Geology

Senior High

Grades 11 and 12

Syllabus

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
IHD	Integral Human Development
NDoE	National Department of Education
OBC	Outcome-Base Curriculum
OBE	Outcome-Base Education
PNG	Papua New Guinea
SAC	Syllabus Advisory Committee
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Art, and Mathematics
UNCRC	United Nations Convention on the Rights of the Child

Secretary's Message

The ultimate aim of Standards-Based Education (SBE) in Papua New Guinea (PNG) is to prepare children for careers, higher education, and citizenship. This means that education should focus on developing and equipping students with essential career, higher education, and citizenship readiness knowledge, skills, values, and attitudes that they can use to work, study, and live in the complex, competitive, technology driven, and knowledge-based economy and society of the 21st Century. Rigorous and comparable learning standards have been set at the national and grade-levels to enable all students to acquire essential career, higher education, and citizenship proficiencies before leaving school at the end of grade 12.

Education must also aim to motivate and prepare students to pursue Science, Technology, Engineering, Arts, and Mathematics (STEAM) courses in higher education and pursue careers in STEAM related fields. Essential STEAM principles, concepts, processes, and skills have been embedded in the national content standards and grade-level benchmarks to enable all students to learn and use these to solve problems created by both the natural and physical environments by developing creative and innovative solutions.

The realigned Science curriculum is focused on scientific skills and process, utilizing the analytical and inquiry based approaches where students will be encouraged to predict, explore, question, test ideas, formulate questions and challenge their own ideas and overtime become scientifically literate. Scientific literacy is critically important for Papua New Guinea to participate productively in an increasingly competitive knowledge and technologically based society. By the end of grade 12, all students will acquire the essential Scientific proficiencies and develop the ability to be creative, innovative, productive, and competitive in diverse knowledge and technology-based contexts.

Teachers are encouraged to use the syllabus, in conjunction with the teacher guides and other relevant resources, to teach the Geology content and enable all students to progressively learn and master the essential scientific knowledge, skills, values, and attitudes.

I approve and commend this Grades 11 and 12 Geology syllabus to be used by teachers in all Senior High Schools throughout Papua New Guinea.

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UKE W. KOMBRA, PhD
Secretary for Education

Introduction

The 21st Century is a time of rapid change. New knowledge, tools, and ways of doing and communicating Science continue to emerge and evolve, and impact on our lives in many different ways.

Papua New Guinea needs to be on par with the rest of the world. The need to understand and use geology in everyday life, in schools, and in the workplace has never been greater. Geological knowledge, skills, values, and attitudes are needed in a variety of careers, including STEAM related careers, in the 21st Century. The 21st Century job market is very competitive. Those who do not possess the in-demand proficiencies will find it difficult to get any sort of employment or create and sustain their own career pathways. Thus, it is important that students are encouraged, motivated, and enabled to develop a mathematical attitude of the mind to enjoy learning geology and, simultaneously, achieve high academic standards and attain the required career, higher education, and citizenship proficiencies before leaving school.

In this Century and beyond, those who understand and can-do geology will have more opportunities and options to create and sustain a future of their choice. Scientific competence increases career choices and opens doors to productive and rewarding futures. All students should be provided the opportunity and necessary support to learn geology and achieve the expected geology standards and proficiencies before leaving school.

Grades 11 and 12 Geology learning standards are comparable to regional and global geology standards. This syllabus and the teacher guide will provide the bases for all students to progressively learn and master the essential scientific knowledge, skills, values, and attitudes to effectively prepare them for careers, higher education, and citizenship in the 21st Century and beyond.

Time allocation for Grades 11 and 12 Geology is 240 minutes per week.

Teacher can use the time allocated to do their time table or program according to their school needs.

Aims and Goals

The ultimate aim of education in PNG is to prepare students for careers, higher education, and citizenship. To achieve this aim, a number of enabling aims and goals were formulated based on evidence. The ultimate aim and the enabling aims and goals are closely linked. The enabling or operational aims and goals are described below.

Aims and Goals of Standards-Based Education and Curriculum

Curriculum aims and goals articulate the outcomes that will be achieved in the long-term and the medium-to-long term. They embed the development and educational aspirations of PNG and its citizens. These have been influenced by evidence from the analysis of context and research on teaching and learning, and on social, economic, political, technological, and cultural developments. There is a close link between the aims and goals of the curriculum. This is important for ensuring that the chain of learning results is clear.

Aim 1: Students will acquire essential and relevant knowledge, skills, values, and attitudes that will prepare them for careers, higher education, and citizenship.

Goals

Students will be able to;

(a) obtain prerequisite knowledge and skills and cultivate and foster important values and attitudes required to effectively function in a higher education and training environment.
(b) achieve high language, mathematics, science, social science, moral, values, and ethical, creative and vocational skills, and citizenship standards that will ensure a smooth transition from secondary school to higher education and training institutions.
(c) acquire and use intellectual, emotional, cultural, physical, creative, vocational, recreational, and spiritual knowledge, skills, values, and attitudes as bases for living fulfilling, purposeful, and productive lives in communities in which they choose to live.

Aim 2: Students will achieve high standards in Language, Mathematics, Science and Technology, Social Science, Civic and Citizenship Education, Character and Social Development, and Skills Education (Creative, Physical, and Vocational skills).

Goals

Students will be able to;

(a) acquire and use intellectual, emotional, cultural, physical, creative, vocational, recreational, and spiritual knowledge, skills, values, and attitudes as a basis for living a fulfilling and a productive life in the communities in which they choose to live.
(b) understand and apply mathematical reasoning, processes, formulas, and concepts to solve mathematical problems.
(c) examine and apply scientific reasoning, processes, and concepts to improve real life situations.
(d) aware of scientific standards and methods and their application across all branches of science.
(e) aware of logical and abstract thinking in the formulation of problems, the importance of mathematics in science reasoning, and recognize the role of science in every aspect of life.
(f) explain the connection between science and technology and recognize the importance of technology in the development of communities, the improvement of peoples' lives, in communication, and industry.
(g) acquire fundamental knowledge and skills to build and market different types of technology.
(h) communicate orally and in writing, use different approaches and modes of communication, identify different purposes of communication, and understand and appreciate PNG's languages and the languages of people from different cultures.
(i) aware of their civic and citizenship responsibilities, the importance of these responsibilities to harmonious living and maintaining social cohesion, and to community and national development and well-being.
(j) acquire knowledge, skills, values and attitudes required for learning and practice of creative arts, and the application of knowledge and skills to express themselves, promote PNG's cultures, and make a living.
(k) recongnise the importance of healthy mind, body, and spirit, the importance of physical exercise and sport, balanced diet, and regular exercise in living a healthy life style.
(l) recognise the importance of healthy mind, body, and spirit, the importance of physical exercise and sport, balanced diet, and regular exercise in living a healthy life style.
(m) attain essential agriculture knowledge, skills, values, and attitudes required for making a living in agriculture related contexts, starting and managing agriculture businesses for personal and family sustainability, and pursing agriculture-oriented livelihoods.

Aim 3: Students will attain both regional and internationally comparable standards in literacy and numeracy

Goals

Students will be able to;

(a) acquire essential reading skills to enable them to learn to read and read to learn throughout their lives.
(b) learn basic skills of writing, comprehending and evaluating information, following instructions, analysing others writing, and communicating with others.
(c) learn and apply basic mathematic skills in real life situations to improve their own personal growth and the advancement of their communities and the nation.

Aim 4: Students will develop their full potential and empowered to be dynamically involved in the process of freeing themselves from oppressive situations, contribute to promoting the common good and welfare of society, and develop a sense of responsibility for oneself and others.

Goals

Students will be able to;

(a) recognize and critically analyse the situations that oppress and marginalize them and others, and take appropriate individual and collective actions to transform these situations in order to improve their wellbeing.
(b) develop a positive attitude towards community service and responsibility for the well-being of the community while being responsible for their personal behaviour and conduct and hold others to account for their behaviour and attitudes in the interest of public good.
(c) develop effective communication and social skills, and think critically and rationally when solving problems and making decisions at different stages of their personal development.
(d) interpret language and cultural expressions attributed to oppressed and marginalized groups by dominant and powerful groups and challenge these in order to improve their situations.

Aim 5: Students will contribute towards the development of knowledge-based economy and society, and the transformation of Papua New Guinea from a developing to a middle income country by continuously learning and applying knowledge, skills, values, and attitudes to improve the prevailing social, economic, political, cultural, scientific, and technological conditions.

