Environment

Senior High

Grade 12

Teacher Guide

Standards-Based

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 Grade 12 Social Science Environment Teacher Guide to be used by teachers in all high schools throughout Papua New Guinea.

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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 12.

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 12 Environment 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 12 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

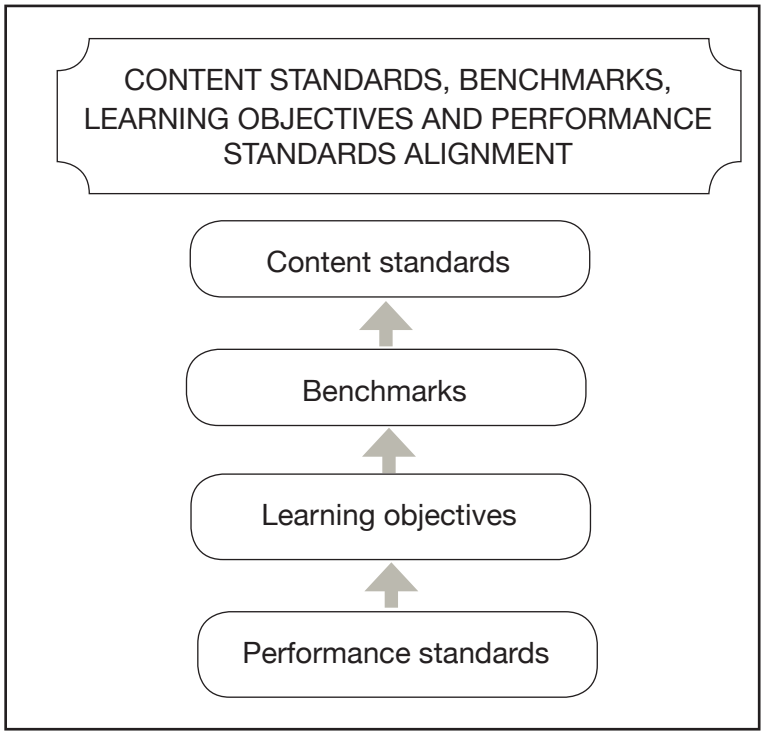
The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what 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 12 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;

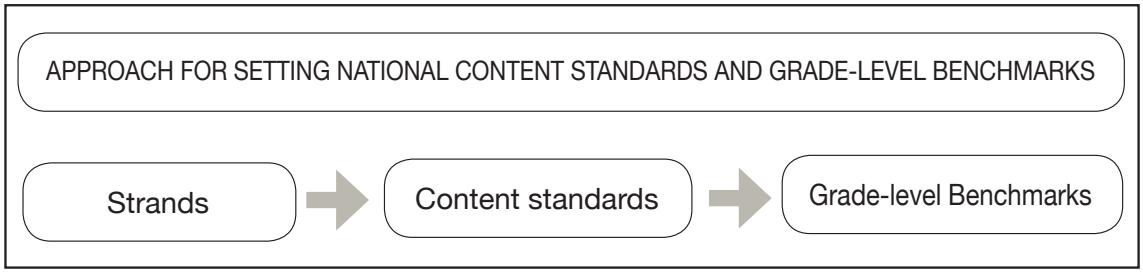
- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

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:

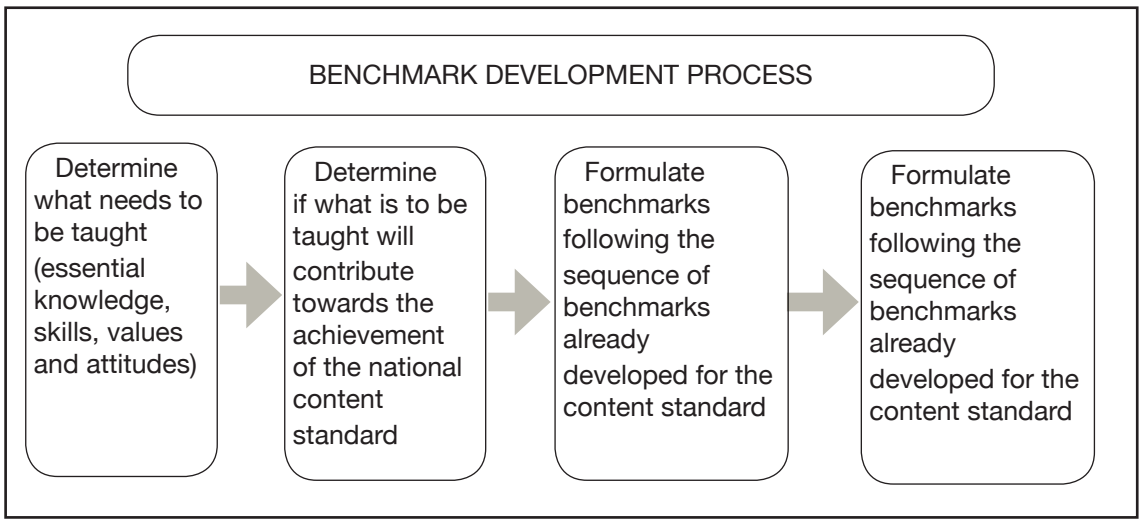
- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate 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.

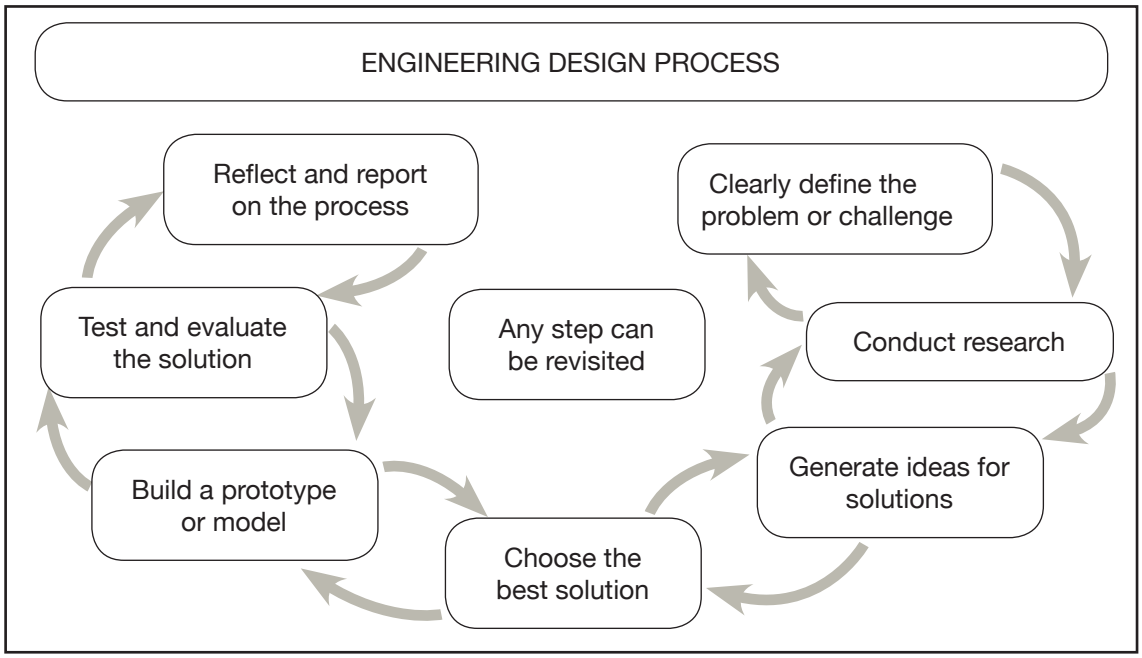
Extreme cases
Considering “extreme cases” – envisioning the problem in a greatly exaggerated or greatly simplified form, or testing using extreme condition – can often help to pinpoint a problem. An example of the extreme-case method is purposely inputting an extremely high number to test a computer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



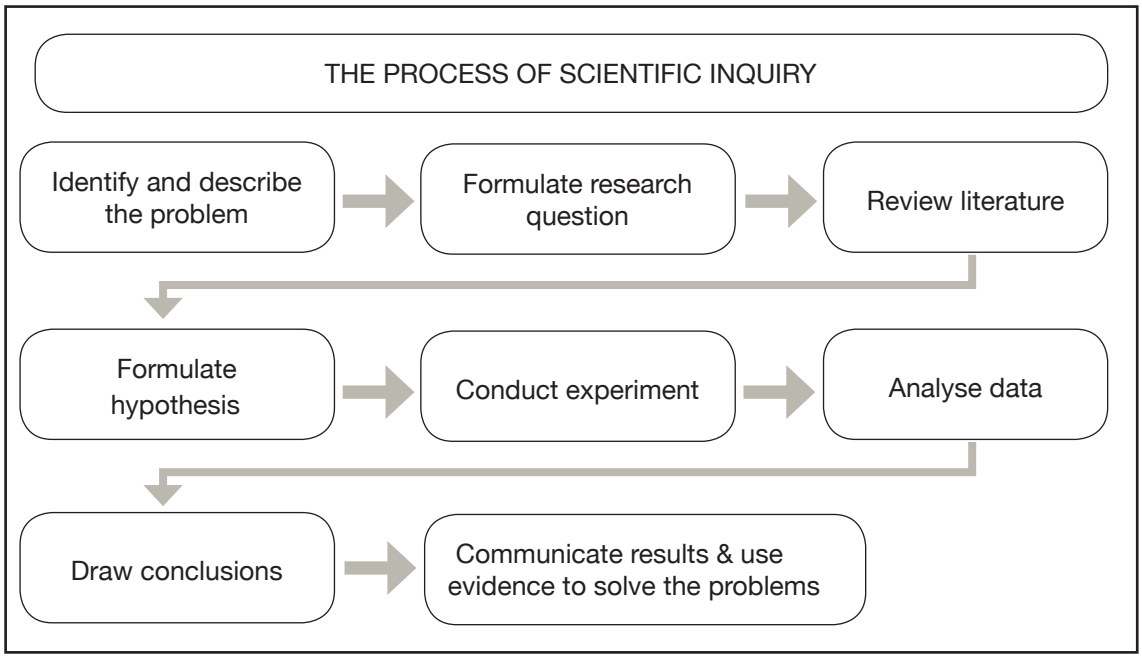
The scientific method and approach to problem-solving

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.

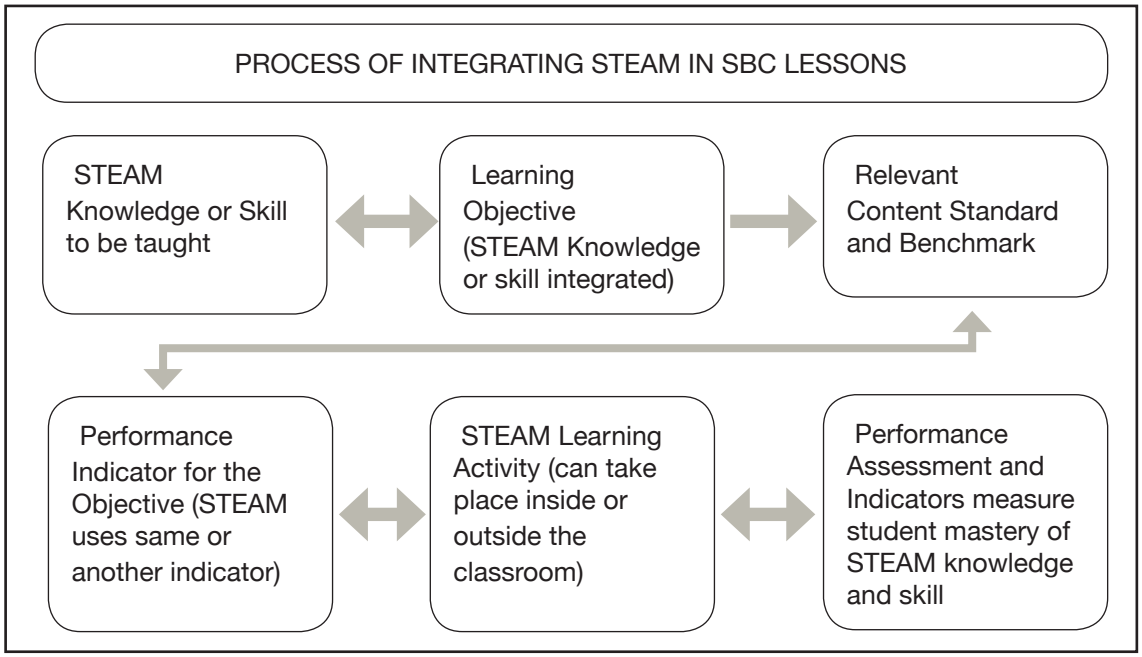
Integration of STEAM problem-solving skills into standards-based lesson plans

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 12 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).*

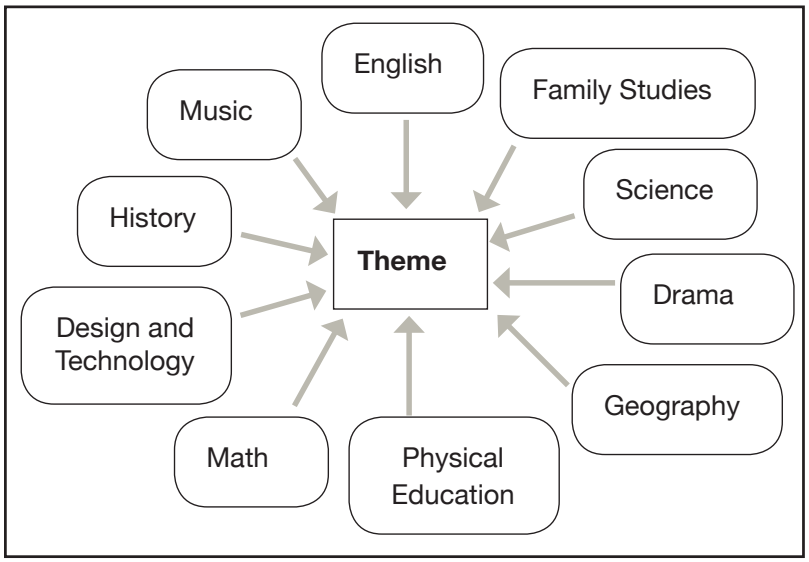
Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented teaching to one who is knowledge based and who should be perceived as a 21st century innovative educator. Curriculum integration is a holistic approach to learning thus curriculum integration 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.

