

Science

Upper primary

Teachers Guide

2003



Papua New Guinea
Department of Education

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Central

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Eastern Highlands

East Goroka, West Goroka, North Goroka, Okiufa

East New Britain

Kerevat, Malaguna, Napapar, Vunairoto, Kalamanaguan.

Madang

Bahor, Holy Spirit, Megiar, Sagalau, Bogia, Jomba,
Lutheran Day, Gum, Dangsai, Dor

Manus

Kari, Kawaliap, Lombrum, Buyang, Mokoreng, Naringel, Lundret,
Lorengau East, Pombrut, Dungomashi, Worei, Sohoneriu, Ahus,
Ndrolokou,

Milne Bay

Alotau, Ladava, Rabe, Divinai, Siasiada, Sideia, Logeia, Fife Bay, Naura,
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Inservice Units

A set of inservice units have been written to support the implementation of the upper primary reform curriculum.

These units are:

- self-instructional, so you can access them according to your needs when and where suits you,
- self-paced, so you can study at your own pace,
- outcomes-based, so you can experience outcomes-based approaches to education,
- based on adult learning principles of learning, doing, sharing and reflecting,
- practical and related to your daily work as a teacher or a supervisor,
- collegial, so you can learn together in small groups, whole school or cluster settings,
- accredited with PNG Education Institute, so you can improve your qualifications,
- designed to promote best practice, so you can effectively implement the curriculum,
- applicable across Upper Primary Syllabuses.

These units integrate principles contained in the *National Curriculum Statement (2002)* and the *National Assessment and Reporting Policy (2003)*.

These units can be used in conjunction with this Teachers Guide.

Secretary's Message

Primary teachers are generalist teachers and this Teachers Guide is for all teachers in Upper Primary schools. It is one of a set of seven guides written for teachers of Upper Primary, Grades 6 to 8.

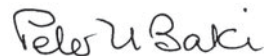
The Upper Primary syllabuses identify the learning outcomes. The Teachers Guides give more information about what to teach and describe ways of implementing the syllabuses. The Teachers Guides are supported by the Inservice Units that have been written to assist the implementation of the Upper Primary syllabuses and provide valuable information about teaching.

I also encourage teachers to work closely with members of their school communities to ensure that local community needs are met.

Important reforms to our education system will only be successful with the support and understanding of teachers. Every Teachers Guide contains detailed information about appropriate subject content, a broad range of ideas and strategies to help teachers use and understand the subject syllabuses. Each Guide is written for a particular subject but many of the ideas and strategies can be used with different subjects or when using an integrated approach to teaching and learning.

Teachers should read each Guide carefully and become familiar with the content of each subject as specified in the Elaborations of outcomes section in each guide.

I encourage teachers to try out the ideas and strategies that they believe will be effective in their schools with their students. Teachers have the right to modify and amend these ideas to suit their local circumstances.



Peter M Baki
Secretary for Education

Introduction

Purpose

The Teachers Guide is to be used in conjunction with the Science Syllabus and other Teachers Guides in Upper Primary. The main purpose of the Teachers Guide is to help you to implement the Science Syllabus in Upper Primary. It provides you with information and processes to:

- use the elaborations to identify relevant content and contexts,
- develop units of work or projects relevant to your students' needs, interests and social and economic opportunities,
- select appropriate teaching and learning strategies,
- plan a school based program suitable to your school,
- plan and conduct assessment to monitor students learning and achievement of learning outcomes.

How to use the Teachers Guide

When you receive this book, you need to do the following:

- read it carefully and grasp the flow of the content,
- read it carefully so that you become familiar with the Strands, the Substrands, the processes and skills, the Elaborations of learning outcomes and the teaching and learning strategies,
- identify specific projects based on the 10 learning outcomes for Grades 6, 7 & 8,
- consider how to use the information to develop your own programs and units of work.

Some options for developing programs include:

- teaching one of the sample units of work from a particular Strand,
- using the sample units of work as a guide to develop your own units of work relevant to local contexts,
- using the sample unit of work as a guide to develop integrated units of work with other subject outcomes.

Nature of science at Upper Primary

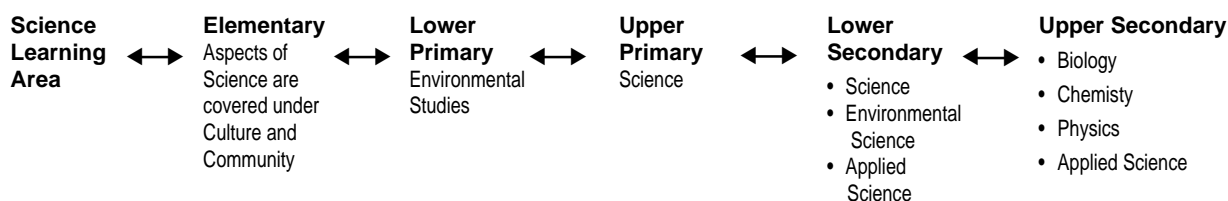
Science is best understood when it is related to real-life situations. It is important to present Science to students with an emphasis on Papua New Guinean contexts and issues. Teaching in local contexts allows students to be aware of how Science influences their everyday lives and how it can inform personal, community and government decisions.

The skills developed through a study of Science will prepare students for continuing studies, for entering the work force or for living in the community. Through learning Science in schools, students will become aware of some of the natural laws that explain the world around us. They will learn to gather evidence according to methods developed in Science such as hypothesising, experimenting, observing, recording, interpreting, analysing and drawing conclusions. The nature of Science provides students with many opportunities to solve problems using recognised scientific thinking skills and procedures.

Students at primary level are inquisitive and active by nature and enjoy participating in hands-on activities. They learn best by exploring the environment in which they live. It is recognised that at the Primary level of schooling, students like to work with concrete concepts and they learn best if they are encouraged to manipulate real objects in real-life situations. For them, learning is observing and doing rather than rote learning. A student-centred approach must provide the learner with multiple opportunities to work in a variety of contexts and to seek meaningful solutions to problems using the knowledge, skills and processes outlined in the Grades 6 to 8 Science Syllabus.