Goals

Students will be able to;

(a) value creativity and innovation; the spirit of autonomy and independence; and foster an attitude to knowledge creation and application to improve working and development conditions.
(b) obtain relevant knowledge, skills, values, and attitudes that will enable them to be multi-skilled, lifelong learners, and knowledge-based workers capable of functioning in a changing world and work environment.

Aim 6: Students will continue to learn throughout their lives and apply the outcomes of learning to improve their personal and collective learning, growth and development, and the quality of life for oneself and others.

Goals

Students will be able to;

(a) think sensibly for themselves and to develop as individual members of a community.
(b) develop and foster an attitude towards continuous learning as a basis for improving one's own knowledge, thinking, practice, value and belief system and hence improve life outcomes.
(c) cultivate a positive attitude towards research, reflection, and critical analysis as bases for lifelong learning.

Aim 7: Students will acquire essential knowledge, skills, values, and attitudes necessary for the building of peaceful and safe communities, living together, upholding the principles of a democratic state and society, building social cohesion, promoting equity and social justice, and ensuring economic prosperity for all.

Goals

Students will be able to;

(a) value justice, responsibility, equality between men and women, mutual respect and cooperation, and actively contribute to the building and fostering of peaceful, safe, and inclusive communities.
(b) use effective communication skills and think creatively in a rational manner and develop better problem solving and decision making skills at appropriate levels and ages.

Aim 8: Students will foster an understanding and an appreciation of PNG's many cultures and languages, their influence on the construction and representation of Papua New Guinean's identities, and the value, knowledge, and belief systems that underlie these diverse cultures and languages; while embracing the cultural and linguistic differences, and take actions to sustain the good and eliminate the bad aspects of cultures.

Goals

Students will be able to;

(a) have pride and responsibility towards their cultures and languages, and preserve and promote one's identity through language and culture while at the same time learning, appreciating, and tolerating other cultures and languages, both local and international.
(b) communicate with other people through written and spoken language, through mathematics and through other ways such as art, music and movement.
(c) investigate the underlying knowledge, value, and belief systems of different cultures and languages, and take appropriate individual and collective actions to eliminate aspects of cultures that hinder the building and fostering of healthy relationships and peaceful and safe environments, that are oppressive and detrimental to human development, and detrimental to the promotion of inclusive development and a hindrance to promoting and safeguarding fundamental human rights.

Aim 9: Students will develop their knowledge and an appreciation and respect for the natural environment and physical and human resources, and the need to develop these in ways that are sustainable for the benefit of current and future generations.

Goals

Students will be able to;

(a) cultivate and maintain an attitude to respect life, care for nature, and contribute to the protection of the environment.
(b) help develop and sustain Papua New Guinea's environment and its physical and human resources, for the benefit of current and future generations.
(c) become wise guardians of Papua New Guinea's resources.
(d) act responsibly and within the spirit of environment sustainability in the use of natural resources with the knowledge that local actions on environment have both local and global consequences.

Aim 10: Students will develop healthy self-concepts; contribute to the establishment and sustainability of healthy communities; the eradication of common diseases; and improvement in the health status of all citizens.

Goals

Students will be able to;

(a) demonstrate an understanding of the different stages of child development from conception to childhood, adolescence to adulthood.
(b) show awareness and understanding of the importance of building and promoting healthy life styles and healthy communities as prerequisites for healthy living and life style.
(c) investigate common diseases in PNG and their causes and symptoms, appreciate the consequences and impact they have on the citizens, look at what is being done to eradicate these diseases, and know how they can contribute to eradicating these diseases.

Aim 11: Students will understand that parenthood is a lifelong responsibility however, in exercising this right they should be aware of the impact of uncontrolled population growth and its consequences on families, communities, the environment, available resources, and the nation.

Goals

Students will be able to;

(a) appreciate the importance of having a family unit and show awareness of parental responsibilities, recognize the consequences of the decisions they make regarding the size of their families, recognizing the fact that the quality of life for their students depend on the decisions they make.
(b) aware of the contributing factors to population growth and demonstrate an understanding of the consequences of uncontrolled population growth.

Aim 12: Students will acquire knowledge, skills, values, and attitudes required for social and economic development, for gainful employment and self-employment, and for transforming individual and collective livelihoods and alleviating poverty.

Goals

Students will be able to;

(a) acquire knowledge, skills, values, and attitudes required for active participation in the formal and informal economy as means for making a sustainable living.
(b) explain and apply the concepts and practices of self-reliance and personal viability to create own employment as an alternative to formal employment.
(c) foster an attitude towards work by acquiring relevant values, knowledge, and skills that will prepare them to pursue vocational skills occupations.

Aim 13: Students will develop required values and respect for oneself, others, and the community, and use these as a basis for developing effective national and global citizenships traits.

Goals

Students will be able to;

(a) learn about and show awareness about past and present outstanding and model citizens whose character, moral standing, ethical standards, and contributions have shaped PNG and the world.
(b) demonstrate awareness and understanding of their civic and citizenship roles and responsibilities, the importance of performing these responsibilities in a transparent and accountable way for the greater good of PNG and their communities, and the consequences of neglecting these roles and responsibilities.
(c) develop and foster values, behaviours, attitudes, and communication competencies required to live together and in harmony with peoples of other cultures and linguistic groupings.
(d) show awareness and concern for the welfare and the rights of others, contribute to the promotion of justice for all and the empowerment of the oppressed and marginalized people, promote gender and social inclusion as the basis for protecting and promoting the rights of all.

Overarching Curriculum Principles

Curriculum principles identify, describe, and focus attention on the important concerns that must be addressed when developing the curriculum at all levels of schooling. They are based on significant social, economic, political, cultural, religious, philosophical, environmental, and educational values and beliefs. Curriculum principles are evidence-based and influenced by best practice. The following principles underpin the design, development, and implementation of SBC in PNG.

Relevance

The national curriculum should target the national, community, and personal social, economic, political, cultural, environmental, and spiritual, development needs and aspirations. Curriculum should aim to prepare students for careers, higher education and citizenship. Students should be equipped with essential, in demand knowledge, skills, values, and attitudes to meet the demands and challenges of working, studying, and living in a complex, knowledge-based, and technology driven economy and society of the 21st century. This can be achieved through the development of rigorous and comparable learning standards, design, development, implementation, and monitoring of a quality SBC, and embedding of values and critical, creative, decision-making, reasoning, problem-solving, high level, 21st century, and STEAM skills in the curriculum.

The national curriculum will enable teachers to support students' learning by encouraging teaching and learning in real-life contexts, and providing opportunities for students to address the problems posed by the natural and physical environments by developing creative and innovative solutions. This means students will relate and use the knowledge, skills, values and attitudes learnt in different subjects to real life situations.

Multiculturalism

PNG is blessed and fortunate to have so many languages and cultures. The diversity of our cultures is the source of our knowledge, skills, attitudes, and values. As a multicultural society, we must protect, promote, and respect our many cultures and languages. There are many people from our own ethnic groupings and from other countries with their own cultures living and working together in PNG. This is the most multicultural country in the world. We must ensure that we promote and share our cultures with the rest of the world. We must also critically examine and address the problematic aspects of our cultures.

Ethics, Morals, and Values

PNG is striving to create a society in line with democratic liberal traditions. The citizens of PNG should recognise appropriate social relationships based on sound human and religious ethics, morals and values. These are required for interaction with families and people from other provinces and nations. The process of socialisation requires a belief in the ethics, morals and values of the Melanesian extended family, dialogue with and respect for others and a willingness to conserve and promote those aspects of our traditions, which are consistent with studying, working, and living in the 21st Century global society. Socialisation also requires an awareness of the interdependence of individuals, societies, and nations in the postmodern world. It requires involvement with family, school, church, community, and the world beyond.

Integral Human Development

Integral human development focuses on the holistic development of every person. National curriculum should provide opportunities for all students to receive an education that will enable them to;

- be dynamically involved in the process of freeing themselves from every form of domination and oppression so that they will have the opportunity to develop as integrated persons in relationship with others. This means that the national curriculum must integrate and maximise socialisation, participation, liberation, and equality,
- be aware of human potential and the willingness to develop and maximize this potential so that each individual can solve his or her own problems, contribute to the common good of society, and maintain, promote, and improve the learning, working, and living conditions of all, and
- acquire and consistently use Biblical and spiritual values, personal, social and sustainability values, and work, relationship, health, and peace values in their lives.