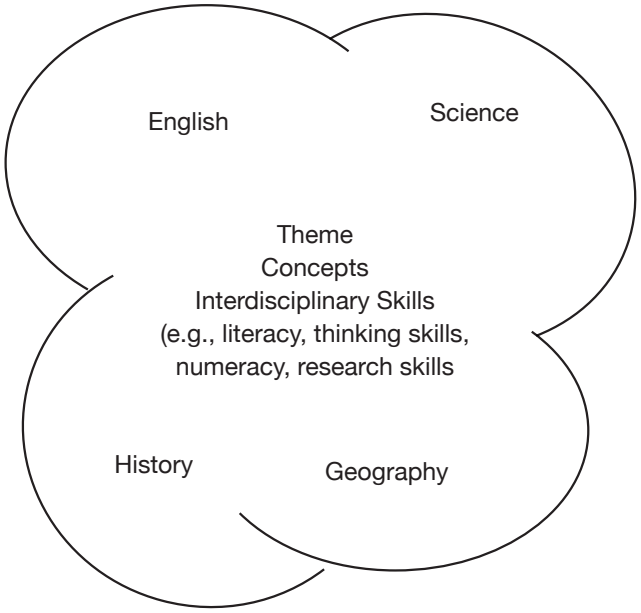
1. Multidisciplinary approach

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).*

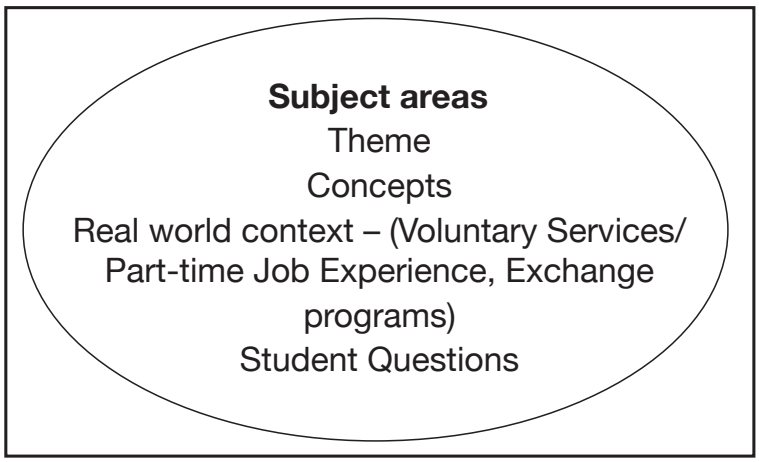
1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources
2. The teacher finds out what the students already know and helps them generate questions to explore. The teacher also provides resources for students and opportunities to work in the 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 12. It consists of;

- units
- topics

Environment in grade 12 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 12 to be taught in an academic year. .

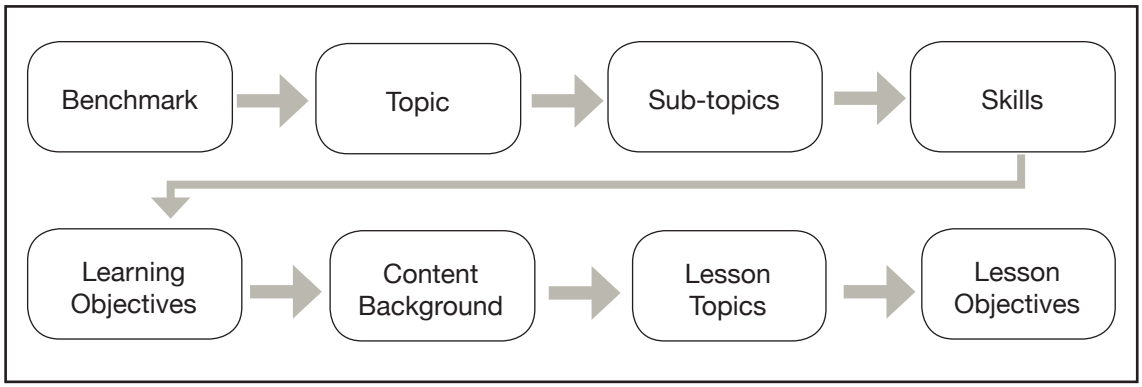
Units	Topics
Resources and Environment	Topic 1: Biomass Topic 2: Types of natural resources Topic 3: Types of physical environments Topic 4: Ecosystems of great variety Topic 5: Adaptation versus extinction
The Earth and Its Systems	Topic 1: The process of greenhouse effect Topic 2: Enhanced greenhouse effect Topic 3: Effects of enhanced greenhouse effect on biodiversity Topic 4: Global warming Topic 5: Evidence of global warming Topic 6: Effects of global warming on PNG and the world Topic 7: The Paris Declaration (Paris Agreement) on global warming and climate change Topic 8: Papua New Guinea's strategic plan on global warming and climate change
Biological Dynamics of the Earth	Topic 1: Biological diversity in an ecosystem Topic 2: Limiting factors to species adaptation in an ecosystem Topic 3: Causes of extinction of plant and animal species Topic 4: Wildlife Management Laws
Environmental Change and Sustainability	Topic 1: Impact of human activities on natural processes Topic 2: Impact of plantation economy on environments Topic 3: Environmental protection and resources sustainability in PNG

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 12.5.1.1: Compare the different biomass.

Topic 1: Biomass

Sub-topics:
- Sources of different types of biomass
- Uses of the different types of biomass
- Costs and benefits of the different types of biomass I

Critical thinking skills: Comparing & contrasting different biomass.

Learning Objectives: By the end of the topic, students will be able to:
- Identify different biomasses and describe the sources and uses of each one of them.
- Discover and explain the advantages and disadvantages of different biomasses.
- Identify and explain the differences and similarities between different biomasses.

Content Background

Biomass is organic matter found in nature that can be extracted and converted into bio fuel. In other words, it refers to plant and animal material that is converted into fuel known as bio fuel.

Sources of biomass	Types of biomass	Use of biofuel
Wood	Saw dust, wood chips	- Wood chips are used as solid fuel, as raw materials for making wood pulp, mulch for gardening, - Saw dust is used; as fertilizer known as sawdust compost in agricultural industries, in manufacturing paper, water boards, cooking stoves.
Agricultural waste	By products of agricultural activities such as crop wastes	Used to produce biogas further used for producing electricity
Animal waste (animal farming)	Manures from animals	Used as soil conditioner or fertilizer in agriculture. Produce biogas further used for generating electricity
Human waste (sewage plants)	Urine and faeces	Used as soil conditioner or fertilizer in agriculture. Produce biogas which is further used for generating electricity

Manufacturing waste and land fill gas		
Algae or algae derived biomass		
Enzymes or bacteria from various sources grown in cell cultures or hydroponic (growing plants without soil)		

Sources of different biomass
Major sources of biomass that produces bio fuel which is heat or power are animal dung, wood – logs, chips, bark, sawdust, and grass clippings such as switch-grass. Those that produce biogas and biodiesel are solid waste from humans or animals (sewage, animal farm manure) and landfills.

Historically, humans have harnessed biomass-derived energy since the time when people began burning wood fuel. Even in 2019, biomass is the only source of fuel for domestic use in many developing countries. All biomass is biologically-produced matter based in carbon, hydrogen and oxygen. The estimated biomass production in the world is approximately 100 billion metric tons of carbon per year, about half in the ocean and half on land.

Uses of different types of biomass
It is known as waste energy feed-stock for the fact that the waste released from industrial and manufacturing processes as well as domestic waste is converted into fuel for electricity or heat generation. It can also be used in various industrial processes as raw material for a range of products.

Advantages of different biomass
- Biomass is a renewable source of energy
- Reduces the over reliance of fossil fuels
- Cheaper than fossil fuels
- Makes revenue for biomass producers

Disadvantages of different biomass
- Biomass is not as efficient as fossil fuel
- Escalates methane gas which is damaging to the environment
- Can lead to deforestation
- Biomass plants requires a lot of space

Suggested Resources

1. N. Sriram. & M. Shahidehpour. (2005). *Renewable biomass energy.* San Francisco, USA. IEEE Power Engineering Society.
2. Retrieved from:
   i. Biomass https://en.m.wikipedia
   ii. Biomass explained: https://www.eia.gov

Benchmark 12.5.1.2: Distinguish between perpetually renewable resources, potentially renewable resources, and non-renewable resources and document natural processes involved with their formation and/or renewal.

Topic 2: Types of natural resources

Sub-topics:
- Renewable resources
- Non-renewable resources

Critical thinking skills: Distinguishing between different types of natural resources.

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

- Identify natural resources.
- Categorise natural resources into renewable and non-renewable resources.
- Discuss the difference between perpetually and potentially renewable resources.
- Identify and describe the formation and renewal processes of perpetually renewable resources.
- Explain the formation and renewal processes of potentially renewable resources.
- Explain the formation and renewal processes of non-renewable resources.

Content Background

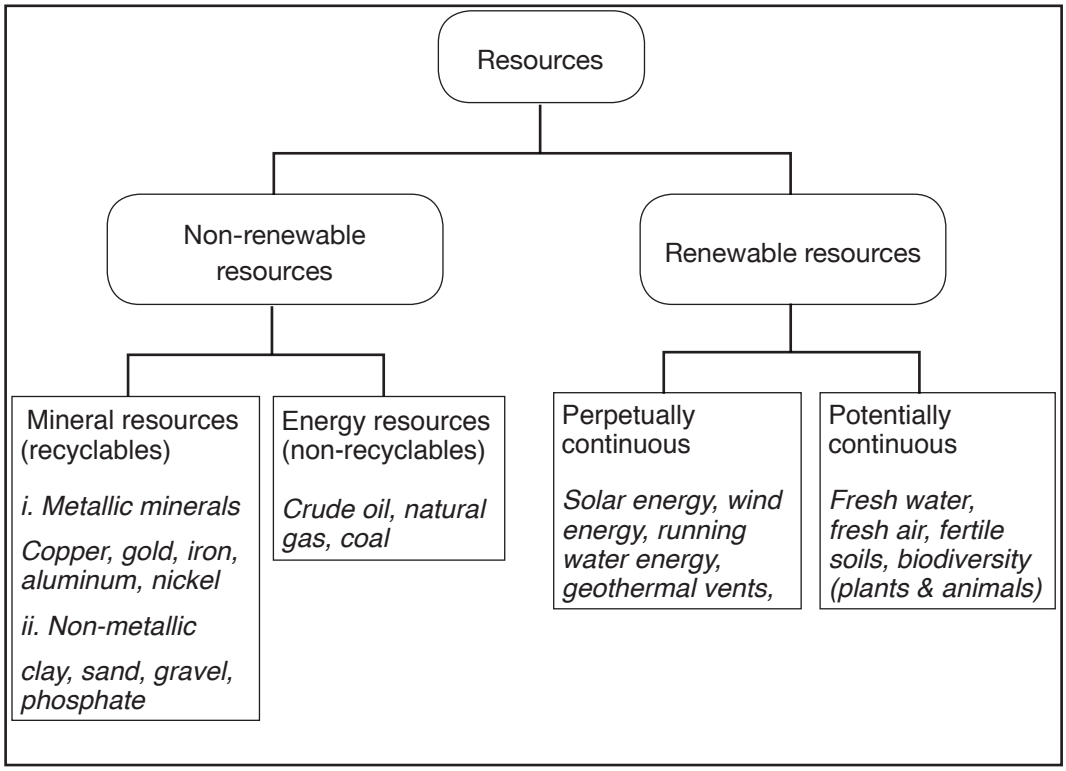
A resource is anything useful for satisfying a need or a want that is of economic value found in the environment. The environment can be both, the physical natural environment, or the cultural or man-made environment. A renewable resource is a resource which can be used repeatedly and replaced naturally. A non-renewable resource by contrast is a resource in nature by which once its supply or quantity has been consumed will never replenish in a finite amount of time in a human time scale.

Renewable resources are subdivided into two categories. They are perpetually renewable resources and potentially renewable resources. Perpetually renewable resources are provided by nature without human intervention and they do not become exhausted regardless of their rate of use. They are also known as continuous because they are forever found in nature. Some examples of perpetual resources include solar energy, energy of the running water and wind energy and geothermal energy. These sources of energy are also referred to as renewable and clean energy sources.