Links with different levels

The Science learning outlined in the Syllabus and supporting Teachers Guide builds on aspects of Science covered under Culture and Community at Elementary level, Environmental Studies in Lower Primary and makes links to the body of Science knowledge covered in Lower and Upper Secondary. Students leaving school at the end of Grade 8 should have basic scientific knowledge and skills as well as a foundation for studying Science at Secondary level. These links can be seen in the diagram below.



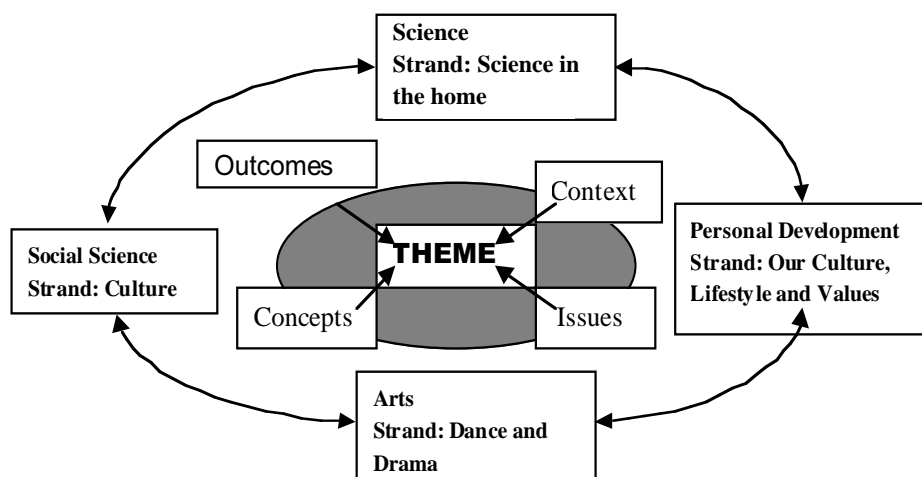
Links with other subjects

Teaching and learning can be organised in an integrated way as a whole school program or within a single subject. The Science outcomes in Upper Primary can be linked with:

- outcomes from other Upper Primary subjects to create themes for units of work,
- outcomes across Strands within a particular subject or Grade,
- outcomes within one Strand of one subject for one Grade.

Teachers can use the Science outcomes described as knowledge, skills and attitudes along with concepts, contexts, topics or issues based on the nature of the course to develop integrated units of work.

Below is a model that shows how related Strands in Arts, Personal Development, Science and Social Science may be linked to plan integrated units of work in Grade 6.



Links across the Science Strands

Use the same model above but replace the names of the subjects with Strands and Substrands from the Science Syllabus in order to create units of work for Science that include teaching and learning activities, assessment tasks and programs.

Units of work from one outcome

Not all outcomes will easily be integrated. Where the outcomes do not link naturally there should not be any integration taking place. Instead the outcome should be taught by itself and a unit of work created to teach that outcome to students.

Key Features

The key features outlined in this section are identified as unique to Science and important in the planning, development, and implementation of whole school programs. The key features of the Grades 6 to 8 Science curriculum emphasise recommended knowledge, skills and processes and provide ideas on how to teach Science without a laboratory and practical Science.

Science without a laboratory

Science without a laboratory is a reality for many Papua New Guinean schools. With this understanding, the Grades 6 – 8 Science Syllabus together with the Teachers Guide have been specifically designed to assist teachers in planning and developing worthwhile learning opportunities for all students irrespective of the school’s resources. Science processes and procedures can be taught and learned without a conventional Science laboratory. Students and teachers are encouraged to use the resources that are readily available to them in their own surroundings. Local knowledge and situations become very important in this approach.

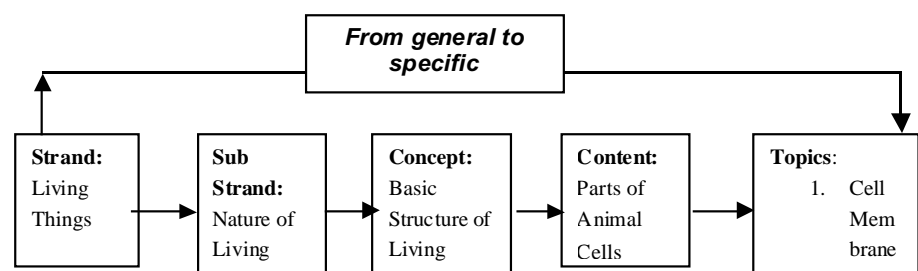
Content, skills and processes

Each of the four Strands in the Science Syllabus identify a particular aspect of Science and each outcome statement within each Strand has content, skills and process components. The principal tool for planning learning experiences and assessment activities are the learning outcomes.

Recommended content

To assist teachers in planning, the Science Syllabus organises the recommended content into Strands, Substrands, and Grades. Students will be given many learning opportunities to develop an understanding of the recommended content and opportunities to demonstrate their achievement of the outcomes.

The diagram below explains how teachers can work from the Strands and Substrands, through to teaching and learning programs, when using the Science Syllabus.

