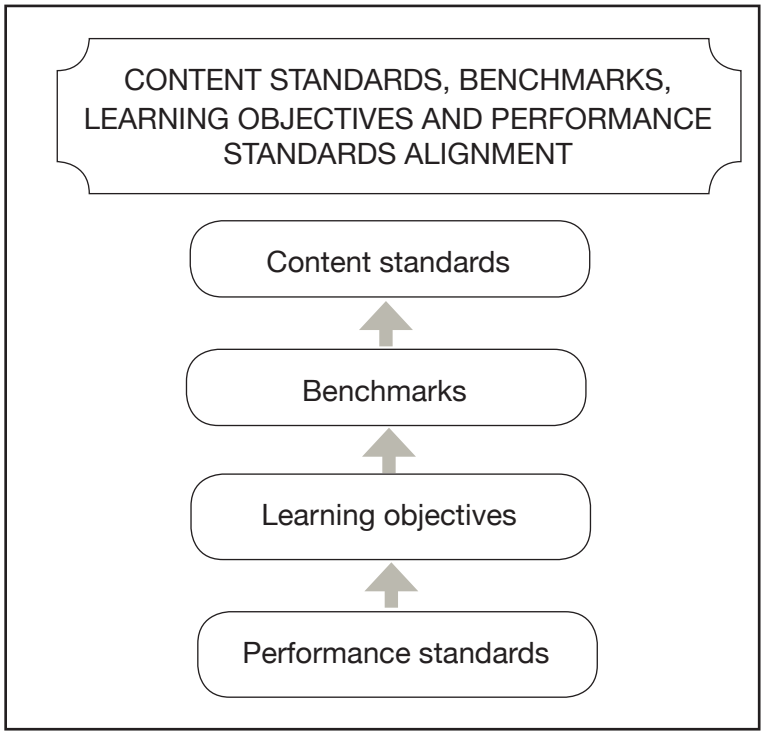
The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what is outlined in the syllabus by describing the approaches or the how of planning, teaching, learning, and assessing the content so that the intended learning outcomes are achieved.

This teacher guide should be used in conjunction with the syllabus. Teachers should use these documents when planning, teaching and assessing Grade 11 Social Science content.

Teachers will extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and is for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Learning and performance standards alignment

Content standards, benchmarks, learning objectives, and performance standards are very closely linked and aligned. There is a close linear relationship between these standards. Students' performance on a significant aspect of a benchmark (KSVA) is measured against a set of performance standards or criteria to determine their level of proficiency using performance assessment. Using the evidence from the performance assessment, individual student's proficiency on the aspect of the benchmark assessed and progression towards meeting the benchmark and hence the content standard are then determined.



Effective alignment of these learning standards and all the other components of PNG SBE and SBC (ultimate aim and goals, overarching, SBC and subject-based principles, core curriculum, STEAM, and cognitive, high level, and 21st century skills) is not only critical but is also key to the achievement of high academic standards by all students and the intended level of education quality. It is essential that teachers know and can do standards alignment when planning, teaching, and assessing students' performance so that they can effectively guide their students towards meeting the grade-level benchmarks (grade expectations) and subsequently the content standards (national expectations).

Learning and Performance Standards

Standards-Based Education (SBE) and Standards-Based Curriculum (SBC) are underpinned by the notion of quality. Standards define the expected level of education quality that all students should achieve at a particular point in their schooling. Students' progression and achievement of education standard(s) are measured using performance standards or criteria to determine their demonstration or performance on significant aspects of the standards and therefore their levels of proficiency or competency. When they are judged to have attained proficiency on a content standard or benchmark or components of these standards, they are then deemed to have met the standard(s). That is, achieved the intend level of education quality.

Content standards, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorised as performance standards. These standards are used to measure students' performance, proficiency, progression and achievement of the desired level of education quality. Teachers are expected to understand and use these standards for lesson planning, instruction and assessment.

Content standards

Content standards are evidence-based, rigorous and comparable regionally and globally. They have been formulated to target critical social, economic, political, cultural, environmental, and employable skills gaps identified from a situational analysis. They were developed using examples and experiences from other countries and best practice, and contextualized to PNG contexts.

Content standards describe what (content - knowledge, skills, values, and attitudes) all students are expected to know and do (how well students must learn and apply what is set out in the content standards) at each grade-level before proceeding to the next grade. These standards are set at the national level and thus cannot be edited or changed by anyone except the National Subject-Based Standards Councils. Content Standards:

- are evidence-based;
- are rigorous and comparable to regional and global standards;
- are set at the national level;
- state or describe the expected levels of quality or achievement;
- are clear, measurable and attainable;
- are linked to and aligned with the ultimate aim and goals of SBE and SBC and overarching and SBC principles;
- delineate what matters, provide clear expectations of what students should progressively learn and achieve in school, and guide lesson planning, instruction, assessment;
- comprise knowledge, skills, values, and attitudes that are the basis for quality education;
- provide teachers a clear basis for planning, teaching, and assessing lessons;

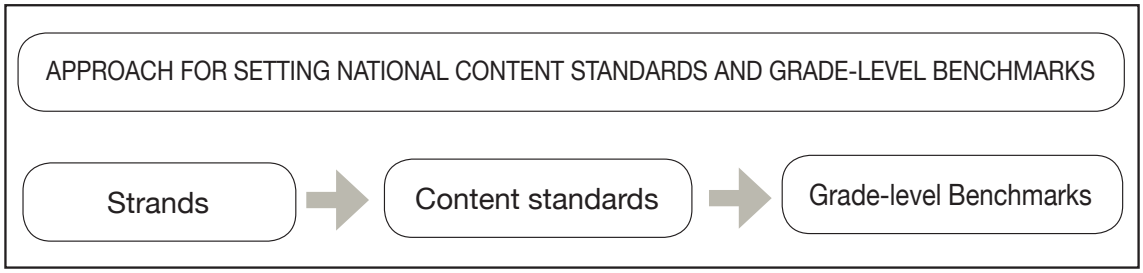
- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

Benchmarks

Benchmarks are derived from the content standards and benchmarked at the grade-level. Benchmarks are specific statements of what students should know (i.e., essential knowledge, skills, values or attitudes) at a specific grade-level or school level. They provide the basis for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Grade-level benchmarks:

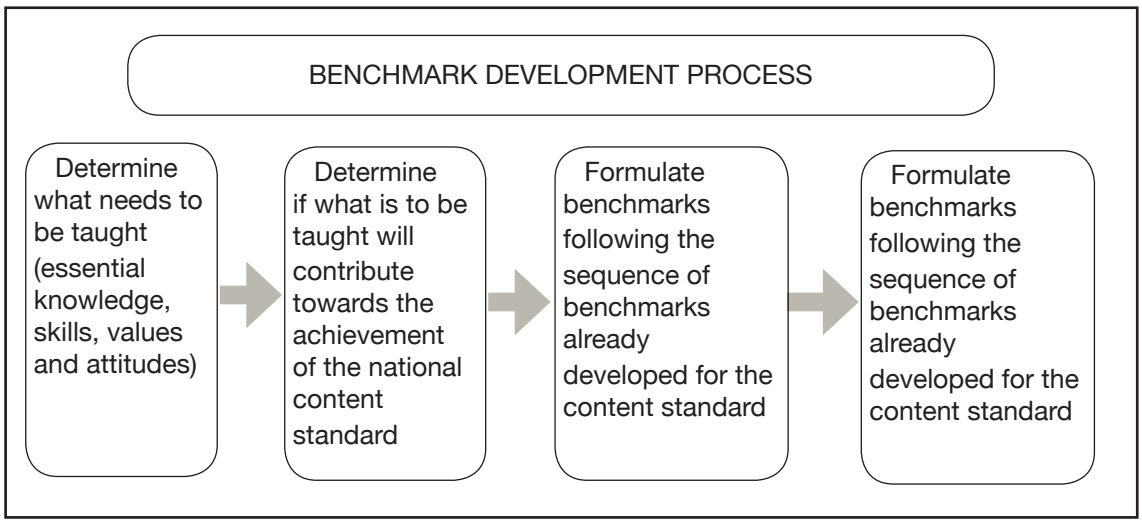
- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate that they are making progress towards attaining the national content standards;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- state clearly what students should do with what they have learned at the end of each school-level;
- enable students' progress towards the attainment of national content standards to be measured, and
- enable PNG students' performance to be compared with the performance of PNG students with students in other countries.



Development of additional benchmarks

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content. However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional

benchmarks. An innovative, reflect, creative and reflexive teacher will continuously reflect on his/her classroom practice and use evidence to provide challenging, relevant, and enjoyable learning opportunities for his/her students to build on the national expectations for students. Teachers should follow the following process when developing additional grade-level benchmarks.



Learning objectives

Learning or instructional objectives are precise statements of educational intent. They are formulated using a significant aspect or a topic derived from the benchmark, and is aligned with the educational goals, content standards, benchmarks, and performance standards. Learning objectives are stated in outcomes language that describes the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour.

For example, students will be able to identify all the main towns of PNG using a map.

Performance standards

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the **"be able to do"** of **"what students should know and be able to do."** Performance standards are the indicators of quality that specify how competent a student's demonstration or performance must be. They are explicit definitions of what students **must do to demonstrate proficiency or competency at a specific level on the content standards.**

Performance standards:

- measure students' performance and proficiency **(using performance indicators)** in the use of a specific knowledge, skill, value, or attitude in real life or related situations
- provide the basis **(performance indicators)** for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude

- are used to plan for individual instruction to help students not yet meeting expectations **(desired level of mastery and proficiency)** to make adequate progress towards the full attainment of benchmarks and content standards
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards.

Proficiency standards

Proficiency standards describe what all students in a particular grade or school level can do at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. They are also categorized as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

Core Curriculum

A core set of common learnings (knowledge, skills, values, and attitudes) are integrated into the content standards and grade-level benchmarks for all subjects. This is to equip all students with the most essential and in-demand knowledge, skills, and dispositions they will need to be successful in modern/ postmodern work places, higher-education programs and to be productive, responsible, considerate, and harmonious citizens. Common set of learnings are spirally sequenced from Preparatory - Grade 12 to deepen the scope and increase the level of difficulty in the learning activities so that what is learned is reinforced at different grade levels.

The core curriculum includes:

- cognitive (thinking) skills (refer to the syllabus for a list of these skills);
- reasoning, decision-making and problem-solving skills
- high level thinking skills (analysis, synthesis and evaluation skills);
- 21st century skills (refer to illustrative list in *Appendix 2*);
- reading, writing and communication skills (literacy skills);
- STEAM principles and skills;
- essential values and attitudes (Core personal and social values, and sustaining values), and
- spiritual values and virtues.

The essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship.

All teachers are expected to include the core learnings in their lesson planning, teaching, and assessment of students in all their lessons. They are expected to foster, promote and model the essential values and attitudes as well as the spiritual values and virtues in their conduct, practice, appearance, and their relationships and in their professional and personal lives. In addition, teachers are expected to mentor, mould and shape each student to evolve and possess the qualities envisioned by society.

Core values and attitudes must not be taught in the classroom only; they must also be demonstrated by students in real life or related situations inside and outside of the classroom, at home, and in everyday life. Likewise, they must be promoted, fostered and modeled by the school community and its stakeholders, especially parents. A whole school approach to values and attitudes teaching, promoting and modeling is critical to students and the whole school community internalising the core values and attitudes and making them habitual in their work and school place, and in everyday life. Be it work values, relationship values, peace values, health values, personal and social values, or religious values, teachers should give equal prominence to all common learnings in their lesson planning, teaching, assessment, and learning interventions. Common learnings must be at the heart of all teaching and extracurricular programs and activities.

Science, Technology, Engineering, Arts and Mathematics

STEAM education is an integrated, multidisciplinary approach to learning that uses science, technology, engineering, arts and mathematics as the basis for inquiring about how STEAM has and continues to change and impact the social, political, economic, cultural and environmental contexts and identifying and solving authentic (real life) natural and physical environmental problems by integrating STEAM-based principles, cognitive, high level and 21st century skills and processes, and values and attitudes.

Social Science is focused on both goals of STEAM rather than just the goal of problem-solving. This is to ensure that all students are provided opportunities to learn, integrate, and demonstrate proficiency on all essential STEAM principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

Objectives

Students will be able to:

- examine and use evidence to draw conclusions about how STEAM has and continues to change the social, political, economic, cultural and environmental contexts.
- investigate and draw conclusions on the impact of STEAM solutions to problems on the social, political, economic, cultural and environmental contexts.
- identify and solve problems using STEAM principles, skills, concepts, ideas and process.
- identify, analyse and select the best solution to address a problem.
- build prototypes or models of solutions to problems.
- replicate a problem solution by building models and explaining how the problem was or could be solved.
- test and reflect on the best solution chosen to solve a problem.
- collaborate with others on a problem and provide a report on the process of problem-solving used to solve the problem.
- use skills and processes learnt from lessons to work on and complete STEAM projects.
- demonstrate STEAM principles, skills, processes, concepts and ideas through simulation and modelling.
- explain the significance of values and attitudes in problem-solving.

Content overview

STEAM is a multidisciplinary and integrated approach to understanding how science, technology, engineering, arts and mathematics shape and are shaped by our material, intellectual, cultural, economic, social, political and environmental contexts. And for teaching students the essential and in-demand cognitive, high level and 21st century skills, values and attitudes, and empower them to effectively use these skills and predispositions to identify and solve problems relating to the natural and physical environments as well as the impact of STEAM-based solutions on human existence and livelihoods, and on the social, political, economic, cultural, and environmental systems.

STEAM disciplines have and continue to shape the way we perceive knowledge and reality, think and act, our values, attitudes, and behaviours, and the way we relate to each other and the environment. Most of the things we enjoy and consume are developed using STEAM principles, skills, process, concepts and ideas. Things humans used and enjoyed in the past and at present are developed by scientists, technologists, engineers, artists and mathematicians to address particular human needs and wants. Overtime, more needs were identified and more products were developed to meet the ever changing and evolving human needs. What is produced and used is continuously reflected upon, evaluated, redesigned, and improved to make it more advanced, multipurpose, fit for purpose, and targeted towards not only improving the prevailing social, political, economic, cultural and environmental conditions but also to effectively respond to the evolving and changing dynamics of human needs and wants. And, at the same time, solutions to human problems and needs are being investigated and designed to address problems that are yet to be addressed and concurred. This is an evolving and ongoing problem-solving process that integrates cognitive, high level, and 21st century skills, and appropriate values and attitudes.

STEAM is a significant framework and focal point for teaching and guiding students to learn, master and use a broad range of skills and processes required to meet the skills demands of PNG and the 21st century. The skills that students will learn will reflect the demands that will be placed upon them in a complex, competitive, knowledge-based, information-age, technology-driven economy and society. These skills include cognitive (critical, synthetic, creative, reasoning, decision-making, and problem-solving) skills, high level (analysis, synthesis and evaluation) skills and 21st century skills. Knowledge-based information and technology driven economies require knowledgeable workers and not technicians. Knowledge workers are lifelong learners, are problem solvers, innovators, creators, critical and creative thinkers, reflective practitioners, researchers (knowledge producers rather than knowledge consumers), solutions seekers, outcomes oriented, evidence-based decision makers, and enablers of improved and better outcomes for all.

STEAM focuses on the skills and processes of problem-solving. These skills and processes are at the heart of the STEAM movement and approach to not only problem-solving and providing evidence-based solutions but also the development and use of other essential cognitive, high level and 21st century skills. These skills are intertwined and used simultaneously to gain a broader understanding of the problems to enable creative, innovative, contextually

relevant, and best solutions to be developed and implemented to solve the problems and attain the desired outcomes. It is assumed that by teaching students STEAM-based problem-solving skills and providing learning opportunities inside and outside the classroom, more students will be motivated to pursue careers and academic programs in STEAM related fields thus, closing the skills gaps and providing a pool of cadre of workers required by technology, engineering, science, and mathematics-oriented industries.

Although, STEAM focuses on the development and application of skills in authentic (real life) contexts, for example the use of problem-solving skills to identify and solve problems relating to the natural and physical worlds, it does not take into account the significant influence values and attitudes have on the entire process of problem-solving. Values and attitudes are intertwined with knowledge and skills. Knowledge, skills, values and attitudes are inseparable. Decisions about skills and processes of skills development and application are influenced by values and attitudes (mindset) that people hold. In the same light, the use of STEAM principles, processes and skills to solve problems in order to achieve the outcomes envisaged by society are influenced by values and the mindset of those who have identified and investigated the problem as well as those who are affected by the problem and will benefit from the outcome.

STEAM problem-solving methods and approaches

Problem-solving involves the use of problem-solving methods and processes to identify and define a problem, gather information to understand its causes, draw conclusions, and use the evidence to design and implement solutions to address it.

Even though there are many different problem-solving methods and approaches, they share some of the steps of problem-solving, for example:

1. identifying the problem;
2. understanding the problem by collecting data;
3. analysing and interpret the data;
4. drawing conclusions;
5. using data to consider possible solutions;
6. selecting the best solution;
7. testing the effectiveness of the solution by trialling and evaluating it, and
8. reviewing and improve the solution.

STEAM problem-solving processes go from simple and technical to advance and knowledge-based processes. However, regardless of the type of process used, students should be provided opportunities to learn the essential principles and processes of problem-solving and, more significantly, to design and create a product that addresses a real problem and meets a human need.

The following are some of the STEAM problem-solving processes.

Engineering and technology problem-solving methods and approaches

Engineering and technology problem-solving methods are used to identify and solve problems relating to the physical world using the design process. The following are some of the methods and approaches used to solve engineering and technology related problems.

Parts substitution
It is the most basic of the problem-solving methods. It simply requires the parts to be substituted until the problem is solved.

Diagnostics
After identifying a problem, the technician would run tests to pinpoint the fault. The test results would be used either as a guide for further testing or for replacement of a part, which also need to be tested. This process continues until the solution is found and the device is operating properly.

Troubleshooting
Troubleshooting is a form of problem-solving, often applied to repair failed products or processes.

Reverse engineering
Reverse engineering is the process of discovering the technological principles underlying the design of a device by taking the device apart, or carefully tracing its workings or its circuitry. It is useful when students are attempting to build something for which they have no formal drawings or schematics.

Divide and conquer
Divide and conquer is the technique of breaking down a problem into sub-problems, then breaking the sub-problems down even further until each of them is simple enough to be solved. Divide and conquer may be applied to all groups of students to tackle sub-problems of a larger problem, or when a problem is so large that its solution cannot be visualised without breaking it down into smaller components.

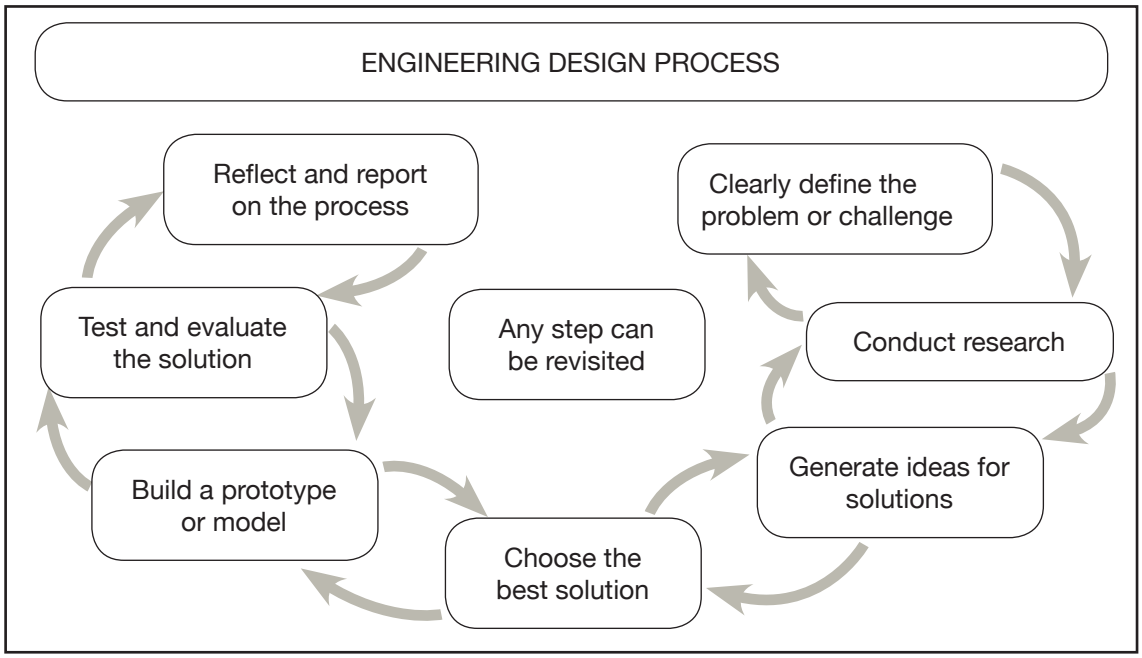
Extreme cases
Considering “extreme cases” – envisioning the problem in a greatly exaggerated or greatly simplified form, or testing using extreme condition – can often help to pinpoint a problem. An example of the extreme-case method is purposely inputting an extremely high number to test a computer program.

Trial and error
The trial and error method involves trying different approaches until a solution is found. It is often used as a last resort when other methods have been exhausted.

Engineering design process

Technological fields use the engineering design process to identify and define the problem or challenge, investigate the problem, collect and analyse data, and use the data to formulate potential solutions to the problem, analyse each of the solutions in terms of its strengths and weaknesses, and choose the best solution to solve the problem. It is an open-ended problem-solving process that involves the full planning and development of products or services to meet identified needs. It involves a sequence of steps such as the following:

1. Analysing the context and background, and clearly defining the problem.
2. Conducting research to determine design criteria, financial or other constraints, and availability of materials.
3. Generating ideas for potential solutions, using processes such as brainstorming and sketching.
4. Choosing the best solution.
5. Building a prototype or model.
6. Testing and evaluate the solution.
7. Repeating steps as necessary to modify the design or correct faults.
8. Reflecting and report on the process.