PNG is a rapidly changing society and faces many challenges. To face these effectively, an individual must strive to become an integrated person and to work with others to create a better community.

The process of integral human development calls for a national curriculum, which helps individuals to;

- identify their basic human needs,
- analyse situations in terms of these needs,
- see these needs in the contexts of spiritual and social values of the community, and
- take responsible action in co-operation with others.

The success of a national curriculum requires the integrated involvement of all the agents of education such as the home, church, school, and community.

The Right to Healthy Living

The health status of PNG is very low. All citizens have a right to clean water, a nutritious diet, improved sanitation, and appropriate and better local health services. Students need to learn attitudes; skills, and knowledge that will help them become productive, healthy, and contented citizens of PNG. They need to be given a set of skills that will enable them to improve their own and their community's health in order to improve the health status of PNG. The national curriculum will ensure that students have the opportunity to learn about healthy living and lifestyles.

Nation Building and National Unity

Our nation is young and there is still a great deal of nation building to be done. Students need to be given the skills to undertake this task and participate in nationally organised events. The national curriculum should enable them to understand how Papua New Guinean societies work and how they can be a useful part of these societies. Students should learn that they have a place in PNG and that PNG has a place in the world as a whole. They will be able to help PNG develop a national identity as one nation if they learn to;

- work together with tolerance,
- respect one another, their traditional ways and resolve problems peacefully;
- respect and act in the spirit of the national Constitution,
- recognise their capabilities and develop their own talents,
- participate in the development of the national community, and
- protect and safeguard the national wealth and resources.

Sustainability

The natural environment of PNG is as diverse as its cultures. It is often under threat from uncontrolled exploitation, over logging, abuses associated with mining, over fishing, dynamiting of reefs, and dumping of toxic wastes. Our diverse cultures are also under threat from over exploitation and commercialisation of sacred cultural practices. Our cultural traditions are not being handed down from generation to generation. The national curriculum will guide students to further appreciate, respect, and value their natural environment, cultures, customs, and traditions. It will give them the skills and knowledge to identify problems and issues and to take action to sustain these aspects of life in PNG.

Gender Equity and Social Inclusion

Gender is what it means to be a woman or a man. Gender refers to those behaviours and attitudes that are culturally accepted as ways of being a woman (femininity) and being a man (masculinity). Addressing gender issues goes well beyond ensuring that females have the same opportunities as males to receive an education. A person's experiences determine the way they understand and make sense of the world. Gender is also culturally determined. In PNG, there is a need for sensitivity to local cultural practices and values, with respect to traditional roles for males and females. The national curriculum will provide students with subjects, resources, activities, and experiences that value the needs of both girls and boys.

Females are generally a disadvantaged group in PNG. PNG does not have in place a good record about gender equity for females. Violence against females is widely acknowledged as a serious problem. A number of health and other indicators of human development show that females have a lower quality of life than males. Females have lower literacy rates and lower income levels than males. Males hold nearly all positions of leadership, authority, and decision making.

Men hold most senior positions in government departments and the community. It is a similar situation in the Department of Education, provincial education divisions, and schools. The national curriculum will provide students with opportunities to consider these problems and ways of addressing gender issues.

Inclusive Curriculum

The national curriculum is inclusive and designed to meet the needs of all students irrespective of their abilities, gender, geographic locations, and cultural language, or socioeconomic backgrounds. The national curriculum must be implemented by teachers in ways that are inclusive of all students at all levels of schooling. Much more can be achieved if parents, community leaders, churches, and schools co-operate and communicate with each other.

Students learn in different ways. It is best to use a variety of methods to teach them. No one method is best. It is true that students are very different and even the same students learn best from different methods at different times. By using a range of teaching methods, it is more likely that the needs of all students will be met. In order to be inclusive of all students, teachers need to cater for a range of physical, social, cultural, emotional, spiritual, and intellectual needs of their students. This can be achieved through using appropriately and carefully planned learning activities, a range of teaching methods and strategies, and thoughtful use of the language of communication.

To be inclusive, teachers will need to ensure that all girls and boys have the opportunity to participate. Teaching practices, including classroom organisation and management, should ensure that girls and boys are able to participate fully in all learning activities. Participation requires that individuals are motivated to achieve the goal of socialisation fully where they are encouraged to develop

a sense of obligation for the opportunity to contribute. Through participation, individual creativity can be recognised and encouraged, without losing sight of the principle of communal sharing. Participation is the key to social interaction and can lead to social mobility. It can also help to conserve and generate knowledge and cultural values for future generations.

Student-Centred Learning

Student-centred learning recognises the fact that no two classes are alike and no two students are the same with respect to their needs. A teacher who uses a student-centred approach will endeavour to create a classroom environment that will motivate students to discover new skills and knowledge. In such an environment, the teacher might focus on teaching students how to learn and help them discover relevant information. It is essential to teach students how to learn while at the same time teaching them important content. A student-centred classroom will usually involve students working together in small groups using activity centres set up in the classroom while the teacher works more closely with one or two students. The national curriculum describes what all students are expected to learn in all subjects. A student-centred approach allows teachers to be more flexible in determining the most effective ways to help all students achieve these learning outcomes

Lifelong Learning

School is an important part of a student's education but learning continues throughout life. The initial experience that students have with the school curriculum is critical in encouraging them to continue learning throughout their lives. Going to school should be an enjoyable and satisfying experience for the students and should prepare them for life after school. Students know many things when they come to school. They will learn many things outside of school and continue to learn after they leave school. The national curriculum should build on what students already know. Teachers should make use of this knowledge and skills. When students are learning new, unfamiliar things, teachers should relate the new things to what students already understand. This important learning will continue throughout life as students increasingly take responsibility for their own learning. Increasingly, students who leave school will look for opportunities to continue their education and to return to school or some other educational or training institutions in order to improve their qualifications.

Language Development Across the Curriculum

The national curriculum will provide opportunities for language development across the curriculum. Language development across the curriculum should be encouraged because all subject areas provide meaningful contexts for purposeful learning. Specific subjects have different language requirements such as, the vocabulary and language features of science and the written and oral genres to narrate, explain, persuade, report, and discuss the particular content of various subjects. The conventions and differences must be explicitly taught in relevant contexts across the curriculum.

21st Century Knowledge, Skills, Values, and Attitudes for Careers, Higher Education, and Citizenship.

PNG shapes and is being shaped by the 21st century social, economic, political, cultural, religious, and environmental discourses and practices. It is important to provide opportunities for students to learn in-depth and master the 21st Century knowledge, skills, values, and attitudes to prepare them for careers, higher education, and citizenship. There is an increasing demand for knowledge-based workers and workers with qualifications in STEAM globally. This cadre of workers is not available in PNG because education is not geared towards preparing this category of workers. PNG students should be equipped with the necessary 21st Century and STEAM proficiencies to ensure that they are marketable globally and can contribute meaningfully to the development of PNG.

Science, Technology, Engineering, Arts, and Mathematics

The majority of careers in the 21st Century is STEAM related. However, demand for STEAM graduates and experienced workers far exceed the supply of this cadre of workers. What is more, although a slow paradigm shift is taking place, careers in STEAM fields are dominated by males. Females are beginning to venture into these careers but at a very slow pace. There is an enormous gender parity gap in this area. Thus, it is critical for STEAM knowledge, skills, values, and attitudes to be taught from prep to post-secondary school level to provide opportunities for all students to attain STEAM related proficiencies before leaving school. The main aim of this education is to shape students' thinking, motivate, and influence them to develop an interest in careers in the STEAM field, and pursue STEAM related academic programs in institutions of higher education.

Standards-Based Curriculum Principles

The principles of SBC include the following:

- Setting of high academic standards and a careful and continuous assessment and reporting of students' performance against these standards will motivate students to perform at a much higher level.
- Standards allow every student, every parent, and every teacher to share in common expectations of what students should know, understand, and be able to do.
- Students will learn more when more is expected of them in school and at home.
- The setting of clear, measurable, and attainable standards is the key to attaining high academic standards and hence the attainment of the desired quality of education.
- All children are capable of learning and achieving high academic standards, regardless of their backgrounds.
- Students can learn in their own ways and at their own rates.