A potentially renewable resource can be replenished fairly rapidly through natural processes with the help of the sun. This group is also known as flows or controls because if their rate of consumption is not controlled or managed, they can eventually become non-renewable. Examples of such resources include forests, grassland, wild animals, fresh lake and stream water, groundwater, fresh air and fertile soil. Non-renewable resources are also subdivided into two categories.

Mineral resources and energy resources. Most non-renewable minerals are recyclable once in their finished product such as aluminium, copper, iron or nickel. The non-renewable energy resources are in limited supply and once their stock or reserves have been used up can never be replaced. They take thousands of years to be formed through geological time. Examples of such resources include coal, nuclear energy, natural gas, crude oil or petroleum. Many of them are fossil fuels.

The flowchart summarises the types and examples of both renewable and non-renewable resources.



Suggested Resources

1. Department of Education, FODE, (2016). *Grade 12 Geography – Resource Use and Management.* Port Moresby. National Department of Education.
2. Department of Education. FODE, (2016). *Grade 10 Social Science – Resource Development and Management.* Port Moresby. National Department of Education.
3. Retrieved from:
   i. *Resource https://en.m.wikipedia.org*
   ii. *Types of natural resources http://www.eschooltoday.com.*

Benchmark 12.5.1.3: Examine the different types of physical environments; (deserts, cold, temperate, arid, mountainous, etc.) and show where they are located using a global map.

Topic 3: Types of physical environments

Sub-topics:
- Desert environments
- Cold environments
- Temperate environments
- Arid environments
- Mountainous environments
- Equatorial wet environments

Critical thinking skills: Examining the different types of physical environments.

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

- Identify the different types of physical environments.
- Describe and illustrate each of the physical environments.
- Investigate the location of each of the physical environments and show them on the world map.
- Explain the relationship between climate and the different physical environments.

Content Background

Anything that supports life such as the atmosphere, the oceans and climate zones such as deserts, tundra, mountains and tropical rainforests that are found in the world is categorised as a physical environment. This environment encompasses the interaction of all living and non-living things and affects human survival and economic activity.

Physical environments are greatly influenced by;
i. Climate
ii. Geology
iii. Geomorphology
iv. Oceanography

Together, these forces produce environments that range from wet to dry, cold to hot and biologically diverse to less diverse physical environments.
Note that;
- Climate influences plant and animal distribution across the globe as well as fresh water and soil distribution.
- Geology and geomorphology influence metallic and non-metallic minerals distribution, climate, soil distribution and plant and animal distribution.
- Oceanography affects climate and ocean resources including energy, fresh water and fish stock.
- Plants and animals provide humans with food, clothes, building materials for shelter, tools and weapons and fuel.
- Metallic and non-metalic minerals also provide humans important

resources for building & construction, transportation and communication.

- Fossil fuels and renewable energy sources such as solar and hydro drive transport systems, homes and industries.

Desert environments

A desert is a barren area of landscape where little or no precipitation occurs and living conditions are hostile for plant and animal life. The lack of vegetation exposes the unprotected surface of the ground to the processes of denudation. Deserts cover about one fifth of the land surface. Tropical deserts are located between 15° degrees and 30° degrees, north or south of the equator. These latitude belts lie around the Tropic of cancer and the Tropic of Capricorn. Most of the world's tropical deserts are located on the western margins of continents in places such as Australia, Africa, Asia and North and South America. The Sahara desert is the world's largest tropical desert. There are hot deserts and cold deserts. Temperate deserts are found in latitudes between the tropical and polar-regions. They have similar aridity to and lower temperatures than tropical deserts. Examples include deserts in North America such as the Colorado, and the Atacama Desert in Chile, together with the arid regions of Eurasia and China. The Sahara and the Kalahari are examples of hot deserts.

Cold environments

Cold environments are places on earth where the temperature is extremely and exceedingly below zero degrees (0C°) limiting vegetation growth. They have an extreme climate and unique characteristics such as a permafrost soil cover. They cover about one quarter (25%) of the world's land surface. Some

cold environments are permanently cold and others are seasonally cold. There are four main types of cold environments which are polar, alpine, glacial and peri-glacial. Winter temperatures in cold environments often drops to 50°C. Cold environments including polar and tundra are found in high latitude areas and mountainous regions of the world. Examples of cold environments are Antarctica, Greenland and some of the places and islands inside the Arctic and Antarctic Circles. A cold environment that is influenced by altitude is the Himalayas.

Temperate environments

In geography temperate environments are regions or places on the globe that experiences seasonal changes and variations in climate and weather conditions. These are places that experiences the full four seasons of summer, autumn, winter and spring. They are located between the Tropic of Cancer and the Arctic Circle in the Northern Hemisphere, and the Tropic of Capricorn and the Antarctic Circle in the Southern Hemisphere. These are the middle latitudes which lie between the tropics and the polar-regions. They experience temperate climates with moderate rainfall all year around, with mild to warm summers and cold winters.

Arid environments

Arid environments are also known as semi deserts and they lie within the periphery of desert regions at latitudes 30° north or south of the equator. Arid or semi desert environments have minimal to no vegetation due to lack of available water which hinders the development of plant and animal life. It is a very hot and dry region which covers about one third of the earth's surface. Arid environments refer to both desert environments and environments with a prolonged dry spell that support limited vegetation with special adaptive features.

Mountainous environments

Mountain environments are land areas that rise above the surrounding lowland areas in the form of a peak or a chain of fold-mountains. They have been formed through tectonic forces or volcanism when the earth's surface was raised. They lie in between continental tectonic plate boundaries and cover 24 percent of the earth's surface. Some of the world's famous mountain ranges and regions such as the Himalayas in Nepal, the Andes in Chile, the Rockies in USA and Canada are located in the temperate environments. Life in the mountains can be very extreme where organisms are exposed to permanent snow and ice, apart from polar-regions. Temperature decreases with altitude and the air is very thin due to the thinning of the atmosphere. The air is usually warmed by the heat from the sun. Food is scarce and the climate is very cold.

Suggested Resources

1. Brian Parker, Kate Lanceley, Debra Owens & Rebecca Fitzpatric, (2008). *Geography for Global Citizens (3rd edition).* Claremont Street, South Yarra. Macmillan.
2. Department of Education, FODE. (2016). *Grade 11 Geography, Natural Processes and Disasters.* Port Moresby. National Department of Education.
3. Retrieved from:
   i. Desert Environment https://www.britannica.com/science
   ii. Mountains http://www.primaryhomeworkhelp.co.uk/
   iii. Mountain https://study.com/academy/lesson
   iv. Temperate-environment https://www.sciencedirect.com

Benchmark 12.5.1.4: Identify, illustrate, and interpret the types of ecosystems (e.g. forests, grasslands, deserts, tundra, freshwater, marine), and food chains and food webs typical in each of these environments.

Topic 4: Ecosystems of great variety

Sub-topics:

- Types of ecosystems
- Food chains in different ecosystems
- Food webs in different ecosystems

Critical thinking skills: Examining and analysing the food chains and webs in different ecosystems.

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

- Identify types of ecosystems.
- Describe each type of ecosystems.
- Examine food chains and food webs typical in each ecosystem.
- Illustrate food chains and food webs typical in each ecosystem.
- Interpret food chains and food webs typical in each ecosystem.

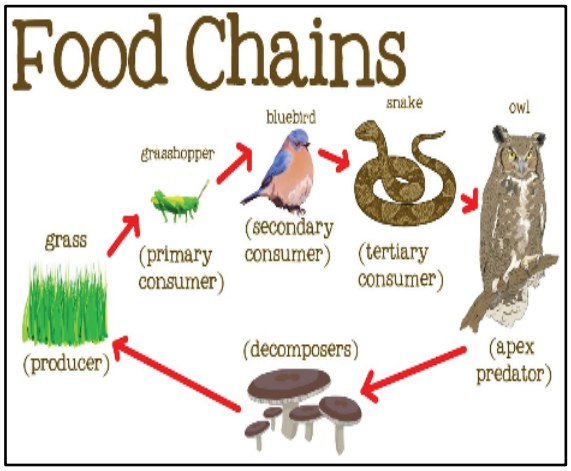
Content Background

An ecosystem is also known as a biome. It is a community of living things and non-living things (plants & animals, micro-organisms, rocks, soil, minerals, atmosphere, etc.) interacting with one another in their physical environment. The two major types of ecosystems or biome and their sub-divisions are summarised in the table below.

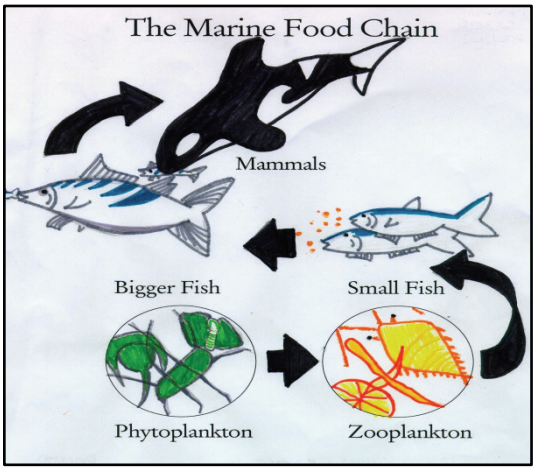
Types of ecosystems (biomes)	
Aquatic Ecosystem	Terrestrial Ecosystem
Marine (contain salt water) coral reefs, salt water swamps, mangroves	Forest ecosystem - rainforest, tundra, tropical evergreen, deciduous, woodland,
Fresh water - lentic (slow-moving water like lakes, pools, ponds) - lotic (fast moving water like rivers, streams) - fresh water swamps	Desert ecosystem
	Grassland - savannah, prairies, steppes
	- Mountain

Food chains and food webs

A food chain is a linear network of links showing the transfer of energy through the consumption of food from one organism to another.

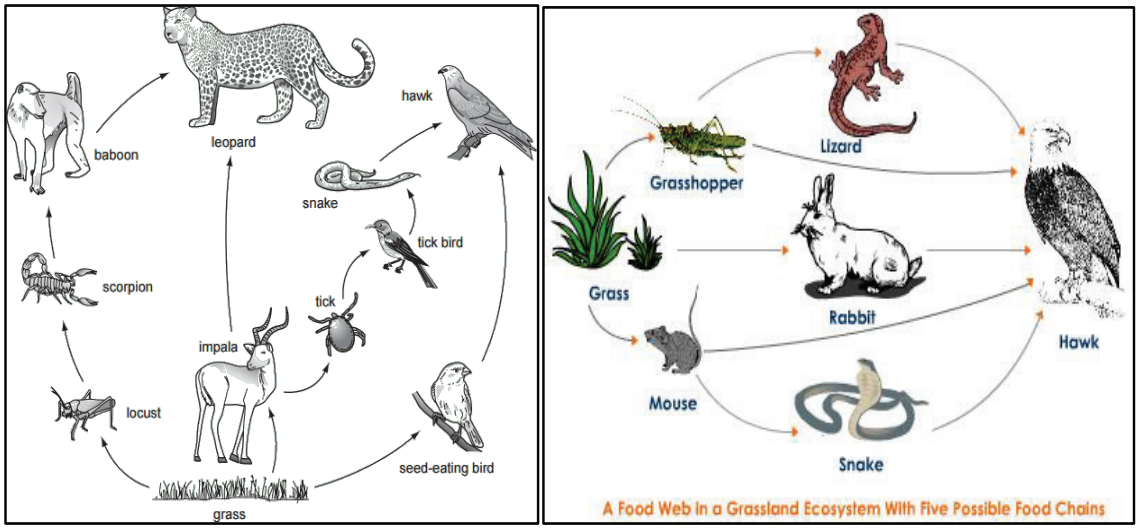


Food chain in a terrestrial (grassland) ecosystem

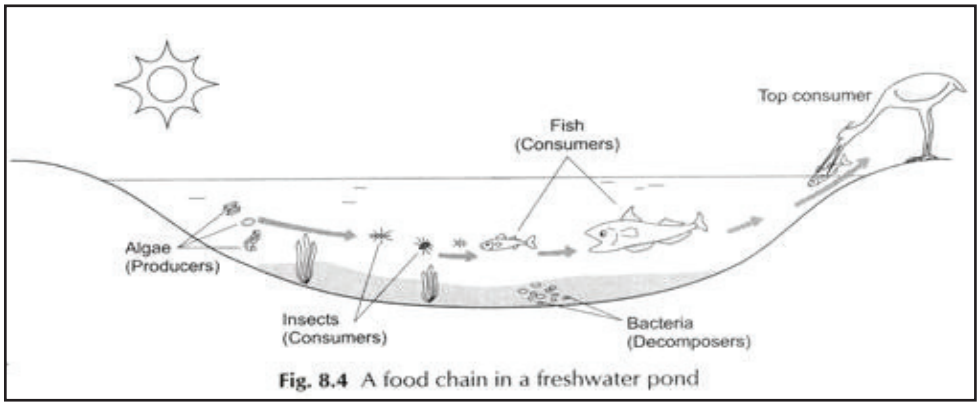


Food chain in an aquatic (marine/sea) ecosystem
Retrieved from: http://kids.britannica.com

A food web is a complex connected network of various food chains in the ecosystem. They always begin with a producer which are usually plants, and ends with a consumer which obviously are animals.



Food webs in grassland ecosystem
Retrieved from: https://www.importantindia.com.



Food web in an aquatic (freshwater pond) ecosystem
Retrieved from: https://www.importantindia.com.

The sun is the main source of energy in every food chain and food web. The producers form the base of the food chain. Green plants form the base of terrestrial food chains upon deriving energy from the sun to photosynthesis.