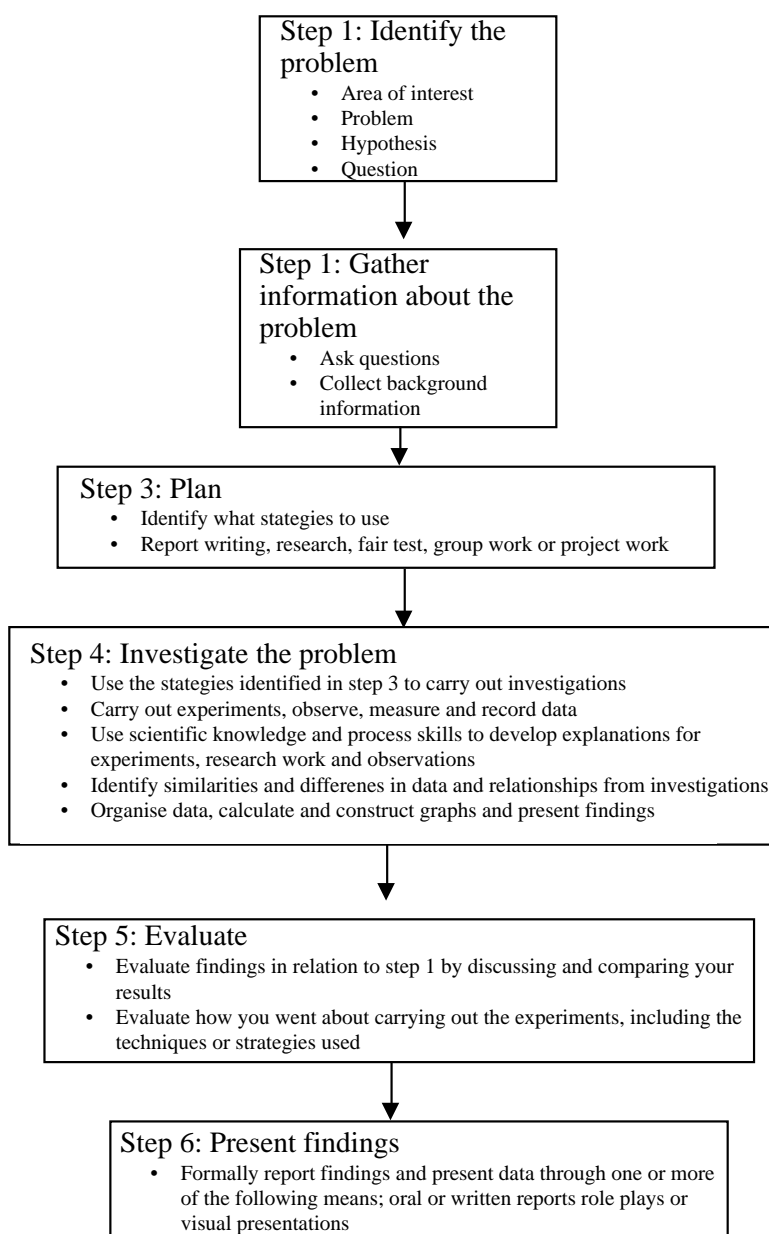


Recommended processes and skills

Primary school students learn best when given opportunities to experience many and varied hands-on activities. Early exposure to practical Science, at a level that is appropriate to the age of the learner, is seen as advantageous in building future capacity for working scientifically.

Science processes

Science teachers, students and others who are involved in teaching and learning Science use these processes when carrying out investigations. These processes can be simplified to suit the learning needs of the students.



Science skills

Working Scientifically which is a skills-oriented Strand for Upper Primary Science, helps empower students to implement problem-solving strategies to help them understand the world around them. There are three aspects of working scientifically:

- investigating students use different ways of collecting information and give reasons for collecting it in a particular way,
- comprehending students use different ways of making sense of information and check the validity and reliability of information,
- communicating students use a variety of situations and means of communications to present findings.

When selecting contexts and planning units of work, it is important that the skills and processes listed in the table below be developed using the outcome statements, indicators and elaborations found in the Grades 6 to 8 Science Syllabus and Teachers Guide. The skills and processes in this table are to complement those listed in the 'Elaborations of Outcomes' section of the Teachers Guide.

You can work with other teachers to determine the Grade at which these skills are most appropriate, based on the learning needs of students. Remember that some of the specific Science skills and processes are to be taught in all Grades but using different contexts and varied activities. For example, measuring is a fundamental Science skill that is common in all Grades but varies in level of difficulty and the resources used for measuring.

Investigating	Comprehending	Communicating
<ul style="list-style-type: none"> • collecting information • exploring phenomena • seeking reasons • hypothesising • looking for patterns and meanings • making observations • measuring • playing with toys • accessing resources • designing experiments • engaging with problems • identifying and controlling variables • making plans • handling materials • performing investigations • representing data • using written and oral texts as references • cooperating • clarifying and challenging values • expressing a point of view • actively listening • formulating questions • experimenting 	<ul style="list-style-type: none"> • making decisions • solving problems • predicting • taking action • classifying • reporting in both oral and written forms • logical thinking • talking and listening • analysing • interpreting data • making suggestions • using ideas, theories and principles • assessing • constructing meanings • formulating and elaborating ideas • making generalisations • looking for alternatives • making comparisons • making links • applying ideas and concepts • making judgments • reflecting • drawing conclusions • examining and evaluating • gathering data 	<ul style="list-style-type: none"> • interpreting data • observing • creating • comparing • recording • working safely • making models • developing a point of view • clarifying ideas and concepts • discussing • exploring and elaborating ideas • listening and questioning • responding and debating • using scientific terminology • negotiating • supporting ideas • arguing a position • constructing models • creating presentations • creating tables and graphs • summarising and reporting • using scientific report genres

Practical science

Students need to be confident in using basic Science equipment such as a ruler or reading an instrument correctly. The Grades 6 to 8 Science curriculum encourages learners to be active participants in developing and monitoring growth in the skills linked to working scientifically.

The ongoing assessment of students' ability to demonstrate outcomes is a fundamental component of an outcomes approach to learning. Not all practical work needs to be assessed. The intent of collecting information from ongoing assessment is to determine students' growth within the boundaries of the learning outcomes.

Students are encouraged to be active participants in the assessment process by knowing the types of assessment methods and the criteria to be used for assessment prior to the start of a learning unit.

Teaching and learning strategies

Teaching and learning

A student-centred approach to teaching and learning encourages students to actively acquire knowledge, skills and attitudes. The teacher takes on the role of guide and facilitator of students' learning. The following three teaching and learning approaches and related teaching and learning strategies use a student-centred approach.

Teaching and learning approaches and strategies

A teaching and learning approach is usually a model, consisting of phases, that organises teaching and learning over a period of time. A teaching and learning strategy is a way of developing teaching and learning within each phase of the approach. For example, the 5Es approach consists of 5 phases: engage, explore, explain, elaborate and evaluate. Several teaching and learning strategies such as group work, experiments, discussions and surveys could be used to develop students' learning in each phase of the approach.

Student-centred approaches

The three teaching and learning approaches described in this section are student-centred and can be used by teachers to develop students' achievement of the outcomes.

Approach 1: the 5Es

This '5Es' is a constructivist approach based on the idea that students learn best when they participate in activities that give them opportunities to work things out for themselves. As the names suggests, there are five phases; engage, explore, explain, elaborate and evaluate.

Engage

In this phase:

- teachers engage students in activities that capture their interests and stimulate curiosity,
- students raise questions,
- teachers verify students' prior understandings of the topic,
- students compare ideas.