Protection of Children's Rights

It is paramount that children's rights stipulated in national legal and policy frameworks, and international conventions such as the United Nations Convention on the Rights of the Child (UNCRC) are recognised, promoted, protected, and safeguarded by everyone and every organisation working and dealing with children's welfare and well-being. A child is defined by UNCRC as a human being below the age of 18 years. However, definitions of a child may differ based on the socio-cultural contexts of different countries. Notwithstanding the differences in definitions, biologically, a child is generally anyone between birth and puberty.

The four core principles of UNCRC underpinning children's rights are:

- non-discrimination.
- devotion to the best interests of the child.
- the right to life, survival and development.
- respect for the views of the child.

Children's rights are human rights and therefore they should be promoted and safeguarded by the whole of the education system. They should permeate all education plans, policies, programs, and activities, and firmly embedded in the school curriculum, teaching and learning practices, and the overall management of the education system

Geology Rationale, Aim and Goal, and Guiding Principles

The active land formation of Papua New Guinea indicates that the country is geologically young. It is one of the most unstable regions in the world. The geological activities have led to the formation of natural resources such as minerals, oil and natural gas. While these natural resources are contributing to the development of Papua New Guinea, their extraction does have some impacts on the lives of the people and the environment.

Human beings have always had a great influence on the earth and the environment since they came into existence; and human beings must accept responsibility for their actions on earth. This is the context within which scientifically literate geologists, including Papua New Guinean geologists, must demonstrate a sound understanding of geological principles, concepts, processes, systems and interactions, and make informed decisions.

Students' skills in problem solving, critical thinking and working cooperatively in small groups are enhanced in the study of Geology. Acquiring these skills enables students to explore various solutions to geological, environmental and other related problems. Students develop values and attributes such as flexibility, curiosity, critical reflection and respect for evidence. These help them to consider issues and implications of having respect for the environment, both living and non-living. Students are able to recognise and understand the strengths and limitations of geological techniques and technologies in the field of geoscience.

The geological knowledge and skills acquired through this course will provide students with a foundation for sustainable living in their community, further education and the workforce.

Since Geology is a rapidly changing field, teachers of Geology play a pivotal role by being innovative and creative, and by keeping abreast of new information that is based on scientific research and innovations in technological change.

Through the study of Geology, students consider the impact of human activities on ecosystems and the environment, as well as on individual human beings and human society, both in Papua New Guinea and globally. An understanding of Geology, and the application of this understanding, will help students to appreciate factors such as the culture, ethics, economics, power, and relationships that influence the pursuit of science, and have a significant impact on the way people live.

Ultimate Aims of Geology

Geology aims to enable students to:

- appreciate Earth as a dynamic system that interacts directly or indirectly with other systems in the universe
- appreciate the composition (rocks and minerals) and structure of the Earth and its origin and development through time
- appreciate the processes that occur inside and outside the Earth and its interaction with the atmosphere
- appreciate the timing (geological time) of these processes (plate tectonics) and methods to determine geological time (age dating)
- appreciate that while the end products of some of these processes are beneficial to society (economic resources, groundwater, weather), others are not (weathering, erosion, earthquakes, volcanoes and global climate change)
- appreciate the formation, exploration and development Earth resources for the benefit of society and the governing policies and regulations for undertaking such activities
- appreciate the advantages and disadvantages of extracting Earth resources
- participate in and assist future developments, using past and present geological knowledge

Goals of Geology

Students will be able to;

- demonstrate an understanding of fundamental concepts of Geology
- design or use geological models to explain the internal and external activities of the Earth,
- analyse, evaluate and interpret geological data and information,
- communicate geological information in different ways, and
- demonstrate an understanding of geological knowledge and practices in their societies.

Guiding principles

This is a critical time for students to understand how Earth works as a system and how humans interact with Earth. Understanding the causes and potential societal consequences of natural Earth processes (e.g., earthquakes, floods, landslides, tsunamis, volcanic eruptions, weather, and global climate change) and the production, availability, and potential depletion of natural resources (e.g., water, soil, mineral, and energy) is of particular importance. These processes and resources impact our economy, our security, and the safety and sustainability of our environment. The context for understanding modern Earth processes lies in deciphering records of Earth's past. Investigating these records, as well as human interaction with modern Earth processes and resources, is therefore critical to the wellbeing of humanity and the planet. Empowering students with scientific knowledge and skills to make informed decisions as citizens of our common home is a vital undertaking and a key responsibility for science educators and geoscientists.

Geo-science is an integrated science, bringing together biology, chemistry, and physics as they apply to the workings of Earth. The applied, and often visual, nature of earth science helps learners see its relevance to their lives and to their communities. Engaging students in learning about Earth supports the development of problem solving and critical thinking skills and highlights the importance of science, technology, engineering, arts and math (STEAM) careers to society. Therefore, earth science can serve as an introduction to the life and physical sciences or as a capstone course requiring students to apply their knowledge of these sciences. Earth science can also serve as a framework for investigating life and physical sciences in museums and other informal education venues.

Science as Inquiry

Scientists engage in scientific inquiry by following key science practices that enable them to understand the natural world and answer questions about it. Learning science is something that students do, not something that is done to them. Hands-on activities, while essential are not enough. Students must have minds-on experiences in which they become fully engaged in creative scientific thinking.

Students of science must become proficient at these practices to develop an understanding of how the scientific enterprise is conducted. These practices include skills from daily life and school studies that students use in a systematic way to conduct scientific inquiry. These include students asking questions, make observations, make predictions and carry out experiments to test their predictions.

The science practices are fundamental to all science disciplines. When students are engaged, they are:

- Asking questions based on observations.
- Generating evidence.
- Working with data.
- Answering the research question.
- Making an argument from evidence.

Five practices that are fundamental to scientific inquiry are represented in detail in the Grades 11 and 12 Teachers Guides. In this syllabus the Science as Inquiry recommended for Grades 11 and 12 are provided in the table below and are also expanded in the teachers' guides.

Grade 11 recommended working scientifically skills	Grade 12 recommended working scientifically skills
• Perform tests, collect data, analyse relationships, and display data. • Identify and communicate • Identify and examine possible and reasons • Formulate explanations by using logical thinking and evidence. • Solve scientific problems • Examine the usefulness of data presented	• The locations, sequences, or time intervals • Recognise and assess the issues of statistical variability and the need for controlled tests. • Analyse situations and solve problems • Combining and applying concepts from more than one area of science. • Researching the literature, analyse data, and communicating the findings • Determine when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent.

Monitoring and Mastering Science Inquiry skills

The table below shows the expectation for students studying Science to master the Science Inquiry Skills from Preparatory to Grade 12. It shows:

- **Emerging** – when the student starts
- **Progressing** – when the student shows evidence of progressing and working towards mastering the skill
- **Mastering** – When the student has mastered the skill and is able to apply in all life situations.

This practice must be on-going and progressively carried out throughout the child's learning in that particular grade.

Schools are encouraged to use this for each student and should be passed on to the next grade so the students mastery level of each skill is monitored right throughout their learning from Preparatory to grade 12.

Level of skills	Low				Medium					High			
Inquiry Skills by grades	P	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9	G 10	G 11	G 12
Observing	*	*	**	***	***	***	***	***	***	***	***	***	***
Classifying		*	*	**	***	***	***	***	***	***	***	***	***
Measuring		*	*	**	**	**	***	***	***	***	***	***	***
Inferring				*	**	**	***	***	***	***	***	***	***
Predicting			*	**	***	***	***	***	***	***	***	***	***
Hypothesizing				*	*	**	***	***	***	***	***	***	***
Experimenting				*	**	**	***	***	***	***	***	***	***
Communicating			*	**	**	**	***	***	***	***	***	***	***
Researching				*	*	*	**	***	***	***	***	***	***
Problem-solving				*	*	**	**	***	***	***	***	***	***
Identifying and controlling variables				*	*	*	**	**	**	***	***	***	***
Use/make models			*	*	**	**	***	***	***	***	***	***	***
Use numbers				*	*	**	**	***	***	***	***	***	***
Collect data				*	*	*	**	**	**	***	***	***	***
Analyse relationships						*	*	**	**	***	***	***	***
Use appropriate tools and techniques to make observations and gather data				*	**	***	***	***	***	***	***	***	***
Assess the reliability of data that was generated in the investigation					*	**	***	***	***	***	***	***	***
Formulating questions that can be answered through scientific investigations				*	*	*	**	**	***	***	***	***	***
Formulate explanations by using logical thinking and evidence							*	*	*	**	**	***	***
Proving scientific theories as facts or fraudulent										*	**	***	***
Identifying and explaining misconceptions							*	*	*	**	***	***	***
Looking for patterns and meanings								**	**	***	***	***	***
Read, interpret and examine the credibility and validity of scientific claims in different sources of information							*	*	*	**	**	***	***
Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.							*	**	**	***	***	***	***
Explain and distinguish independent and dependent variables including those that are kept constant and those used as controls.							*	**	**	***	***	***	***
Use mathematical operations to analyse and interpret data and present relationships between variables in appropriate forms.							*	**	**	***	***	***	***

Draw conclusions and present plausible explanations based on research data and assess results based on the design of the investigation								*	*	**	**	***	***
Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.					*	*	*	**	**	***	***	***	***
Science as Inquiry/grades	P	G1 G	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12
Level of skills	**Low**				**Medium**					**High**			

The number of asterisks denotes the amount of emphasis given to each process skill in each year level.