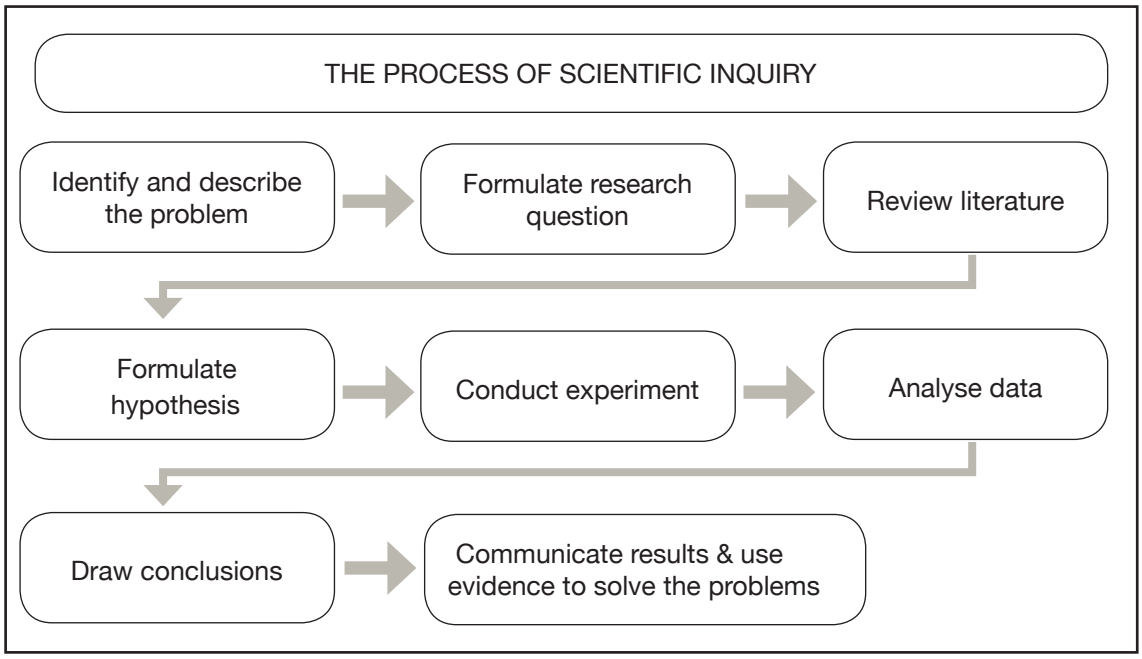
The scientific method and approach to problem-solving

Science uses predominantly the quantitative-scientific inquiry process to investigate, understand, and make informed decisions about problems relating to the natural world. The steps in the process vary, depending on the purpose of the inquiry and the types of questions asked.

There are six basic science process skills:

1. Observation
2. Communication
3. Classification
4. Measurement
5. Inference
6. Prediction

These processes are at the heart of the scientific inquiry and problem-solving process.



The steps above should be taught and demonstrated by students separately and jointly before they implement the inquiry process. Students should be guided through every step of the process so that they can explain it and its importance, and use the steps and the whole process proficiently to identify, investigate and solve problems. A brief explanation and examples of each step are provided below to help teachers plan and teach each step. Students should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next one.

Step 1: Identify and describe the problem

Problems are identified mainly from observations and the use of the five senses – smell, sight, sound, touch and taste. Students should be guided and provided opportunities to identify natural and physical environment problems using their five senses and describe what the problem is and its likely causes.

Example - Observation

i. When I turn on a flashlight using the on/off switch, light comes out of one end.

Step 2: Formulate research question

After the problem is identified and described, the question to be answered is then formulated. This question will guide the scientist in conducting research and experiments.

Example - Question

i. What makes light comes out of a flash light when I turn it on?

Step 3: Review literature

It is more likely that the research problem and question have already been investigated and reported by someone. Therefore, after asking the question, the scientist spends some time reading and reviewing papers and books on past research and discussions to learn more about the problem and the question asked to prepare him/her for his own research. Conducting literature review helps the scientist to better understand his/her research problem, refine the research question and decide on the experiment/research approach before the experiment is conducted,

Example - Literature review

i. The scientist may look at the flashlight's instruction manual for tips or conduct online search on how flashlights work using the manufacturer's or relevant websites. The scientist may even analyse information and past experiments or discoveries regarding the relationship between energy and light.

Step 4: Formulate hypothesis

With a question in mind, the researcher decides on what he/she wants to test (The question may have changed as a result of the literature review). The research will clearly state what he/she wants to find out by carrying out the experiment. He/She will make an educated guess that could answer the question or explain the problem. This statement is called a hypothesis. A hypothesis guides the experiment and must be testable.

Example – Hypothesis

i. The batteries inside a flashlight give it energy to produce light when the flashlight is turned on.

Step 5: Conduct experiment

This step involves the design and conduct of experiment to test the hypothesis. Remember, a hypothesis is only an educated guess (a possible explanation), so it cannot be considered valid until an experiment verifies that it is valid.

Example - Experimental procedure

i. Remove the batteries from the flashlight, and try to turn it on using the on/off switch.
   Result: The flashlight does not produce light
ii. Re-insert the batteries into the flashlight, and try to turn it on using the on/off switch.
   Result: The flashlight does produce light.
iii. Write down these results

In general, it is important to design an experiment to measure only one thing at a time. This way, the researcher knows that his/her results are directly related to the one thing he/she changed. If the experiment is not designed carefully, results may be confusing and will not tell the researcher anything about his/her hypothesis.

Researchers collect data while carrying out their experiments. Data are pieces of information collected before, during, or after an experiment. To collect data, researchers read the measuring instruments carefully. Researchers record their data in notebooks, journals, or on a computer.

Step 6: Analyse data

Once the experiment is completed, the data is then analysed to determine the results. In addition, performing the experiment multiple times can be helpful in determining the credibility of the data.

Example - Analysis

i. Record the results of the experiment in a table.

ii. Review the results that have been written down.

Step 7: Draw conclusions

If the hypothesis was testable and the experiment provided clear data, the scientist can make a statement telling whether or not the hypothesis was correct. This statement is known as a conclusion. Conclusions must always be backed up by data. Therefore, scientists rely heavily on data so they can make an accurate conclusion.

If the data support the hypothesis, then the hypothesis is considered correct or valid. However, if the data do not support the hypothesis, the hypothesis is considered incorrect or invalid.

Example - Valid hypothesis

i. The flashlight did not produce light without batteries. The flashlight did produce light when batteries were inserted. Therefore, the hypothesis that batteries give the flashlight energy to produce light is valid, given that no changes are made to the flashlight during the experiment.

Example - Invalid hypothesis

ii. The flashlight did not produce light when the batteries were inserted. Therefore, the hypothesis that batteries give the flashlight energy to produce light is invalid. In this case, the hypothesis would have to be modified to say something like, “The batteries inside a flashlight give it energy to produce light when the batteries are in the correct order and when the flashlight is turned on.” Then, another experiment would be conducted to test the new hypothesis.

An invalid hypothesis is not a bad thing! Scientists learn something from both valid and invalid hypotheses. If a hypothesis is invalid, it must be rejected or modified. This gives scientists an opportunity to look at the initial observation in a new way. They may start over with a new hypothesis and conduct a new experiment. Doing so is simply the process of scientific inquiry and learning.

Step 8: Communicate findings

Scientists generally tell others what they have learned. Communication is a very important component of scientific progress and problem-solving. It gives other people a chance to learn more and improve their own thinking and experiments. Many scientists' greatest breakthroughs would not have been possible without published communication or results from previous experimentation.

Every experiment yields new findings and conclusions. By documenting both the successes and failures of scientific inquiry in journals, speeches, or other documents, scientists are contributing information that will serve as a basis for future research and for solving problems relating to both the natural and physical worlds. Therefore, communication of investigative findings is an important step in future scientific discovery and in solving social, political, economic, cultural, and environmental problems.

Example - Communication of findings

i. Write your findings in a report or an article and share it with others, or present your findings to a group of people. Your work may guide someone else's research on creating alternative energy sources to generate light, additional uses for battery power, etc.

Artistic design

Science uses predominantly the quantitative-scientific inquiry process to investigate, understand, and make informed decisions about problems. The steps in the process vary, depending on the purpose of the inquiry and the types of questions asked. There are six basic science process skills:

The equipping and enabling of students to become proficient in a broad range of STEAM skills, processes and predispositions can also lead to the attainment of many other societal goals, including national and global development goals and aspirations. These goals include:

- sustainability goals;
- peace related goals;
- work related goals;
- academic goals;
- relationship goals;
- health goals;
- adoption and internalisation of values and attitudes accepted by society, and
- improved social, political, economic outcomes.

Even though the original purpose and the drive of STEAM was to develop a pathway to engage students in learning about, experiencing, and applying STEAM skills in real life situations to motivate and hopefully get them to pursue careers in STEAM related fields and undertake STEAM related higher education programs to meet the demand for STEAM workers, STEAM education can also be used to teach and engage students to study more broadly the impact of STEAM on the social, economic, political, intellectual, cultural and environmental contexts. This line of inquiry is more enriching, exciting, empowering and transformative.

STEAM-based lesson planning

Effective STEAM lesson planning is key to the achievement of expected STEAM outcomes. STEAM skills can be planned and taught using separate STEAM-based lesson plans or integrated into the standards-based lesson plans. To effectively do this, teachers should know how to write effective standards and STEAM-based lesson plans.

Developing STEAM-based lesson plans

Teachers should integrate STEAM content and teaching, learning and assessment strategies into their standards-based lesson plans.

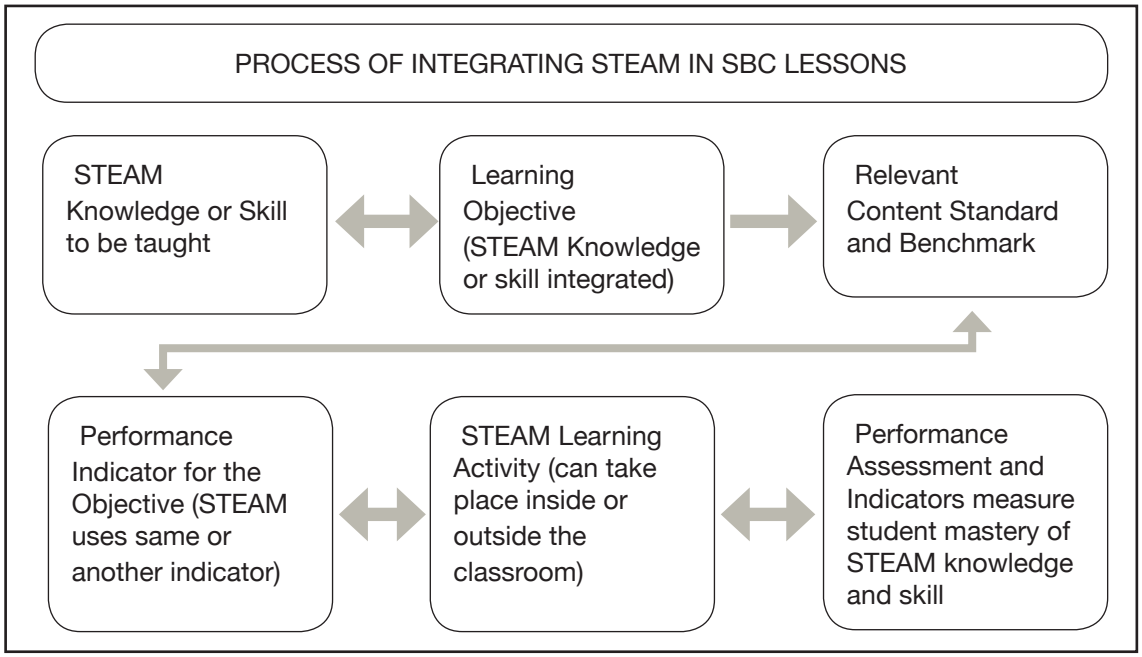
Integration of STEAM problem-solving skills into standards-based lesson plans

Knowing how to integrate STEAM problem-solving skills, principles, values and attitudes as well as STEAM teaching, learning, and assessment strategies into the standards-based lesson plans is essential for achieving the desired STEAM learning outcomes. When integrating STEAM problem-solving skills into the standards-based lesson plans, teachers should ensure that these skills are not only effectively aligned to the learning objective and performance standards, they must also be effectively taught and assessed.

STEAM principles and problem-solving skills are integrated into the content standards and grade-level benchmarks. A list of these skills, including 21st century skills, is provided in the Social Science Grades 11 & 12 Syllabus. Teachers should ensure that these skills are integrated in their standards-based lesson plans, taught and assessed to determine students' level of proficiency on each skill or specific components of the skill. Teachers should use the following process as guide to integrate STEAM principles and problem-solving skills into the standards-based lesson plans.

Teachers are expected to integrate the essential STEAM principles, processes, skills, values and attitudes described in the grade 11 benchmarks when formulating their standards-based lesson plans. Opportunities should be provided inside and outside of the classroom for students to learn, explore, model and apply what they learn in real life or related situations. These learning experiences will enable students to develop a deeper understanding of STEAM principles, processes, skills, values and attitudes and appreciate their application in real life to solve problems.

Process for integrating STEAM principles and problem-solving skills into standards-based lessons



Teachers should follow the steps given below when integrating STEAM problem-solving principles and skills into their standards-based lesson plans.

Step 1: Identify the STEAM knowledge or skill to be taught (From the table of KSVAs for each content standard and benchmark). This could already be captured in the learning objective stated in the standards-based lesson plan.

Step 2: Develop and include a performance standard or indicator for measuring student mastery of the STEAM knowledge or skill (e.g. level of acceptable competency or proficiency) if this is different from the one already stated in the lesson plan.

Step 3: Develop student learning activity (An activity that will provide students the opportunity to apply the STEAM knowledge or skill specified by the learning objective and appropriate statement of the standards). Activity can take place inside or outside of the classroom, and during or after school hours.

Step 4: Develop and use performance descriptors (standards or indicators) to analyse students' STEAM related behaviours and products (results or outcomes), which provide evidence that the student has acquired and mastered the knowledge or skill of the learning objective specified by the indicator(s) of the standard(s).

STEAM teaching strategies

STEAM education takes place in both formal and informal classroom settings. It takes place during and after school hours. It is a continuous process of inquiry, data collection, data analysis, making decisions about interventions, and implementing and monitoring interventions for improvements.

There are a variety of STEAM teaching strategies. However, teaching strategies selected must enable teachers to guide students to use the engineering and artistic design processes to identify and solve natural and physical environmental problems by designing prototypes and testing and refining them to effectively mitigate the problems identified. The following are some of the strategies that could be used to utilise the STEAM approach to solve problems and coming up with technological solutions.

1. Inquiry-Based Learning
2. Problem-Based Learning
3. Project-Based Learning
4. Collaborative Learning

Collaborative learning involves individuals from different STEAM disciplines and expertise in a variety of STEAM problem-solving approaches working together and sharing their expertise and experiences to inquire into and solve a problem.

Teachers should plan to provide students opportunities to work in collaboration and partnership with experts and practitioners engaged in STEAM related careers or disciplines to learn first-hand about how STEAM related skills, processes, concepts, and ideas are applied in real life to solve problems created by the natural and physical environments. Collaborative learning experiences can be provided after school or during school holidays to enable students to work with STEAM experts and practitioners to conduct inquiry and solve problems by developing creative, innovative and sustainable solutions. Providing real life experiences and lessons, e.g., by involving students to actually solve a scientific, technological, engineering, or mathematical, or Arts problem, would probably spark their interest in a STEAM career path.

Developing STEAM partnerships with external stakeholders e.g., higher education institutions, private sector, research and development institutions, and volunteer and community development organizations can enhance students' learning and application of STEAM problem-solving principles and skills.

1. Participatory Learning
2. Group-Based Learning
3. Task Oriented Learning
4. Action Learning
5. Experiential Learning
6. Modeling
7. Simulation

STEAM learning strategies

Teachers should include in their lesson plans STEAM learning activities. These activities should be aligned to principle or a skill planned for students to learn and demonstrate proficiency at the end of the lesson to expose students to STEAM and giving them opportunities to explore STEAM-related concepts, they will develop a passion for it and, hopefully, pursue a job in a STEAM field. Providing real life experiences and lessons, e.g., by involving students to actually solve a scientific, technological, engineering, or mathematical, or arts problem, would probably spark their interest in a STEAM career path. This is the theory behind STEAM education.

STEAM-based assessment

STEAM-based assessment is closely linked to standards-based assessment where assessment is used to assess students' level of competency or proficiency of a specific knowledge, skill, value, or attitude taught using a set of performance standards (indicators or descriptors). The link also includes the main components such as the purpose, the assessment principles and assessment strategies and tools.

In STEAM-based assessment, assessments are designed for what students should know and be able to do. In STEAM learning students are assessed in a variety of ways including portfolios, project/problem-based assessments, backwards design, authentic assessments, or other student-centered approaches.

When planning and designing the assessment, teachers should consider the authenticity of the assessment by designing an assessment that relates to a real world task or discipline specific attributes (such as simulation, role play, placement assessment, live projects, debates) which should make the activity meaningful to the students, and therefore be motivating as well as developing employability skills and discipline specific attributes.

Effective STEAM-based assessment strategies

The following sections describe six assessment tools and strategies shown to impact teaching and learning as well as help teachers foster a 21st century learning environment in their classrooms:

1. Rubrics
2. Performance-Based Assessments (PBAs)
3. Portfolios
4. Student self-assessment
5. Peer-assessment
6. Student Response Systems (SRS).

Although the list does not include all innovative assessment strategies, it includes what we think are the most common strategies, and ones that may be particularly relevant to the educational context of developing countries in this 21st century. Many of the assessment strategies currently in use fit under one or more of the categories discussed. Furthermore, it is important to note that these strategies also connect in a variety of ways.

1. Rubrics

Rubrics are both a tool to measure students' knowledge and ability as well as an assessment strategy. A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess discrete knowledge at a fixed moment in time. Rubrics are also frequently used as part of other assessment strategies (portfolios, performances, projects, peer-review and self-assessment). They will be discussed in those sections as well.

2. Performance-Based Assessments

Performance-Based Assessments (PBA), also known as project-based or authentic assessments, are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a "real-world" situation. By asking them to create an end product, PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting.

The implementation of performance-based assessment strategies can also impact other instructional strategies in the classroom.

3. Portfolio Assessment

Portfolios are a collection of student work gathered over time that is primarily used as a summative evaluation method. The most salient characteristic of the portfolio assessment is that rather than being a snapshot of a student's knowledge at one point in time (like a single standardized test), it highlights student effort, development, and achievement over a period of time; portfolios measure a student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centered and authentic assessments of learning.

4. Self-assessment

While the previous assessment tools and strategies listed in this report generally function as summative approaches, self-assessment is generally viewed as a formative strategy, rather than one used to determine a student's final grade. Its main purpose is for students to identify their own strengths and weaknesses and to work to make improvements to meet specific criteria. Self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance. In this way, self-assessment aligns well with standards-based education because it provides clear targets and specific criteria against which students or teachers can measure learning.

Self-assessment is used to promote self-regulation, to help students reflect on their progress and to inform revisions and improvements on a project or paper. In order for self-assessment to be truly effective four conditions must be in place: the self-assessment criteria is negotiated between teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments and teachers help students use assessment data to develop an action plan.

5. Peer assessment

Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning. Peer assessment approaches can vary greatly but, essentially, it is a process for learners to consider and give feedback to other learners about the quality or value of their work. Peer assessments can be used for a variety of products like papers, presentations, projects, or other skilled behaviours. Peer assessment is understood as more than only a grading procedure and is also envisioned as teaching strategy since engaging in the process develops both the assessor and assessee's skills and knowledge.

The primary goal for using peer assessment is to provide feedback to learners. This strategy may be particularly relevant in classrooms with many students per teacher since student time will be more plentiful than teacher time. Although any single student's feedback may not be rich or in-depth as teacher's feedback, the research suggests that peer assessment can improve learning.

6. Student Response System

Student response system(SRS), also known as classroom response system (CRS) or audience response system (ARS) is a general term that refers to a variety of technology-based formative assessment tools that can be used to gather student-level data instantly in the classroom through the combination of hardware, (voice recorders, PC, internet connection, projector and screen) and software.

Teachers can ask students a wide range of questions (both closed and open ended), where students can respond quickly and anonymously, and the teacher can display the data immediately on graphs. The use of technology also includes a use of video which examines how a range of strategies can be used to assess students' understanding.

The value of SRS comes from teachers analyzing information quickly and then devising real-time instructional solutions to maximize student learning. This includes a suggested approach to help teachers and trainers assess learning.

Curriculum Integration

What is Curriculum Integration?