In the water, microscopic single cell organisms in the likes of phytoplankton that live on the surface of the water harness the energy from the sun to photosynthesis and are later consumed by the first consumer of each food web.

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.
3. Retrieved from:
   i. Ecosystems https://sc-s.si/joomla/images/Ecosystems.pdf
   ii. Examples natural ecosystem https://www.eartheclipse.com/ecosystem

Benchmark 12.5.1.5: Explain and illustrate how plants, animals and human beings adapt to and survive in these different ecosystems and environments, use and manage resources, and relate to and protect the environment.

Topic 5: Adaptation versus extinction

Sub-topics:

- Plant adaptation in different environments
- Animal adaptation in different environments
- Human adaptations in different environments
- Resource management
- Environmental protection

Critical thinking skills: Examining and analysing the food chains and webs in different ecosystems.

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

- Explain plant and animal adaptation in different environments.
- Examine the concept of adaptation versus extinction by plants and animals.
- Explain human adaptation in different environments.
- Evaluate the use and management of resources in different environments.
- Examine the concept of environmental protection in different environments.

Content Background

Adaptation is an evolutionary process of alteration in the structure or functions of an organism that results from natural selection, and makes it become better fitted to survive and multiply in its environment. The special characteristics that enable plants and animals to be successful in a particular environment are called adaptations. The three types of adaptations are structural, physiological and behavioural.

Type of adaptation	Description
Structural	Changes in the physical features of an animal in order to adapt to a new environment (e.g. animals in cold climates may develop thicker fur to withstand the cold).
Physiological	Internal organs changes based on body chemistry and metabolism. These changes do not show from the outside.
Behavioural	Changes in things that animals or people act or do to survive in a new environment (external). This refers to the actions of animals and other organisms that enable them to survive in their environment. For example, birds and whales migrate to warmer climates or bears hibernate to escape cold.

The idea develops around the notion that if plants and animals are unable to adapt to change they eventually become extinct. Some species become extinct because they can no longer survive and reproduce in their altered environment. When members of a particular species are unable to cope with extreme climate changes, the opportunity for the species evolution is lost and they eventually cease to exist.

Plant and animal adaptation in different environments
Plants and animals adapt to changing environments through two major adaptation techniques. These are natural selection and mutation. In the process of natural selection adaptations occur over a series of generations. Mutation on the other hand enables instant adaptations. A mutation is an alteration of the DNA sequence of an organism or species which accelerates its ability to become better suited to its environment. However, some mutation cases can result in an organism becoming a pest in its environment.

Human adaptation in different environments
Humans adapt differently than most animals. We humans have the ability to alter our environment in so many different ways to suit our needs including clothing, cooling and heating, houses, buildings and cities. We turn forests into meadows and meadows into forests. We make and produce food to suit us rather than having to adapt to nature's food sources.

Human adaptation in various environments are characterised by five major factors.

1. Temperature
2. Sun exposure
3. Resistance to disease
4. Muscular growth
5. Senses

There are three types of relationships that exist in nature; mutualism, commensalism and parasitism.

Type of relationship	Description
Mutualism	Co-existence of two organisms whereby both organisms benefit. For instance, the zoo anthalae and the algae that lives in it together form coral reefs.
Commensalism	In this symbiosis, one organism benefits but does not harm the other organism in any way. For example, epiphytes like orchids that grow on other plants
Parasitism	On one way relationship whereby one organism benefits to the extent of killing the host. For example, a virus in a human being.

Humans coexist with the natural environment and are engaged in one of these types of relationships in his quest to satisfy his needs and wants.

Use and management of resources and environmental protection in different environments
The way in which we consume and manage our resources is greatly influenced by our ability to rapidly adapt to varying environmental conditions. Our quest to adapt to varying environmental conditions cause us to become careless and more-reckless in our rate of resource consumption.

The desire in us to continuously modify our physical environment for our own benefit has both positive and negative impacts on the environment. Some of the ways in which humans impact the environment are;

- Pollution
- Global warming
- Climate change
- Genetic modification
- Ocean acidification
- Water pollution
- Deforestation

In order for the environment to continuously supply us with finite resources, we need to mitigate some of the negative impact on the environment, and achieve sustainability in the way we manage and protect the environment.

Suggested Resources

1. Retrieved from:
   i. *Adaptation https://www.nationalgeographic.org/encyclopedia*
   ii. *Evolution, adaptation & extinction https://study.com/academy/topic/*

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 12.5.2.1: Illustrate and interpret the process of greenhouse effect.

Topic 1: The process of greenhouse effect

Sub-topics:

- Greenhouse
- The greenhouse gases
- The greenhouse effect

Critical thinking skills: Analysing and evaluating the process of greenhouse effect.

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

- Explain how a greenhouse relates to greenhouse effect.
- Identify the greenhouse gases that influence greenhouse effect.
- Investigate how the process of greenhouse effect works.
- Illustrate the process of greenhouse effect.

Content Background

A green house is a structure with walls and roof made of transparent materials like glass. It is built to grow crops or flowers inside it. Green houses are suitable for cool climates because they allow sunlight to enter and also prevent heat from escaping.

The greenhouse effect phenomenon operates in a similar way to a greenhouse where vegetables and other farm crops are grown in high latitude climate zones where temperatures are very low in winter. The glass in a greenhouse traps the incoming heat from the sun during the summer months and during winter, it slowly releases the heat throughout the greenhouse and allows the plants and crops in the greenhouse to be kept warm. The greenhouse is specifically designed to control and regulate temperature so that the farm crops are not severely affected by the extreme cold and hot temperatures during winter and summer.

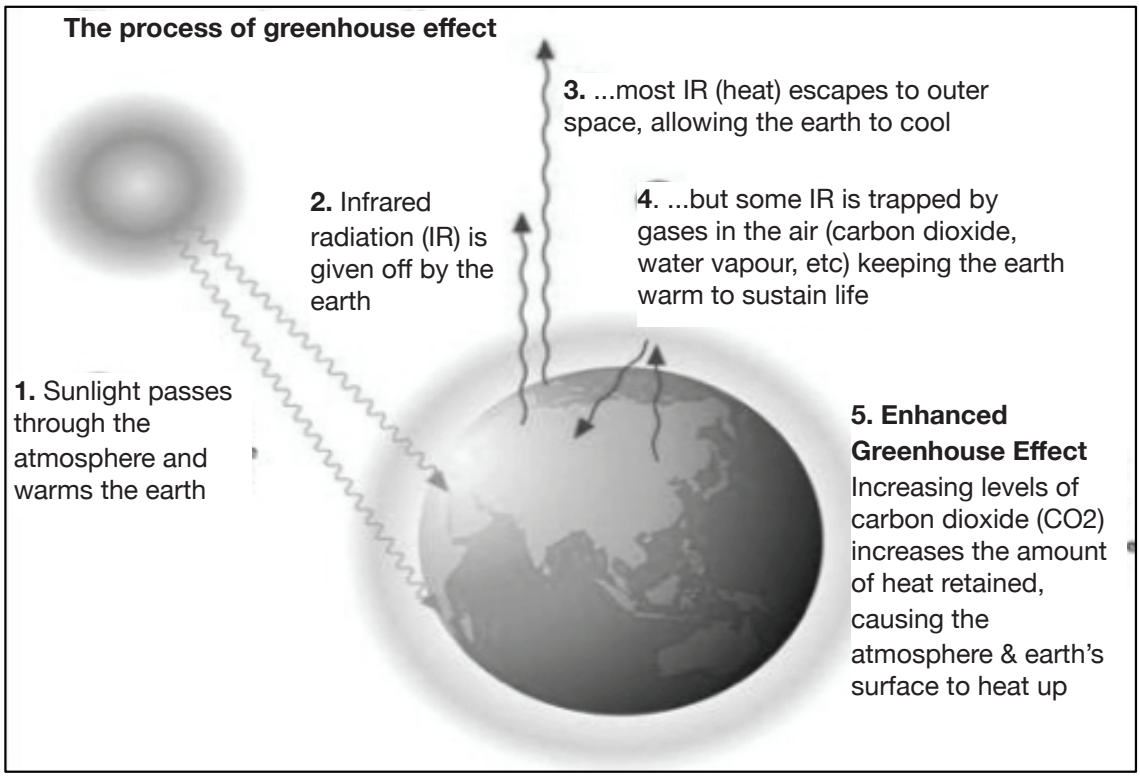
In a similar fashion, carbon dioxide and water vapor (naturally occurring) in the atmosphere trap the energy (heat) from the sun during the day after it has been converted into long-wave terrestrial radiation. The short-wave solar radiation immediately bounces off back into the atmosphere in its converted form upon reaching the earth's surface. The atmosphere then absorbs this heat energy and keeps it. At night that heat energy is slowly released back onto the earth's surface and that is how the earth is kept warm at night. If this did not happen, all the heat would be rapidly lost and we would all freeze to death at night. The reason why carbon dioxide and water vapor are called greenhouse gases is because they act in a similar manner to the glass in a greenhouse. The earth

isn't actually inside a greenhouse, but our atmosphere traps the sun's heat just like the glass walls of a greenhouse.

The greenhouse effect is a natural process that occurs when gases in the earth's atmosphere trap the sun's heat and keep it from escaping back into outer space. This process makes earth much warmer than it would be without an atmosphere. The greenhouse effect is one of the things that make earth a comfortable place to live.

Greenhouse gases
There are 5 main greenhouse gases; carbon-dioxide, ozone, water vapor, methane, and nitrous oxide.

The processes of the greenhouse effect and how it works is illustrated in the diagram on the left below.



The earth's greenhouse gases make the earth the only known planet to support life. The planet Mercury that is closest to the sun is lack of sufficient quantities of greenhouse gases which makes the planet to be very hot. This means water remains as liquid only and no living things can survive the heat.

On earth the ozone gas found in the second layer of the atmosphere filters out the dangerous rays of the sun so that living cells can survive if the other greenhouse gases in the first layer warm up the earth with a conducive temperature. The role of greenhouse gases can be likened to that of cloud cover in an area in the day and in the night time.

Suggested Resources

1. Stan Squire, (1988). *Interactions in Physical Geography Today.* Australia. Oxford University Press.
2. Colin Sale, (1989). *Our Wonderful World.* Melbourne, Australia. Longman Cheshire Pty Limited.
3. Retrieved from:
   i. Greenhouse effect https://www.environment.gov.au/
   ii. Greenhouse Effect-Greenhouse Gases and Their Impact on Global Warming https://www.researchgate.net/publication/323223192
   iii. Greenhouse effect https://en.wikipedia.org/wiki/

Benchmark 12.5.2.2: Identify and analyse the causes of enhanced greenhouse effect and examine ways of mitigating these causes.

Topic 2: Enhanced greenhouse effect

Sub-topics:
- Causes of enhanced greenhouse effect
- Impact of enhanced greenhouse effect
- Ways of mitigating the causes of enhanced greenhouse effect

Critical thinking skills: Analysing the causes and effects of enhanced greenhouse effect and how to lessen these causes.

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

- Examine the causes of enhanced greenhouse effect (caused by humans).
- Highlight the impact of enhanced greenhouse effect.
- Identify and describe strategies to mitigate the causes of enhanced greenhouse effect.

Content Background

'Enhanced greenhouse effect' is the action of mankind which releases extra quantities of greenhouse gases into the atmosphere which traps more heat energy enhancing the effect of the natural greenhouse effect. It is also and sometimes known as; Global warming or Climate change. The enhanced effect is caused by the build-up of greenhouse gases in excessive quantity. This leads to an increase in the rate of heat energy that is absorbed by the atmosphere, thus the atmosphere releases more heat back to the earth's surface causing the earth to become warmer than it should be. The enhanced effect is a direct result of man's continuous activities in his pursuit of development.

The causes, impact and mitigating techniques are summarized in the table.

Enhanced Greenhouse Effect			
Cause	**Primary impact**	**Secondary impact**	**Mitigation**
Burning of fossil fuels	CO2 emission	Global warming, climate change, sea level rise.	Use renewable energy sources, e.g. solar energy, wind energy
Industrial operations	CO2, CFC, methane & nitrous oxide emission	Global warming, climate change, sea level rise. Air pollution Acid rain	Use renewable energy sources, e.g. solar energy, wind energy. Use biofuel, biogas & biodiesel.
Logging and other forest operations	CO2 emission	Global warming, climate change, sea level rise, saltiness of the oceans	Use renewable energy sources, e.g. solar energy, wind energy. Use biofuel & biodiesel.

Car exhaust	CFC emission	Air pollution Acid rain Ozone depletion	Use unleaded petrol. Use biodiesel

The earth naturally goes through warming phases called global warming and cooling phases called ice ages depending on its pattern of obit around the sun. When the earth follows a near - circular pattern of orbit as it currently does, then the earth has a somewhat neutral temperature. When it moves into the elongated (extended/stretched-out) pattern of orbit, then, there will be alternated phases of global warming and ice ages depending on the earth's distance from the sun. However, the type of global warming faced together is induced by anthropogenic activities (human activities) since the dawn of the industrial revolution that has seen an enhanced greenhouse effect.