Explore

In this phase students undertake hands-on activities where they:

- experience the phenomenon or concept,
- explore the questions they have raised, test their ideas and solve problems.

Explain

Only after students have had opportunities to explore, do they have opportunities to:

- compare their ideas with scientific explanations,
- use scientific terminology,
- construct explanations that can be justified using information collected.

Elaborate

In this phase students have opportunities to:

- apply what they have learnt to new contexts,
- develop a deeper understanding of the problem or phenomenon as they discuss and compare ideas.

Evaluate

In this phase students and the teacher:

- look for evidence of changes in students' ideas, beliefs and skills,
- evaluate what students know and can do.

Example of the 5Es teaching and learning approach

Phase of the teaching and learning approach	Examples of teaching and learning activities	Sample Questions
Engage Create interest Reveal personal ideas and beliefs	Brainstorming, concept mapping, developing questions, demonstrations, asking open-ended questions.	What do you mean by . . . ? Tell me more about . . . ? I find that hard to understand: tell me . . . ? What makes you think . . . ? How do you know . . . ? How did you find out about that idea . . . ?
Explore Explore questions and test student ideas	Prioritise class questions, group tasks, investigations, test ideas, research.	How are you going to . . . ? How will you be able to tell . . . ? Is that the question you really want to ask . . . ? What will you do when . . . ? It might be a good idea to think about . . . How will you know it . . . ? What do you need to find out more about . . . ? Why are you doing it that way . . . ? How will you be sure it is a fair test . . . ? How did you arrive at that idea . . . ?
Explain Compare ideas Construct explanations and justify them in terms of observations and data	Reporting, group discussion, gathering information.	What do you think others might think about this . . . ? How is that idea different to . . . ? Some people say . . . Does that fit with your idea . . . ? How did you arrive at that idea . . . ? How will you be able to tell . . . ?
Elaborate Apply concepts and explanations in new contexts	Further practical work, videos, debates, research.	Same as the <i>explore</i> phase. How could you verify that . . . ? What will happen if . . . ?
Evaluate Gather evidence of changes in students' ideas, beliefs and skills	Refining concept maps, responding to open-ended questions, reflection.	How have your ideas changed . . . ? How is that different to . . . ? It seems you are not sure about . . . Do you have any questions about . . . ? What have you found out? What else do we need to know . . . ? What else might you do to be really sure of that . . . ?

Approach 2: the interactive approach

The interactive approach involves a teacher-student partnership in which the student and teacher discuss and cooperate in selecting the topic. The students are active participants and this helps improve their understanding about familiar and unfamiliar concepts as well as their learning processes. There are five phases in this approach; preparation, exploration, students' questions, investigations and reflection.

Preparation

In this initial phase, teachers:

- select the topics jointly with students,
- verify students' prior understandings of the topic,
- assemble background information.

Exploration

In this phase students:

- clarify the topic and focus their thinking on particular aspects of the topic,
- participate in an activity, preferably hands-on, that enables them to become more familiar with the topic.

Students' Questions

In this phase students:

- explore the topic and pose further questions for investigation.

Investigations

In this phase students and the teacher:

- select questions to investigate,
- plan and carry out investigations to finalise their answers to the selected questions.

Reflection

In this phase students have opportunities to:

- compare their views on the topic before and after exploration, questioning and investigation,
- reflect on what has been determined and what needs further exploration.

Example of the interactive teaching and learning approach

At every step of this approach, there must be constant interaction and consultation between the teacher and the student.

Name:

Class

Outcomes

Preparation Phase

Topic:

What do I know about this topic?

What background information do I need?

Exploration Phase

What are some of the things that I am expected to do in this topic?

What are some of the problems I am expected to come across when trying to understand this topic?

How will I explain these to my teacher: as a report, demonstration, role play or oral report?

Students' Questions Phase

Are there other questions that I should ask my teacher about?

Are there any other questions I will need to explore?

Investigations Phase

The following are my findings during and after the investigations

Reflection Phase

The following are my views before and after the exploration.

Approach 3: Predict, observe, explain

This approach is based on students drawing on their own experiences to make predictions. There are three phases in this approach: predict, observe and explain.

Predict

In this phase:

- teachers pose the question and allow time for students to think about and clarify the question,
- students make a prediction and give reasons for their prediction,
- teachers and students accept all predictions without judgement,
- students may change their minds as they share their predictions and reasons.

Observe

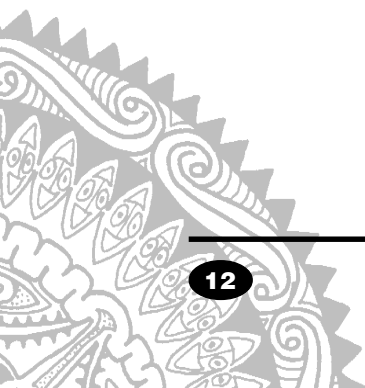
In this phase teachers or students perform relevant activities, either as a class demonstration, in a group or individually, and students record their observations.

Explain

In this phase students attempt to explain their observations which may conflict with their original prediction. Teachers encourage students to reflect on their predictions and modify them to better fit the observations.

Example of the predict, observe, explain teaching and learning approach

Demonstration	Sample Format
<ul style="list-style-type: none"> • You have been provided with: <ul style="list-style-type: none"> – Balloons – Plastic Cups (2) • Blow up a balloon a little way and then have your partner firmly hold two plastic cups against opposite sides of the balloon (the open end of the cups come in contact with the balloon) <p>Now WAIT!</p> <ul style="list-style-type: none"> • Predict what will happen when you fully inflate the balloon and your partner lets go of the cups. Record your predictions and write your reasons for this prediction before you carry out the investigation. <p>Now PROCEED!</p> <ul style="list-style-type: none"> • Fully inflate the balloon and let go of the cups, Observe what happens. • Explain what was observed and your predictions and try to find a solution to any difference between your prediction and observation. 	<p>Prediction</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>Reasons for prediction</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>Observation</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>A solution to your prediction and observation , if necessary.</p>



Teaching and learning strategies

This table outlines some student-centred teaching and learning strategies that are appropriate for Science.