Curriculum integration is making connections in learning across the curriculum. The ultimate aim of curriculum integration is to act as a bridge to increase students' achievement and engage in relevant curriculum *(Susan M. Drake and Rebecca C. Burns 2008).*

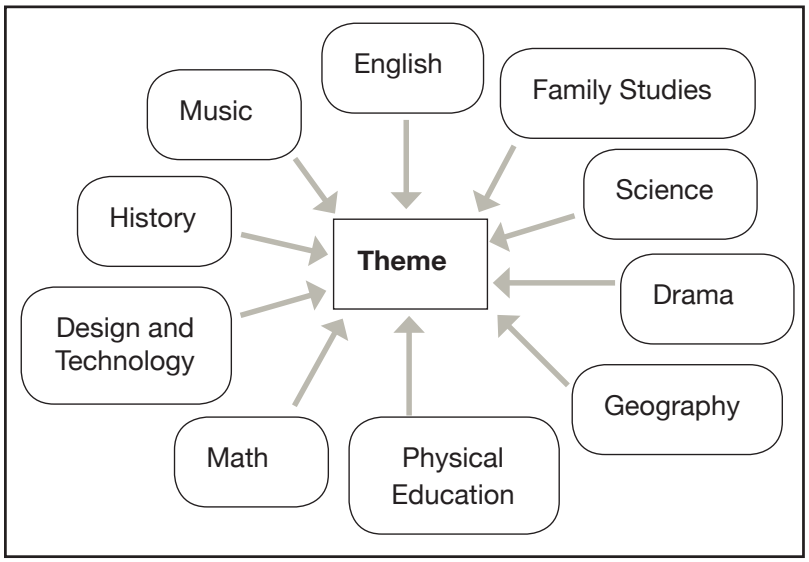
Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented teaching to one who is knowledge based and who should be perceived as a 21st century innovative educator. Curriculum integration is a holistic approach to learning thus curriculum integration in PNG SBC will have to equip students with the essential knowledge, skills, values and attitudes that are deemed 21st century.

There are three approaches that PNG SBC will engage to foster conducive learning for all its children whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these children thus they can be able to see themselves as catalyst of change for a competitive PNG. Not only that but they will be comparable to the world standards and as global citizens.

Engaging these three approaches in our curriculum will surely sharpen the knowledge and ability of each child who will foresee themselves as assets through their achievements and thus contribute meaningfully to their country. They themselves are the agents of change. Integrated learning will bear forth a generation of knowledge based populace who can solve problems and make proper decisions based on evidence. Thus, PNG can achieve its goals like the Medium Term Development Goals (MTDG) and aims such as the Vision 2050 for a happy, healthy and wealthy society whereby, all its citizens should have access to and fair distribution to income, shelter, health, education and general goods and services thus improving the general standard of living for PNG in the long run.

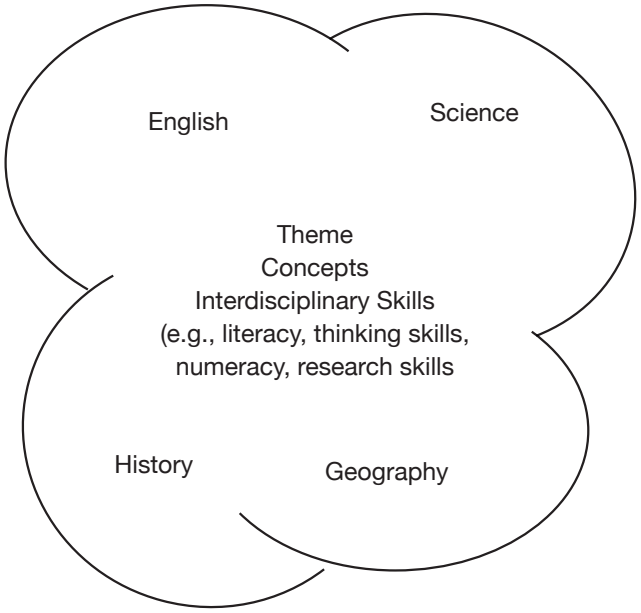
1. Multidisciplinary approach

In this approach, learning involves a theme or concept that will be taught right across all subject areas of study by students. That is, content of a particular theme will be taught right across all subjects as shown in the diagram below. For instance, if the theme is global warming, subject areas create lessons or assessment as per their subjects around this theme. Social Science will address this issue and Science and all other subject will do likewise.



2. Interdisciplinary approach

This approach addresses learning similarly to the multidisciplinary approach of integrated learning whereby learning takes place within the subject area. However, it is termed interdisciplinary in that the core curriculum of learning is interwoven into each subject under study by the students. For instance; in Social Science geography strand, students write essay on internal migration however, apart from addressing the issues of this topic, they are to apply the skill of writing text types in their essay, such as; argumentative, informative, explanatory, descriptive, expository and narrative essay. They must be able to capture the mechanics of English skills such as grammar, punctuation and so forth.



Though these skills are studied under English, they are considered as core skills that cut across all subjects. For example; if Science students were to write about human development in biology, then the application of writing skills has to be captured by the students in their writing. It is not seen as an English skill but a standard essential skill all students must know and do regardless.

Therefore, essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship in this learning.

3. Intra-disciplinary approach

This approach involves teachers integrating sub disciplines within a subject area. For instance, within the subject Social Science, the strands (disciplines) of geography, environment, history and political science will all be captured studying a particular content for Social Science. For example, under global warming, students will study the geographical aspects of global warming, environmental aspect of global warming and likewise for history, political science and economics. Thus, children are well aware of the issues surrounding global warming and can address it confidently at each level of learning.

4. Trans-disciplinary approach

In this approach, learning goes beyond the subject area of study. Learning is organized around students'questions and concerns. That is, where there is a need for change to improve lives, students develop their own curriculum to effect this need.

The trans-disciplinary approach addresses real-life situations thus giving the opportunity to students to attain real life skills. This learning approach is more to do with Project–Based Learning which is also referred to as problem-based learning or place-based learning.

The three steps to planning project based curriculum *(Chard 1998).*

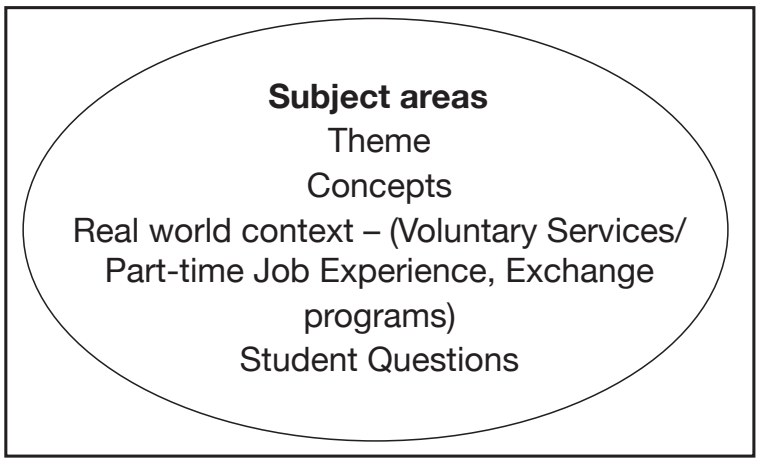
1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources
2. The teacher finds out what the students already know and helps them generate questions to explore. The teacher also provides resources for students and opportunities to work in the field
3. Students share their work with others in a culminating activity. Students display the results of their exploration and review and evaluate the project.

For instance; students may come up with slogans for school programs such as 'Our culture – clean city for a healthier PNG'. The main aim could be to curb betel nut chewing in public areas especially around bus stops and local markets. Here, students draw up their own instructions and criteria for assessment which is; they have to clean the nearest bus stop or local market once a week throughout the year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness.

Studies *(Susan M. Drake and Rebecca C. Burns 2008).* have proven that Project based-programs have led to the following:

- Students go far beyond the minimum effort
- Make connections among different subject areas to answer open-ended questions
- Retain what they have learnt
- Apply learning to real-life problems
- Have fewer discipline problems
- Lower absenteeism *(Curtis, 2002)*

These integrated learning approaches will demand for teaches to be proactive in order to improve students learning and achievements. In order for PNG Standards-Based Curriculum to serve its purpose fully, these three approaches must be engaged for better learning for the children of Papua New Guinea now and in the future.



Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards will depend on their mastery and application of essential knowledge, skills, values, and attitudes in real life or related situations.

Social Science has 5 broad areas (strands) which contain essential knowledge captured in the national content standards and benchmarks. Knowledge is 'what students must know and understand' in Social Science. The fundamental concepts in Social Science are outlined below.

Geography
- The examination, description, and explanation of the earth - its variability from place to place, how places and features change over time, and the processes responsible for these variations and changes.
- Human geography (population, migration,)

History
- Historical roots and how past events have shaped Papua New Guinea and the world.
- Reconstructing and interpreting historical events

Political Science
- Political ideologies and systems (power, authority, governance and functions of different political systems)

Economics
- The concept of scarcity (limited resources & unlimited needs & wants)
- Satisfying needs and wants
- Decision making

Environment
- Physical systems and processes of the environment
- Relationship between people and the environment
- Impact of the exploitation of the natural environment
- Good stewards of the environment

Social Science requires 'inquiry–based learning'. The inquiry–based learning 'is an approach that emphasises the role of the student in the learning process, rather than the teacher telling the students what they need to know. It encourages the students to explore a topic, ask questions and share ideas. Therefore, the skills outlined here are essential for 'inquiry–based learning'.

Research Skills
- Access information
- Organise information
- Evaluate sources
- Use information
- Align solution with task
- Cite all sources accurately

Collaborating Skills Working effectively with peers, listen and share ideas and compromise to create good products - Show independent initiative - Assume shared responsibility - Assist others in their roles - Contribute ideas - Keep an open mind - Apply strategies - Take a variety of roles - Tolerate different view points
Critical Thinking Create products that demonstrate abilities to justify augments, asking questions, analyse complex systems, evaluate evidence, draw conclusions, reflect on learning and explain how to solve problems
Creative and Innovative Skills - Think creatively - Generate ideas - Work creatively with others - Implement innovations
Communicating Skills - Ability to listen, read, write, present, comprehend, share and express ideas and thoughts between different audiences and use multiple forms of media

Thinking is problem-solving. Critical thinking is motivated by a problem. Teachers are advised to raise the level of higher thinking skills for the students.

The 'inquiry-based learning' is a process where students are engaged in;

1. Identify the problem
2. Develop an action plan
3. Research/gather/collect data
4. Analyse/organise data and form conclusions
5. Report the results/presentation

Moreover, Social Science is driven by values. These values and attitudes must be emphasised and reinforced in the teaching and learning process.

Values & Attitudes
• Curiosity • Initiative • Adaptability • Leadership • Collaboration & teamwork • Participation • Passion for exploring & learning • Appreciation of the awesomeness of nature, events, people etc • Being patriotic and responsible • Show consideration • Respect the environment and people • Embrace diversity • Maintain positive values

Teaching and Learning Strategies

Social Science emphasises and embraces the use of cognitive, reasoning, decision-making, problem-solving and higher-level thinking skills to teach to enhance students' understanding of inter-disciplinary concepts and issues in relation to environment, geography, history, politics and economic within PNG and globally. It aims to provide a meaningful pedagogical framework for teaching and learning essential and in-demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st century.

Students must be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organize and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

These teaching and learning strategies will help teachers to;

- familiarize themselves with different methods of teaching in the classroom
- develop an understanding of the role of a teacher for application of various methods in the classroom

Successful teachers always keep in view that teaching must "be dynamic, challenging and in accordance with the learner's comprehension. He/she does not depend on any single method for making his/her teaching interesting, inspirational and effective".

Please find a list of the different teaching and learning strategies in Appendix 3.

These strategies;

- make learning more engaging
- make learning more effective
- make learning fun
- encourage higher motivational level
- improve attention spans
- develop higher order thinking and reflective skills
- improve communication skills
- develop the spirit of teamwork/collaboration
- develop leadership skills and qualities
- encourage discovery learning

Therefore, teachers are encouraged to utilise the suggested strategies as well as others.

Units and Topics

This section of the teacher guide contains the Social Science – Environment content to be taught in grade 11. It consists of;

- units
- topics

Environment in grade 11 has four units and they are;

1. Resources and Environment
2. The Earth and Its Systems
3. Biological Dynamics of the Earth
4. Environmental Change and Sustainability

The table below outlines the units and topics of Environment in grade 11 to be taught in an academic year. This will guide teachers to plan and teach the Environment strand in grade 11.

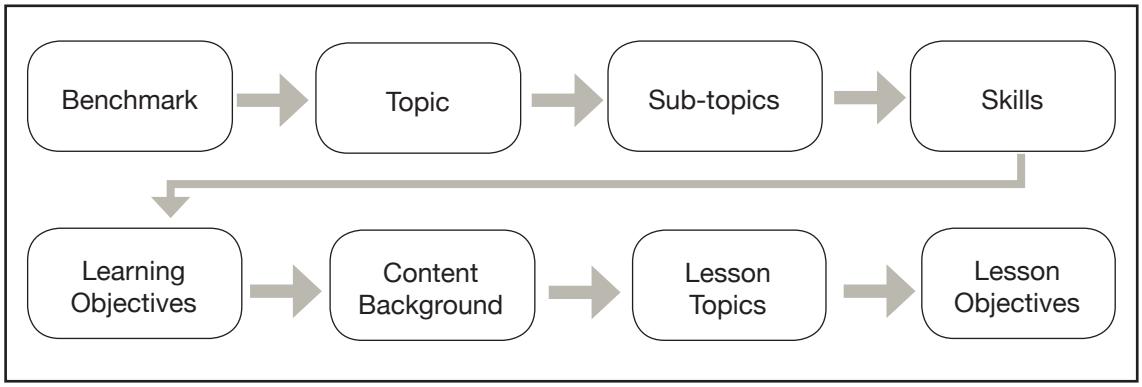
Units	Topics
Resources and Environment	Topic 1: Influence of abiotic factors Topic 2: Influence of abiotic factors – Extension 1 Topic 3: Influence of abiotic factors – Extension 2
The Earth and Its Systems	Topic 1: The hydrosphere and the water cycle Topic 2: The atmosphere Topic 3: Agricultural practices
Biological Dynamics of the Earth	Topic 1: Man's impact on energy flow within an ecosystem Topic 2: Impacts of development on the environment Topic 3: Impact of colonisation on resource exploitation
Environmental Change and Sustainability	Topic 1: Resource consumption and management Topic 2: Issues; health, population, resources and environment Topic 3: Economic development, resource consumption and conservation

How were the topics developed?

The topics given in the table were derived from the benchmarks. That is, National content standards are benchmarked at each grade level, which allows for essential KSAVs to be reinforced and expanded throughout the grades. Benchmarks show grade level expectations of what students are able to do to demonstrate that they are making progress towards attaining the content standard. These grade-level benchmarks were then unpacked to identify the topics. From the topics, teachers should be able to develop sub-topics and learning objectives and of course the lesson topics and lessons objectives to be achieved per lesson.

When we unpack a benchmark, we are identifying what students will know and be able to do when they have mastered the benchmark.

1. Write out the benchmark.
2. Write the verbs (skills/actions) – Higher order thinking skills.
3. Underline or highlight the big idea (content) in the benchmark. The big idea (content) is the topic derived from the benchmark.
4. Develop sub-topics from the big idea (topic).
5. Write learning objectives according to the sub-topics.
6. Derive lesson topics from the learning objectives.



Unit of work

The unit of work outlines the topics, sub-topics and the learning objectives for each of the four (4) units in Environment, derived from the content standard and the benchmarks. It basically presents what the teacher is expected to teach. Teachers are advised to use the learning objectives to create lesson topics and lesson objectives in preparing lessons. Brief content background of each topic is provided to support teacher's lesson preparation.

Unit 1: Resources and Environments

Content Standard 5.1: Students will be able to examine and make sense of different resources and different environments.

Benchmark 11.5.1.1: Investigate the influence of abiotic factors – precipitation, temperature, and soil on living and non-living things in different environments and regions of the world.

Topic 1: Influence of abiotic factors

Sub-topics:
- Precipitation
- Temperature
- Soil

Skills: Analysing (investigate).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and explain abiotic factors.
- Explain the influence of precipitation on living and non-living things in different environments.
- Explain temperature change in different environments.
- Explain the influence of temperature on living and non-living things in different environments.
- Identify and explain types of soil.
- Explain the influence of soil on living and non-living things in different environments.

Content Background

Abiotic factors are the non-living parts of the environment. They are all of the non-living things in an ecosystem that can often have a major influence on living organisms.

Both biotic and abiotic factors are related to each other in an ecosystem. If one factor is changed or removed, it can affect the entire ecosystem. In fact living things thrive on non-living things such as gases, water, heat and light. Abiotic factors are important because they directly affect how organisms survive.

Abiotic factors: Precipitation, Temperature, and Soil

1. Precipitation: refers to the descent of water as liquid or soild onto the earth's surface under the influence of gravity. Certain kinds of precipitation are associated with summer or winter weather conditions. The form precipitation takes when it falls to the Earth's surface depends on the temperature of the air both in the atmosphere and at ground level.

   The five main types of precipitation are rain, snow, sleet, drizzle and hail. They are all forms of moisture that is available on the Earth's surface. Ground moisture balance is very important for the continuous flow of

natural systems and cycles, soil moisture balance and plant growth and the co-inhabitation of the biosphere (plants and animals).

2. Temperature: refer to how hot or cold a place or a thing is. It is expressed in terms of any of several arbitrary scales and indicating the direction in which heat energy will flow from a hotter body to a colder body.

   Body temperature is a measure of the body's ability to generate and get rid of heat. The average normal body temperature is generally accepted as 98.6°F (37°C). Normal body temperature varies by person, age, activity, and time of day.

   Temperature affects the physiology of living things as well as the density and state of water and the air (gases). Temperature exerts an important influence on living things because few living things can survive at temperatures below 0°C (32°F) due to metabolic constraints. It is also rare for living things to survive temperatures exceeding 45°C (113°F). Each living thing has a range of temperature (maximum and minimum) within which it thrives and reproduction. This is a reflection of evolutionary response to typical temperatures. The temperature range is normally referred to as the 'optimum range'. Outside of a species' optimum range, this species will struggle to live and reproduce its kind.

   Enzymes are most efficient within a narrow and specific range of temperatures; enzyme degradation can occur at higher temperatures. Therefore, organisms either must maintain an internal temperature or they must inhabit an environment that will keep the body within a temperature range that supports metabolism.

   Some animals have adapted to enable their bodies to survive significant temperature fluctuations, such as seen in hibernation or reptilian torpor. Similarly some bacteria are adapted to surviving in extremely hot temperatures such as geysers. Temperature can limit the distribution of living things. Animals faced with temperature fluctuations may respond with adaptations, such as migration, in order to survive. Migration, the movement from one place to another is an adaptation feature found in many animals, including many that inhabit seasonally cold climates. Migration solves problems, related to temperature, locating food, and finding a mate.

   Temperature and moisture are important influences on plant production and the amount of organic matter available as food.

3. Soil is the thin layer of material covering the earth's surface and is formed from the weathering of rocks. Soils are complex mixtures rock of minerals, water, air and organic matter. Organic matter includes both living organisms like decomposers as well as dead or decaying matter. Each of these complex mixtures is important for supporting plant growth, microbial communities, and chemical decomposition.

   Soil composition is an important aspect of nutrient management. The amount of each of the four major components of soil depends on the

quantity of vegetation, soil compaction, and water present in the soil. Soils that are tightly compacted need organisms like worms to aerate the soil.

A soil type is a taxonomic unit in soil science. All soils that share a certain set of well-defined properties form a distinctive soil type. Soil type is a technical term of soil classification, the science that deals with the systematic categorisation of soils. Every soil of the world belongs to a certain soil type.

Suggested Resources

1. Christian Leveque, (2003), *Ecology: From Ecosystem to Biosphere.* USA, Science Publishers Inc,
   Retrieved from: https://books.google.com.pg/
2. Jo van As, (2012), *The story of life and the environment.* Cape Town, South Africa, Struik Nature (Pty) Ltd.
   Retrieved from: https://books.google.com.pg/
3. Disha Experts, *Biology for CBSE Board.* New Delhi, DISHA Publication.
   Retrieved from: https://books.google.com.pg/

Benchmark 11.5.1.2: Examine the influence of abiotic factors – water, air, and energy on different aspects of various types of environments, and natural systems and cycles, in different regions of the world.

Topic 2: Influence of abiotic factors - Extension 1

Sub-topics:
- Water
- Air
- Energy

Skills: Analysing (examine).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and explain the water sources.
- Explain the influence of water on living and non-living things in different environments.
- Identify and explain air composition.
- Explain the influence of air on living and non-living things in different environments.
- Identify and explain the source and flow of energy.
- Explain the influence of energy on living and non-living things in different environments.

Content Background

In an ecosystem, there are biotic and abiotic factors. The biotic factors are the living things within an ecosystem, and the abiotic factors are the non-living things in that ecosystem.

Abiotic factors: Water, Air, Energy

1. Water is a very important factor which controls the world's climate and it is essential for all life. Our bodies are made up of about 70 percent water. Living things need to continually take in water because they also continually lose it. Water, once used or lost, needs to be purified and taken back into the body. The water cycle is important in making sure that water is always available for living things to use. Without water there would be no life on Earth.

   Water also helps to control the climate of the Earth. Whenever water evaporates it takes heat from the air around it. When water vapor condenses back into water droplets this heat is given off to the air. In tropical regions, vast amounts of water vapor are lost from the leaves of plants. This helps to cool down the tropical areas. Much of this water vapor is carried by the atmosphere to temperate regions. When the water vapor condenses to form rain, heat is given off to the air. This helps to warm up the temperate regions. Clouds in the atmosphere also help to keep the Earth cool by reflecting the heat of the sun back into outer space.

Water is required by all living things because it is critical for cellular processes. Since terrestrial organisms lose water to the environment by simple diffusion, they have evolved many adaptations to retain water. Animals will be covered in an oily or waxy skin or cuticle to retain moisture. Plants have a number of interesting features on their leaves, such as leaf hairs, and waxy cuticle, that serve to decrease the rate of water loss via transpiration.

Organisms surrounded by water are not immune to water imbalance; they too have unique adaptations to manage water inside and out of their cells. Water is also important in the weathering process and is also an important component of soils. Nutrients from the soil are transported by water through the roots of plants as dissolved nutrients.

2. Air is the Earth's atmosphere. Air around us is a mixture of many gases and dust particles. It is the clear gas in which living things live and breathe. It has an indefinite shape and volume. It has no color or smell. It has mass and weight because it is matter. The weight of air creates atmospheric pressure.