* Emergent ** Progressive *** Mastery

Enhancing Science Teaching and Learning Using Instructional Technology

The use of current and emerging technologies is essential to the P–12 Sciences instructional program. Specifically, technology must accomplish the following:

- Assist in improving every student's functional literacy. This includes improved communication through reading/information retrieval (the use of telecommunications), writing (word processing), organization and analysis of data (databases, spreadsheets, and graphics programs), presentation of one's ideas (presentation software), and resource management (project management software).
- Be readily available and regularly used as an integral and ongoing part of the delivery and assessment of instruction.
- Include instrumentation oriented toward the instruction and learning of science concepts, skills, and processes. Technology, however, should not be limited to traditional instruments of science, such as microscopes, lab ware, and data-collecting apparatus, but should also include computers, robotics, interactive-optical laser discs, video-microscopes, graphing calculators, CD-ROMs, probe ware, global positioning systems (GPS), online telecommunication, software and appropriate hardware, as well as other emerging technologies.
- Be reflected in the "instructional strategies" generally developed at the local school division level.

In most cases, the application of technology in science should remain "transparent" unless it is the actual focus of the instruction. One must expect students to "do as a scientist does" and not simply hear about science if they are truly expected to explore, explain, and apply scientific concepts, skills, and processes.

As computer/technology skills are essential components of every student's education, it is important that teaching these skills is a shared responsibility of teachers of all disciplines and grade levels.

Creating and Promoting a Safe Working Environment

During Science lessons, teachers must be certain that students know how to follow safety guidelines, demonstrate appropriate laboratory safety techniques, and use equipment safely while working individually and in groups. Safety must be given the highest priority in implementing the instructional program for science. Correct and safe techniques, as well as wise selection of experiments, resources, materials, and field experiences appropriate to age levels, must be carefully considered with regard to the safety precautions for every instructional activity. Safe science classrooms require thorough planning, careful management, and constant monitoring of student activities. Class enrolment should not exceed the designed capacity of the room.

Teachers must be knowledgeable of the properties, use, and proper disposal of all chemicals that may be judged as hazardous prior to their use in an instructional activity. The identified precautions involving the use of goggles, gloves, aprons, and fume hoods must be followed as prescribed.

While no comprehensive list exists to cover all situations, the following should be reviewed to avoid potential safety problems. Appropriate safety procedures should be used in the following situations:

- observing wildlife; handling living and preserved organisms; and coming in contact with natural hazards, such as poison ivy, ticks, mushrooms, insects, spiders, and snakes;
- engaging in field activities in, near, or over bodies of water,
- handling glass tubing and other glassware, sharp objects, and lab ware,
- handling natural gas burners, Bunsen burners, and other sources of flame/ heat,
- working in or with direct sunlight (sunburn and eye damage),
- using extreme temperatures and cryogenic materials,
- handling hazardous chemicals including toxins, carcinogens, and flammable and explosive materials,
- producing acid/base neutralization reactions/dilutions,
- handling power equipment/motors, and
- working with high voltage/exposed wiring.

STEAM Rationale, Aim and Goals, and Guiding Principles

Ultimate Aim

The ultimate aim of STEAM education is to develop a STEAM literate society in which all citizens have the expected level of STEAM literacy. STEAM literacy refers to an individual's:

- knowledge, skills, values, and attitudes to identify problems and questions in life situations, explain the natural and design world, and draw evidence-based conclusions about STEAM issues;
- understanding of characteristic features of STEAM disciplines as forms of human knowledge, inquiry, and design;
- awareness of how STEAM disciplines shape our material, intellectual, and cultural environments, and
- willingness to engage in STEAM related issues and with the ideas of STEAM as a constructive, concerned, and reflective citizen.

Goals

The following are the goals of STEAM.

(i) Provide students with STEAM related experiences and opportunities to use STEAM concepts, ideas, and skills to solve problems relating to the natural and physical worlds, and use the evidence to make informed decisions about the interventions.

(ii) Build positive attitudes and embed essential STEAM values in students thereby motivating them to choose STEAM related careers or undertake STEAM related academic programs or courses of study.

(iii) Provide students opportunities to work in collaboration and partnership with people engaged in STEAM related careers or disciplines to learn about how STEAM skills, concepts, processes, and ideas are applied in real life.

(iv) Build a pool of STEAM workers who can contribute to national and global development and progress.

(v) Enable students to achieve high academic standards

Guiding Principles

Integration and application of knowledge and skills in real life situations

Integration of STEAM knowledge and skills and their application to real-life situations inside and outside of the classroom setting will enable students to explain how STEAM disciplines shape our material, intellectual, cultural, economic, social, and environmental contexts.

Emphasis is on the learning and the application of STEAM knowledge and skills to investigate, explain, and solve problems rather than on content

STEAM education emphasizes the learning and the application of knowledge, and skills to investigate, explain, and solving physical and natural problems rather than on in-depth teaching and learning of STEAM content.

STEAM related knowledge and skills are used to investigate, explain, and solve problems relating to the natural and physical environments

STEAM education focuses on providing the learners real life experiences of how STEAM related skills, concepts, processes, ideas, principles, values, and attitudes are applied and used to identify problems and questions in real life situations, explain the natural and physical world, and draw evidence-based conclusions.

Core curriculum

A core set of common learning's (knowledge, skills, values, and attitudes) have been integrated into the curriculum to provide all students an opportunity to acquire and master these before they are career, higher education, and citizenship ready. The core curriculum includes:

- Cognitive skills (critical and creative thinking);
- Reasoning, problem-solving and decision-making skills;
- High level thinking skills (analysis, evaluation and synthesis);
- 21st Century skills;
- STEAM principles and skills;
- Spiritual values and virtues;
- Reading, writing and communication skills, and
- Essential values and attitudes.

The above knowledge, skills, values and attitudes should be taught and assessed by all teachers from prep to grade 12. These are reinforced at each school grade and school level to enable students to become proficient in their application in different careers, higher education and citizenship contexts.

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.

These knowledge, skills, values and attitudes have been integrated into the content standards and benchmarks. They will also be integrated into the performance standards. Teachers are expected to plan and teach these essential knowledge, skills, values and attitudes in their lessons, and assess students' performance, proficiency and progression towards the attainment of content standards.

Provided here are examples of different types of knowledge, processes, skills, values and attitudes that all students are expected to learn and master as they progress through the grades. These are expanded and deepened in scope and the level of difficulty and complexity are increased to enable students to study in – depth the subject content as they progress from one grade to the next.