Suggested Resources

1. Brian Parker, (2008). *Geography for Global Citizens. (3rd edition).* South Yarra (Victoria). Macmillan Education Australia.
2. Colin Sale, (1989). *Our Wonderful World.* Melbourne, Australia. Longman Cheshire Pty Limited.
3. Rob. Berry, (2006). *Thinking Geography.* South Yarra (Victoria). Macmillan Education Australia.
4. Stan Squire, (1988). *Interactions in Physical Geography Today.* Australia. Oxford University Press.
5. Retrieved from:
   i. *Greenhouse effect https://ozcoasts.org.au/indicators/coastal-issues*
   ii. *Greenhouse gases and the enhanced greenhouse effect. https://study.com/academy/lesson*

Benchmark 12.5.2.3: Investigate the effects of enhanced greenhouse effect on different types of environments and on the plants, animals, human beings, organisms, ecosystems, and natural cycles.

Topic 3: Effects of enhanced greenhouse effect on biodiversity

Sub-topics:
- Effects of enhanced greenhouse effect on natural cycles
- Effects of enhanced greenhouse effect on humans
- Effects of enhanced greenhouse effect on plants
- Effects of enhanced greenhouse effect on animals & organisms

Critical thinking skills: Analysing the effects of enhanced greenhouse effect.

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

- Examine the effects of enhanced greenhouse effect

Content Background

The enhanced greenhouse effect is becoming a major global concern because there is an accelerated increase in the amount of heat trapped by greenhouse gases. This is all attributed to human activities such as burning of fossil fuels, particularly coal and oil, and the destruction of vast amounts of vegetation (rainforests) that normally absorb carbon dioxide. The warmer than normal the earth becomes, the more turbulence is created in regard to conditions of extreme temperature and climate for both biotic and abiotic life on earth.

This phenomenon is now becoming a hot topic in the global arena of an extremely warming earth. Many of the world's renowned climate scientists believe that climate change is real and the time to mitigate the impact of climate change is relatively short, and human actions of the past and at present are already affecting some of the earth's natural systems.

The main effect of increased greenhouse gas emissions is global warming. Carbon dioxide, methane, nitrous oxide and fluorinated gases all help trap heat in the earth's atmosphere as a part of the greenhouse effect. The earth's natural greenhouse effect makes life possible. However, human activities, particularly burning of fossil fuels and deforestation have intensified the greenhouse effect, causing global warming.

Effects of global warming
The impact of increased surface temperatures is significant in itself. But global warming will have additional, far-reaching effects on the planet. Warming changes rainfall patterns, increases coastal erosion, prolongs the growing season in some regions, melts ice caps and glaciers, and alters the ranges of some infectious diseases.

1. Changing weather
Global warming will shift major climate patterns, possibly prolonging and intensifying droughts. For most places, global warming will result in more frequent hot days and fewer cool days, with the greatest warming occurring over land. Longer, more intense heat waves will become more common. Storms, floods, and droughts will generally be more severe as precipitation

patterns change. Hurricanes may increase in intensity due to warmer ocean surface temperatures.

Apart from driving temperatures up, global warming is likely to cause bigger, more destructive storms, leading to an overall increase in precipitation. With some exceptions, the tropics will likely receive less rain as the planet warms, while the Polar Regions will receive more precipitation.

2. Rising sea levels
Rising sea levels will erode coasts and cause more frequent coastal flooding. Some island nations will disappear. It is a serious problem because people around the world live places less than 10 meters above sea level. For example; the Carterets in PNG.

3. Impacting ecosystems
More importantly, perhaps, global warming is already putting pressure on ecosystems, the plants and animals that co-exist in a particular climate zone, both on land and in the ocean. Warmer temperatures have already shifted the growing season in many parts of the globe. The growing season in parts of the Northern Hemisphere became two weeks longer in the second half of the 20th century. Spring is coming earlier in both hemispheres.

This change in the growing season affects the broader ecosystem. Migrating animals have to start seeking food sources earlier. The shift in seasons may already be causing the lifecycles of pollinators, like bees, to be out of synch with flowering plants and trees. This mismatch can limit the ability of both pollinators and plants to survive and reproduce, which would reduce food availability throughout the food chain.

Warmer temperatures also extend the growing season of plants. This means that plants need more water to keep growing throughout the season or they will dry out

In some ecosystems, maximum daily temperatures increase beyond the tolerance of indigenous plant or animal. To survive the extreme temperatures, both marine and land-based plants and animals have started to migrate towards the poles. Those species, and in some cases, entire ecosystems, that cannot quickly migrate or adapt, face extinction.

4. Impacting humans
All the effects of enhanced greenhouse effect will finally affect human beings. We are the ultimate recipients of our own activities. The changes to weather and ecosystems will affect people more directly. People living in low-lying coastal areas and those in poorer countries will be facing very serious problems. As tropical temperature zones expand, the reach of some infectious diseases, such as malaria, will change. More intense rains and hurricanes and rising sea levels will lead to more severe flooding and potential loss of property and life.

Hotter summers and more frequent fires will lead to more cases of heat stroke and deaths, and to higher levels of ozone and smoke, which would cause air pollution. Intense droughts can lead to an increase in malnutrition. After some time, fresh water will become scarcer, especially during the summer, as mountain glaciers disappear.

Moreover, there are other effects of greenhouse effect apart from global warming.

They are;

i. ocean acidification,
ii. smog and ozone pollution,
iii. ozone layer depletion
iv. changes to plant growth and nutritional levels.

Increase in carbon dioxide levels has made the oceans more acidic. The ocean serves as a sink for this gas and absorbs human carbon dioxide emissions, which then goes to react with sea water to form carbonic acid. So as the level of carbon dioxide in the atmosphere rises. The acidification of the ocean increases.

Plants need carbon dioxide to grow, so high amounts is good for plants to grow. However, they do not only grow by having carbon dioxide, they also need other nutrients. Therefore, the nutritional quality of plants decreases due to so much carbon dioxide.

The ozone layer of the atmosphere is in between the troposphere (1st layer) and the stratosphere (2nd layer). The ozone filters out the sun's harmful rays from reaching the earth. Recently, the greenhouse gases (nitrous oxide) have created a hole in the ozone layer of the atmosphere known as *'ozone layer depletion'.* This is because these gases are harmful for the ozone layer.

Smog is a kind of air pollution caused by burning large amounts of coal. It is a mixture of smoke and fog which reduces visibility.

Droughts, floods and hailstorms which cause a whole host of concerns for humans are actually climate extremes. Severe wind systems in the form of cyclones, tornadoes and twisters are also climate extremes.

The arrival of pests on food crops and agricultural crops are the result of organisms undergoing genetic mutation.

The developments of new strands of viruses and bacteria that affect and resist the human body are evidence of temperature change affecting organisms.

Temperature regulates all physical processes and cycles. Temperature determines climate extremes, water cycle, various nutrient cycles, weathering process and biochemical processes in living things.

Suggested Resources

1. Brian Parker, (2008). *Geography for Global Citizens. (3rd edition).* South Yarra (Victoria). Macmillan Education Australia.
2. Rob. Berry, (2006). *Thinking Geography.* South Yarra (Victoria). Macmillan Education Australia.
3. Retrieved from:
   i. Enhanced greenhouse effect https://www.science.org.au/curious/earth-environment/

Benchmark 12.5.2.4: Examine the issue of global warming (i.e. its definition, greenhouse gases, causes, and effects on optimum range and sea level rise).

Topic 4: Global warming

Sub-topics:
- Greenhouse gases
- Causes of global warming
- Effects of global warming

Critical thinking skills: Examining, analysing and evaluating the issue of global warming.

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

- Expound on greenhouse gases.
- Identify and analyse the causes of global warming.
- Examine the effects of global warming on optimum range.
- Investigate the effect of global warming on the sea level.

Content Background *(Refer to Benchmarks 12.5.2.2/12/5/2/3)*

The temperature of the earth is the result of a delicate balance between the radiations (energy/heat) received and remitted. In order for the earth to maintain a given temperature, it needs to radiate (release) as much energy back into space as it receives. The warmer the earth is, the more energy it remits. If remittance is hampered by greenhouse gases, which absorb low-frequency emissions, but do not impede (hinder/delay/) high frequency emissions, the earth has to be warmer to nevertheless remit the energy it receives. Global warming is the gradual increase in the overall optimum temperature of the earth's atmosphere. It is caused by the concentration of increased levels of greenhouse gases in particular, carbon dioxide, CFCs and other air pollutants. Major gases that cause the greenhouse effect and their percentage distribution

- Water vapor – about 36-70%.
- Carbon dioxide –about 9-26%e
- Methane – about 4-9%
- Ozone – about 3-7%

Some of the effects of global warming on people and the environment can be identified as:

- Major alterations to the earth's geological, biological and ecological systems.
- Rising sea levels due to thermal expansion and melting of ice sheets, and warming of the ocean surface.
- Changes global rainfall patterns, snow, streamflow, quantity and quality of water supply, warmer water temperature affects water quality and increases rate of water pollution.
- Extreme weather conditions such as droughts, floods, earthquakes, cyclones, avalanches, landslides, tsunami seafloor displacement, heat waves and bushfires.
- Ozone depletion.

- Loss of habitat and biodiversity.
- Stress to food producing systems.
- Global spread of infectious diseases such as dengue, HIV/AIDS, swine flu, TB and malaria.

Effect of global warming on optimum range

The 'optimum range' of temperature is the favourable temperature for the growth or reproduction of living things (plants, animals, organisms) under specific conditions. However, as a result of global warming, plants, animals and organisms that cannot withstand the high temperatures become extinct because they are not able to reproduce or even grow.

Finally, global warming will impact life on earth in many ways, but the degree of the change is largely up to human beings. Scientists have shown that human emissions of greenhouse gases are pushing global temperatures up, and many aspects of climate are responding to the warming. Since people are causing global warming, people can mitigate global warming, if they act in time. Greenhouse gases are long-lived, so the planet will continue to warm and changes will continue to happen far into the future, but the degree to which global warming changes life on earth depends on our decisions now.

Suggested Resources

1. Brian Parker, (2008). *Geography for Global Citizens. (3rd edition).* South Yarra (Victoria). Macmillan Education Australia.
2. Leggett. J. (1990). *Global Warming- The Greenpeace Report.* Texas A&M University. Oxford University Press.
3. Rob. Berry, (2006). *Thinking Geography.* South Yarra (Victoria). Macmillan Education Australia.
4. Timothy Wirth, (1989). *The challenge of global warming.* Amazon. Island Press.
5. Retrieved from:
   i. *Enhanced greenhouse effect https://www.science.org.au/curious/earth-environment/*
   ii. *Global-warming https://www.nrdc.org/stories/*

Benchmark 12.5.2.5: Evaluate the evidence on global warming and draw appropriate conclusions and predictions.

Topic 5: Evidence of global warming

Sub-topics:
- Evidence of global warming
- Conclusions and predictions on global warming

Critical & creative thinking skills: Evaluating the evidences of global warming and drawing conclusions and predictions.

Learning Objectives: By the end of the topic, students will be able to:
- Evaluate the evidence of global warming.
- Draw appropriate conclusions and predictions based on the evidence.

Content Background

Global warming is real and is evident in all parts of the world. The planet's average surface temperature has risen since the late 19th century, a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere.

Below are some evidences showing that global warming is real.
- Rise in sea level
- Changes in rainfall and weather patterns
- Increase in temperature (shown by direct surface temperature measurements)
- Loss of land and sea ice in the Artic (ice melting)

Rising sea levels threaten PNG islanders

About 2000 people on Papua New Guinea's low-lying Carteret Islands could be among the first in the world forced to relocate because of rising sea levels put down to global warming. Salt water already had invaded much of their fresh water sources and destroyed food gardens. Storm surges and high tides aid the sea's invasion.

The islanders have been battling the sea's take over for many years, building sea walls and planting mangroves, but storm surges and high tides continue to wash away houses and food gardens.

Source: Geography for global citizens, page 274.

Some predictions and future consequences of global warming and climate change:
- Sea level will rise by 6 millimeters every 10 years in the next century.
- The Antarctic glacier in particular is in accelerated retreat.
- Greenhouse gas concentrations are likely to triple in a hundred years at the current rate of industrialization.
- By the year 2030 the number of cars in the world would have doubled.

- By the year 2100 the average surface temperature would experience an increase between1°C and 5°C.
- Global warming could adversely affect crop yields due to soil moisture loses.
- Ecosystems such as rainforests, wetlands and coral reefs could be at risk.
- Up to 25 percent of the world's mountain glaciers could disappear by 2050 and up to 50 percent by 2100.
- Quality of clean and fresh drinking water will be affected due to continuous effects of drought, flooding and rising seas.
- Damaging effects to organisms on land and in the oceans could compromise food production and alter the functioning of the ecosystems that provide the life support systems for everything on this planet.

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.
3. G. Tyler Miller. & S. Spoolman, (2017) *Living in the Environment (any edition).* Cengage Learning.

Benchmark 12.5.2.6: Investigate and ascertain the effects of global warming on Papua New Guinea and other countries and people of the world.

Topic 6: Effects of global warming on PNG and the world

Sub-topics:
- Effects of global warming on PNG
- Effects of global warming on the world

Critical thinking skills: Analysing the effects of global warming on PNG and the world.

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

- Investigate and ascertain the effects of global warming on Papua New Guinea and other countries and people of the world.
- Compile a profile of a place in PNG that is affected by global warming.
- Analyze a documentary on effects of global warming.

Content Background

Global warming and climate change is a global problem and Papua New Guinea is in one way or another in the midst of it all. One of the major consequences of global warming is melting of ice and glaciers, and rising sea levels.