   Air is a mixture of about 78% nitrogen, 21% of oxygen, 0.9% of argon, 0.04% of carbon dioxide, and very small amounts of other gases. It also contains a variable amount of water vapor, on average around 1% at sea level, and 0.4% over the entire atmosphere. Animals live by aerobic respiration and need to breathe the oxygen in the air. In breathing, the lungs put oxygen into the blood and send back carbon dioxide to the air. Plants need the carbon dioxide in the air to live. They give off the oxygen that we breathe. Without it we die of asphyxiation.

   The movement of air from an area of high pressure to an area of low pressure is called wind. Wind is the moving air and it affects weather and weather conditions. Wind can be an important abiotic factor because it influences the rate of evaporation and transpiration. The physical force of wind is also important because it can move soil, water, or other abiotic factors, as well as an ecosystem's organisms. Air can be polluted by some gases such as carbon monoxide, smoke and ash which can damage people's health. This air pollution causes various problems including smog, acid rain and global warming. Different gases perform different roles. For example, carbon dioxide and oxygen sustain things apart from breaking down rocks and being part of soils. Greenhouse gases like carbon dioxide, methane, ozone, nitrous oxide and water vapour regulate Earth's average temperature so that it is not too hot or too cold. They play much the same role as clouds do in a single place. Nitrogen is also an important plant nutrient when converted to nitrate in the nitrogen cycle.

3. Energy is the capacity to do work. The various types of energy include kinetic, potential, and chemical energy. The potential energy stored in molecules can be converted to chemical energy, which can ultimately be converted to kinetic energy, enabling an organism to move. Energy associated with objects in motion are called kinetic energy. The jet engines are converting potential energy in fuel to the kinetic energy of

movement. This type of potential energy is called chemical energy, and like all potential energy, it can be used to do work.

All organisms require energy to complete tasks; metabolism is the set of the chemical reactions that release energy for cellular processes. Plants convert light energy from the sun into chemical energy stored in molecules during the process of photosynthesis. Some of these chemical reactions are spontaneous and release energy, whereas others require energy to proceed.

Energy is needed to perform heavy labor and exercise, but humans also use a great deal of energy while thinking and even while sleeping. Just as energy is required to both build and demolish a building, energy is required for both synthesis and breakdown of molecules.

All living things require energy in one form or another since energy is required for different metabolic processes. The processes of all organisms, from bacteria to humans, require energy. To get this energy, many organisms access stored energy by eating food. But where does the stored energy in food originate? All of this energy can be traced back to the process of photosynthesis and light energy from the sun. It is important to understand how organisms acquire energy and how that energy is passed from one organism to another through food webs and food chains.

Suggested Resources

1. Department of Education (PNG), *Changing World.* John Wiley and Sons Australia, Ltd; QLD 4064, AUST.
2. Paul .S.Giller, *The Biology of Streams and Rivers.* Oxford University Press. *Retrieved from: https://books.google.com.pg/*
3. Audrey Tomera, (2001). *Understanding Basic Ecological Concepts.* J.Weston. WALCH Publisher. *Retrieved from: https://books.google.com.pg/*

Benchmark 11.5.1.3: Assess the influence of abiotic factors – light, dissolved oxygen, phosphorous, nitrogen, and pH, on sustenance of life and survival of plants, animals, and human beings, and on the function of various natural systems and cycles in different environments and regions of the world.

Topic 3: Influence of abiotic factors - Extension 2

Sub-topics:
- Light and heat
- Oxygen and carbon dioxide
- Phosphorous
- Nitrogen
- pH

Skill: Evaluating (assess).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and explain light and heat sources.
- Explain the influence of light and heat on sustenance of life and functions of natural systems and cycles.
- Identify and describe dissolved oxygen.
- Explain the influence of dissolved oxygen on the sustenance of life and the functions of natural systems and cycles.
- Identify and explain phosphorous.
- Explain the influence of phosphorous on the sustenance of life and the functions of natural systems and cycles.
- Identify and explain nitrogen.
- Explain the influence of nitrogen on the sustenance of life and functions of natural systems and cycles.
- Examine the influence of pH of water and soils on the sustenance of life and functions of natural systems and cycles.

Content Background

Abiotic factors: Light, oxygen, Phosphorous, Nitrogen, and pH

1. Light – a light source is anything that makes light. There are natural and artificial light sources. Natural light sources include the Sun, stars, fire, candles and electricity in storms. Artificial light sources include light bulbs, lamp posts, televisions, table lamps, neon lights. Light energy is the only visible form of energy which our sense of sight can detect. It is made of electromagnetic radiation, and travels in a straight line in an electromagnetic spectrum or EMS. Light is always in motion and cannot be stored. It is either emitted or reflected from one source to another, and absorbed and converted from one form to another. With light comes heat.

   Sunlight coupled with the radiant heat energy is an essential source of light energy for many natural processes such as water cycle, photosynthesis, sterilization, sanitation. The energy on the sun is generated because of hydrogen fusion. The light from the sun reaches planets and other cosmic bodies including earth. On earth, this energy sustains life and generates the functions of natural systems, processes and cycles.

2. Dissolved Oxygen – is a relative measure of the amount of oxygen (O2) dissolved in water. Oxygen gets into the water by diffusion from the atmosphere, aeration of the water as it tumbles over rocks, waterfalls and rapids, and as a waste product of photosynthesis. Water temperature and the volume of moving water can affect dissolved oxygen levels. Oxygen dissolves easier in cooler water than in warmer water.

   Dissolved oxygen is a key determinant of the oxidation process in which compounds are dissolved in water, and it is also a very important measure of the amount of oxygen available to aquatic life forms. Levels that are too high or too low can harm aquatic life and affect water. It is one of the most important indicators of water quality which is essential for the survival of fish and other aquatic organisms. Oxygen dissolved in the water is also needed in the biodegradation of organic matter by aerobic (oxygen consuming) bacteria.While aquatic aerobic organisms need sufficient dissolved oxygen, their terrestrial counterparts take in pure oxygen from the atmosphere. Dissolved oxygen and carbon dioxide are needed by aquatic animals and plants while terrestrial ones take in pure oxygen and carbon dioxide. Dissolve oxygen and carbon dioxide are also vital for the chemical weathering of rocks to form soils and sedimentary rocks. In the freshwater bodies like lakes and rivers, the amount of dissolved oxygen is affected by the run-off of fertilisers used in agriculture. These nutrients used in agriculture enrich the water and cause an algae bloom. The algae and the green plants like water hyacinth tend to block off dissolved oxygen for the aerobic organisms like fish and they eventually die. This enrichment of water bodies by excessive nutrients used in agriculture is called eutrophication.

3. Phosphorous – is a chemical element with the symbol P and an atomic number 15. As an element phosphorous exists in two major forms, white phosphorous and red phosphorous, but because it is highly reactive, it is never found as a free element on Earth. It is the second most abundant mineral in the body after calcium and is part of every cell in your body. It is found in high amounts in protein foods such as milk and dairy products and meat and alternatives such as bean, fish, nuts and poultry. The body needs phosphorous to perform a range of essential functions. The main function of phosphorous is in the formation of bones and teeth. It plays an important role in how the body uses carbohydrates and fats. Phosphorous is recycled in the environment through the phosphorus cycle.

   Phosphorous helps to:
   - build strong bones and teeth
   - filter out waste in your kidneys
   - manage how your body stores and uses energy
   - grow, maintain, and repair tissue and cells
   - produce DNA and RNA – the body's genetic building

   Phosphorous deficiency may cause bone diseases such as rickets in children and osteomalacia in adults. An improper balance of phosphorus and calcium may cause osteoporosis. Phosphorous deficiency in crops is more difficult to diagnose than a deficiency of nitrogen and potassium.

Phosphorus deficiency is a major growth limiting factor in acid upland soils.

4. Nitrogen: The chemical element with the symbol N and the number 7. It was first discovered in 1772 by a Scottish Chemist and physician, Daniel Rutherford, when he removed oxygen and carbon dioxide from air, demonstrating that the residual gas would not support living organisms or combustion. In its gas form, nitrogen is colourless, odourless and generally considered as inert. In its liquid form nitrogen is also colourless and odourless and looks similar to water. It is the fifth most abundant element in the universe and constitutes 78 percent of Earth's air. Nitrogen in its pure state is almost of no use. It is converted to the nutrient nitrate during lightening by the nitrogen fixing bacteria in soils with legume plants. Nitrogen is recycled in the environment through the nitrogen cycle. Nitrogen is essential to life on earth. It is a component of all proteins, and it can be found in all living systems. Nitrogen compounds are present in organic materials, foods, fertilisers, explosives and poisons. Nitrogen is crucial to life, however, in excessive amounts it can also be harmful to the environment.

5. pH stands for *power of Hydrogen,* which is a measurement of the hydrogen ion concentration in the body. In chemistry, pH is a scale used to specify how acidic or basic a water based solution is. Acidic solutions have a lower pH, while basic solutions have a higher pH.

   One of the most basic elements of our health and the wellness of our body is the pH level we maintain. The human body is built to naturally maintain a healthy balance of acidity and alkalinity. The lungs and kidneys play a key role in this process. Soil pH is a measure of the acidity and alkalinity in soils. Soil pH affects the availability of some plant nutrients and can affect plant growth in several ways. The pH of a soil affected by the concentration of CO2 in the soil air, salt concentration (salt effect) and the presence of colloidal substances. The pH value of both water and soils are largely threatened today by acid rain, forest fires, fertilisers used in agriculture and rising sea levels that result in salt intrusion of fresh ground water and fertile soils for agriculture.

Suggested Resources

1. Department of Education (PNG), *Changing World.* John Wiley and Sons Australia, Ltd; QLD 4064, AUST.
2. Paul .S.Giller, *The Biology of Streams and Rivers.* Oxford University Press.
   Retrieved from: https://books.google.com.pg/
3. Audrey Tomera, (2001). *Understanding Basic Ecological Concepts.* J. Weston. WALCH Publisher.
   Retrieved from: https://books.google.com.pg/

Unit 2: The Earth and its Systems

Content Standard 5.2: Students will be able to investigate and explain the physical dynamics of Earth that result in the flow of energy and cycling of matter within an ecosystem to demonstrate that Earth is one interconnected system.

Benchmark 11.5.2.1: Interpret man-made environments and natural environments through the lens of the hydrological cycle.

Topic 1: The hydrosphere and the water cycle

Sub-topics:
- Hydrosphere
- Water cycle

Skills: Understanding (interpret)

Learning Objectives: By the end of the topic, students will be able to:

- Explain the hydrosphere.
- Explain the water cycle.
- Explain the influence of the water cycle on natural and man-made environments.

Content Background

Our wonderful world is a unique planet in the solar system in the abundance of water it holds. The term hydrosphere is used to describe the waters of the earth. Some is in the form of liquid water, some is solid such as ice, and some is gaseous in the form of water vapor. Water is able to exist in all stated of matter only on planet Earth because of the role of the Greenhouse gases. On planets that are too close to the sun like mercury water remains only in gaseous state (water vapour/steam) while planets that are too distant from the sun have water in frozen state (solid). Water is very essential in its liquid state for sustaining many physical systems.

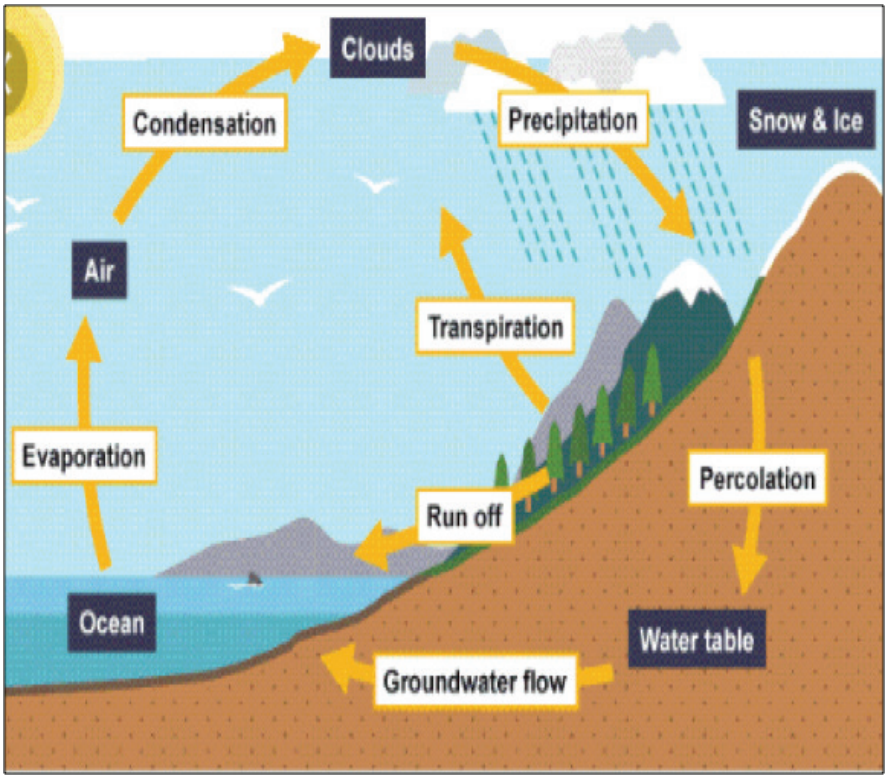
Water is essential for all life forms. It also has a great effect on the landforms and climate we experience. The earth's water is constantly circulating. This global system of circulation is called the water cycle. The water cycle is driven by the sun's radiant energy. Solar energy brings about changes in the physical state of the water and also affects the movement of water in its various forms.

Movement of water in the water cycle

The water cycle diagram shows that evaporation from the surface takes place over land and sea. Because the oceans contain 97% of the earth's water, there is naturally more evaporation from the oceans. The process of evaporation from plant tissue is called transpiration. The term 'evapo-transpiration' is used to cover all forms of change from liquid water to water vapour.

Condensation is the reverse process of evaporation. It involves a change in the state of water from gas or vapour back into liquid water droplets.

Condensation happens when the air is cooled and liquid water forms around fine particles of dust and other impurities in the atmosphere. The process leads to heat being released. This is known as latent heat.



Condensation in the air is visible to us in the form of clouds and fog, or when you have a shower on a cold day. If condensation continues in the atmosphere and large droplets are formed, the moisture will descend onto the in the form of precipitation, such as, rain, snow, sleet, or hail. Some of the precipitation that falls on the land surfaces soaks into the ground. This is known as infiltration. If infiltration goes on until the soil is saturated, excess water will either sink under the force of gravity to the ground water zone or will flow over the surface as runoff. Most runoff water drains down slopes and enters rivers and lakes. Not all of the vapour that rises into the atmosphere can reach full condensation and finally precipitation. Disturbances in the atmospheric temperature can cause rising air to not reach the full point of condensation in order for precipitation to occur.

Movement of water on natural and man-made environments

The movement of water through the ground is affected by the permeability of rock or soil. Water that seeps into the groundwater zone will percolate downwards until it reaches an impermeable rock layer. This rock stratum will stop any further downward percolation, and a water-bearing layer will build up. This is known as an aquifer.

Rainwater absorbs carbon dioxide as it passes through the atmosphere. This then becomes a very mild form of carbonic acid. Chemical weathering takes place as the mildly acidic groundwater passes through the rocks. Limestone, in particular, is subjected to chemical solution of this sort. This chemical breakdown in rock joints and tissues produces underground cave systems. Because the lime stones are permeable, surface streams may disappear underground through sinkholes. The collapse of underground caves and

tunnels leads to a distinctive irregular surface known as karst landforms. Surface runoff occurs when rain falls on an impermeable surface, or when the soil is saturated with water. If the runoff flows over an even sloping surface, a sheet flow results. However, because the resistance of the soil or rock surface varies, the runoff will usually become a channelled flow along the lines of lowest resistance. The flow of streams fed by direct runoff is usually irregular, and the stream bed will be dry soon after the rain ceases and the soil begins to dry out.

Permanent streams may appear on a slope where the groundwater table reaches the surface and provides a continuous supply of groundwater from below. This is known as a spring. When a number of permanent streams join each other, a drainage system develops. Each branch stream or tributary discharges its water into larger channels downstream. Drainage systems or river basins can be studied in terms of a hierarchy of streams. The total area drained by a river system is known as the river basin or catchment area. Many river catchment areas have been harnessed to meet the water supply needs of our major cities and towns through Hydro-electric power (HEP).

All the water that precipitate on the land will either get evaporated or transpired by plants or will run-off into the sea as surface run-off and underground run-off in response to the law of gravity where everything is drawn to 0 meters (sea level).

Regular and normal precipitation tend to take place in areas that are less heated by anthropogenic activities then in built-up areas where ground and atmospheric temperatures are compromised by the excess heat released by human activities. This is because temperature on the ground and high in the atmosphere will induce evapotranspiration, condensation and precipitation to ensure a constant supply of fresh water in the environment.

Suggested Resources

1. Rob. Berry, (2006). *Thinking Geography.* South Yarra (Victoria). Macmillan Education Australia.
2. Stan Squire, (1988); *Interactions in Physical Geography Today;* Australia, Oxford University Press.

Benchmark 11.5.2.2: Investigate man-made environments and natural environments by examining the atmospheric temperatures, air quality, and water quality.

Topic 2: The atmosphere

Sub-topics:

- Atmospheric temperature
- Air quality
- Water quality

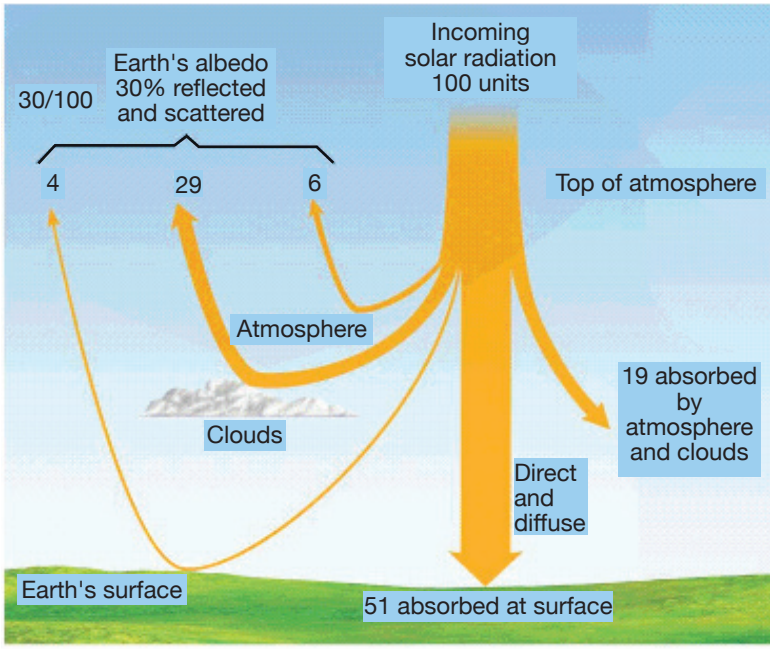
Skills: Analysing (investigate).

Learning Objectives: By the end of the topic, students will be able to:

- Explain the composition of the atmosphere.
- Identify and explain the atmospheric temperature in the atmosphere.
- Describe air quality in the atmosphere.
- Examine water quality in the atmosphere.

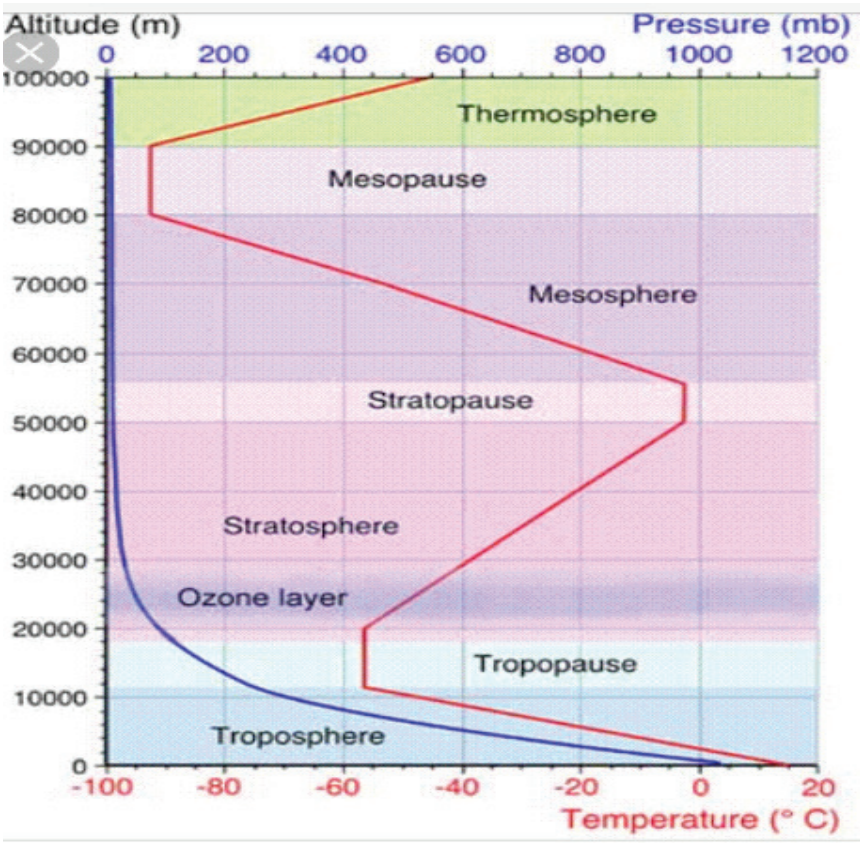
Content Background

A very important envelope of gases called the atmosphere surrounds the Earth. More than three quarters of it consists of the gas nitrogen which is important in helping to dilute the other gases to a more useful form. The most useful gas oxygen is made by plants and used by all animals. The other important gas is carbon dioxide, produced by animals and used by plants; its quantity is on the increase. It also contains a varying but small amount of water vapour, and other rare gases.