Types of Knowledge

There are different types of knowledge. These include:	
• Public and private (privileged) knowledge • Specialised knowledge • Good and bad knowledge • Concepts, processes, ideas, skills, values, attitudes • Theory and practice • Fiction and non-fiction • Traditional, modern, and postmodern knowledge	• Subject and discipline-based knowledge • Lived experiences • Evidence and assumptions • Ethics and Morales • Belief systems • Facts and opinions • Wisdom • Research evidence and findings • Solutions to problems

Types of Processes

There are different types of processes. These include:	
• Problem-solving • Logical reasoning • Decision-making • Reflection	• Cyclic processes • Mapping (e.g. concept mapping) • Modelling • Simulating

Types of Skills

There are different types of skills. These include:

1. Cognitive (Thinking) Skills

Thinking skills can be categorised into critical thinking and creative thinking skills.

i. Critical Thinking Skills

A person who thinks critically always evaluates an idea in a systematic manner before accepting or rejecting it. Critical thinking skills include:	
Analysis Skills – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.	Evaluation Skills – Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.
Key words	**Key words**
Analyse, compare, contrast, classify, distinguish, infer, explain, separate, select, categorise, connect, differentiate, discriminate, divide, order, point out, prioritise, sub-divide, survey, advertise, appraise, breakdown, calculate, conclude, correlate, criticize, devise, deduce, arrange, discover, establish, examine, organize, outline, investigate, examine, simplify, see, research, recognize, highlight, in-depth, discuss, list, find, group, divide, focus, question, experiment, test, illustrate, identify, deconstruct, simplify,	Evaluate, criticize, order, appraise, judge, support, compare, decide, discriminate, recommend , summarise, assess, choose, convince, defend, estimate, find errors, grade, measure, predict, rank, score, select, test, argue, conclude, consider, monitor, check, debate, determine, justify, explain, give reasons, interpret, opinion, validate, value,

ii. Creative Thinking Skills

A person who thinks creatively has a high level of imagination, able to generate original and innovative ideas, and able to modify ideas and products. Creative thinking skills include;
Synthesis/Creative Skills – Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.
Key words
Categorise, combine, compose, create, devise, design, explain, generate, modify, organize, plan, rearranges, construct, deconstruct, reconstruct, relate, reorganize, revise, rewrite, summarise, tell, write, formulate, invent, hypothesise, develop, compile, prepare, produce, arrange, rearrange, assemble, role-play, anticipate, make, predict, act-out, model, build, convert, discuss, elaborate, solve, propose, visualize, imagine, extend, tabulate, transform, integrate, innovate, maximize, minimize,

2. **Reasoning Skills** - Reason is a skill used in making a logical, just, and rational judgment.
3. **Decision-Making Skills** - Decision-making involves selection of the best solution from various alternatives based on specific criteria and evidence to achieve a specific aim.
4. **Problem Solving Skills** – These skills involve finding solutions to challenges or unfamiliar situations or unanticipated difficulties in a systematic manner.

Types of Values

1. Personal Values (importance, worth, usefulness, etc)

Core values	Sustaining values
• Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality	• Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core values	Sustaining values
• Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment	• Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilisation • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

3. Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
• Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative	• Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.

Content Standards, Benchmarks, and Evidence Outcomes

Content standards, benchmarks, and evidence outcomes are all curriculum standards. However, they have specific curriculum purposes. Despite this, these curriculum standards are interconnected and enable the intended learning outcomes to be attained.

Content Standards

Content Standards are broadly stated expectations of what students should know, understand, and be able to do in a particular subject, grade, or school level. They embed essential knowledge, skills, values, and attitudes that all students are expected to learn and master in each strand or unit to prepare them for the next grade or level of schooling.

Benchmarks

Benchmarks are specifications of content standards or more detailed descriptions of a specific level of performance expected of students at particular ages, grades, or levels of development. Benchmarks focus on the essential knowledge, skills, values and attitudes that all students are expected to learn, master and demonstrate proficiency.

Evidence Outcomes

Evidence outcomes are indicators that indicate students' progress towards meeting an expectation at the mastery level. They measure students' mastery and application of knowledge, skills, values, and attitudes at each grade, cluster or school level. They indicate that a student is meeting an expectation or achieving a benchmark at the mastery level. They enable teachers to know if a student can do what he/she was expected to know, understand, and do in real life or relevant situations. Evidence outcomes are given for each strand in each grade to describe what all students should do at the end of the different strands of geology.

Content Standards and Benchmarks Coding

The following is the coding system used to code the content standards and benchmarks to not only make it easier to interpret and understand the relationship between these two learning standards but also to guide lesson planning, instruction, assessment and reporting of students' performance in relation to a benchmark and content standard.

Grade	: Grade is indicated by the first number (*for example,* **11**.1.1.1)
Strand	: Strand is indicated by the second number (*for example,* 11.**1**.1.1)
Content Standard	: Content Standard is indicated by the third number (*for example*, 11.1.**1**.1)
Benchmark	: Benchmark is indicated by the fourth number (*for example,* (11.1.1.**1**).

Thus, the code will read as **Content Standard 11.1.1**. and **Benchmark** as **11.1.1.1**

Content Overview

Geology grades 11 and 12 syllabus is organised by strands. Strands are broad content areas that define and describe the subject matter to be taught and learned. They incorporate cross-curriculum learning as well. Each strand is further expanded to units which has a rationale that justifies its inclusion in the geology curriculum.

Each unit embeds a particular aspect of Geology and articulates the subject matter to be learnt. What students are expected to learn and demonstrate proficiency on is described in the unit content standard. Each unit has one content standard which is set at the national level. Significant aspects of the content standards (knowledge, skills, values and attitudes) are benchmarked at the grade-level.

The Geology strands and units for grades 11 and 12 are as follows:

Table of strands and units

Strand		Grade 11 Units	Grade 12 Units
GEOLOGY	**Science as Inquiry**	1. Thinking Scientifically 1	1. Thinking Scientifically 2
	Earth Science	1. Introduction to Geology 2. Earth Materials 3. Geological Time and Fossils 4. Plate Tectonics 5. Atmosphere and Hydrologic Cycle	1. Earth Resources 2. Age Dating 3. Earthquakes and Volcanoes 4. Surface Processes and Groundwater

Grades 11 and 12 Strands

Strand 1: Science as Inquiry

Rationale

Science is all about learning and understanding something new. Inquiry means to ask for information or investigate something to find out more. So, scientific inquiry is using evidence from observations and investigations to create logical explanations and answer questions. The Science as Inquiry standards are described in terms of activities resulting in student development of certain abilities and in terms of student understanding of inquiry.

Students at grades 11 and 12 in Earth Science strand should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analysing alternative explanations, and communicating scientific arguments.

Students studying geology must be able to master the inquiry approaches and processes. These approaches and processes are well established and are used by scientists to investigate and understand different phenomena. They have resulted in useful inventions and innovations that have and continue to improve the lives of mankind.

Science as Inquiry is logically embedded in the Earth Science strand standards as inquiry is the process through which students develop a key understanding of sciences.

Evidence Outcomes

At the end of grades 11 and 12, all students can:

- Identify and formulate questions that can be answered through scientific investigation.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information
- Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment
- Design and conduct appropriate types of scientific investigations to answer different questions
- Explain and distinguish independent and dependent variables, including those that are kept constant and those used as controls
- Use appropriate tools and techniques to make observations and gather data
- Assess the reliability of the data that was generated in the investigation
- Use mathematical operations to analyse and interpret data, and present relationships between variables in appropriate forms
- Draw conclusions and present plausible explanations based on research data, and assess results based on the design of the investigation
- Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic
- Draw conclusions and present plausible explanations based on research data, and assess results based on the design of the investigation.
- Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Grade 11

Unit 1: Thinking Scientifically 1

In this unit, students will be able to understand and apply the units and scales of measurement used in quantifying objects, and read and interpret geological maps, and the use of common geological equipment.

Content Standard: 11.1.1

Students will be able to understand and use the units of measurement, geological maps, common geological equipment and techniques.

Benchmarks

11.1.1.1 Identify and assess the units of measurement used to quantify objects.

11.1.1.2 Analyse the use of common geological equipment used by geologists.

11.1.1.3 Analyse the techniques used to acquire, analyse and display information about the Earth.

Grade 12

Unit 1: Thinking Scientifically 2

In this unit, students will understand the units of measurement, use of basic geological equipment such as geological hammer, hand lens, compass, clinometer, global positioning system and petrographic microscope.

Content Standard: 12.1.1

Students will be able to understand and compare units of measurement and use basic geological equipment.

Benchmarks

12.1.1.1 Recognise and convert units of measurement used to quantify objects.

12.1.1.2 Demonstrate the use of geological equipment.

Strand 2: Earth Science

Rationale

Students can develop skills and knowledge of science by studying about the The geology of Papua New Guinea is very unique in that most of the natural processes that are responsible for shaping the planet Earth are found here. Students will understand that the Earth is a dynamic system and gradually undergoing changes. The observations of today's processes will enable students to understand the events that happened in the past. By understanding the structure and composition of the Earth, students will appreciate why certain events occur, where they occur, and come up with explanations as to how they happen.