Coastal communities and low lying islands and atolls all around the world are at a greater risk of being impacted and affected by rising seas. For example, the Islands of the Carribeans in Central America, the Galapagos on the west coast of South America, the Arctic and Antarctic lands, South East Asia and, the Pacific Islands and Atolls.

The island nations, coral reefs and atolls of the Pacific such as Nauru, Kiribati, Solomon Islands and Papua New Guinea are severely vulnerable. For example, Kiribati has already started mass migration of some of its severely affected communities to countries like Australia, New Zealand, the USA and Canada.

In Papua New Guinea, the Cartaret Islanders from the Autonomous Region of Bougainville, and the Manus Islanders from Manus Province have been living with the impact of global warming for the last four decades or so. Some of the effects of sea level rise on the Manus Islanders are:

- Continuous occurrences of kings tides, storm surges, strong winds and cyclones.
- Flooding and salt water inundation to gardening grounds and fresh water sources.
- Food crops destroyed by salt water.
- Traditional fishing grounds affected.
- Peoples day to day routines and mobility affected by changes in daily weather conditions.
- Children find difficulty in attending school.

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 12.5.2.7: Deconstruct the Paris Declaration on Global Warming and Climate Change to ascertain its purposes, main advocators and adversaries, underlying assumptions, intended outcomes, implementation processes and emission targets, and the arguments for and against the proposed strategies and actions.

Topic 7: The Paris Declaration on global warming and climate change

Sub-topics:

- Paris Declaration on global warming and climate change
- Purpose of the Paris Declaration
- Advocators and adversaries of the Paris Declaration
- Assumptions and intended outcomes of the Paris Declaration
- Implementation processes and target emissions of the Paris Declaration
- Proposed strategies of the Paris Declaration

Creative thinking skills: Examination and critiquing of the Paris Declaration.

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

- Analyse the purpose of the Paris Declaration on global warming and climate change.
- Proposed strategies of the Paris Declaration on global warming and climate change.
- Identify the advocators and adversaries of the Paris Declaration on global warming and climate change.
- Investigate the assumptions and intended outcomes of the Paris Declaration on global warming and climate change.
- Examine the implementation processes and target emissions outlined in the Paris Declaration on global warming and climate change.
- Explore the proposed strategies and actions on targeting global warming on global warming and climate change.

Content Background

What is the 'Paris Agreement?

The Paris Agreement is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC), dealing with greenhouse-gas-emissions mitigation, adaptation, and finance, adopted by every nation of the world in December 2015. The treaty was signed by 195 countries on the 22nd of April, 2016 and became effective in November 2016.

Purpose of the Paris Agreement

The ultimate purpose of the Paris Agreement was to strengthen the global response to climate change by creating an international network of government bodies, all dedicated to lowering emissions.

Unlike the Kyoto Protocol, which sets commitment targets that have legal force, the Paris Agreement with its emphasis on consensus-building allows for voluntary and nationally determined targets which is politically encouraged rather than legally bound. There is no enforcement mechanism or legal infringement procedure or penalties for nations who do not meet compliance standards.

Advocates of the Paris Agreement

Nearly all the countries in the world are signatories to the Paris Agreement. This includes industralised countries like, China, Japan, India, UK, Germany, Egypt, France have agreed to strengthen the global response to climate change by creating an international network of government bodies, all dedicated and pledged to lowering or reducing emissions. However, US has decided to withdraw from the 'Paris Agreement' on Climate Change.

Assumptions and intended outcomes

The Paris Agreement was basically to limit and to keep the global average temperature from increasing to 2°C (below 2°C).

The Paris Agreement also aims to strengthen and support poorer countries' ability to deal with the impacts of climate change.

Proposed Strategies

The Paris Agreement requires that all countries rich or poor, developed and developing do their part and reduce greenhouse gas emissions.

Every nation has volunteered to develop its own 'National Climate Plan" to mitigate its greenhouse gas emissions. Britain is working towards a plan to reduce its emission to net zero by 2050.

One major argument is that the world still isn't meeting its climate goals three years after nearly 200 countries signed a landmark climate agreement in Paris. They are still far off-track from preventing severe global warming in the decades ahead.

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.
3. Retrieved from:
   i. Paris Agreement on Climate Change-2017 https://www.nrdc.org
   ii. Paris Agreement https://en.wikipedia.org/wiki/
   iii. Implementing the Paris Agreement https://www.oecd.org/mcm-2018/documents/C-MIN-2018-12-EN.pdf
   iv. Paris Agreement https://www.britannica.com/topic/Paris-Agreement-2015

Benchmark 12.5.2.8: Analyze Papua New Guinea's frameworks for action on climate and actual actions that are being taken at various levels to minimize the effects of climate change on people, places, and the environment.

Topic 8: Papua New Guinea's strategic plan on climate change

Sub-topics:

- Papua New Guinea's frameworks for action on global warming and climate change
- Plans and policies on climate change

Critical thinking skills: Examining and analysing Papua New Guinea's policies and plans addressing climate change.

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

- Examine the purposes and outcomes of PNG's frameworks, plans and policies for action on climate change.
- Identify and describe actual actions that are being taken at various levels to minimize the effects of climate change on people, places, and the environment.

Content Background

Papua New Guinea has its plans and policies on climate change through the 'Office of Climate Change and Development' (OCCD). This office works closely with a range of stake holders from government, NGOs, development agencies and the private sector entities, local communities and the wider public to address the issue of global warming and climate change. There are plans and policies outline short-term and long-term development goals to mitigate the impacts of global warming.

For instance;

i. National Climate Compatible Development Management Policy

This policy provides a clear demarcation of the roles and responsibilities for coordinating, implementing and reviewing climate change strategies. It also provides an avenue in encouraging greater indigenous participation from the community and ward levels.

ii. Framework for the National Climate Change Strategy and Action Plan

This document sets out a draft Framework for the National Climate Change Strategy and Action Plan to reduce PNG's vulnerability to the impact of climate change while also limiting the country's net emissions of GHGs. The framework is intended to lead to national and other policies which will provide the basis of a coordinated government and stakeholder approach to addressing the challenges of climate change under two broad areas, adaptation and mitigation, and to bridge these with appropriate technologies and finance.

iii. REDD Strategy

The Government of Papua New Guinea (GoPNG) officially launched its National REDD+ Strategy (NRS) 2017-2027 in 2017. REDD stands for Reduction in Deforestation and forest Degradation. The strategy is a key component of PNG's response to climate change and the country's Green Growth

Development agenda as per the National Strategy for Responsible and Sustainable Development.

The NRS aims to strengthen the sustainability of PNG's forest while helping to improve land use planning and management to ensure PNG's forests and environments are protected. This will in turn reduce greenhouse gas emissions and reduce the vulnerability of communities to climate change. Currently, a development of a National REDD+ Finance and Investment Plan is underway for PNG to ensure long-term sustainable financing and management systems are in place to support the implementation of the Strategy.

Moreover, REDD + is focused on conservation of forest as opposed to their deforestation. In this carbon trade, landowners are paid for preserving their trees which in turn continues to absorb and store carbon in them, rather than cutting down trees which leads to the emission of carbon which combines with oxygen to form carbon dioxide. Both the burning and decomposition of living things release carbon that combines with oxygen to form carbon dioxide.

Carbon trade is the opposite economic activity of logging where deforestation occurs and contributes to the buildup of the greenhouse gas (carbon dioxide).

Thus conservation of trees contribute to other ecosystem services such as regulating climate and weather, binding and enriching soils, purifying and recycling water in the environment and providing food and shelter for animals in the ecosystems that they are a part of.

iv. Project: Building Resilience to Climate Change in PNG

The proposed "Building Resilience to Climate Change" (BRCC - the project) is aimed at achieving transformational change in addressing the current and future threats from climate change and related hazards. This will be achieved by mainstreaming climate resilience into development planning and addressing country priorities that focus on vulnerable communities in the provinces of Bougainville, East New Britain, Manus, Milne Bay and Morobe that are in danger in the near future.

There are many other policies, plans and strategies (Vision 2050, pillar #5) put together to combat climate change in PNG. Teachers are required to research and identify more policies and their purposes and outcomes.

Suggested Resources

1. GoPNG and World Bank, (2010). *Climate Change in Papua New Guinea – Framework for the National Climate Change Strategy and Action Plan.* Port Moresby, PNG. *Available online http://documents.worldbank.org/curated/en*
2. Papua New Guinea Office of Climate Change and Development, (2010). *Papua New Guinea's Commitment to Act on Climate Change.* Port Moresby.PNG. *Available online: https://www.unredd.net*
3. Office of Climate Change and Development, (2015). *Policy and Strategy Response Climate Change in Papua New Guinea.* Port Moresby. PNG. *Available online: https://www.thecvf.org/*

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 12.5.3.1: Analyse the significance of biological diversity in an ecosystem.

Topic 1: Biological diversity in an ecosystem

Sub-topics:
- Biological diversity
- Ecosystems

Critical thinking skills: Examining and analysing the importance of biological diversity in an ecosystem.

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

- Examine biological diversity.
- Investigate and explain the types of biological diversity in an ecosystem.
- Highlight and explain the significance of biological diversity in an ecosystem.

Content Background

Biological diversity also known as biodiversity is the variation among living organisms from all sources such as terrestrial, marine and fresh water ecosystems. It is all about the interrelationships and interconnectedness within species, between species, and of ecosystems locally, regionally or globally. There are three major types of biological diversity and they are genetic diversity, species diversity and ecological diversity.

i. Generic diversity
   Generic characteristics in the make of up plants, animals and organisms. It is the variation of genes within the species.

ii. Species diversity
   Species diversity is the number of different species that are represented in a given community

iii. Ecological diversity
   This is the number of species in a community of organisms. Maintaining both types of diversity is fundamental to the functioning of ecosystems and hence to human welfare

Ecologists and environmental scientists use a number of methods to measure biodiversity. The method used depends very much on the number of organisms that are being counted and the type of habitat. Two of the most biologically diverse ecosystems on earth are tropical rainforests and coral reefs.

Biological diversity is very significant or crucial for a number of reasons such as:

- greater species diversity ensures natural sustainability for all life forms. Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play. For example, a larger number of plant species means a greater variety of crops.
- biodiversity is important because it clears out our water, changes our climate, and provides us with food.
- food production relies on biodiversity for a variety of food plants, pollination, pest control, nutrient provision, genetic diversity, and disease prevention and control. Both medicinal plants and manufactured pharmaceuticals rely on biodiversity.
- the importance of biodiversity to human health is one of the most important indicators of sustainable development. Biodiversity is the foundation for human health. By securing the life-sustaining goods and services which biodiversity provides to us, the conservation and sustainable use of biodiversity can provide significant benefits to our health and overall wellbeing.

Suggested Resources

1. Retrieved from:
   i. Biology Discussion: https://www.biologydiscussion.com.
   ii. Global Issues: http://www.globalissues.org
   iii. Environmental Pollution: http://www.environmentalpollution.
   iv. Bioscience: https://www.aboutbioscience.org

Benchmark 12.5.3.2: Investigate how species adapt to limiting factors in an ecosystem.

Topic 2: Limiting factors to species adaptation in an ecosystem

Sub-topics:
- Species adaptation in an ecosystem
- Limiting factors in an ecosystem

Critical thinking skills: Investigating and examining species adaptation.

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

- Explain species adaptation in an ecosystem.
- Identify and explain the limiting factors in an ecosystem.

Content Background

All living things have to adapt to the environment they live. If they cannot adapt to that particular environment, then, they become extinct. Adaptation is a change (physical or behavioural) that helps an organism (plants & animals) to survive in its environment. Adaptations are a result of an evolution.
Refer to the preceding topics for the different types of adaptions.

A limiting factor is an abiotic environmental condition or lack of a particular resource which limits the growth, distribution, and abundance of an organism or population within an ecosystem. A limiting factor is also known as an organism's tolerance range within its abiotic environmental domain. Those are factors that an organism can become susceptible to in order for it to live and continue its existence. There can be many different limiting factors at work all at the same time in a single habitat.

The major limiting factors are resources like food, water, light, space, shelter and access to mates. Other abiotic factors that can also play a major role in affecting the existence of organisms are:

- temperature
- altitude
- oxygen level
- parasites
- disease
- humidity
- soil chemistry
- pH
- salinity
- cycle of nutrients or minerals and /or waste
- severe climate and weather changes
- predator-prey relationships
- commercial development
- environmental pollution and more.

All these factors can critically change animal and plant populations in an ecosystem within the environment.

Plants and animals have adapted in various ways to overcome these limiting factors. The adaptation features have developed over successive generations. That is why; some plants and animals live in very extreme environments such as; very hot, very cold, very wet, very dry and very high altitudes with low oxygen levels. They adapt through their root systems, leaf features, shape of the leaves and trees, ability to remain green or deciduous, increased or reduced metabolism rates and the ability of plants to lie dormant for animals to hibernate. They have developed features to maintain a suitable body temperature, moisture and energy level.

Suggested Resources

1. Retrieved from:
   i. https://www.merriam.webster.com
   ii. www.imthird.org
   iii. https://biologydictionary.net
   iv. https://nhpbs.org
   v. https://www.nature.com
   vi. https://en.m.wikipedia.org
   vii. https://sciencing.com
   viii. https://www.nationalgeographic.org
   ix. https://www.khanacademy.org
   x. www.life.illinois.edu
   xi. https://www.ck12.org

Benchmark 12.5.3.3: Analyse the differences between natural causes and human causes of extinction.