The horizontal layers of the atmosphere as shown in the diagram are; the Troposphere, the Stratosphere, the Mesosphere, and the Thermosphere, which is also called the Ionosphere. Atmospheric temperature and pressure varies as altitude increases throughout the various layers of the atmosphere.

As the earth revolves, the atmosphere circulates with it. The sun's heat and light energy warm us and provide the energy for life on earth. The earth is at a distance of 150 000 000 kilometres from the sun and so absorbs only a tiny part of its radiated energy.



The sun's energy reaches the outer atmosphere as parallel rays or short-wave solar radiation, and it travels at the speed of light - 300 000 km per second – taking 8.3 minutes to reach the earth. The light passes straight through the layer of atmosphere in a fraction of a second. It is changed into heat only when it is absorbed by something solid like the earth's surface.

Not all of the solar radiation coming to the Earth is absorbed by the earth; it may be reflected back into space by any shiny, light-coloured or bright surfaces; the clouds, the oceans and snow surfaces reflect a lot. Dark-coloured surfaces absorb most, especially dense forest areas and dark soil.

Solar Radiation Budget

The incoming solar energy is absorbed and used to provide the necessary energy for life to go on. A balance exists between the heat energy entering the atmosphere from the sun and the energy leaving the atmosphere (terrestrial radiation). Most of this radiated energy is lost at night. The incoming solar short-wave radiation enters the atmosphere and penetrates to the earth's surface. It is then changed into longwave radiation or infra-red rays. The heat energy in this form can be absorbed and stored by Greenhouse gases such as water vapour and carbon dioxide. If this did not occur the heat would be rapidly lost and temperatures would be lower. The principle by which the atmosphere holds its heat and keeps us warm through the night is called the **greenhouse effect.** The 5 naturally occurring gases that perform this function are called **greenhouse gases.**

The temperature, or amount of heat in the atmosphere, is a very important part of our weather and climate. Temperatures vary in the atmosphere over the surface of the Earth from time to time or from place to place, in nine different ways;

1. Hotter by day; colder by night
2. Hotter towards the equator; colder towards the poles
3. Hotter in summer; colder in winter
4. Hotter and colder away from the sea
5. Hotter or colder with different wind directions
6. Hotter or colder with different offshore currents
7. Hotter at lower altitudes; colder at higher altitudes
8. Hotter or colder depending on the cloud cover
9. Hotter or colder depending on the aspect (slope of the land)

Air quality in the atmosphere

It is now realised that the amount of carbon dioxide in the atmosphere is increasing. This is because of the large scale release of carbon dioxide caused by burning of fossil fuels, which dates back as far as the Industrial Revolution of the eighteenth and nineteenth centuries. Clearance of the world's forests is adding to the problem. Carbon dioxide absorbs heat and its build up in the atmosphere is likely to cause an increase in world temperatures.

We have also added artificial gases to the atmosphere which did not exist before. This group of gases, called chlorofluorocarbons (CFCs), have been produced for use in refrigerators, aerosol sprays and foam plastics. These gases also absorb the energy which would otherwise have been lost in the atmosphere.

Water quality in the atmosphere

Water in the atmosphere can be found in three states; solid, liquid and gas. Atmospheric water pollution is the pollution of water caused by air pollution. Air pollution causes damage to crops, animals, forests, and bodies of water. It also contributes to the depletion of ozone. Ozone depletion is caused by the accumulation of artificial gases called chlorofluorocarbons (CFCs) that have been produces for use in refrigeration, aerosol sprays foam plastics and air conditioners and fire extinguishers.

In the atmosphere, water particles mix with carbon dioxide, sulphur dioxide and nitrogen oxides forming a weak acid. When acid rain pollutes environments and ecosystems, life is harmed. Clean air and safe water are prerequisites for good health and long life. Poor air and water quality can be particularly detrimental to vulnerable populations such as the very young, the elderly, and those with chronic health conditions.

Clean air and water support healthy brain and body function, growth, and development. Air pollutants such as fine particulate matter, ground-level ozone, sulphur oxides, nitrogen oxides, carbon monoxide, and enhanced greenhouse gases can harm our health and the environment.

Excess nitrogen and phosphorous run-off, medicines, chemicals, lead, and pesticides in water also pose threats to well-being and quality of life.

The earth's atmosphere has taken more than 3.5 billion of its 4.6 billion years of life span to arrive at the current composition of the atmosphere. Dangerous gases like ammonia has been depleted and carbon dioxide appeared followed by oxygen. Ozone has also risen to the second layer of the atmosphere to shield living tissues from the sun's ultraviolet radiation. It is now up to man to maintain the current composition of the atmosphere to ensure the continuity of life on this planet. This is because gases regulated temperature and temperature regulates physical processes and systems. Gases like oxygen and carbon dioxide and nitrogen also directly sustain living things. Furthermore, oxygen and carbon dioxide contribute to chemical weathering to form soils and new sedimentary rocks. Gases are also an important component of soils.

Suggested Resources

1. Colin Sale, (1989). *Our Wonderful World.* Longman Cheshire Pty Limited, Melbourne 3205 Australia
2. Stan Squire, (1988); *Interactions in Physical Geography Today;* Australia, Oxford University Press.

Benchmark 11.5.2.3: Review and compare commercial agricultural practices in the world and analyse their impact on the environment and ecosystems.

Topic 3: Commercial agricultural practices

Sub-topics:
- Environment
- Ecosystems
- Global agricultural practices
- Impact of commercial agricultural practices
- Global agricultural practices

Skills: Evaluating (review, compare).

Learning Objectives: By the end of the topic, students will be able to:

- Explain environments.
- Explain ecosystems.
- Identify and describe commercial agricultural practices.
- Explain the impact of commercial agricultural practices on environments and ecosystems.
- Compare commercial agricultural practices in different parts of the world.

Content Background

Environment refers to the surroundings or conditions in which a person, animal, or plant lives and operates. It is the natural world, as a whole or in a particular geographical area, especially as affected by human activity. Words such as natural world, nature, the living world, the earth, the ecosystem, the biosphere, Mother Nature, Gaia, wildlife, flora and fauna, the countryside, the landscape, all refer to the environment.

An ecosystem includes all of the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environment (weather, earth, sun, soil, climate, atmosphere). Usually, biotic members of an ecosystem, together with their abiotic factors depend on each other. Man's interaction with his natural surroundings have both positive and negative impacts. Agricultural practices is one such activity that has detrimental consequences to the environment. It is also the main activity that through which man interacts with his natural environment. Man subsists on the environment through agriculture.

Commercial agriculture is a large-scale production of crops for sale, intended for widespread distribution to wholesalers and retail outlets. In commercial farming crops such as wheat, maize, tea, coffee, sugarcane, cashew, rubber, banana and cotton are harvested and sold in the world markets. It is a global enterprise system that is aimed at meeting the food needs and demands of the world's population. It is an economic activity, also known as agribusiness where crops are grown and animals are raised for the purpose of making profit. This type of agriculture is different from subsistence agriculture which is primarily aimed at meeting a farmer's nutritional needs on a day to day basis.

The environmental impact of agriculture depends on the type of agricultural practices, and the production system used by farmers around the world. There are two types of indicators of environmental impact:

1. Means-based – which is based on the farmer's production methods or practices of agriculture, particularly pesticides and fertilization methods that farmers are using. For example, the quality of ground water, that is affected by the amount of nitrogen applied to the soil.

2. Effect-based – which is the impact that farming methods have on the farming system or on emissions to the environment. For example, how much carbon dioxide is being emitted or what the Nitrogen content of the soil is.

The environmental impact of agriculture involves a variety of factors from the soil, to water, the air, animal and soil variety, people, plants, and the food itself. Some of the environmental issues that are related to agriculture are;

- Climate Change: The large scale commercial farming of cattle and wet rich farming (paddy–fields) leads to the excessive emission of methane into the atmosphere. Methane is a greenhouse gas.
- Deforestation: The need to clear land form for large scale commercial agriculture such as plantations affects ecosystems in that area and create a host of environmental concerns. These include (i) increase CO2 in the atmosphere (ii) loss of biodiversity (iii) sedimentation (iv) soil erosion, (iv) atmospheric pollution if burning techniques are used to clear the vegetation.
- Genetic engineering: The need to meet the growing market demand is forcing food agricultural scientists to engineer the species of food and to the extent of cultivating lab grown met and vegetables instead of relying on foods grown organically.
- Irrigation problems: The need to irrigate vast hectares of agricultural land has taken a toll on the natural water cycle in areas of limited water such as the hinterlands of Australia. Being largely on the agriculture-based economy farmers struggle to provide for the world market during drought due to the limited amount of ground and surface water found on the continent.
- Pollutants: The main water pollutants from the use of fertilizers are nitrate and phosphate. These two nutrients enrich fresh water systems like lakes and rivers and cause eutrophication.
- Soil degradation: In tropical grassland where wheat are farmed, the top-soil is left bare and exposed to the agents of erosion after wheat is being harvested. Millions of tonnes of soils are being eroded by the wind. This condition is known as a dust-bowl.
- Waste: Large scale production of food result in a lot of waste, especially in developed countries who rely on a constant fresh supply of food. Substantial amounts of foods are wasted daily while the subsistence farmers an developing countries hardly waste any food as they produce just enough from day to day.

Suggested Resources

1. Rob. Berry, (2006). *Thinking Geography.* South Yarra (Victoria). Macmillan Education Australia.

Unit 3: Biological Dynamics of the Earth

Content Standard 5.3: Students will be able to investigate and interpret the biological dynamics of the earth.

Benchmark 11.5.3.1: Research how humans affect energy flow within an ecosystem.

Topic 1: Energy flow within an ecosystem

Sub-topic:
- Man's impact on energy flow within an ecosystem

Skills: Analysing (evaluate).

Learning Objectives: By the end of the topic, students will be able to:

- Explain how energy flows within an ecosystem.
- Identify man's impact on the flow of energy within an ecosystem.
- Explain man's impact on the flow of energy within an ecosystem.

Content Background

Energy is the ability to do work. Energy flow is the amount of energy that moves through a food chain and a food web. The energy input, or energy that enters the ecosystem, is measured in Joules or calories. In the study of energy flow, ecologists try to quantify the importance of different species and feeding relationships.

The largest source of energy for an ecosystem is the sun. Energy that is not used in an ecosystem is eventually lost as heat. Energy and nutrients are passed around through the food chain, when one organism eats another organism. Any energy remaining in a dead organism is consumed by decomposers. Nutrients can be cycled through an ecosystem but energy is simply lost over time.

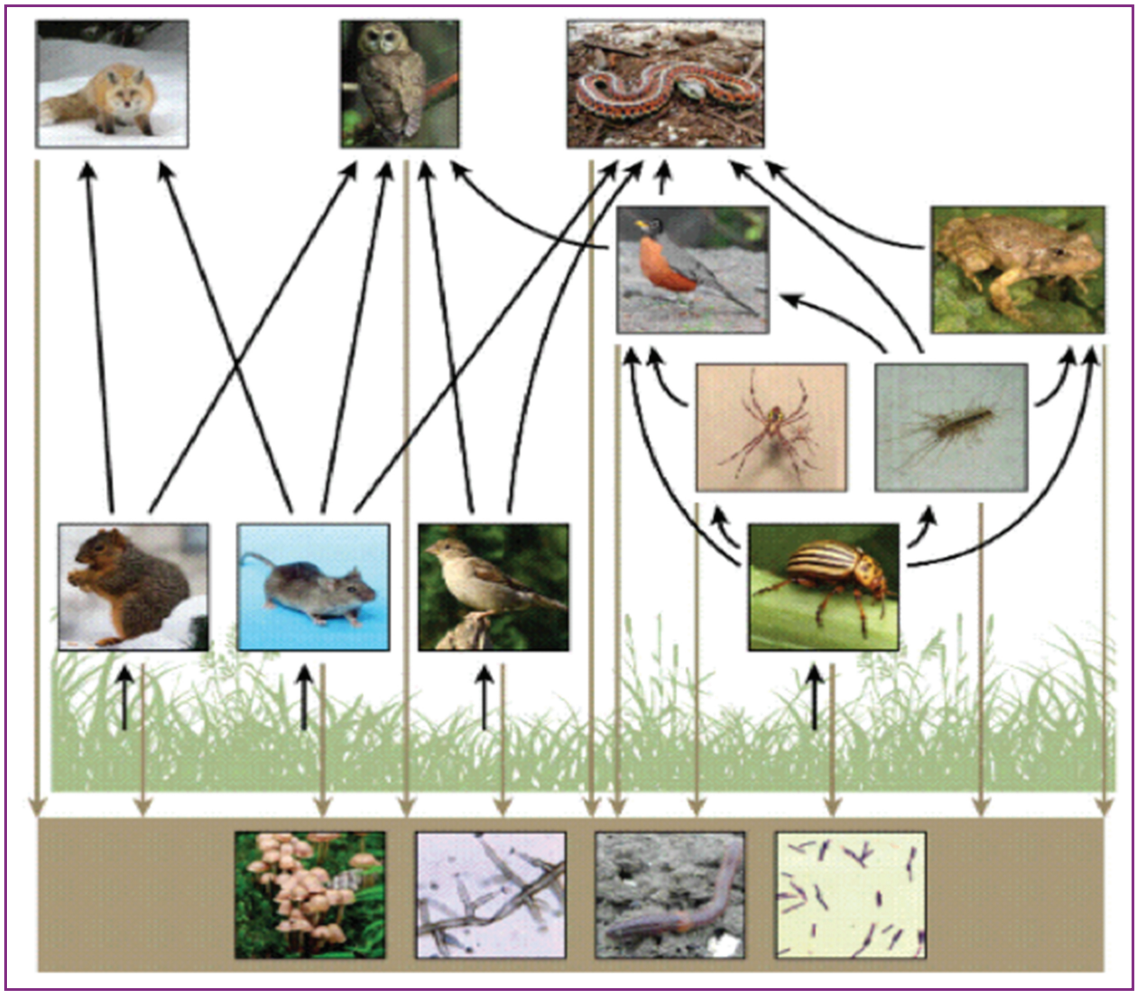
A food chain consists of;

Producers → First Order Consumers (Herbivores) → Second Order Consumers (Carnivores) → Third Order Consumers (Omnivores) → Decomposers (Detrivores).

The arrow represents the flow of energy from the prey to the predator. Each organism in a food chain occupies a specific energy level (trophic), which is, its position in the food chain or food web. A food web is a concept that accounts for the multiple trophic (feeding) interactions between each species.

This food web shows the interactions between organisms across trophic levels. Arrows point from an organism that is consumed to the organism that consumes it. All the producers and consumers eventually become nourishment for the decomposers (fungi, mould, earthworms, ant and bacteria in the soil).

All living things require energy in one form or another. Living organisms would not be able to assemble complex organic molecules (proteins, lipids, and carbohydrates) without a constant energy input.



Food web diagrams illustrate how energy flows directionally through ecosystems. When food chains and food webs are disturbed by the impact of man's activities, the entire web of life is affected.

One of the most important consequences of ecosystem dynamics in terms of human impact is bio-magnification. Bio-magnification is the increasing concentration of persistent, toxic substances in organisms at each successive trophic level. These are substances that are lipid soluble and are stored in the fat reserves of each organism. Many substances have been shown to bio-magnify, including classical studies with the pesticide dichlorodiphenyl-trichloroethane (DDT). DDT was a commonly used pesticide before its dangers to consumers such as the bald eagle became known. DDT and other toxins are taken in by producers and passed on to successive levels of consumers at increasingly higher rates. As bald eagles feed on contaminated fish, their DDT levels rise. It was discovered that DDT caused the eggshells of birds to become fragile, which contributed to the bald eagle being listed as an endangered species under U.S law. The use of DDT was banned in the United States in the 1970s.

Other concerns include the bio-magnification of heavy metals, such as mercury, lead and cadmium, in certain types of seafood. The United States Environmental Protection Agency recommends that pregnant women and young children should not consume any swordfish, shark, king mackerel, or other tile fish because of their high mercury content. These individuals are advised to eat fish low in mercury; salmon, shrimp, pollock, and catfish.

Bio-magnification is a good example of how ecosystem dynamics can affect our everyday lives, even influencing the food we eat.

Suggested Resources

1. Brian Parker, Kate Lanceley, Debra Owens & Rebecca Fitzpatric, (2008). *Geography for Global Citizens (3rd edition).* Claremont Street, South Yarra. Macmillan.
2. Colin Sale, (1989). *Our Wonderful World.* Melbourne, Australia. Longman Cheshire Pty Limited.
   Retrieved from:
   i. *Ecosystems https://sc-s.si/joomla/images/Ecosystems.pdf*
   ii. *Examples natural ecosystem https://www.eartheclipse.com/ecosystem*

Benchmark 11.5.3.2: Analyse the impact of industrial, agricultural and commercial enterprise on an ecosystem in different environments and economic systems.

Topic 2: Impacts of development on the environment

Sub-topics:
- Impact of industries on the environment
- Agriculture and its impact on the environment
- Commercial enterprises and their impact on the environment

Skills: Analyse (analyse).

Learning Objectives: By the end of the topic, students will be able to:

- Examine the impact of industries on ecosystems and economic systems.
- Analyse the impact of agriculture on ecosystems and economic systems.
- Identify types of commercial enterprises.
- Explain types of commercial enterprises.
- Evaluate the impact of commercial enterprises on ecosystems and economic systems.

Content Background

The impact of man's activities on the environment for the purpose of development can be assessed in terms of; industry, agriculture, commercial enterprises, and economic systems.

An industry is a sector that produces goods and related services within an economy. It is the whole of all economic activities by companies, people, and organisations involved in the production of goods and services for a particular field. Industries are usually categorised by the type of goods and services that they produce. In economics, industries are classified as primary, secondary, tertiary and quaternary. Industrialization, while important for the economic growth and development of a society, can also be harmful to the environment. Amongst other things industrial process can cause climate change, pollution to air, water and soil, health issues, extinction of species, and more.

Industrialization, while important for the economic growth and development of a society, can also be harmful to the environment. Amongst other things industrial process can cause climate change, pollution to air, water and soil, health issues, extinction of species, and more.

Agriculture is the science and art of producing crops and livestock for economic purposes. It is a commercial enterprise and an industry in this regard, where inputs are required and harnessed from the environment for food production to meet world population needs and demands. However, in this process, it has major impacts on the environment. These impacts are;
- degradation of land
- deforestation
- biodiversity
- pest problem
- disposal of agricultural wastes.

Commercial enterprises refers to the activity of providing goods and services involving financial and commercial and industrial aspects.

An economic system, or economic order is a system of production, resource allocation and distribution of goods and services within a society or a given geographic area. It includes the combination of the various industries, institutions, agencies, entities, decision-making processes and patterns of consumption that comprise the economic structure of a given community.

Human impact on the environment includes changes to biophysical environments and ecosystems, biodiversity, and natural resources caused directly or indirectly by humans including global warming, environmental degradation (such as ocean acidification), mass extinction and habitat loss.

Poor environmental quality in turn affects economic growth and well-being by lowering the quantity and quality of resources or due to health impacts and so forth. The environment provides resources for the economy and acts as a sink for emissions and waste. Natural resources are essential inputs for production in many sectors, while production and consumption also lead to pollution and other pressures on the environment. Natural ecosystem functions and processes make our life possible. Any decrease in the ecosystem negatively affects the whole natural system. Loss of trees, rivers, animals, plants and the whole nature as such impacts our economy, our health and well-being and even our longevity. Every development activity affects natural balance.

Ecosystems provide vital ecosystem services such as purifying and recycling gases, water and nutrients within an ecosystem. Every individual biotic and abiotic element in an ecosystem performs an ecological role (niche) to create a dynamic ecosystem. For example; remove the decomposers such as worms and the soils will be lacking in gases such as nitrogen, oxygen and carbon dioxide because worms wriggle the soil to create pores for air (gases) to pass through. This is referred to as aeration. Likewise, plants store water and transpire water into the atmosphere which eventually principates and is used by all the elements in the ecosystems ranging from drinking, nutrients-uptake by plants, weathering, soil and temperature regulation.

Prior to establishing an economic activity on the land deforestation is a prerequisite. Deforestation in turn affects biodiversity, the water cycle, the soil quality, temperature and the quality of the atmosphere and surrounding surface water such as lakes and rivers.

Suggested Resources

1. Brian Parker, (2008). *Geography for Global Citizens. (3rd edition).* South Yarra (Victoria). Macmillan Education Australia.
2. Rob. Berry. (2006). *Thinking Geography. (1st edition).* South Yarra (Victoria). Macmillan Education Australia.

Benchmark 11.5.3.3: Examine the impact of colonisation of places on the environment, the effects of resources exploitation, and predict changes to the environment and the natural systems, and the consequences.

Topic 3: Impact of colonisation and resource exploitation on the environment

Sub-topics:
- Colonisation
- Consequences of colonisation
- Resource exploitation
- Consequences of resource exploitation

Skills: Analysing (examine).

Learning Objectives: By the end of the topic, students will be able to:

- Explain colonisation.
- Identify and explain the impacts of colonisation of places on the environment.
- Identify and explain the effects of resource exploitation on the environment.
- Analyse changes to the environment and natural systems.
- Predict the consequences of changes to the environment and natural systems.

Content Background

Colonization is the process in biology by which a species spreads to new areas. It is one of the processes of ecological succession, which is the gradual process by which ecosystems change and develop over time. Nothing remains the same and habitats are constantly changing. For example, a complex rainforest ecosystem or a marine ecosystem.

Colonization often refers to successful immigration where population becomes integrated into a community, having resisted initial local extinction. Colonization occurs on several scales;
- Biofilm scales – the formation of communities of microorganisms on surfaces
- Small scales – colonizing new sites as a result of environmental change
- Large scales – where a species expands its range to encompass new areas.