Teaching and Learning Strategies	Descriptions and Examples of Strategies
<p>Survey</p>	<p>A survey is usually used to find out what other people think about an issue. It involves interviewing people or giving out questionnaires. Results may be presented as reports, tables or graphs.</p> <p>Examples of survey topics Drinking water supply, household wastes, explaining natural phenomena, uses of plants, traditional Science and effects of drought</p>
<p>Testing predictions</p>	<p>This involves making a prediction and testing it. Choose a problem you want to investigate, carry out background research on the problem and predict what might happen.</p> <p>Examples of issues Energy content of different fuels, effects of soap detergents on the environment, water quality, effectiveness of insecticides, strength of a sling-shot, effects of salt water on plants, what makes a healthy soil.</p>
<p>Collecting and observation</p>	<p>Observing is an open ended activity. Observations may be carried out over a short or long period. Specific or general observations may be made and data collected to be later classified and analysed.</p> <p>Examples of observations Position of sun at sunset, position of Southern Cross, bird study, changes in tides, growth of seedlings, pollution on coral reefs or other areas.</p>
<p>Making models</p>	<p>Models can be used to show a Science concept. Models can be working models or built to scale if they are demonstration models.</p> <p>Examples of models Worm farm, butterfly farm, waste disposal, food drier, making a telescope, weather station and operation, model house circuit.</p>
<p>Excursions and field trips</p>	<p>Excursions and field trips are a valuable and positive addition to any Science program. Science teachers should take every opportunity to study and increase their knowledge of local resources and places suitable for excursions. On any excursion, identify safety measures required to ensure students' safety.</p> <p>Examples of excursions Use the local environment outside the school, both natural and built, and obtain the support of local community agencies, local government departments, conservation groups and local industries and consider local resources and landscapes such as geological formations, rivers, mining sites, fisheries and hydro-electric plants.</p>
<p>Demonstrations</p>	<p>Science demonstration lessons are usually practical lessons where demonstration steps or procedures are outlined and then followed, while others are observing and taking notes. Demonstrations can be conducted by the teacher, students or an expert from a Science related background. Students can then repeat the same demonstration lesson. In any student demonstration, supervision is required at all times.</p>
<p>Projects</p>	<p>Upper Primary Science Projects should focus on practical work carried out by one or more students over a number of lessons. The students can demonstrate physically their understanding of the outcomes in various activities they have chosen to investigate.</p> <p>Examples of projects Studying marine life, pollution or erosion, food sources, weather and climate change, monitoring rainfall, growth of particular plants, animals of the neighbourhood, making an aquarium with fish, snails, water plants, sand and rocks.</p>

Teaching and learning strategies	Descriptions and examples of strategies
Role play	<p>In role play students imitate the behaviour or characteristics of something. For example, they can perform how energy is passed on from one form to another by giving themselves names that represent each type of energy and then upon the word 'go', the student representing the source of energy taps the next student and so on till the last.</p> <p>Examples of role play How energy is passed from one form to another, electrical circuits, behaviour of particles in matter, food chains and food webs, digestive system in action, force and friction.</p>
Peer teaching and learning	<p>This is organised as a partnership activity. One student performs while the other observes and assists in making corrections and suggesting new ideas and changes. The teacher's role in this strategy is to observe as well encourage positive interaction and effective communication through which the intended outcome is achieved.</p> <p>Examples of peer teaching and learning This strategy can be applied in most Science topics.</p>
Group Work	<p>The purpose of group work is to give students opportunities to share ideas and at the same time learn from group members. Every group should have a group leader to supervise the group's activities such as delegating tasks and consulting the teacher. Group work activities can take place anywhere: in the classroom, under a tree, on a riverside, at the beach, in a forest or school garden.</p> <p>Examples of group work This strategy can be applied in most Science topics.</p>
Research	<p>Research involves collection of data and analysing them in order to gain new information or knowledge about a particular subject. Any form of research must be well planned and those who will be involved must be notified well in advance.</p> <p>Examples of research Topics for research could include: common diseases in their local community, certain species of animals that are becoming rare in the local area, erosion of river banks or seashores, food that is unsafe for human consumption, rubbish dumps being a health hazard to the community.</p>
Discussions	<p>Discussions are a way of exploring issues. Discussions can occur between teacher and students and students and students.</p> <p>Examples of discussion topics This strategy can be applied in most Science topics.</p>
Debates	<p>A debate is a fair and formal way of discussing a topic or issue. It normally takes place after preparations from two groups – one for the topic and one against the topic.</p> <p>Examples of debate topics Traditional drugs and medicines are more effective for curing certain diseases. Manufactured food is better than local food. Chemical fertilizers should be used to treat agricultural and commercial crops.</p>
Science clubs	<p>Students with the help from their teachers can form Science clubs within each class, Grade or one for the whole school. The members are responsible for organising Science activities that they wish to explore further. The club does not necessarily need funds to carry out these activities. Students should make use of local resources available in the school or community.</p> <p>Examples of Science Club activities Activities could include organising meetings as well as take part in extra curricular activities that are associated with Science, such as inviting guest speakers to talk to club members, forming a daily bulletin team that places notices on a bulletin board for the whole student body to read for information and producing daily or weekly Science quizzes for interested students.</p>

Teaching and learning strategies	Descriptions and examples of strategies
Science day or night	The Science Club or teachers organise a day or night for the students to show their products and models from Science lessons and to conduct demonstrations for other students, parents and community members. Students are given the opportunity to talk to other students as well as the members of the public to share their learning.
A fair test	A 'fair test' means controlling the variables and changing one variable at a time in order to find out which change causes a particular result. Students observe and record what they see and compare it to what they thought would happen. They ask questions such as why, how and what if? Students then test their models and write up their findings. This strategy is appropriate for introducing students to the nature of a controlled investigation. It requires them to recognise the various kinds of variables. That is, they identify what is to be changed, what is to be measured and what is to be kept the same.
Open investigations	<p>In open investigations students actively engage in all aspects of scientific investigation. Students and teachers are encouraged to identify a problem and ask questions, design and plan relevant activities with clear steps to follow, carry out activities using scientific knowledge, skills and processes to solve the problem, collect results and data and draw conclusions and make decisions for actions and follow-up.</p> <p>Examples of open investigations</p> <p>Experiments, demonstrations, excursions and research.</p>

Sample student worksheets

Planning and reporting worksheet for an short-term open investigation

This sample is useful for activities that require students to work as small groups or individuals during a lesson.