From the global perspective, students can focus on processes that led to the formation of minerals, which are building blocks of rocks. They focus on the geological time scale, its major subdivisions, and events that occurred in the past. Students will closely examine the materials of the Earth, its internal and surficial processes, and how systems of the Earth interact with its other. They will learn how these forces, processes, and their products affect life on Earth.

Earth processes also leads to formation of certain resources, some of which are useful for mankind. Students will learn about these resources, how they are extracted, processed and used. They will learn about the impacts on environment when these resources are extracted and appreciate how these can be mitigated.

The study of geology draws support from several disciplines including biology, chemistry, physics, mathematics, electronics, and computer science. These enable to observe and either directly or inferred to explain the geological phenomena. Geology is the discipline that makes people observe and be able to reason using relevant evidence. Hence, these will prepare students to study geology courses at the tertiary level.

Evidence Outcomes

Grade 11	Grade 12
At the end of the grade, all students can; • explain the significance of geology as a discipline • explain the formation of the universe and the Earth • demonstrate knowledge of the Earth's layers • describe the formation of rocks and minerals • differentiate between rocks and minerals • differentiate between igneous, sedimentary, and metamorphic rocks • classify minerals and mineral groups according to their chemical composition • explain the composition of igneous, sedimentary and metamorphic rocks • describe igneous rock features • trace the origins of geological resources including mineral deposits, coal, petroleum, and natural gas • explain the formation of fossil fuels • assess the significance of age dating, the fossil record, and the geological time scale • outline the development of plate tectonic theory • explain the characteristics and significance of the atmosphere • describe the function of the hydrologic cycle	At the end of the grade, all students can; • explain the significance of geological resources and their economic development • assess the extraction and use of Earth resources • relate relative age dating to the development of the geological time scale • contrast relative and absolute age dating • relate the fossil record to the geological time scale • analyse and evaluate applications of earthquakes • relate rock formations and structures to the forces that create them • explain the basic concepts of earthquake and volcano • compare extrusive and intrusive volcanic features and action • analyse structures, processes, and evidence that support plate tectonics • analyse features and processes associated with weathering and erosion • relate sedimentary features to their depositional environments • explain the processes and features associated with mass movement • evaluate the importance of groundwater

Grade 11

Unit 1: Introduction to Geology

Geology is the scientific study of the Earth, its origins and evolution, the materials it is made up of, and the processes that act on it.

Content Standard: 11.2.1

Students will be able to understand the significance of geology as a discipline and the formation of the Earth.

Benchmarks

11.2.1.1 Recognise geology as a discipline.

11.2.1.2 Investigate and analyse the formation of the Earth.

Unit 2: Earth Materials

Earth materials include rocks, minerals and fossil fuels. Rocks are naturally formed aggregate of usually inorganic materials from within the Earth; minerals are naturally occurring, usually inorganic, solid consisting of either a single element or a compound, and having a definite chemical composition and a systematic internal arrangement of atoms; and fossil fuels are non-renewable energy sources, such as oil, gas, or coal, that are derived from the organic remains of past life. Fossil fuels consist primarily of hydrocarbons.

Content Standard: 11.2.2

Students will be able to compare and contrast between minerals, minerals and rocks, rocks, and understand the formation of rocks, minerals and fossil fuels, and their uses.

Benchmarks

11.2.2.1 Analyse and compare minerals according to their properties, formation and uses.

11.2.2.2 Recognise and analyse the types of rocks based on their properties, compositions and uses.

11.2.2.3 Investigate and assess the formation of fossil fuels such as coal, crude oil and the importance of crude oil and gas.

Unit 3: Geological Time and Fossils

The geological time scale is a method used to understand the history of the Earth. Geoscientists have devised and used both absolute and relative age dating techniques such as radioactive techniques and fossils. The division of all of Earth history into blocks of time distinguished by geologic and evolutionary events, ordered sequentially and arranged into eons, made up of eras, which are in turn made up of periods, which are in turn made up of epochs, and the fossil record.

Content Standard: 11.2.3

Students will be able to assess the significance of the geological time scale and fossils.

Benchmarks

11.2.3.1 Examine the geological time scale in terms of Eon, Era, Period and Epoch.

11.2.3.2 Examine the types of fossils, the processes of fossil formation and the significance of fossils.

Unit 4: Plate Tectonics

Plate Tectonics is the theory which supports the movement of the Earth's lithosphere. The Earth's lithosphere consists of large, rigid plates that move horizontally in response to the flow of asthenosphere beneath them, and that interactions among the plates at their boundaries, cause most major geologic activities, including the creation of oceans, continents, mountains, volcanoes, and earthquakes.

Content Standard: 11.2.4

Students will be able to understand and explain the plate tectonics with supporting evidence.

Benchmarks

11.2.4.1 Analyse and explain the plate tectonic process and the supporting evidence for the drifting of continents.

11.2.4.2 Apply the understanding of divergent, transform, and convergent plate boundaries to provide evidence supporting plate movement.

Unit 5: Atmosphere and Hydrologic Cycle

Atmosphere is one of the four components of the Earth's ecosystem (the other three are biosphere, hydrosphere, and lithosphere) and is a band of gases enveloping the Earth's surface. The hydrosphere encompasses the total amount of water on a planet. It includes water that is on the surface of the planet, underground, and in the air. The cycle that involves the continuous circulation of water in the Earth to the atmosphere is the hydrological cycle.

Content Standard: 11.2.5

Students will be able to explain the characteristics and movement of water among the mantle, oceans, land and atmosphere of the Earth.

Benchmarks

11.2.5.1 Examine the structure and composition of the atmosphere.

11.2.5.2 Examine and explain the hydrologic cycle including how temperature and pressure are related to the phase changes of water in the atmosphere.

Grade 12

Unit 1: Earth Resources

A natural resource is material that is found in nature and can be used by people. Earth's natural resources include light, air, water, plants, animals, soil, rocks, minerals, and fossil fuels. The origins of Earth resources include the deposition of minerals, coal, petroleum, and natural gas, and their economic development and the regulations relating to the environment in which they are operating in.

Content Standard: 12.2.1

Students will be able to trace the origins of Earth resources including the deposition of minerals, coal, petroleum, and natural gas, and their economic development and the regulations relating to the environment in which they are operating in.

Benchmarks

12.2.1.1 Examine the common minerals, their formations and the uses of economic minerals.

12.2.1.2 Analyse the formation and characteristics of fossil fuels such as crude oil and natural gas.

12.2.1.3 Examine and analyse the exploration and mining of minerals.

12.2.1.4 Examine and analyse the exploration and extraction of oil and gas.

12.2.1.5 Explore and analyse the environmental regulations of mining activities set by the government.

Unit 2: Age Dating

Age dating involves determining the age of the rocks of the Earth. It includes both the absolute (numeric) and relative methods. The absolute methods mostly involve the study of radioactive elements and the relative methods involve the principles of stratigraphy.

Content Standard: 12.2.2

Students will be able to assess the significance of age dating including relative and absolute dating techniques.

Benchmarks

12.2.2.1 Analyse the age dating techniques.

12.2.2.2 Explore the principles of stratigraphy.

Unit 3: Earthquakes and Volcanoes

An earthquake can be described both as a sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the Earth. A volcano is a rupture in the Earth's crust where molten lava, hot ash, and gases from below the Earth's crust escape into the air. Earthquakes and volcanoes both result from the vmovement of tectonic plates within the Earth's crust or mantle, caused by the sudden rapture or repositioning of underground rocks as they release stress; and the set of geological processes that result in the expulsion of lava, pyroclastics, and gases at the Earth's surface.

Content Standard: 12.2.3

The students will be able to understand and explore the processes of earhquakes and volcanoes.

Benchmarks

12.2.3.1 Analyse the process of earthquakes.

12.2.3.2 Analyse the process of volcanoes.

Unit 4: Surface Processes and Groundwater

Weathering is the process by which exposure to atmospheric agents causes rocks and minerals to break down; erosion is the process by which particles of rock and soil are loosened, and then transported elsewhere; and groundwater is water that exists beneath the Earth's surface as underground streams or in aquifers.

Content Standard: 12.2.4

Students will be able to understand and explain the processes of weathering and erosion, and the groundwater system.