Colonization and its consequences on the environment

The term is generally used to refer to the spread into new areas by natural means, as opposed to introduction or translocation by humans, which are called introduced species and sometimes becoming invasive species. Some large-scale pre-historic species colonization events include human colonization of the Americas by First peoples eventually resulting in the extinction of Mastodom. Other large-scale colonization events in the 20th Century are;
- Birds – for example, the colonization of western North America by the barred owl.
- Dragonflies – for example, the colonization of Britain by the small red-eyed damselfly
- Moths – for example, the colonization of Britain by Blair's shoulder-knot.

The effect of colonization is the formation of a colony in a habitat or an ecosystem. A colony is composed of two or more individuals living in close association with one another for mutual benefit such as stronger defense or the ability to attack bigger prey. They create a symbiosis effect for mutual co-habitation in order to survive and procreate. On the other hand a solitary organism is one in which all individuals live independently and have all of the functions needed to survive and reproduce. Animals such as humans and rodents form breeding or nesting colonies for more successful mating and to better protect offspring.

Studying colonization is crucial to understand meta-populations, evolutionary ecology and species resilience to global environmental change. There are numerous effects and consequences of migration by plants and animals and their spread to new areas. Some examples are;

- Some plant species can affect the normal functioning of microorganisms below ground level
- Restructuring of the genetic makeup of certain plant or animal species in order to adapt to their new environment
- Some plant and animal species drastically effect the natural balance of the ecosystem if they end up becoming invasive due to the modification of their genetic makeup in order to build up resilience in their new environment
- Some plants and animals can affect the prey and predator balance in a particular ecosystem
- Some species end up having completely new and regenerated stalk or young.

When natural ecosystems such as forests are fragmented due to increasing human activities such as logging or shifting cultivation, it can have very negative consequences on plant and animal species. When we take good care of the environment, the environment will take care of us.

Resource exploitation and its consequences on the environment

Natural resources are not limitless, the exploitation and overuse of resources can cause the destruction of ecosystems which in turn can lead to consequences such as those outlined in the table;

Resource exploitation and its consequences	
Causes	**Effects**
Logging / lumbering	Deforestation / desertification / habitat fragmentation / habitat loss / extinction of species / soil erosion / loss of biodiversity / climate change
Farming / Agriculture	Soil degradation / habitat fragmentation / habitat loss / extinction of species / eutrophication
Fishing / overfishing / dynamite fishing	Reduction in fish population / extinction of species
Mining / querying / oil & gas extraction	Mine slurry spillage / oil spill / river pollution / soil erosion / deforestation
Untreated sewage disposal in the oceans	Algae bloom / coral bleaching / euphorification

Suggested Resources

1. Barrie. Bolton (editor), (2009). *The Fly River, PNG: Environmental Studies in an impacted Tropical River System.* Amsterdam, Netherlands. Elsevier Publications.
   Retrieved from: https://books.google.com.pg/
2. Brian Parker, (2008). *Geography for Global Citizens. (3rd edition).* South Yarra (Victoria). Macmillan Education Australia.
3. David. B. Lindenmayer, (2008). *Salvage Logging & Its Ecological Consequences.* Washing, USA. Island Press.
   Retrieved from: https://books.google.com.pg/
4. Rob. Berry. (2006). *Thinking Geography. (1st edition).* South Yarra (Victoria). Macmillan Education Australia.

Unit 4: Human Activities and Environmental Change

Content Standard 5.4: Students will be able to critique and make sense of the impact of human activities on the environment.

Benchmark 11.5.4.1: Assess the relationships between human consumption of natural resources and the stewardship responsibility for reclamations, including disposal of hazardous and non-hazardous waste.

Topic 1: Resource consumption and management

Sub-topics:

- Human consumption of natural resources
- Resource management strategies
- Man's stewardship responsibility for reclamation of resources
- Disposal of hazardous and non-hazardous waste

Skills: Evaluating (assess).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and categorise natural resources.
- Assess human consumption and management of natural resources.
- Identify and explain resource management strategies.
- Evaluate the effectiveness of resource management strategies in PNG.
- Explain man's stewardship responsibility to reclaiming natural resources.
- Identify hazardous waste.
- Explain the disposal of hazardous waste.
- Identify non-hazardous waste and explain ways to dispose them.
- Explain the stewardship responsibility of man to proper waste disposal.

Content Background

Natural resources are elements of the physical environment that can be used to satisfy human needs and wants. A natural resource may exist as a separate entity such as fresh water, air, as well as living organisms such as fish, or it may exist in an alternate form that must be processed to obtain the resource such as metal ores, rare earth metals, petroleum, and most forms of energy. Resources are classified according to their origin, stages of development and renewability.

Source of origin	Stage of development	Renewability
Biotic Resources	Potential Resources	Renewable Resources
Abiotic Resources	Actual Resources	Non-renewable Resources
	Reserved Resources	
	Stock Resources	

Human consumption and management of natural resources

Human consumption of earth's natural resources has tripled in the last forty years according to a new UN report. Currently it is obvious that developed countries consume more resources than developing countries. Resource consumption is about the consumption of non-renewable, or less often, renewable resources. This includes;

- Water consumption
- Energy consumption
  – electronic energy consumption and world energy consumption
- Natural gas consumption /gas depletion
- Logging/deforestation
- Fishing/overfishing
- Land-use/land loss
- Resource depletion
- General exploitation and associated environmental degradation

Measures of resource consumption are resource intensity and resource efficiency. Industrialization and globalized markets have increased the tendency for overconsumption of resources. It is obvious that unsustainable consumption by the steadily growing human population may lead to resource depletion and the shrinking of the earth's carrying capacity.

Natural resource management is the management of natural resources such as land, water, soil, plants, and animals – with a particular focus on how management affects the quality of life for the present and future generations. It deals with managing the way in which people and natural landscapes interact. It brings together land use planning, water management, biodiversity conservation, and the future sustainability of industries like agriculture, mining, tourism, fisheries and forestry.

In recent years, the depletion of natural resources has become a major focus of governments and organizations such as the United Nations. This is evident in the UN's Agenda 21 Section Two, which outlines the necessary steps for countries to take to sustain their natural resources. The depletion of natural resources is considered a sustainable development issue. For example, habitat conservation is a land management practice that seeks to conserve, protect and restore habitat areas for wild plants and animals, especially conservation reliant species, and prevent their extinction, fragmentation or reduction in range.

Man's stewardship responsibility for reclamation of resources

Stewardship is ethical behavior that embodies the responsible planning, conducting, supervising, or managing of something, especially the careful and responsible management of something entrusted to one's care. It is therefore, incumbent on the organization to carefully manage those key resources in the most effective manner possible. The term stewardship also refers to the theological belief that humans are responsible for taking care of the world. People who believe in stewardship are usually people who believe in one God who created the universe and all that are within it, also believing that they must take care of creation and look after it forever.

Environmental stewardship is the responsible management of human activity affecting the natural environment to ensure the conservation and preservation of natural resources and values for the sake of future generations of human and other life on planet earth. It deals with sustaining and enhancing Earth's life-support systems. It creates the consciousness for us to re-define our relationship with the planet to reduce risks of dangerous global destruction. The ultimate test to man's conscience probably is his willingness to advocate responsible stewardship of resources.

Disposal of hazardous and non-hazardous waste

Hazardous wastes are wastes with properties that make them dangerous or potentially harmful to human health or the environment. Hazardous wastes can be liquids, solids, contained gases, or sludge. They can be by-products of manufacturing processes or simply discarded commercial products, like cleaning fluids and pesticides. In regulatory terms, hazardous wastes are wastes that exhibit at least one of the following four characteristics; ignitability, corrosivity, reactivity, or toxicity.

Worldwide, the United Nations Environment Program (UNEP) estimated that more than 400 million tons of hazardous wastes are produced universally each year, mostly by industrialized countries. About 1 percent of this is shipped across international boundaries, with the majority of the transfers occurring between countries in the Organization for Economic Cooperation and Development. One of the reasons for industrialized countries to ship the hazardous waste to industrializing countries for disposal is the rising cost of disposing of hazardous waste in the home country.

In the United States, the treatment, storage, and disposal of hazardous waste are regulated under the Resource Conservation and Recovery Act (RCRA). The requirements of the RCRA apply to all the companies that generate hazardous waste as well as those companies that store or dispose hazardous waste in the United States.

Non-hazardous waste is any type of industrial waste which, according to regulations, cannot be added to a dumpster or sewage line. Examples of non-hazardous wastes would be sugars, lactic acid, bromides, or carbonates. Hazardous waste management is the collection, treatment, and disposal of waste material that, when improperly handled, poses a serious threat to human health and the environment.

Suggested Resources

1. B.B.Dhar & D.N.Thakur, (1996). *Mining Environment.* New Delhi, India. A.A. Balkema Publishers.
   Retrieved from: https://books.google.com.pg
2. Rob. Berry. (2006). *Thinking Geography. (1st edition).* South Yarra (Victoria). Macmillan Education Australia.
3. David. B. Lindenmayer, (2008). *Salvage Logging & Its Ecological Consequences.* Washing, USA. Island Press.
   Retrieved from: https://books.google.com.pg/

4. Douglas Sheil, (2005). *Life after Logging.* Jakarta, Indonesia. Centre for International Forestry Research.
Retrieved from: https://books.google.com.pg
5. Ronald Kuk & Jerome Tioti, (2012). *Fisheries Policy and Management in PNG.* Port Moresby. National Research Institute.
Retrieved from: https://books.google.com.pg/

Benchmark 11.5.4.2: Evaluate the impact of different points of view on health, population, resources, and environmental issues from the government, businesses, and ordinary citizens.

Topic 2: Issues: health, population, resources, environment

Sub-topics:
- The perception of the government
- The perception of the businesses and organizations
- The perception of the ordinary citizens

Skills: Evaluating (evaluate).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and discuss health issues in PNG.
- Examine population related problems in PNG.
- Assess the problem of resource exploitation in PNG.
- Analyse the environmental problems in PNG.
- Examine the government's perception on these issues and explain how it had addressed them.
- Discuss businesses views on these issues and evaluate measures adopted to minimize these problems.
- Discuss what ordinary citizens think about all these issues and explain how individuals can address them.

Content Background

The relationship between man and his environment is complex in nature. The world man lives in is made up of the human and the natural environments. The human environment is one that man modifies and recreate to suit his wishes and benefits. Certain issues are of significant importance for man in his social and cultural setting. These are health, population, resources and environment. Different entities and institutions, and the general public have different opinions, and perceptions about the use of the natural environment.

Health and population

Governments, through the ministry of health and other agencies, play an important role in strengthening health systems and the generation of human, financial and other resources. Governments have social obligations to provide health services as well as to facilitate socioeconomic development. It does this in partnership with the private sector, non-governmental organisations and charitable institutions/organisations. The role of the government is to steer the overall health development by designing health policies and programs, and regulating the delivery of health services. In order to fulfil its public health functions and protect national health security, governments are responsible for the provision of necessary medicines and vaccines and supporting laboratory networks.

Access to quality and affordable vaccines and immunisation programmes faces several challenges. These challenges include limited financial resources, inappropriate supply systems and lack of effective national regulatory

authorities to implement quality and safety standards. Strategic decisions have to be made by governments in terms of national investment in developing self-reliance and self-sufficiency in medical technology, including medicines and vaccines. The private sector is taking a leading role in both financing and delivery of health care. However, the privatisation of health service delivery must be well designed and regulated by ministries of health and other stakeholders such as academia, professional associations, the private sector and civil society organisations.

The private sector refers to those individuals and organisations who provide health care services or products that are not owned or controlled by the government. An ever increasing population's demand for a better and more efficient health care, requires health care providers to improve in quality and patient care. With lifestyle diseases and other endemic diseases on the rise, ordinary citizens and the general public who can afford hospital fees are now turning towards private hospitals for care and treatment. The general percepti on of government public health care systems, particularly in many developing and least developed countries, is of very poor quality, low standard in the effectiveness of drugs and medicines, ill and semi-trained health care professionals, lack of commitment by health professionals to proper, and quality patient care and treatment. The disparity in the provision of quality health care to the general public, and civil society is very evident between the developed and developing countries. Quality health care is only wishful thinking for the poorest of the poor in marginalised, least developed parts of the world.

Resources and environment

Sustainable development is now an important agenda in the development goals of many governments throughout the world with finite resources on accelerated decline. As the earth ring alarm bells of environmental threats, human health issues, diminishing habitats and ecosystems, excessive pollution levels, uncontrolled population explosion, enhanced greenhouse effect, soil degradation and reduced availability of arable land, proper planning and management of resources and environmental sustainability is a priority area of focus by governments, private organisations and ordinary citizens.

The notion of **"Think Globally and Act Locally"** is now everyone's responsibility. People everywhere in the world require collaborative efforts from governments and private organisations, non-governmental organisations, donor funding agencies and unions, to empower, and mobilise communities and earth watch groups in the walk towards proper care, protection and management of the world's diminishing resources and fragile environments for sustainable habitation of life on planet earth.

Teachers are advised to discuss the issues and allow students to carry out a mini research (questionnaire) to find out different views about these issues (health, population problems, environmental, and resources exploitation) and the measures taken to address each one of them by the government, businesses and the ordinary citizens.

Suggested Resources

1. Asian Development Bank, (2007). *Strategic Directions for Human Development in PNG.* Washington, D.C. The World Bank.
   Retrieved from: *https://books.google.com.pg/*
2. World Bank, (2011). *PNG Health Work Force Crisis: A Call to Action.* World Bank.
   Retrieved from: *https://books.google.com.pg/*
3. Stephen Nichols, (2004). *The Priority environmental concerns of Papua New Guinea. SPREP.*
   Retrieved from: *https://books.google.com.pg/*

Benchmark 11.5.4.3: Distinguish between developed and developing countries with respect to economic development and resource consumption and conservation.

Topic 3: Economic development, resource consumption and conservation

Sub-topics:
- Developing countries
- Developed countries

Skills: Evaluating (distinguish).

Learning Objectives: By the end of the topic, students will be able to:

- Identify and explain the level of economic development in developing countries.
- Identify and explain the level of economic development in developed countries.
- Compare the level of economic development in developed and developing countries.
- Identify and explain the rate of resource consumption in developing countries.
- Identify and explain the rate of resource consumption in developed countries.
- Compare the rate of resource consumption in developed and developing countries.
- Identify and explain the measures of resource conservation in developing countries
- Identify and explain the measures of resource conservation in developed countries.
- Compare the measures of resource conservation in developed and developing countries.

Content Background

Developed and developing countries can be distinguished with regard to their level of economic development, resource consumption and conservation measures. Economic development is the process by which the economic well-being and quality of life of a nation, region or local community are improved.

Resource consumption refers to the consumption of natural resources such as water, energy and electric energy consumption.

Conservation is the protection of things found in nature. It requires the sensible use of all of earth's natural resources: water, soil, minerals, wildlife, and forests, so that they can persist for future generations. For example, preserving wetlands, saving old buildings of importance, or an attempt to minimize the amount of electricity you use by turning off lights when you leave a room. It includes maintaining diversity of species, genes, and ecosystems, as well as the functions of the environment. It is all about the proper management of a resource to prevent its destruction or exploitation.

Developed and developing countries

A developed country is identified by labels such as industrialized country, more developed country, economically more developed country (EMDC). It is a sovereign state that has a developed economy and advanced technological infrastructure, with a high industrial and Human Development Index (HDI) when compared to other nations.

Developing countries on the other hand, are generally categorized as countries that are less industrialized and have lower per capita income levels. The level of economic development in developing nations or least developed countries is seen to be underdeveloped. Underdevelopment refers to the state of an economy where levels or standard of living of masses are extremely low due to very low levels of per capita income resulting from low levels of productivity and high growth rates of population. A recent report by the United Nation states that material footprint per capita in high-income countries is 60 percent higher than in upper-middle income countries and more than 13 times the level of low-income countries.

Consumption of resources is higher in developed countries than in developing countries because developed countries have more financial resources and technology to make use of the resources. These developed countries are mostly industrialized countries which require more and more resources for their industrial growth. While both developed and developing countries have contributed to global environmental problems, developed countries with 85 percent of the gross world product and 23 percent of its population account for the largest part of mineral and fossil-fuel consumption, resulting in significant environmental effects.

Energy and resource use in developing countries by contrast accelerates poverty. According to the New York Times, they are seen as poor countries with rich resources. The distribution and consumption of energy resources in particular is very uneven. It seems that only the rich and the powerful get to benefit from a developing country's development plans and goals. The majority of the people in the least developed countries live in extreme poverty. Vast disparities exist in the consumption and impact between the rich world and Global South, and within countries themselves. A more just global system, in which resources are distributed more equitably, is essential. Whatever form that takes, in order to ensure that there is enough to meet everyone's right to a decent standard of living, the richest must consume more sustainably.

Conservation measures in developing or least developed countries are not up to desirable levels of expectations. Many governments of developing countries do not have environmental management and climate change policies. Many lack an information database on knowledge of the environment, and issues about environmental management and conservation. There is a general perception of irresponsible attitude towards care of the environment from residents of least developed and economically struggling countries due to the trajectories and challenges of life.

Many developed countries have taken legislative measures in world conservation. Countries such as France is in the forefront of the establishment of international unions such as the Intentional Union for Conservation of

Nature and Natural Resources (IUCN) founded in 1948. The World Conservation Strategy of 1980 is the first international document on living resource conservation. It was documented with inputs from governments, non-governmental organizations, and other experts. The report argues that for development to be sustainable, it should support conservation rather than hinder it. Conservation of biodiversity helps to maintain existence of living beings in nature and saves valuable resources for future generations.

Suggested Resources

1. Retrieved from:
   - *https://googleweblight.com*
   - *https://www.nationalgeographic.com*
   - *www.businessdictionary.com*
   - *https://kidsbritanica.com*
   - *https://www.yourdictionary.com*
   - *https://populationmatters.org*

Standards-Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teacher instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. Teacher must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teacher should at least identify 3-5 teaching strategies in a lesson; teacher lectures, ask questions, put students into groups for discussion and role play what was discussed.

Why is Standards-Based Lesson Planning Important?

There are many important benefits of having a clear and organized set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organizing the materials and the teacher for the purpose of helping the students achieve the standards. Lesson plans also provide a record that allows good, reflective teachers to go back, analyze their own teaching (what went well, what didn't), and then improve on it in the future.

Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

Components of a Standards-Based Lesson Plan

An effective lesson plan has three basic components;

- aims and objectives of the course;
- teaching and learning activities;
- assessments to check student understanding of the topic.

Effective teaching demonstrates deep subject knowledge, including key concepts, current and relevant research, methodologies, tools and techniques, and meaningful applications.

Planning for under-achievers

Who are underachieving students?
Under achievers are students who fail or do not perform as expected. Underachievement may be caused by emotions (low self-esteem) and the environment (cultural influences, unsupportive family)

How can we help underachievement?
Underachievement varies between students. Not all students are in the same category of underachievement.

Given below a suggested strategies teachers may adopt to assist underachievers in the classroom.

- Examine the Problem Individually
  It is important that underachieving students are addressed individually by focusing on the student's strengths.
- Create a Teacher-Parent Collaboration
  Teachers and parents need to work together and pool their information and experience regarding the child. Teachers and parents begin by asking questions such as;
  - In what areas has the child shown exceptional ability?
  - What are the child's preferred learning styles?
  - What insights do parents and teachers have about the child's strengths and problem areas?

- Help student to plan every activity in the classroom
- Help students set realistic expectations
- Encourage and promote the student's interests and passions.
- Help children set short and long-term academic goals
- Talk with them about possible goals.
- Ensure that all students are challenged (but not frustrated) by classroom activities
- Always reinforce students

Sample of Standards-Based Lesson Plan

To help teachers plan effective Standards-Based lesson plan, a sample lesson is provided here. Teachers are encouraged to study the layout of the different components of this lesson and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher to focus on the essential knowledge, skills, values and attitudes that students are expected to learn and master at the end of the lesson.

Unit 1: Resources and Environments

Content Standard 5.1: Students will be able to examine and make sense of different resources and different environments.

Benchmark 11.5.1.1: Investigate the influence of abiotic factors – precipitation, temperature and soil on living and non-living things in different environments and regions of the world.

Topic 1: Influence of abiotic factors on living and non-living things in different environments

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Lesson Topic: Abiotic factors

Grade: 11

Length of lesson: 40 minutes

Essential knowledge, skills, values and attitude

Knowledge:

- Abiotic factors
- Living and non-living things
- Influence of abiotic factors on living and non-living things in different environments and regions of the world

Skill(s): Understanding (Identify). Evaluate (justify and analyze types of abiotic factors and their influence on different environments).

Values: Appreciate the balance of nature in different environments.

Attitudes: Being responsible in caring for natural resources, and the functions of natural processes that are part of living and non-living things in different environments.

Performance indicator: Identify and explain abiotic factors

Materials:

Instructional Objective(s): By the end of the lesson, students will be able to;

- Identify abiotic factors
- Explain abiotic factors

- Explain living and non-living things
- Explain the influence of abiotic factors on living and non-things in different environments and regions of the world

Essential Questions:

- What are abiotic factors?
- What are living and non-living things?

Lesson Procedure

Teacher Activities	Student Activities
Introduction (time in minutes)	
Engage students at the start of the lesson by giving a demonstrative explanation of how air temperature in the classroom can affect a student's body heat. • Inform students about the lesson topic and the correlation between the demonstrative explanation and its relevance to the topic. • Get students into groups of four for a brief discussion to test their knowledge about what they think they know about the content of the topic. • Encourage students to establish a concept map, by listing other words or concepts that are related to the topic, and connecting them together. • Get the group leader of each group to present to the rest of the class on the group's findings as a feed-back of what students came up with. • Do a brief summary of students feedback and connect the relevance of the brief activity back to the topic, and then distribute lesson notes on handout to students or it can be written on the board for students to take notes.	Listen carefully Observe Answer questions before and during the demonstration Participate in the demonstration by actually doing what is asked by the teacher and answer questions
Body (time in minutes)	
Modeling	
Students continue to be in groups of four. Review the lesson notes with students in class by getting volunteers from each group to read aloud, certain sections of the lesson notes and you further elaborate, clarify and explain where necessary. Walk around the room to each group and ask questions *(what are abiotic factors? What are living and non-living things? What are some example of living and non-living things? How do abiotic factors influence living and non-living things in different environments?..etc.)*	Get into the assigned groups. Read and discuss the content in the handout. Identify and make sense out of new words and meanings, and concepts and ideas.