Topic 3: Causes of extinction of plant and animal species

Sub-topics:
- Natural causes of extinction
- Human causes of extinction

Critical thinking skills: Examining and analysing the causes of extinction of plants and animals.

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

- Identify and explain natural causes of extinction.
- Identify and describe the human causes of extinction.
- Explain the difference between natural and human causes of extinction.

Content Background

Extinction simply means the state of being or becoming extinct, and when there is no more of that particular species alive anywhere in the world. It is a state of the disappearance of a species or a population on the face of the earth. An organism is at risk of extinction when they become threatened or endangered. An endangered species is one that is in danger of extinction and, a threatened species is one that is at risk of becoming endangered in the near future.

Extinction may occur naturally due to changes in weather and climatic variations or it may also occur due to human activities. Natural extinction is an evolutionary process and it usually occurs slowly by natural selection. Human activities on the other hand, may lead to extinction occurring at a much faster rate than usual. About 25 percent of all mammals and 13 per cent of birds are now threatened with extinction due to increasing human activities.
Some examples of human activities that cause extinction:

- deforestation (habitat destruction)
- an introduced and invasive species
- pollution (air, water, sea,)
- explosive and unsustainable human population growth
- overconsumption and over-harvesting of resources

The world is going through an extinction crisis. There are thousands of plants and animals that are in decline and may be in danger of extinction.
Natural causes of extinction
- natural fires
- floods
- volcanoes

Suggested Resources

1. *Retrieved from:*
   i. *https://www.thoughtco.com*
   ii. *https://en.m.wikipedia.org*
   iii. *https://www.amnh.org*
   iv. *https://www.factmonster.com*
   v. *https://people.uwec.edu*
   vi. *https://m.huffpost.com*
   vii. *https://www.scholastic.com*

Benchmark 12.5.3.4: Research wildlife management laws and their effect on biodiversity.

Topic 4: Wildlife management laws

Sub-topics:
- Wildlife management laws in PNG
- Global wildlife management laws
- Biodiversity practices of wildlife management laws
- Impacts of wildlife management laws on biodiversity

Critical thinking skills: Researching on the wild life management laws and analysing the impact on biodiversity.

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

- Explore and identify wildlife management laws in PNG.
- Evaluate the practices of the Wildlife Management Laws in PNG.
- Identify and analyse global Wildlife Management Laws.
- Assess the effectiveness of the application of these laws across the globe.

Content Background

Wildlife management is about maintaining populations of wild animals at levels consistent with the best interest of wildlife and the public. Wildlife management laws are legislated policies or Acts of Parliament that provides a framework of rules and regulations on the sustainable use, consumption and management of animals in the wild. Every country in the world have either provisions in their constitutions or legislated amendments for the management, care and nurturing of wildlife.

For example, in the United States, wildlife management practices are usually implemented by a government agency to uphold a law such as the Wildlife and Coutryside Act/1981.

In Papua New Guinea, the government at independence, made provisions in the constitution to protect some of our unique animal species such as the Bird of Paradise, in the Conservation Areas Act/1980/1992, the Fauna Act/1982, the Crocodile Trade Act/1982, and the International Trade Act/1982. The government agency responsible for that is the Conservation and Environment Protection Authority which was formerly the Department of Environment and Conservation.

Effects of wildlife management laws
- Protects wildlife
- Minimises over-use of wildlife
- Monitors exploitation
- Slows down extinction of endangered species
- Encourages conservation and sustainability

Suggested Resources

1. Retrieved from:
   i. *https://en.m.wikipedia.org*
   ii. *www.faolex.fao.org*
   iii. *www.fao.org*
   iv. *www.cic-wildlife.org*
   v. *https://www.legal.atlas.com*

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 12.5.4.1: Examine the reciprocal relationships between earth's processes (natural disasters) and human activities.

Topic 1: Impact of human activities on natural processes

Sub-topics:
- Earth's natural processes
- Human activities

Critical thinking skills: Analysing the impact of human activities on natural processes.

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

- Identify and explain earth's natural processes such as natural disasters.
- Identify and describe human activities that disrupt the earth's natural processes.
- Describe how the earth's natural processes respond to human activities and impact people's livelihoods.

Content Background

Earth's natural processes are processes existing in or produced by nature. They can be internal processes that occur within the earth's crust or external processes that occur on the earth's surface. Examples of internal processes are tectonic plate movement, volcanism, and diastrophism (faulting & folding). Some examples of external processes are weathering and denudational processes, geomorphic processes such as fluvial, aeolian, glaciation, oceanography and climatic forces.

They occur both on the land and in the ocean and are affected by constructive forces or destructive forces. Constructive forces build up the surface of the earth by the formation of new landform features, and destructive forces break down and wear away the surface of the earth.

Some of earth's processes are referred to as natural hazards and disasters. A volcano, earthquake, and tsunami are known as geological hazards. A flood, cyclone, tornado, wildfire, landslide, hurricane, avalanche, storm surge, drought and thunderstorms are examples of meteorological hazards. These are natural phenomenon that are prone to occur in nature and are part of natural systems and cycles. A hazard becomes a disaster when human populations are in the way, and when lives and property are damaged and destroyed. It is then referred to as a catastrophe because it brings death and destruction.

Natural disasters are caused by events such as soil erosion, seismic activities, tectonic movements, air pressure, and ocean currents.

It is now evident that the activities of human beings increase the likelihood and intensity of natural disasters. With an ever increasing issue of global population growth and the need for higher and greater consumption of natural resources, and the complexities of the processes of industrialisation and urbanisation, and globalisation, humans undoubtedly have a major impact on the accelerated occurrences of natural disasters which are more commonly becoming catastrophic events on a global scale.

As humans rapidly change the natural environment, the natural processes are affected and in turn affect humans in the forms of natural disasters and hazards.

Teachers may research and teach all the natural processes and how they are being disturbed by human activities and of course how natural disasters affect humans.

Suggested Resources

1. Retrieved from:
   i. https://www.explorenaturalcommunities.org
   ii. www.edu.pe.ca
   iii. https://brainly.com
   iv. https://www.eea.europa.eu
   v. https://www.anderson5.net
   vi. https://beyondpenguins.ehe.osu.edu
   vii. https://www.yourdictionary.com

Benchmark 12.5.4.2: Appraise the impact of plantation economy on various environments.

Topic 2: Impact of plantation economy on various environments

Sub-topic:
- Impact of plantation economy on various environments

Critical thinking skills: Assessing the impact of plantation economy on environments.

Learning Objectives: By the end of the topic, students will be able to:
- Identify and explain the impact of plantation economy on various environments.
- Assess the impact of plantation economy on various environments.

Content Background

Plantation economy or plantation agriculture is a type of commercial farming where large areas of forest lands are cleared for growing a single cash crop in large estates or plantations for profit purposes. It is a form of monoculture and it is both labour intensive and capital intensive.

The most conducive environments for this type of farming activity are tropical lands with a tropical climate of high annual rainfalls and temperatures. The farmer specialises on one particular type of crop and is highly specialised.

It is common in many parts of Asia, Africa, sub-tropical zones of America and even in Pacific Island countries such as Papua New Guinea. For example, oil palm production in West New Britain and Sugar production in Ramu, Madang Province.

Plantation agriculture can have both positive and negative impacts on people and the environment. Some environmental impacts of plantation agriculture are:
- Large areas of forest land cleared for plantations which eventually leads to deforestation.
- Soil erosion, soil fertility decline, and carbon sequestration.
- Water pollution and chemical contamination into waterways and river systems, particularly oil palm production that result in eutrophication.
- Dislocation of local people and create land shortage and land tenure problems among them.
- Weaken local food security by export crop specialisation.
- Reduce biodiversity, habitat degradation and loss of animal habitat.
- Cause general destabilization or disturbance of the socio-economic system including land and the natural environment.

Suggested Resources

1. Retrieved from:
   i. https://journals.sagepub.com
   ii. https://www.fix.com
   iii. https://brainly.in
   iv. https://en.m.wikipedia.org
   v. https://www.epa.gov
   vi. https://www.researchgate.net
   vii. https://oxforde.com

Benchmark 12.5.4.3: Evaluate the roles and responsibilities of various national agencies and non-governmental organisations in Papua New Guinea that advocate for and act in various ways to protect and ensure environment and natural resources sustainability.

Topic 3: Environmental protection and resource sustainability in PNG

Sub-topics:

- Roles and responsibilities of national agencies in protecting the environment and ensuring natural resources sustainability in PNG.
- Roles and responsibilities of non-governmental organisations (NGOs) in protecting the environment and ensuring natural resources sustainability in PNG.
- Strategies used in protecting the environment and sustaining natural re sources in PNG.
- Advocacy in environment and natural resources protection and sustain ability.

Critical thinking skills: Assessment of the roles and responsibilities of national agencies and non-government organisations in protecting the environment and ensuring sustainability of our natural resources in PNG.

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

- Identify PNG national agencies and analyse their roles and responsibilities in protecting the environment and ensuring sustainability in our natural resources.
- Identify non-governmental organisations (NGOs) and examine their roles and responsibilities in protecting the environment and ensuring sustainability of our natural resources.
- Identify the strategies and mechanisms used in advocating for the protection of the environment and sustaining natural resources.
- Assess the effectiveness of the strategies used in protecting the environment and ensuring sustainability in our natural resources.

Content Background

Papua New Guinea is a unique land which holds about 5% of the world's biodiversity in only about 1% of the world's total land area. One of the government's development goals is to maintain sustainability in all facets of its development agenda with regards to the effects of climate change. This includes advocacy in conservation and wildlife management which focuses on creating awareness and educating people in the knowledge that resources are finite and there is a need for careful management and sustainable use of biodiversity. The government department responsible for that is the Conservation and Environment Protection Authority (CEPA), which was formerly the Department of Environment and Conservation (DEC) until 2014.

Roles of Conservation and Environment Protection Authority (CEPA):
CEPA's aim is to ensure natural and physical resources are managed to sustain environmental quality and human well-being.

Listed here are a few roles and responsibilities of Papua New Guinea Conservation and Environment Protection Authority.

- Environment management policy development
- Biodiversity protection policy development
- Pollution control and the regulation of hazardous substances
- Management of water resources
- Environmental Impact assessments of major projects including infrastructure, forestry, agriculture, mining and petroleum proposals;
- Biodiversity assessment and data management
- Hydrological investigation, data collection and analysis
- Coordination of donor funded programs
- Education and awareness

The PNG government recognised the relationship between the people and nature and at independence, provision was made in the constitution for "…all necessary steps to be taken to give adequate protection to all our valued birds, animals, fish, insects, plants and trees."

Currently biodiversity is explicitly protected by the following legislation:

- Fauna Act/1982
- Conservation areas Act/1980, 1992
- Crocodile Trade Act/1982
- International Trade Act/1982

The PNG government's effort to conserve biodiversity is supported by Non-governmental organisations such as:

- Conservation International (CI)
- Wildlife Conservation Society (WCS)
- World Wildlife Fund (WWF)
- Binatang Research Centre (BRC)
- The Nature Conservancy (TNC)
- Research and Conservation Foundation of PNG (RCF)
- Tenkile Conservation Alliance (TCA)
- PNG Institute of Biological Research (PNGIBR) and many others.
  Adapted from: https://en.m.wikipedia.org

This topic needs a lot of research. Therefore, teachers are advised to allow students to research and find out the national agencies and non-government organisations' roles and responsibilities in protecting and sustaining our natural resources. And also, identify the government policies on environmental protection and resources sustainability.

Suggested Resources

1. Retrieved from:
   i. https://en.m.wikipedia.org
   ii. www.pngembassy.org
   iii. www.fiapng.com
   iv. www.pg.undp.org
   v. https://www.cbd.int

vi. www.devpolicy.org
vii. https://forestlegality.org
viii. https://png.wcs.org
ix. www.fao.org
x. https://eeas.europa.eu

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 plans, 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 12.5.1.1: Compare the different biomass.

Topic 1: Biomass

Lesson Topic: Sources and uses of different biomass

Grade: 12

Length of lesson: 40 minutes

Essential knowledge, skills, values and attitude

Knowledge:

- Sources of different biomasses
- Uses of different biomasses

Skill(s): Critical thinking skills of analyzing the sources of different biomasses.

Values: Respect for the natural environment as sources of fuel and energy.

Attitudes: Being respectful and responsible in caring for the environment.

Performance indicator: Describe the sources and uses of different biomasses.

Materials:

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

- List the sources of different biomass.
- Explain the uses of different biomasses.

Essential Questions:

- What are the different biomasses and where do they come from?
- How are biomasses useful to humans?