Open Investigation

Name: _____ Class: _____

Other members of the group:

Outcomes:

Step 1: Identify a problem and ask questions

I am going to investigate . . .

What I think will happen . . .

Why I think this will happen . . .

Step 2: Design and plan activities with clear steps to follow

What I am going to do?

What I will need?

Step 3: Carry out activities using scientific knowledge, skills and processes to solve the problem using identified steps outlined in Step 2 above.

How I will make it happen?

Step 4: Collect results and data and draw conclusions

What happened?

Was this what I predicted?

Why did it happen this way?

What was difficult?

How could I improve this investigation?

Step 5: Make decisions for actions and follow up

What will I do next because of my action and decision?

Planning and reporting worksheet for a long-term open investigation

This sample is useful to use in project work and other practical tasks that require a lot more work over a long period.

Open Investigation

Name: _____ Class: _____

Class or Group members:

Stage 1: Getting started: Topic, aim, title

Which method or methods will I use to gather information? Examples could be survey, observations or experiments.

What notes and background knowledge do I need?

Use the points above to develop an aim for your project.

Use the aim to develop a title.

Stage 2: Planning materials, personnel, organisation of activities, safety

How will I carry out the project?

Where will I do most of my work?

Who will I need to contact or work with?

What safety measures are there? These might be measures for approval such as letters

How often will I check with my teacher?

Stage 3: Carrying out task

Carrying out the tasks, asking questions, collecting data, consultations with teacher, checking progress.

Conduct any tests, observations or experiments needed to gather information.

Stage 4: Results and products

Results and products, consultation with teacher, changes made

Show completed task to teacher for further assistance.

Collect and compile test results. This will be completed by . . .

Stage 5: Reporting

Explain processes, products or results through notes, demonstrations, written or oral reports or models.

How do I present my final product?

Planning and reporting worksheet for a fair test

This is useful when students want to see what happens when certain conditions are changed within a test and others are kept as they are.

Open Investigation

Name : _____ Class: _____

Other members of the group:

Outcomes:

What are you going to investigate?

Example: To see how fast a nail will rust if placed in water, saltwater and exposed to the air.

What equipment will you need?

Example: 3 nails, fresh water, saltwater, empty glass

What do you think is going to happen? Explain why?

Example: I think the nail in the saltwater will rust faster than in water and air. This is because saltwater contains chemicals that will make the nail rust faster.

What will I keep the same?

The nail placed in a glass exposed only to the air.

What will I change?

Place one nail in fresh water and the other in saltwater

Draw your set up here.

What will I measure?

Observe each day and record what you see happening to each of the nails.

What happened?

Describe your observations and record your results.

Example: The nail in the saltwater rusted very quickly. This was because saltwater contains substances that helped the nail to rust much faster than in freshwater and when exposed to the air.

Can your results be presented on a graph or a table?

Example: Use graph paper or draw a table from information given above to complete this.

What do your results tell you?

Try to use scientific terms to explain the relationships in this experiment.

Were your findings different from your prediction at the start?

Explain

How can you improve this experiment if you had some difficulties carrying it out?

Assessment

General information on assessment

In an outcomes based approach to education, a student's performance is assessed according to demonstrations of what he or she knows and can do. This approach uses criterion-referenced assessment. Teachers work with students to develop specific assessment criteria for each assessment task that are derived from the learning outcomes. These criteria are used to judge the performance of individual students. Criterion-referenced assessment does not compare the performance of one student to another.

What is assessment?

Assessment is the ongoing process of identifying, gathering and interpreting information about students' achievement of the learning outcomes (*National Assessment and Reporting Policy, 2003*).

Assessment requires that students are able to show what they have learned, they can demonstrate what they know and can do. There is an integral relationship between the experiences that promote learning and the assessment methods that facilitate students' demonstrations of learning outcomes. The assessment process is based on the learning outcomes and assessment methods and instruments are selected by teachers to enable students to demonstrate the knowledge and skills outlined in the outcomes. The experiences provided for students will determine the specific assessment task to be used. To ensure fairness in assessment and reporting, specific assessment criteria are developed by the teacher to suit the assessment task and to describe characteristics of ideal responses.

Purpose of assessment

The purpose of assessment is to improve students' learning and is focused on students' demonstration of learning outcomes. The information obtained from assessment will be used to:

- provide feedback on students' progress,
- inform decision making about student learning,
- improve teaching and learning strategies and the effectiveness of teaching, learning and assessment programs.

The *National Assessment and Reporting Policy* outlines the following purposes for assessment and reporting:

- feedback is provided to the individual learner and the teacher on students' progress towards the achievement of the learning outcomes,
- students improve their standards of achievement by knowing what they do well and where they need to improve,
- evidence gathered from assessments is monitored and used by teachers to improve their teaching and help students raise their standards of achievement,

- assessment information is reported to parents, guardians and other stakeholders to enhance their understanding of students' standards of achievement,
- reports are used to inform students' choices of suitable careers and selection for educational progression and employment.

National Assessment and Reporting Policy, 2003, p. 5

Principles of assessment

Assessment and reporting must be culturally appropriate for Papua New Guinea. For assessment and reporting to be effective, it should:

- focus on students' demonstrations of learning outcomes,
- be comprehensive,
- be valid and reliable,
- take account of the needs of individual students,
- reflect equity principles,
- be an integral part of the teaching and learning process,
- provide opportunities for students to take responsibility for their own learning and to monitor their own progress,
- be based on a criterion-referenced approach.

Upper Primary statement about assessment

The *National Assessment and Reporting Policy* states that assessment at Upper Primary should:

- be flexible and use a range of assessment methods,
- be continuous and show the development of knowledge, skills and understanding in all school subjects,
- use local cultural approaches to assess and report students' achievement where appropriate,
- be mainly internal but may include external assessment at the end of Grade 8,
- use criterion referencing and learning outcomes as the basis of external assessment at the end of Grade 8,
- result in the issue of National Certificates of Basic Education approved by the Board of Studies reporting academic achievement, attitudes, values and other relevant achievements.