Guided Practice	
Ask students to work on the activity questions that have been prepared together with the lesson notes, particularly words and meanings, and explanation of new concepts. Appoint a student from each group to supply answers to each of the activity questions by writing it on the board or by reading it aloud to the rest of the class. Confirm and validate students' answers.	Work on the questions in the list of activities. Provide answers to each question by volunteering to write the answer on the board for everyone to make sure the answers are correct.
Independent Practice	
Ask students to remain in their same groups however, to work individually on the question in the practice exercise. Give instructions; • Draw 2 columns on a new section of your exercise book and label; biotic factors, abiotic factors. • Under each column, insert two sub-columns and label living things, non-living things. • List down examples of living and non-living things under biotic factors, and examples of living and non-living things under abiotic factors.	In groups, however, individually listen, observe and do the practice exercise.
Conclusion (time in minutes)	
Ask students to complete the table in the practice exercise. Ask students to show their completed work to the rest of the members in their group.	Complete practice exercise. Show completed work to the rest of the members in the group.

Assessment, Monitoring and Reporting

What is Standards-Based Assessment (SBA)?

Standards-Based Assessment is an on-going and a systematic process of **assessing, evaluating, reporting** and **monitoring** students' performance and progression towards meeting grade and national level expectations. It is the measurement of students' proficiency on a learning objective or a specific component of a content standard and progression towards the attainment of a benchmark and content standard.

Purpose of Standards-Based Assessment

Standards-Based Assessment (SBA) serves different purposes. These include instruction and learning purposes. The primary purpose of SBA is to improve student learning so that all students can attain the expected level of proficiency or quality of learning.

Enabling purposes of SBA is to:

- measure students' proficiency on well-defined content standards, benchmarks and learning objectives
- ascertain students' attainment or progress towards the attainment of specific component of a content standard
- ascertain what each student knows and can do and what each student needs to learn to reach the expected level of proficiency
- enable teachers to make informed decisions and plans about how and what they would do to assist weak students to make adequate progress towards meeting the expected level of proficiency
- enable students to know what they can do and help them to develop and implement strategies to improve their learning and proficiency level
- communicate to parents, guardians, and relevant stakeholders the per formance and progress towards the attainment of content standards or its components
- compare students' performances and the performances of other students

Principles of Standards-Based Assessment

The principle of SBA is for assessment to be;

- emphasising on tasks that should encourage deeper learning
- be an integral component of a course, unit or topic and not something to add on afterwards
- a good assessment requires clarity of purpose, goals, standards and criteria
- of practices that should use a range of measures allowing students to demonstrate what they know and can do
- based on an understanding of how students learn
- of practices that promote deeper understanding of learning processes by developing students' capacity for self-assessment
- improving performance that involves feedback and reflection
- on-going rather than episodic

- given the required attention to outcomes and processes
- be closely aligned and linked to learning objectives, benchmarks and content standards.

Standards-Based Assessment Types

In standards-Based Assessment, there are three broad assessments types.

1. Formative Assessment

Formative assessment includes 'assessment *for* and *as*' and is conducted during the teaching and learning of activities of a topic.

Purposes of Assessment For Learning

- On-going assessment that allows teachers to monitor students on a day-to-day basis.
- Provide continuous feedback and evidence to the teachers that should enable them to identify gaps and issues with their teaching, and improve their classroom teaching practice.
- Helps students to continuously evaluate, reflect on, and improve their learning.
- Help teachers to make inferences about student learning to inform their teaching.
- Provide continuous feedback to both students and teachers which enables them to monitor progress, identify and address gaps and errors in learning.

Purposes of Assessment As Learning

- Occurs when students reflect on and monitor their progress to inform their future learning goals.
- Helps students to continuously evaluate, reflect, and improve their own learning.
- Helps students to understand the purpose of their learning and clarify learning goals.

2. Summative Assessment

Summative assessment focuses on 'assessment of learning' and is conducted after or at the conclusion of teaching and learning of activities or a topic.

Purposes of Assessment Of Learning

- Help teachers to determine what each student has achieved and how much progress he/she has made towards meeting national and grade-level expectations.
- Help teachers to determine what each student has achieved at the end of a learning sequence or a unit.
- Enable teachers to ascertain each student's development against the unit or topic objectives and to set future directions for learning.
- Help students to evaluate, reflect on, and prepare for next stage of learning.

3. Authentic Assessment

- Is performed in a real life context that approximates as much as possible, the use of a skill or concept in the real world.
- Is based on the development of a meaningful product, performance or process.
- Students develop and demonstrate the application of their knowledge, skills, values and attitudes in real life situations which promote and support the development of deeper levels of understanding.

Authentic Assessment Criteria

Authentic assessment refers to assessment that:

- Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard.
- Takes place in real life situations.
- Asks students to apply their knowledge, skills, values and attitudes in real life situations.
- Students are given the criteria against which they are being assessed.

Performance Assessment

Performance assessment is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student may be asked to explain historical events, generate scientific hypotheses, solve math problems, converse in a foreign language, or conduct research on an assigned topic. Teachers, then judge the quality of the student's work based on an agreed-upon set of criteria. It is an assessment which requires students to demonstrate that they have mastered specific skills and competencies by performing or producing something.

Types of performance assessment;

i. Products

This refers to concrete tangible items that students create through either the visual, written or auditory media such as;

- Creating a health/physical activity poster
- Video a class game or performance and write a broadcast commentary
- Write a speech to be given at a school council meeting advocating for increased time for health and physical education in the curriculum
- Write the skill cues for a series of skill photo's
- Create a brochure to be handed out to parents during education week
- Develop an interview for a favorite sportsperson
- Write a review of a dance performance
- Essays
- Projects

ii. Process Focused Tasks

It shows the thinking processes and learning strategies students use as they work such as;

- Survival scenarios
- Problem-solving initiative/adventure/activities
- Decision making such as scenario's related to health issues
- Event tasks such as creating a game, choreographing a dance/ gymnastics routine, creating an obstacle course
- Game play analysis

- Peer assessment of skills or performances
- Self-assessment activities
- Goal setting, deciding a strategy and monitoring progress towards achievement

iii. Portfolio
This refers to a collection of student work and additional information gathered over a period of time that demonstrates learning progress.

iv. Performances
It deals with observable affective or psycho-motor behaviours put into action such as;

- Skills check during game play
- Role plays
- Officiating a game
- Debates
- Performing dance/gymnastics routines
- Teaching a skill/game/dance to peers

Performance Standards

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the "be able to do" of "what students should know and be able to do." Performance standards are the indicators of quality that specify how competent a students' demonstration or performance must be. They include explanations of how well students must demonstrate the content, explaining how good is good enough.

Performance standards:

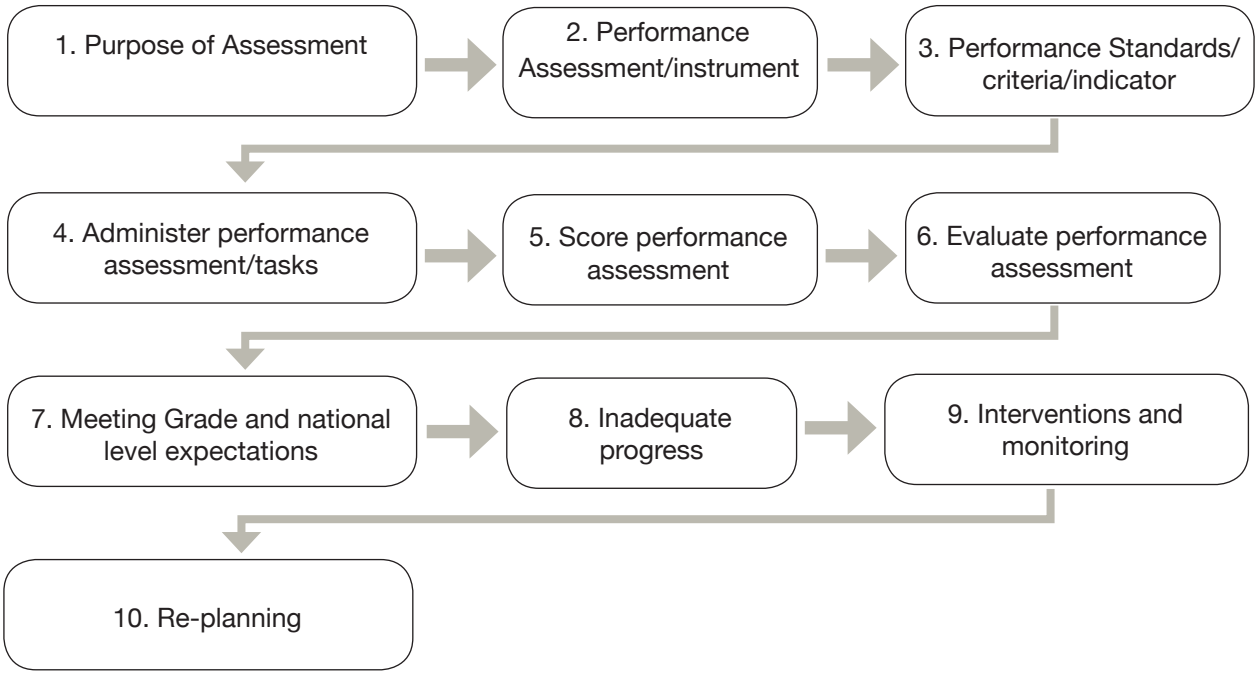
- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations
- provide the basis (performance indicators) for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude
- are used to plan for individual instruction to help students not yet meeting expectations (desired level of mastery and proficiency) to make adequate progress towards the full attainment of benchmarks and content standards
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards.

Assessment Strategies

It is important for teachers to know that, assessment is administered in different ways. Assessment does not mean a test only. There are many different ways to find out about student's strengths and weaknesses. Relying on only one method of assessing will not reflect student's achievement. Provided in the appendices is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types.
Please refer to Appendix 5 to see the suggested strategies.

There are different performance assessment methods and assessment strategies for assessing students' learning and performance on significant components of content standards.

Standards-Based Assessment Process



Scoring Students' Assessment

Assessment scoring methods describe how students' assessment tasks will be scored.

The most commonly used methods of scoring students' assessment are:

i. Checklists
ii. Rating Scales
iii. Rubrics

Students' performance is assessed and scored using:

i. a set of well-defined criteria
ii. performance standards or indicators,

Checklists, rating scales and rubrics are tools that state specific criteria and allow teachers and students to gather information and to make judgements about what students know and can do in relation to the standards. They offer systematic ways of collecting data about specific behaviours, knowledge and skills.

The quality of information acquired through the use of checklists, rating scales and rubrics is highly dependent on the *quality* of the descriptors chosen for assessment.

Checklists usually offer a yes/no format in relation to student demonstration of specific criteria. This is similar to a light switch; the light is either on or off. They may be used to record observations of an individual, a group or a whole class.

Rating Scales allow teachers to indicate the degree or frequency of the behaviours, skills and strategies displayed by the learner. Rating scales state the criteria and provide three or four response selections to describe the quality or frequency of student work.

Teachers can use rating scales to record observations and students can use them as self-assessment tools. Teaching students to use descriptive words, such as *always*, *usually*, *sometimes* and *never* helps them pinpoint specific strengths and needs. Rating scales also give students information for setting goals and improving performance. In a rating scale, the descriptive word is more important than the related number. The more precise and descriptive the words for each scale point, the more reliable the tool.

Effective rating scales use descriptors with clearly understood measures, such as frequency. Scales that rely on subjective descriptors of quality, such as *fair, good* or *excellent,* are less effective because the single adjective does not contain enough information on what criteria are indicated at each of these points on the scale.

Rubrics use a set of criteria to evaluate a student's performance. They consist of a fixed measurement scale and detailed description of the characteristics for each level of performance. These descriptions focus on the *quality* of the product or performance and not the quantity; e.g., not number of paragraphs, examples to support an idea, spelling errors. Rubrics are commonly used to evaluate student performance with the intention of including the result in a grade for reporting purposes. Rubrics can increase the consistency and reliability of scoring.

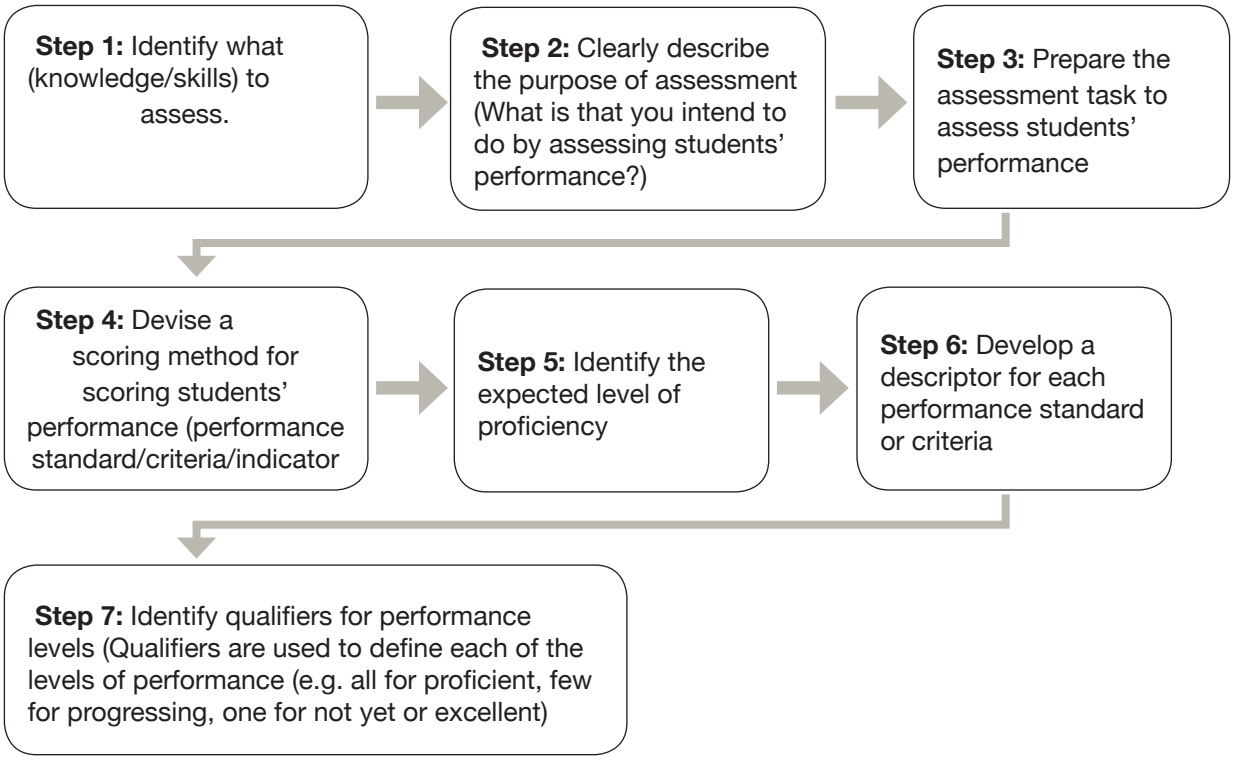
Rubrics use a set of specific criteria to evaluate student performance. They may be used to assess individuals or groups and, as with rating scales, may be compared over time.

Rubrics are recognized as a way to effectively assess student learning and communicate expectations directly, clearly and concisely to students. The inclusion of rubrics in a teaching resource provides opportunities to consider what demonstrations of learning look like, and to describe stages in the development and growth of knowledge, understandings and skills. To be most effective, rubrics should allow students to see the progression of mastery in the development of understandings and skills.

However, regardless of which method is used, students' performance, proficiency, and quality of learning should be meaningfully and effectively measured. This will help ascertain if students are meeting grade-level expectations and progressing towards meeting the content standard.

Assessment Samples

Teachers are required to use the steps outlined below when planning assessment. These steps will guide you to develop effective assessments to improve student's learning as well as evaluating their progress towards meeting national and grade–level expectations.



There are three (3) assessment samples provided here to guide teachers when preparing assessment for students. There is a/an;

i. formative assessment sample
ii. summative assessment sample
iii. authentic assessment sample

Teachers are encouraged to give a variety of assessments using different strategies on one topic to test the understanding and achievement of a content standard and a benchmark by individual students.

Formative Assessment

This assessment is conducted during teaching and learning. Take note that this assessment is linked to the learning objectives. You as the teacher will prepare the formative assessment task to assess the learning objective that you are teaching in class.

Unit 4: Human Activities and Environmental Change

Content Standard 5.4: Students will be able to critique and make sense of the impact of human activities on the environment

Benchmark 11.5.4.1: Assess the relationships between human consumption of natural resources and the stewardship responsibility for reclamations, including disposal of hazardous and non-hazardous waste.

Topic 1: Resource consumption and management

Lesson Topic: Categories of natural resources

What is to be assessed?

- Concept of "natural resources"
- Primary use of natural resources
- Categories of natural resources,

Performance Task

Describe natural resources, their primary use, and their categories and examples

Purpose of this assessment

To judge students' learning of the knowledge being outlined and assess the use of student's critical thinking skills

Assessment Strategy
Complete three (3) Quiz Questions:

Grade 11

Strand 5: Environment

Unit 4: Human Activities and Environmental Change

Topic 1: Resource consumption and management

Lesson Topic: Natural resources

Name: _____ Class: _____ Date: _____

1. What are natural resources?

_____

_____

2. The primary use of natural resources is to _____

3. Describe each category of natural resources and give an example:

Type of category for natural resources	Give one example of a natural resource for each of the categories
1. Their source of origin:	
a. Biotic	
b. Abiotic	
2. Their stage of development	
a. Potential resources	
b. Actual resources	
c. Reserved resources	
d. Stock resources	
3. Their renewability	
a. Renewable natural resources	
b. Non-renewable natural resources	

Assessment Scoring

Grade 11

Strand 5: Environment

Unit 4: Human Activities and Environmental Change

Topic 1: Resource consumption and management

Lesson Topic: Natural resources

Scoring List for the three (3) Quiz Questions
Date: _____

Name of students	Q1	Q2	Q3 (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Joyce .P.	✓	✗	✓	✗	✓	✗	✓	✓	✓	✗
Tracy .W	✗	✓	✗	✓	✗	✓	✗	✓	✗	✓
Brigitte. S	✓	✓	✓	✓	✓	✗	✓	✗	✓	✗
Lily .M	✓	✗	✗	✗	✗	✓	✗	✗	✗	✓
Doris. P	✗	✓	✗	✗	✓	✗	✓	✗	✓	✗
Jenifer. K	✓	✓	✓	✗	✗	✓	✗	✓	✗	✓
Aiba. M	✓	✗	✓	✓	✓	✗	✓	✗	✓	✓

Summative Assessment

A summative assessment is carried out after all the Learning Objectives are taught. When you teach all the Learning Objective, it means you have covered the benchmark. Therefore, it is an assessment that assesses the benchmark.

Unit 4: Human Activities and Environmental Change

Content Standard 5.4: Students will be able to critique and make sense of the impact of human activities on the environment.

Benchmark 11.5.4.1: Assess the relationship between human consumption of natural resources and the stewardship responsibility for reclamations, including disposal of hazardous and non-hazardous waste.

Topic 1: Resource consumption and management

Purpose of this Assessment

The purpose of this assessment is to measure student's learning of the benchmark. It is about how much they have learned out of the required content in the benchmark. It is also about measuring the expected skills such as analysing skills, evaluation skills and other skills that are expected to be demonstrated through their learning of the expected content in the benchmark, too. This assessment measures the students' mastery of the benchmark or displayed competency.

Expected Level of Proficiency

The expected level of proficiency in the student should cover the following areas:

- Identify and categorise natural resources
- Explain human consumption of natural resources
- Explain man's stewardship responsibility to reclaiming natural resources
- Identify hazardous waste
- Explain the disposal of hazardous waste
- Identify non-hazardous waste and explain ways to dispose them
- Explain the stewardship responsibility of man to proper waste disposal
- Identify and explain resource management strategies
- Evaluate resource management in Papua New Guinea

Performance Task

To complete a guided project and it includes a given list of natural resources and a designed table with nine sections.

a. state the types of categories of natural resources,
b. describe the categories and
c. using the given list of natural resources, you then, categorise these re sources correctly
d. describe in a few sentences about the human consumption of these natural resources
e. describe in a few sentences about how human shows its responsibility to reclaim these natural resources
f. state Yes or NO if the dealing of these natural resources' results in any

hazardous waste, and if so,

g. describe how this hazardous waste in (point f) is disposed or managed
h. state any management strategies used in dealing with these natural resources
i. state whether management of these natural resource in PNG is done properly or not
j. all your explanation of concepts should have supported with relevant examples

See sample of the guided project below:

Guided Project

Grade: 11 **Strand 5:** Environment **Unit 4:** Human Activities and Environmental Change

Name: _____ Class: _____ Date: _____ Score: _____

List of natural resources:
forests, animals, birds, fish, and marine organisms, water, air, soil, sunlight, and minerals, Petroleum in sedimentary rocks, uranium, oil, gasoline and sunlight, petrol, trees, soil, mine and coal, oil and gas reserve, coal, oil, gas, gold, copper, tin and uranium, solar, wind, water (hydro), biomass, and geothermal, natural gas and coal, oil and minerals

a. Types of categories of natural resources	b. Description of the categories	c. Types of natural resources for this categorises	d. Description of human consumption of these natural resources	e. Description of how human shows its responsibility to reclaim these natural resources	f. State Yes or No if the dealing of these natural resources' results in any hazardous waste	g. Describe how this hazardous waste in (point f) is disposed or managed	h. State any management strategies used in dealing with these natural resources	i. State whether management of these natural resource in PNG is done properly or not	j. Supporting relevant examples
Their sources of origins									
a.									
b.									
Their stage of development									
a.									
b.									
c.									
d.									
Their renewability									
a.									
b.									
c.									