Benchmarks

12.2.4.1 Compare and distinguish between mechanical and chemical weathering.

12.2.4.2 Analyse the types and causes of soil erosion.

12.2.4.3 Compare and distinguish between erosional and depositional features.

12.2.4.4 Analyse the types and causes of mass wasting.

12.2.4.5 Analyse the features of the ground water system.

Assessment, Monitoring, and Reporting

The relationship between content standards, benchmarks and performance standards is that they all define students' expected level of proficiency or education quality but at different levels of schooling. Content standards describe the national expectations that all Papua New Guinean students are expected to meet while benchmarks describe the grade-level expectation that all students in a particular grade must meet before proceeding to the next grade. Conversely, performance standards describe students' level of proficiency in a specific knowledge, skill, value or attitude taught in a lesson and measure students' progress towards meeting grade-level expectations and the content standards. Effective instruction and assessment are aligned to performance standards, grade-level expectations, and national content standards.

What is Assessment?

The term "assessment" is generally used to refer to all activities that teachers use to assess students' mastery of what is learned, and to measure and monitor students' progress towards meeting grade-level expectations and the content standards. Assessment is an on-going process of gathering and interpreting information about students' performance and progress towards meeting grade-level expectations as well as the achievement of the content standards described in the subject syllabuses. Data should also be used to help and guide students who are yet to meet grade-level and national expectations to make the required progress towards meeting these expectations.

What is Standards-Based Assessment?

In standards-based curriculum, 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) and measuring, monitoring, evaluating, and reporting their progress towards meeting grade and national-level expectations. Assessment is viewed not only as a measurement activity that is performed after a course or a curriculum topic has been taught (summative), but more importantly, as a continuous process (formative) that provides students' performance data to teachers and students regarding their progress towards achieving the intended standards. Timely and ongoing assessment of student's learning and mastery of what is learned are key to the learning process and the attainment of the desired learning outcomes.

Throughout the year, teachers will be assessing students' performance and progress towards meeting each grade-level benchmark (grade-level expectation) and each content standard (national-level expectation), and using the data to identify areas where a student or a group of students need more attention, and monitor their progress towards meeting the required standards.

Purpose of Assessment

The primary purpose of assessment is to improve students' learning and teachers' teaching. The other purposes of assessment are to:

- improve students' learning, levels of proficiency, and progress towards meeting the expected standards,
- provide data that teachers, schools and Department of Education can use to make informed decisions about how to improve the quality of teaching and learning in the education system,
- inform teachers about the progress of students towards meeting grade-level and national expectations (standards) and enable them to adjust their lesson planning, instruction, and assessment to improve student learning and proficiency levels,
- inform parents and guardians about their students's achievements and status of progress towards meeting national standards; and what needs to be done to close the gaps and enable students to make the progress required to meet these standards, and
- provide information for schools and systems about teaching strategies, resource allocations and curriculum; and other educational institutions, employers and the community about the achievements of students in general or of particular students.

Whatever its purpose, assessment is seen as an integral part of the teaching and learning program rather than a separate process.

Types of Assessment

The following types of assessment have been adopted to assess and monitor students' achievement of the education standards.

- Assessment For Learning
- Assessment Of Learning
- Assessment As Learning

Assessment For and assessment Of learning are also known as formative and summative assessments.

Assessment For Learning

Assessment For Learning (AFL), also known as classroom assessment is different. It is an ongoing process that arises out of the interaction between teaching and learning. It is not used to evaluate learning but to help learners learn better. It does so by helping both students and teachers to understand;

- the performance standards, grade-level benchmarks and content standards that students are expected to meet to achieve the desired level of proficiency or quality of education,
- where each learner is in relation to the national curriculum standards,

- where they need to be, and
- what they need to do to make progress towards meeting the expected standards.

Assessment Of Learning

Assessment Of Learning (AOL), is the use of a task or an activity to measure, record, and report on a student's level of achievement in regards to specific learning expectations such as unit tests and end of term or year exams. It is normally referred to as Summative Assessment.

Assessment As Learning

Assessment As Learning (AAL) is the use of an assessment task or an activity by the teacher in his/her everyday teaching. This strategy provides students with opportunities to understand what they have learnt or are having difficulties with. Self and peer assessments allow students to reflect on their own learning and identify areas of strengths and weaknesses. These tasks offer students the chance to set their own personal goals to improve their own learning.

Diagnostic Assessment

Apart from these three main types of assessment, teachers are expected to do the diagnostic test/assessment to identify strengths and weaknesses in students. This can be done before any teaching and learning of a new content and for new entry levels for students.

Diagnostic assessment is a form of pre-assessment that allows a teacher to determine students' individual strengths, weaknesses, knowledge, and skills prior to instruction. It is primarily used to diagnose student difficulties and to guide curriculum and lesson planning.

Assessment Methods

These are some methods that teachers can use to assess students' performance.

- Observing students during the lesson
- Conferencing with students
- Student's Portfolio
- Tests
- Assignments (projects/reports/quizzes/presentations/practical work samples)

Recording and Reporting

Recording

Teachers must keep accurate records of students' performance and achievements. They must report these achievements in fair and accurate ways to parents, guardians, teachers and students. Examples of recording methods include;

- anecdotal notes in a journal or diary,
- checklists,
- portfolios of students' work,
- progressive records, and
- work samples with comments written by the teacher.

Reporting

Reporting is communicating clearly to students, parents, guardians, teachers and others the information gained from assessing students' learning.

Students' reports should be based on assessment information collected from ongoing assessments. Schools will decide on how best the reports will be presented to suit the needs of their communities. Methods will include interviews and written reports. Written reports should include;

- a written record of progress made towards meeting grade-level expectations and the attainment of content standards by each student since the previous report,
- a written record of each student's learning and mastery problems and what needs to be done to make the required progress towards meeting grade-level benchmarks and national content standards, and
- information about students' attitudes, values and general behaviour.

Monitoring and Evaluation

Assessment information should be used to make judgments about students' achievements and monitor their progress towards meeting grade-level expectations and national content standards.

Monitoring

Data from performance assessment should be used to monitor and report on students' performance towards meeting grade-level and national expectations. Performance standards or indicators should be used to report and keep a tab on each students' progress towards meeting the expected level of proficiency or competency. Teachers should develop a clear and measurable set of performance standards or indicators to monitor and report on students' progress and achievements on a regular basis.

Evaluation

Teachers should use assessment data to evaluate the effectiveness of their teaching and their students' learning, and make improvements to their teaching practices in order to improve student learning outcomes. Evaluation tools such as written records, questionnaires, logs and diaries, submissions or records of meetings and discussion with general staff members, teaching staff, parents and other community members should be used to evaluate students and teachers' competency levels, and make informed decisions about how these could be improved.

Glossary

Terms	Definitions
Assessment	Activities teachers use to help students learn and to monitor their progress.
Assessment As/In Learning	It is a design to inform students what they will do well and what they need to improve on daily/weekly bases as an integral part of everyday teaching and learning such as exercise, activities or experiments students do or practice in each lesson.
Assessment For Learning	A common form of assessment. It is an ongoing 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 set period and is generally carried out at the end of a course or project. Sometimes it is referred to as summative assessment and is evaluative.
Assessment Strategies	Different styles and ways of assessing students work.
Assessment Tasks	On-going test of knowledge, skills and attitudes/values gained throughout the unit or topic.
Benchmark	Benchmarks are specifications of content standards or more detailed descriptions of a specific level of performance expected of students at ages, grades, or levels of development.
Content Standards	Broadly stated expectation of what students need to know, understand, and be able to do as intended by the syllabus. They define the breadth and depth of know- edge, skills and processes and attitudes and values that are to be taught in the strand, unit or topic.
Evidence Outcomes	Evidence outcomes are indicators that indicate students' progress towards meeting an expectation at the mastery level. They measure students' mastery and application of knowledge, skills, values, and attitudes at grade and cluster levels.
National Education Assessment	Is a learning system and is a systematic and ongoing process of collecting and interpreting information about students' achievements.
Performance Standard	A descriptive statement of the knowledge and skills that students may display as they work towards the achievement of the content standard. Performance standards make content.
Science process skills	Science process skills are the skills that scientists use to study and investigate the world. They are the vehicle for generating content and a means by which concepts are formed.
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.
Standards-Based Education (SBE)	Is an academic program in which clearly defined academic content, performance standards are aligned. It spells out what schools and communities need to do to ensure achievement of expectations. It is a philosophical concept that is centered on the process of planning, developing, delivering, monitoring and improving education programs.
Standards-Based Curriculum (SBC)	It is a cumulative body of knowledge and set of competencies that form the basis for quality education.

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