Roles and responsibilities

Role of teachers

The *National Assessment and Reporting Policy* (2003) describes teachers' roles in assessment to:

- develop and implement effective school assessment and reporting practices within school assessment and reporting programs,
- discuss with students the assessment, recording and reporting procedures that meet the learning needs of individuals and groups of students,

- develop students' knowledge, skills and understanding of effective assessment and reporting methods,
- maintain and share relevant records of students' progress whilst maintaining confidentiality where appropriate,
- plan tasks and activities which provide sufficient evidence to show that particular learning outcomes have been achieved,
- report students' progress and achievements to students, parents, guardians, teachers and others,
- use assessment information to inform and enhance their teaching and learning practices,
- use assessment information to guide students to career paths,
- make valid reports on students' achievement of outcomes, attitudes and values using the appropriate reporting or certification systems.

Role of students

Students at Upper Primary have the responsibility to:

- use assessment information to improve their learning,
- ensure that they reach their highest potential.

Factors to consider when developing assessment methods and tasks

Below are three factors that may influence teachers' choices of assessment methods and tasks.

1. The experience students have with different assessment methods, tasks and criteria

It is important that students learn how to use different assessment methods and tasks effectively. For example, they need:

- practice in peer assessment and self assessment,
- an understanding of certain features used in written and oral tasks,
- skills in making the best use of time in tests or other assessment tasks.

Familiarity with these methods may give students a degree of ownership of a particular task and a greater willingness to participate actively.

2. Selecting appropriate assessment tasks

Teachers need to select assessment methods and tasks that align with teaching and learning activities. For example, a unit of work that emphasises discussions and presentations will not lend itself well to a pen and paper test.

3. A variety of assessment methods

A variety of assessment methods should be used to take account of students' different levels of understanding, learning styles and backgrounds.

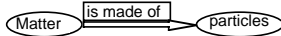
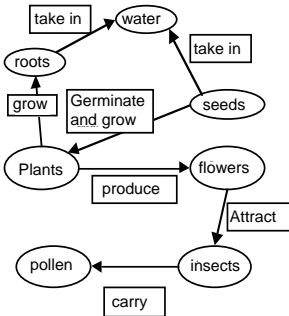

Assessment methods

Assessment methods should be selected according to the context in which the learning outcome is being demonstrated and the type of evidence required. Teachers are encouraged to familiarise students with the methods through modelling and practice.

This table contains various ways of gathering information about students' demonstrations of outcomes. Four main assessment methods are listed with descriptions and examples of appropriate recording methods.

Assessment methods	Description	Recording methods
Observation	Observation is an effective way for gathering information about students' demonstration of outcomes. Teachers monitor students' progress on a given task as they work. Sometimes observation is incidental and takes place as learners participate in activities, or observations are structured to gather particular information.	Anecdotal records Audio tapes and videotapes Checklists (class or individual) Running records Photographs
Consultation	This method involves teachers interacting with students, colleagues, parents, guardians or other relevant people associated with the student. Consultation enriches the teacher's understanding of students' demonstration of outcomes. The information gathered through consultations may confirm or conflict with the teacher's impression when observing students. If it conflicts, then further assessment is needed.	Anecdotal records Checklists (class or individual) Student-teacher discussion or interview notes
Focused analysis	<p>Focused analysis involves teachers in examining specific details and features of students' demonstration of outcomes. Teachers can analyse samples of students' work, either written, oral, products or process skills. Focused analysis can assist teachers to identify and examine the strengths and specific needs of individual students. Examples of learning activities that could be analysed by the teacher appear below.</p> <p>Oral tasks such as <i>group discussion, debates, role play or interviews</i>. Written tasks such as <i>plans, descriptions, information reports, note taking, explanations, reviews or scientific reports, completed worksheets, annotated drawings or journals</i>. Other products such as <i>concept maps, constructed models, posters, journals</i>. Tests such as <i>multiple-choice tests, diagnostic, tests, short answer tests</i>. Portfolios that include <i>diagrams, maps, drawings, sketches, graphs, photographs, assignments, journal entries, other items of written work</i>.</p>	<p>Student work samples with teacher comments on what they have done well and areas for improvement. Checklists that show how well students met the assessment criteria. Portfolios of students' work showing the progression in their learning.</p>
Peer assessment and self assessment	Peer assessment involves students applying criteria to assess the work of their classmates or peers. They reflect on their own learning by focusing on others' learning. Students should understand the roles they play in peer assessment in order to negotiate, collaborate and be fair to support their peers' achievement of the outcomes. Self assessment provides opportunities for students to monitor their own work progress and to control their own learning. Teachers should communicate with students about their work progress and their views on their own learning. Students are able to reflect on what they have learnt, see their strengths as learners and the areas where they need to improve. They make judgements and decide on ways to improve their learning.	<p>Learning logs Individual checklists Worksheets designed to help students reflect on their learning</p>

Samples of assessment methods, instruments and examples

Assessment method	Recording methods	Sample of the listed recording method																																		
Observation	<p>Class checklist</p> <p>A class checklist can be used to record how well students meet the assessment criteria when working on an assessment task. For example the following code could be used to complete the columns for assessment criteria.</p> <p>H – met the criteria to a high standard S – met the criteria to a satisfactory standard NP - needs further practice</p>	<p>A class checklist with assessment criteria</p> <table border="1"> <thead> <tr> <th rowspan="2">Name</th> <th colspan="4">Assessment criteria</th> <th rowspan="2">Comments</th> </tr> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> </tr> </thead> <tbody> <tr> <td>Anitta</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Moa</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Jay</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Andrea</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Name	Assessment criteria				Comments	1	2	3	4	Anitta						Moa						Jay						Andrea					
		Name		Assessment criteria					Comments																											
1	2		3	4																																
Anitta																																				
Moa																																				
Jay																																				
Andrea																																				
Consultation	<p>Interview</p>	<p>Interview</p> <p>Interviews can be conducted with students on Science practical work that may assess:</p> <ul style="list-style-type: none"> • understanding of Science facts, • the steps involved in the experiment, • discoveries made, • comparison of the predictions against discoveries, • ability to draw conclusions from the results. 																																		
Focused analysis	<p>Concept maps</p> <p>Concept maps can be used to assess students' understanding of concepts and the relationships that exist within that concept.</p>	<p>Concept maps</p> <p>A simple concept map</p>  <p>A complex concept map</p> 																																		
Peer assessment and self assessment	<p>Learning logs</p> <p>Checklists (class or individual)</p> <p>Journals</p>	<p>Peer assessment.</p> <p>Students can assess each other's Science practical work, by giving informal feedback to each other. They focus on positive comments and areas that might need improvements. Students make these assessments using assessment criteria that have been developed by the teacher or by the teacher and students together.</p> <p>Self assessment</p> <p>Students can keep journals on the Science skills they are good at and those that they need to improve. One example is measuring accurately —</p>  <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p>I need to improve how I read scales in centimetres</p> </div>																																		

Process for developing specific assessment tasks

Assessment methods are identified during the process of planning a unit of work. The process involves:

- providing students with opportunities to demonstrate what they know, and can do based on the teaching and learning activities and the required learning outcomes,
- gathering and recording evidence of students' demonstrations of the learning outcomes,
- making judgements about students' demonstrations of the learning outcomes.