Assessment Strategy

Students will complete a guided project to assess the knowledge and skills learnt in the expected content outlined in the benchmark.

Assessment Scoring

Name of Student: _____ Class: _____ Date: _____					
Performance Standard/ criteria	**Proficiency**				**Score**
	Unsatisfactory Performance (0-29%)	**Satisfactory Performance (30-69%)**	**Full competent Performance (70-99%)**	**Exceptional Performance (100%)**	
Identify and categorise natural resources	A few natural resources are identified and categorised with very minimum descriptions and examples	A fair number of natural resources are identified and categorised with a fair amount of descriptions and examples	Most but not all of the categories of the natural resources are identified with reasonable descriptions and examples	All categories of the natural resources are identified with full descriptions and relevant supporting examples	
Explain human consumption of natural resources	Very little explanation of human consumption of natural resources	A fair explanation of human consumption of natural resources	Full explanation of human consumption of natural resources but no supporting examples	Full explanation of human consumption of natural resources with relevant supporting examples	
Explain man's stewardship responsibility to reclaiming natural resources	Very little explanation of man's stewardship responsibility to reclaiming natural resources	A fair explanation of man's stewardship responsibility to reclaiming natural resources	Full explanation of man's stewardship responsibility to reclaiming natural resources but no supporting examples	Full explanation of man's stewardship responsibility to reclaiming natural resources With relevant supporting examples	
Identify hazardous waste	Very minimum indication of identifying hazardous waste	identified a number of hazardous waste	Fully identified hazardous waste but no supporting examples	fully identified hazardous waste with relevant supporting examples	
Explain the disposal of hazardous waste	Very minimum explanation of the disposal of hazardous waste	Explained a few concepts surrounding the disposal of hazardous waste	Explained clear details of information surrounding the disposal of hazardous waste but no supporting examples	Explained full details of information surrounding the disposal of hazardous waste with relevant supporting examples	

Identify non-hazardous waste and explain ways to dispose them	Very minimum indication of identifying non-hazardous waste and very minimum explanation of the ways of disposing them	Able to identify a few concepts surrounding non-hazardous waste and able to explain a few ways of depositing non-hazardous waste	Able to fully identify non-hazardous waste and able to fully explain ways in how to dispose them but no supporting examples given	Able to fully identify non-hazardous waste and able to fully explain ways in how to dispose them with relevant supporting examples	
Explain the stewardship responsibility of man to proper waste disposal	Very minimum explanation of the stewardship responsibility of man to proper waste disposal	Explained a few concepts surrounding the stewardship responsibility of man to proper waste disposal	Explained clear details of information surrounding the stewardship responsibility of man to proper waste disposal but no supporting examples	Explained full details of information surrounding the stewardship responsibility of man to proper waste disposal with relevant supporting examples	
Identify and explain resource management strategies	Very minimum explanation of the resource management strategies	Explained a few concepts surrounding the resource management strategies	Explained clear details of information surrounding the resource management strategies but no supporting examples	Explained full details of information surrounding the resource management strategies with relevant supporting examples	
Evaluate resource management in Papua New Guinea	Very minimum evaluation made on resource management in Papua New Guinea	Evaluated a few concepts surrounding resource management in Papua New Guinea	Evidence of detailed evaluation on resource management in Papua New Guinea	Evidence of detailed evaluation on resource management in Papua New Guinea with relevant supporting examples	

Authentic Assessment

Authentic assessment is an assessment that requires the use of a skill or concept in the real life. Students are expected to develop meaningful products, performance or process to demonstrate the application of their knowledge, skills and attitudes in real life situations which promote and support the development of deeper levels of understanding.

Unit 4: Human Activities and Environmental Change

Content Standard 5.4: Students will be able to critique and make sense of the impact of human activities on the environment.

Benchmark 11.5.4.1: Assess the relationships between human consumption of natural resources and the stewardship responsibility for reclamations, including disposal of hazardous and non-hazardous waste.

Topic 1: Resource consumption and management

Purpose of this assessment
The purpose of this assessment is to measure students' ability to apply theory knowledge into application and that is creating something useful in real life. This assessment will strongly express creativity skills, analytical thinking skills, effective communication skills, interpersonal skills as well as values of patience, tolerance and respect towards one and another as a team to produce the end result desired.

Performance Task
Design a simple hazardous and non-hazardous waste disposal strategic plan. It will involve the action of:

- Researching information on the layout of the strategic plan and the content that should go into the layout
- Analyzing of the information gathered
- Designing of the hazardous and non-hazardous waste disposal strategic plan using the correct layout and information gathered

Assessment Strategy
Students will complete a hazardous and non-hazardous waste disposal strategic plan to assess the application of their knowledge and skills learnt in the expected content outlined in the benchmark.

Instructions

i. work in group of four students
ii. research individually and then compile your researched information according to the layout

The hazardous and non-hazardous waste disposal strategic plan layout

i. The vision- Creating a mental image of how you want the environment of the society to be at some point in time in the future, based on your goals and aspirations of handling hazardous and non-hazardous waste disposal positively

ii. The mission- a short statement of why you want to design a hazardous and non-hazardous waste disposal strategic plan, what are your goals for designing a hazardous and non-hazardous waste disposal strategic plan, what kind of outcome do you expect to result from the designing and the using a hazardous and non-hazardous waste disposal strategic plan for the society.

iii. The objectives- state what results you want to achieve when you start using a hazardous and non-hazardous waste disposal strategic plan for the society.

iv. The values– state what values you have for the society when using your hazardous and non-hazardous waste disposal strategic plan.

v. The strategies- state your rules and guidelines by which your mission and objectives maybe achieved when you start using your hazardous and non-hazardous waste disposal strategic plan.

vi. The goals- state your goals of how much you want to achieve within a certain time period for the society when using your hazardous and non-hazardous waste disposal strategic plan.

vii. The programs- state the kinds of programs you will use to implement your plans of hazardous and non-hazardous waste disposal.

Expected Level of Proficiency

- The correct researched information for the layout
- The correct researched information for each section
- The use of effective communication skills, interpersonal skills and leadership skills when working as a team to compile the researched information for each section of the layout
- The use of creativity and analytical thinking skills in designing the correct strategic plan layout and its sections
- A complete designed hazardous and non-hazardous waste disposal strategic plan

Assessment Scoring

Name of Student: _____ Class: _____ Date: _____					
Performance Standard/ criteria	**Proficiency**				**Score**
	Unsatisfactory Performance (0-29%)	**Satisfactory Performance (30-69%)**	**Full competent Performance (70-99%)**	**Exceptional Performance (100%)**	
The correct researched information for the layout	Less than half of the sections of the layout are identified and listed	More than half of the sections of the layout are identified and listed	All seven sections of the layout are identified but not set out logically	All seven sections of the layout are identified and logically set out	
The correct researched information for each section	No evidence of sufficient researched information for each section	More than half of the sections have evidence of researched information	All seven sections of the layout have evidence of researched information	All seven sections of the layout have evidence of researched information with supporting example where applicable	
The use of effective communication skills, interpersonal skills and leadership skills when working as a team to compile the researched information for each section of the layout	Minimum use of effective communication skills, interpersonal skills and leadership skills throughout the duration of the project	A fair use of effective communication skills, interpersonal skills and leadership skills wherever possible but not consistently throughout the duration of the project	A good use of effective communication skills, interpersonal skills and leadership skills throughout the duration of the project but with minimum demonstration of values	Strong values of patience, tolerance and respect is demonstrated in compiling research information alongside the use of effective communication skills, interpersonal skills and leadership skills throughout the duration of the project	
The use of creativity and analytical thinking skills in designing the correct strategic plan layout and its sections	Minimum demonstration of creativity and analytical thinking skills throughout the duration of the project task	A fair demonstration of creativity and analytical thinking skills throughout the duration of the project task	A good demonstration of creativity and analytical thinking skills throughout the duration of the project task but with minimum demonstration of values	Strong values of patience, tolerance and respect is demonstrated in compiling research information alongside the use of creativity and analytical thinking skills in the duration of the project task	

A complete designed hazardous and non-hazardous waste disposal strategic plan	The presentation of the designed hazardous and non-hazardous waste disposal strategic plan is not complete, information and sections are missing	A fair presentation of a hazardous and non-hazardous waste disposal strategic plan that does not really contain volumes of work	A complete designed hazardous and non-hazardous waste disposal strategic plan with name of participants but no proper cover, general presentation and binding	A complete designed hazardous and non-hazardous waste disposal strategic plan with a carefully designed cover, title, names of all participants and general presentation and binding	

Glossary

Term	Definition
Assessment	Activities teachers use to help students learn and to measure and monitor their progress towards the attainment of expected levels of proficiency.
Assessment As Learning	Assessment is used to help students understand and reflect on what they have learnt or are having difficulties with, identify areas of strengths and weaknesses, and set clear, measurable, and attainable personal goals to improve their own learning.
Assessment For Learning	A common form of assessment. It is an ongoing assessment process that arises out of the interaction between teaching and learning. Also referred to as formative assessment.
Assessment Of Learning	Provides a summary of students learning over a given period of time and is generally carried out at the end of a course of study. Also referred to as summative assessment.
Assessment Strategies	Different ways or approaches of assessing students work.
Authentic Assessment	A type of broad assessment that involves students actively engaged in completing a task that represents the achievement of a learning objective or standard. Authentic assessment takes place in real life situations.
Benchmarks	Benchmarks are more detailed descriptions of a specific level of performance expected of students at particular ages, grades, school levels or levels of development. They are the specific components of the knowledge, process, skill, concept, principle, or idea identified by a content standard.
Content Standards	Content Standards are broadly stated expectations of what (content) students should know. They describe the knowledge, skills, values, and attitudes that students should attain.
Curriculum Integration	Curriculum integration in teaching and learning refers to an approach or methodology that cuts across and draws on multiple subject areas to focus on a topic or theme.
Diagnostic Assessment	An assessment given to identify child's strengths and learning needs for improvement.
Formative Assessment	A form of assessment used throughout a unit of study in teaching and learning to measure student's understanding and progress.
Monitoring	General supervision over the teaching and learning of the standards.
Performance Assessment	A form of assessment that is focused on measuring students' mastery of knowledge, skills, values and attitudes taught and learnt in each lesson.
Performance Standards	Performance standards are the indicators of quality that specify how competent a students' demonstration or performance must be.
Proficiency	Mastery of the essential knowledge, skills, values and attitudes in the content standards and benchmarks.

Rubrics	It is a scoring guide used to assess the quality of students responses in an assessment often presented in a table with evaluative criteria at certain levels of achievement.
Self–Assessment	A judgment for official purposes for teachers to make about their abilities, principles or decisions.
Standard	A standard is a level of quality or achievement, especially a level that is thought to be acceptable. It is something used to measure or estimate the quality or degree of something, for example, how good a piece of work is.
Standards-Based Curriculum	Describes **what** all students should know and be able to **do** at the end of a grade or school level. The main idea behind standards-based curriculum is **standards.**
Standards-Based Education	An academic program in which clearly defined academic content and benchmarks are aligned. It spells out what schools and communities need to do to ensure achievement of expectations. The main idea behind standards-based education is **standards.**
Standards-Based Assessment	A systematic and ongoing process of collecting and interpreting information about students' achievements.
STEAM Education	The teaching and learning in the fields of Science, Technology, Engineering, Arts, and Mathematics in both formal and informal classroom settings.
Summative Assessment	A form of assessment used after completing a unit or topic or at a specific point in time in teaching and learning to measure student's mastery of the content standards and benchmarks.
21st Century Skills	Refers to a broad set of knowledge, skills, work habits, and character traits that are believed by educators, school reformers, college professors, employers, and others to be critically important to success in today's world, particularly in collegiate programs and contemporary careers and workplaces.

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Appendices

Appendix 1: Bloom's Taxonomy

Level of Understanding	Key Verbs
Creating Can the student create a new product or point of view?	Construct, design, and develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce, assemble, formulate,
Evaluating Can the student justify a stand or decision?	Appraise, argue, assess, choose, conclude, critique, decide, defend, evaluate, judge, justify, predict, prioritize, provoke, rank, rate, select, support, monitor,
Analyzing Can the student distinguish between the different parts?	Analyzing, characterize, classify, compare, contrast, debate, criticise, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, experiment, question, test,
Applying Can the student use the information in a new way?	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use, demonstrate, illustrate, interpret, operate, sketch, solve, write,
Understanding Can the student comprehend ideas or concepts?	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify,
Remembering Can the student recall or remember the information?	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write, duplicate, memorise, recall, repeat, reproduce, state,

Appendix 2: 21St Century Skills

Ways of Thinking	**Creativity and innovation** • Think creatively • Work creatively with others • Implement innovations **Critical thinking, problem-solving and decision making** • Reason effectively and evaluate evidence • Solve problems • Articulate findings **Learning to learn and meta-cognition** • Self-motivation • Positive appreciation of learning • Adaptability and flexibility
Ways of Working	**Communication** • Competency in written and oral language • Open minded and preparedness to listen • Sensitivity to cultural differences **Collaboration and teamwork** • Interact effectively with others • Work effectively in diverse teams • Prioritise, plan and manage projects
Tools for Working	**Information literacy** • Access and evaluate information • Use and manage information • Apply technology effectively **ICT literacy** • Open to new ideas, information, tools and ways of thinking • Use ICT accurately, creatively, ethically and legally • Be aware of cultural and social differences • Apply technology appropriately and effectively
Living in the World	**Citizenship – global and local** • Awareness and understanding of rights and responsibilities as a global citizen • Preparedness to participate in community activities • Respect the values and privacy of others **Personal and social responsibility** • Communicate constructively in different social situations • Understand different viewpoints and perspectives **Life and career** • Adapt to change • Manage goals and time • Be a self-directed learner • Interact effectively with others

Appendix 3: Teaching and Learning Strategies

Strategy	Teacher	Students
Case study Used to extend students' understanding of real life issues	Provide students with case studies related to the topic of the lesson and allow them to analyse and evaluate.	Study the case study and identify the problem addressed. They analyse the problem and suggest solutions supported by conceptual justifications and make presentations. This enriches the students' existing knowledge of the topic.
Debate A method used to increase students' interest, involvement and participation	Provide the topic or question of debate on current issues affecting a bigger population, clearly outlining the expectations of the debate. Explain the steps involved in debating and set a criteria/ standard to be achieved.	Conduct researches to gather supporting evidence about the selected topic and summarising the points. They are engaged in collaborative learning by delegating and sharing tasks to group members. When debating, they improve their communication skills.
Discussion The purpose of discussion is to educate students about the process of group thinking and collective decision.	The teacher opens a discussion on certain topic by asking essential questions. During the discussion, the teacher reinforces and emphasises on important points from students responses. Teacher guide the direction to motivate students to explore the topic in greater depth and the topic in more detail. Use how and why follow-up questions to guide the discussion toward the objective of helping students understand the subject and summarise main ideas.	Students ponder over the question and answer by providing ideas, experiences and examples. Students participate in the discussion by exchanging ideas with others.
Games and simulations Encourages motivation and creates a spirit of competition and challenge to enhance learning.	Being creative and select appropriate games for the topic of the lesson. Give clear instructions and guidelines. The game selected must be fun and build a competitive spirit to score more than their peers to win small prices.	Go into groups and organize. Follow the instructions and play to win

Observation Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.	Give instructions and monitor every activity students do	Students possess instinct of curiosity and are curious to see the things for themselves and particularly those things which exist around them. A thing observed and a fact discovered by the child for himself becomes a part of mental life of the child. It is certainly more valuable to him than the same fact or facts learnt from the teacher or a book. Students • Observe and ask essential questions • Record • Interpret
Peer teaching and learning *(power point presentations, pair learning)* Students teach each other using different ways to learn from each other. It encourages; team work, develops confidence, feel free to ask questions, improves communication skills and most importantly develop the spirit of inquiry.	Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.	Go into their established working groups. Develop a plan for the topic. Each group member is allocated a task to work on. Research and collect information about the topic allocated to the group. Outline the important points from the research and present their findings in class.
Performance-related tasks (dramatization, song/lyrics, wall magazines) Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date	Students are given the opportunity to perform the using the main ideas of a topic. Provide the guidelines, expectations and the set criteria	Go into their established working groups. Being creative and create dramas, songs/lyrics or wall magazines in line with the topic.
Project (individual/group) Helps students complete tasks individually or collectively	Teacher outline the steps and procedures of how to do and the criteria	Students are involved in investigations and finding solutions to problems to real life experiences. They carry out researches to analyse the causes and effects of problems to provide achievable solutions. Students carefully utilise the problem-solving approach to complete projects.
Use media and technology to teach and generate engagement depending on the age of the students	Show a full movie, an animated one, a few episodes form documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing	Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate

Appendix 4: Lesson Plan Template

Strand: ……

Unit: ……..

Content Standard: .....

Benchmark: ……..

Topic 1: ……..

Lesson Topic: ……

Grade: ……..

Length of Lesson: ……

Essential KSAVs

Knowledge: ……

Skill(s): ……

Values: ……..

Attitudes: ……

Performance Indicator:

Materials:

Instructional (lesson) Objective(s): By the end of the lesson, students will be able to:

- ……
- ……
- ……

Essential Questions:

- ……
- ……

Lesson Procedure

Teacher Activities	Student Activities
Introduction (time in minutes)	
Body (time in minutes)	
Modeling	
Guided Practice	
Independent Practice	
Conclusion (time in minutes)	

Appendix 5: Assessment Strategies

Strategy	Description
Analogies	Students create an analogy between something they are familiar with and the new information they have learned. When asking students to explain the analogy, it will show the depth of their understanding of a topic.
Classroom presentations	A classroom presentation is an assessment strategy that requires students to verbalize their knowledge, select and present samples of finished work, and organize their thoughts about a topic in order to present a summary of their learning. It may provide the basis for assessment upon completion of a student's project or essay.
Conferences	A conference is a formal or informal meeting between the teacher and a student for the purpose of exchanging information or sharing ideas. A conference might be held to explore the student's thinking and suggest next steps; assess the student's level of understanding of a particular concept or procedure; and review, clarify, and extend what the student has already completed.
Discussions	Having a class discussion on a unit of study provides teachers with valuable information about what the students know about the subject. Focus the discussions on higher level thinking skills and allow students to reflect their learning before the discussion commences.
Essays	An essay is a writing sample in which a student constructs a response to a question, topic, or brief statement, and supplies supporting details or arguments. The essay allows the teacher to assess the student's understanding and/or ability to analyse and synthesize information.
Exhibitions/ demonstrations	An exhibition/demonstration is a performance in a public setting, during which a student explains and applies a process, procedure, etc., in concrete ways to show individual achievement of specific skills and knowledge.
Interviews	An interview is a face-to-face conversation in which teacher and student use inquiry to share their knowledge and understanding of a topic or problem, and can be used by the teacher to explore the student's thinking; assess the student's level of understanding of a concept or procedure and gather information, obtain clarification, determine positions, and probe for motivations.
Learning logs	A learning log is an ongoing, visible record kept by a student and recording what he or she is doing or thinking while working on a particular task or assignment. It can be used to assess student progress and growth over time.
Observation	Observation is a process of systematically viewing and recording students while they work, for the purpose of making programming and instruction decisions. Observation can take place at any time and in any setting. It provides information on students' strengths and weaknesses, learning styles, interests, and attitudes.
Peer assessment	Assessment by peers is a powerful way to gather information about students and their understanding. Students can use set criteria to assess the work of their classmates.

Performance tasks	During a performance task, students create, produce, perform, or present works on "real world" issues. The performance task may be used to assess a skill or proficiency, and provides useful information on the process as well as the product.
Portfolios	A portfolio is a collection of samples of a student's work, and is focused, selective, reflective, and collaborative. It offers a visual demonstration of a student's achievement, capabilities, strengths, weaknesses, knowledge, and specific skills, over time and in a variety of contexts.
Questions and answers (oral)	In the question–and-answer strategy, the teacher poses a question and the student answers verbally, rather than in writing. This strategy helps the teacher to determine whether students understand what is being, or has been, presented, and helps students to extend their thinking, generate ideas, or solve problems.
Quizzes, tests, examinations	A quiz, test, or examination requires students to respond to prompts in order to demonstrate their knowledge (orally or in writing) or their skills (e.g., through performance). Quizzes are usually short; examinations are usually longer. Quizzes, tests, or examinations can be adapted for exceptional students and for re-teaching and retesting.
Questionnaires	Questionnaires can be used for a variety of purposes. When used as a formative assessment strategy, they provide teachers with information on student learning that they can use to plan further instruction.
Response journals	A response journal is a student's personal record containing written, reflective responses to material he or she is reading, viewing, listening to, or discussing. The response journal can be used as an assessment tool in all subject areas.
Selected responses	Strictly speaking a part of quizzes, tests, and examinations, selected responses require students to identify the one correct answer. The strategy can take the form of multiple-choice or true/false formats. Selected response is a commonly used formal procedure for gathering objective evidence about student learning, specifically in memory, recall, and comprehension.
Student self-assessments	Self-assessment is a process by which the student gathers information about, and reflects on, his or her own learning. It is the student's own assessment of personal progress in terms of knowledge, skills, processes, or attitudes. Self-assessment leads students to a greater awareness and understanding of themselves as learners.
Posters	
Video analysis	
Reflective writing	
Projects	
Observation reports	

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