Lesson Procedure

Teacher Activities	Student Activities
Introduction (time in minutes)	
Engage students at the start of the lesson by displaying or showing samples of biofuels (saw dust, chicken manure, waste from agricultural activities etc.) and ask questions in line with the topic of the lesson. Questions i. Are these items useful? ii. How can these items be used? iii. Where did each of these items come from? State the topic and write it on the board and relate the answers to the topic and write the meaning and importance of biomass.	Observe carefully Listen and answer the questions orally Listen, observe and write the topic, meaning and importance of biomass.
Body (time in minutes)	
Modeling	
Select one of the biomass displayed and ask students to identify its source and its usefulness to humans. Supervise discussions	Observe, listen and answer question orally in pairs and report in class.
Guided Practice	
Ask students to get into groups of 5. Tell them to choose one of the biomass displayed. Ask students to identify the source and explain its usefulness to humans. Supervise to clarify misunderstandings.	Form groups made up of 5 students. Select a biomass. Work in their groups to identify the source and explain its usefulness to humans. Report findings to the class.
Independent Practice	
Distribute handouts/readings on biomass. Ask students to complete individual activity; Give instructions; a. Draw a table of 3 columns labeled; i. Biomass ii. Source of biomass iii. Uses of biomass b. Read the handouts/readings provided to identify different biomass and their source to complete the table. Assist where necessary.	Listen carefully to instructions. Read the handouts/readings. Complete the table.
Conclusion (time in minutes)	
Ask students to write 2 very new things they have learnt in this lesson. Ask students to give what they have written to another student to read it aloud to the class.	Write two new things learnt in the lesson. Read what their friends have written.

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:

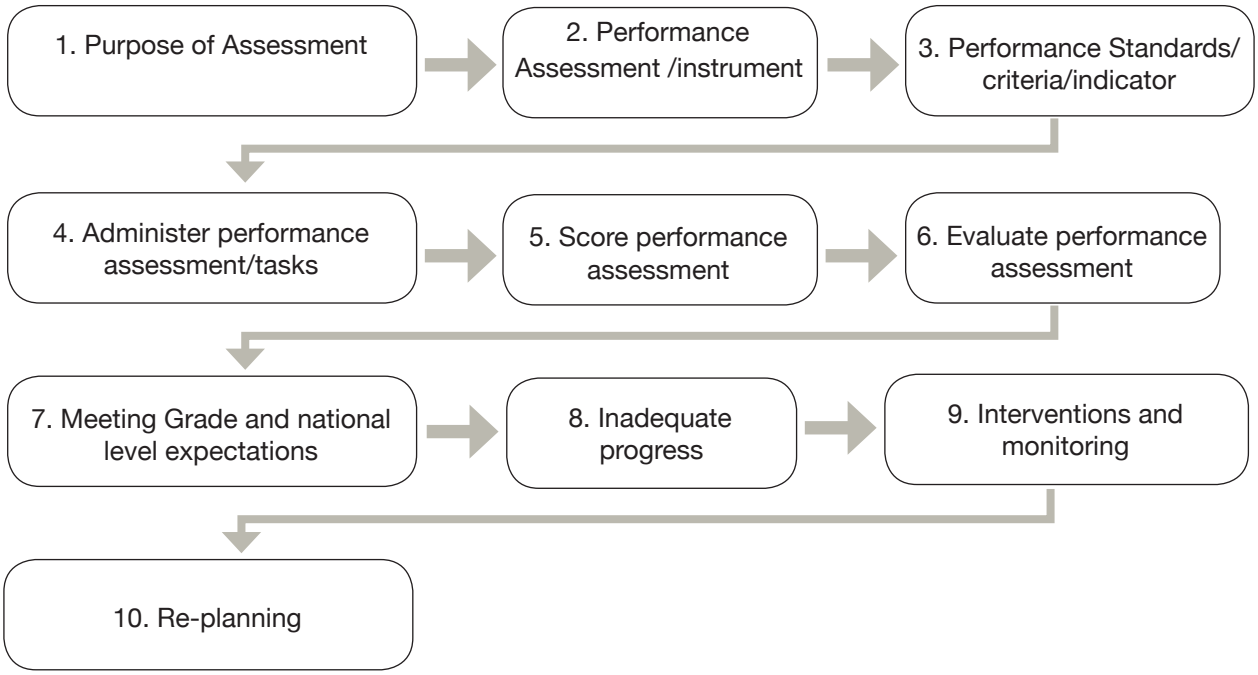
- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations
- provide the basis (performance indicators) for evaluating, reporting and
- monitoring students' level of proficiency in use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

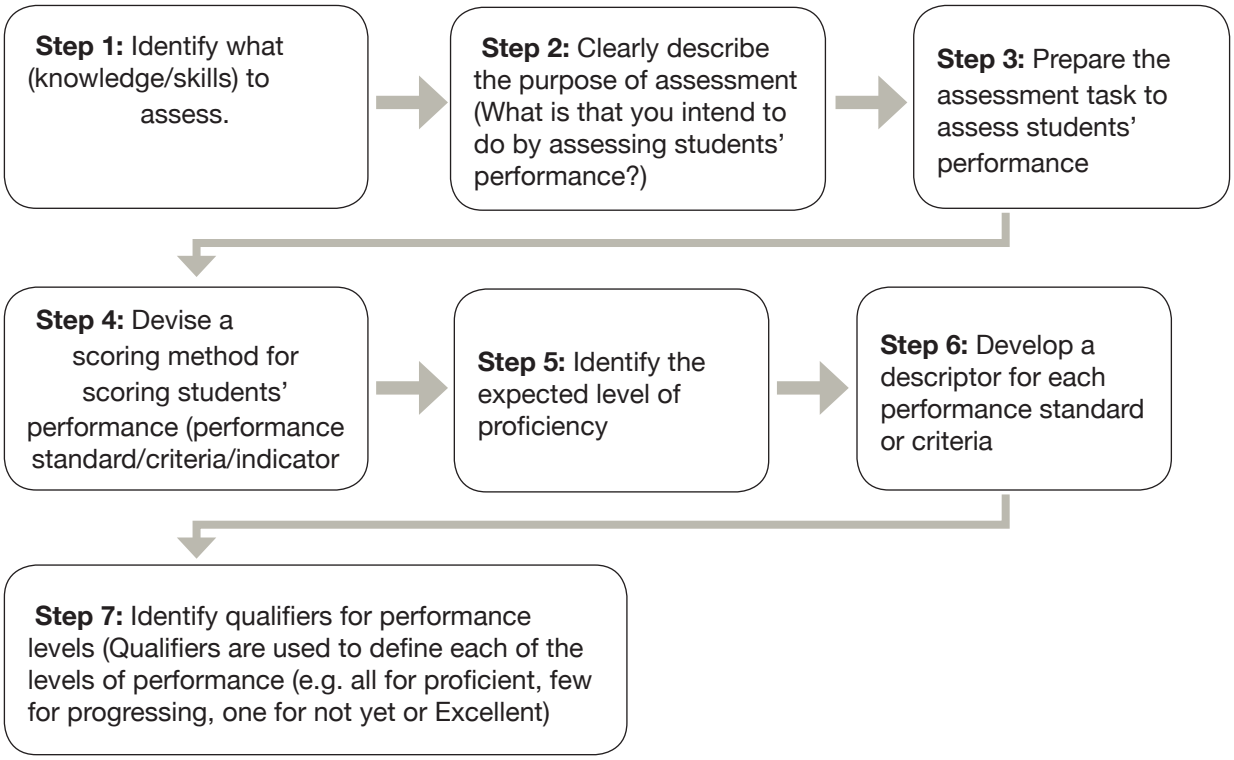
Rubrics use a set of specific criteria to evaluate student performance. They may be used to assess individuals or groups and, as with rating scales, may be compared over time.

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

All these samples are based on one topic;

Unit 1: Resources and Environment

Content Standard 12.5.1: Students will be able to examine and make sense of different resources and different environments.

Benchmark 12.5.1.1: Compare the different biomass.

Topic 1: Biomass

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. It is assessing only one Learning Objective. Assessment should always link to the Learning Objectives.

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: Compare the different biomass.

Topic 1: Biomass

Lesson Topic: Sources and uses of different biomasses

What is to be assessed?

- Sources and uses of different biomass

Performance Task

Describe the sources and uses of different

Purpose of this assessment

To help the teacher to see if students are able to use the analytical skills in identifying the sources of different biomasses

Assessment Strategy

Students will write a short quiz on sources of different biomasses.

Sample Quiz

Grade 12 Environment

Quiz #1: Sources of different biomasses

Name: **Class:** **Date:**

Question

List 5 different biomasses and describe their sources.

Biomass	Description of the source

Scoring Rubric

Checklist
Date: 3rd April, 2020
Code

✓ **Yes**
✗ **No**

Student Name	Performance Indicators	
	Identify the sources of different biomasses	Describe the uses of different biomasses
Ezron John	✓	✓
Willie Kupo	✓	✗
Alphie Kera	✓	✓

Summative Assessment

This assessment is conducted at the end of the topic, which means that it assesses the benchmark.

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: Compare the different biomass.

Topic 1: Biomass

Purpose of this assessment
The purpose of this assessment is to measure student's achievement of the benchmark, i.e. if students have used analytical skills to identify different biomasses and their sources and explain what each biomass is used for and how it is used, the advantages and disadvantages and the similarities and differences in each of the biomass. Also to find out if the students can work independently and have confidence in their abilities and evaluate the effectiveness of their research.

Expected level of proficiency
- Identify different biomasses and describe the sources and uses of each one of them
- Discover and explain the advantages and disadvantages of different biomasses.
- Identify and explain the differences and similarities between different biomasses.

Performance Task
Create a booklet on biomasses. This will include;
- Gather information (research) on the sources, uses, advantages and disadvantages of each of the biomasses and similarities and differences between them.
- Analyse and interpret the data collected from their research.
- Presentation of the data in a booklet

Assessment Strategy
Project to assess the quality of end product

Assessment Scoring

Rubric					
Date: 20th April, 2020					
Performance Standard/ criteria	**Proficiency Levels →**				**Score**
	Beginning (1)	**Developing (2)**	**Accomplishing (3)**	**Exemplary (4)**	
Identify different biomasses and describe the sources and uses of each one of them	Identify the different biomasses	Identify different biomasses and describe few sources	Identify different biomasses and describe few sources and uses	Identify different biomasses and describe the sources and uses of each one of them	
Explain the advantages and disadvantages of different biomasses.	Explain the advantages and disadvantages of one biomass.	Explain the advantages and disadvantages of different biomasses.	List and explain the advantages and disadvantages of few biomasses.	List and explain the advantages and disadvantages of different biomasses.	
Identify and explain the differences and similarities between different biomasses.	Identify similarities or differences between different biomasses.	Identify similarities and differences between different biomasses.	Identify and explain few differences and similarities between different biomasses.	Identify and explain all the differences and similarities between different biomasses.	

Authentic Assessment

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 attitudes in real life situations which promote and support the development of deeper levels of understanding.

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: Compare the different biomass.

Topic 1: Biomass

Purpose of this assessment
The purpose of this assessment is to measure student's achievement of the benchmark, i.e. if students can use their creative thinking skills to create something useful by applying what has been learnt in theory. This assessment will promote teamwork and effective communication among the students. It will build interest and confidence in individual students.

Performance Task
Wood is a fuel and very common and has been used for thousands of years. Wood fuel can be used for cooking and heating. Create a simple potable wood stove. (Teachers may also prepare the assessment on other forms of biomass). Wood stove is just an example.

- Research and collect information on wooden stoves.
- Analyse the information gathered.
- Design the wooden stove.
- Collect the materials needed.
- Create a simple wooden stove.

Assessment Strategy
It is a performance task (project) where students will create and present works on real life.

Instructions

- Form groups of 5 students
- Distribute tasks between the group members
- Apply research skills to research well and collect adequate information
- Have all the materials needed before building the stove
- Take not of all the materials used, the steps outlined clearly, the parts of the stove and how to use. This should be written separately in a booklet as a manual for the stove.

Expected Level of Proficiency

- Use research skills to gather and analyse information related to the topic
- Use effective communication and leadership skills and display teamwork (collaboration) to execute task by all members of the group

- Create a manual for the wooden stove
- Create a complete wood stove

Assessment Scoring

Rubric					
Date: 25th April, 2020					
Performance Standard/ criteria	**Proficiency Levels** ⟶				**Score**
	Exceptional Performance (100% +)	**Fully competent Performance (70%– 100%)**	**Satisfactory Performance (30%- 69%))**	**Unsatisfactory Performance (0 %-29%)**	
Use research skills to collect and analyse information related to the topic	Very outstanding performance in using research skills to gather and analyse vital information related to the topic	Research done well and gathered information needed	Collected a few information through research	No evidence of research work	
Use effective communication and leadership skills and display teamwork (collaboration) to execute task by all members of the group	All group members demonstrate outstanding communication and leadership skills in planning and designing the wood stove. The group discussed and worked together and learnt from each other	Group members demonstrate communication and leadership skills in planning and designing the wood stove. The group worked together and helped each other to complete tasks	Group members worked together in planning and designing the wood stove.	A few group members completed tasks because there was no proper distribution and coordination	
Create a manual for the wooden stove	A well organised manual in the form of a booklet; cover page, table of contents, correct explanations of the importance, procedures, parts and how to use the wood stove and illustrations with proper referencing.	A completed manual in the form of a booklet; cover page, table of contents, explanations of the importance, procedures, parts and how to use the wood stove and illustrations with proper referencing.	A manual in the form of a booklet, however, some information missing and also there is evidence of incorrect referencing.	Manual was not organised in a booklet form. Much information not included and no referencing	
Create a complete woodstove	An extra ordinary woodstove with all the parts in place and ready to be used submitted prior to the actual due date	A complete woodstove with all the parts in place and ready to be used	A woodstove with few parts missing	A half-completed woodstove	

Glossary

Terms	Definitions
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.
Evaluation	Assessment information used to assess the effectiveness of teaching and learning and to make improvements to teaching practices in order to improve students learning.
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	