How to plan and develop assessment tasks

Assessment tasks are an integral part of the students' activities. You will need to select the assessment method that best gives you evidence of students' achievement of the outcomes. Learning outcomes should be used as the starting point in the process of planning assessment tasks. Experienced and creative teachers are encouraged to work with other teachers in improving these steps in terms of identifying suitable assessment methods and developing assessment criteria to meet the needs of the students. When developing or writing an assessment task, the following are some steps that you may find useful to follow.

1. Select students' learning experiences and activities that you will use as assessment tasks while planning the unit of work.
2. Choose which assessment method is most suitable for the assessment task.
3. Develop assessment criteria by breaking down the learning outcomes into knowledge, skills or attitudes students will do in order to complete the activity successfully.
4. Develop a manageable way of recording your assessment information:
 - class checklist or individual checklist, class grid to record observations,
 - comments on students' work showing what they have done well and what they need to improve on,
 - work samples being added to a portfolio,
 - test marks,
 - students' assessment of their own performance using the assessment criteria,
 - student's assessment of their peers using the assessment criteria.

Teachers can also adapt samples from other subjects to develop other assessment tasks.

Demonstration of the steps to develop assessment tasks

Each of the four main steps in the process above are given below, each with sample activities to clarify this.

Step 1: Select students' learning experiences and activities that you will use as assessment tasks while planning of the unit of work.

The sample teaching and learning activities below are from a unit of work for the Strand Earth and Beyond, and address Outcomes 6.4.1, 7.4.1 and 8.4.1. This unit would be suited to a multigrade class of Grades 6, 7 and 8 students.

Teaching and learning activities

- Invite guest speakers such as elders to tell stories and legends on how the earth was made from their cultural point of view.
- Research and present evidence to show that Papua New Guinea was once attached to other continents such as Australia and Asia.
- Research and describe the formation of layers or the internal structure of the Earth. Make a model of the Earth's structure.
- Describe and name rocks according to their physical properties.
- Collect rock samples and compare their properties in order to organise them under some common features, such as hardness, size, colour and weight.
- Research the three main types of rocks: sedimentary, igneous and metamorphic and write a report on how they are formed.
- Identify and discuss differences and similarities between soils from different locations and investigate the formation of soils.
- Describe the effects of wind, rain, sun and ocean waves on the landscape.
- Explain how rocks from the earth's core come up to the surface.
- Explain the effects of the atmosphere such as temperature, weather and rainfall on the earth's surface.

Assessment tasks

The following activities selected from the learning activities above could be developed as assessment tasks for this unit of work.

- Grade 6: make a model of the earth's structure and label it.
- Grade 7: make a model of a local soil profile.
- Grade 8: make a chart showing the formation of the three kinds of rock: sedimentary, igneous and metamorphic. Label the charts correctly.

Step 2: Choose which assessment method is most suitable for the assessment task.

You need to select the assessment method that will best give you the evidence you need to show that students have achieved or partly achieved the selected outcomes in the unit of work. In this unit of work the assessment method to be used is focused analysis and the assessment task is a project that involves making models.

Step 3: Develop assessment criteria by breaking down the learning outcomes into knowledge, skills or attitudes students will do in order to complete the activity successfully.

Sample of Assessment Task

Assessment method: focused analysis

Assessment task: project

The type of investigation selected here is making models, with an assessment task for students in Grades 6, 7 and 8. The processes involved are similar to those used in other investigations and practical work.

Outcome 6.4.1: Investigate the Earth's structure and describe the formation, composition and the cycling of rocks.

Assessment Task for Grade 6

Make a model of the earth's structure and label it.

Assessment Criteria

For a student to successfully demonstrate achievement of this outcome, they must meet the following criteria

- Label in correct order the layers of the Earth
- Draw a rock cycle correctly naming each step of the cycle in the right sequence.
- Identify three ways rock is formed: sedimentary, metamorphic and igneous.
- Describe using appropriate terminology the formation of sedimentary, metamorphic and igneous rocks.
- Identify the mineral composition of three local rock samples.

Step 4: Develop a manageable way of recording your assessment information.

You will need to work out how best to record students' achievement of the outcome. In this case you could use a class checklist with comments to record how well each student met the assessment criteria.

Recording

Recording is what teachers do to collect evidence of students' achievement of the learning outcomes. The *National Assessment and Reporting Policy* (2003) states the purposes of recording are:

- to check students' progress,
- to plan and program future learning,
- to report students' progress or achievement to parents, guardians and others,
- to inform students about their progress (p. 8).

The principles of assessment outlined earlier in this document also apply to reporting.

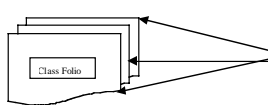
Recording can be done a variety of ways.

Some recording methods include:

- checklists: either whole class or individual,
- anecdotal records,
- journals,
- work samples with teacher comments,
- portfolios.

Samples of recording methods

Student's Folio



Each folder or folio consists of comments and assessments recorded from observations and focused analysis for each individual student. It may also include samples of the student's work. These folios are kept in a place where students have access to the information to help them monitor their progress.

Class Checklist

Make up a sheet like this to keep an ongoing record of your students' performance. You enter comments for each stage from observations of students at work. Your comments should address the assessment criteria. List the assessment criteria and develop a code to show how well the students met the criteria. An example of a code appears below:

- A: met the criteria all of the time
- B: met the criteria some of the time
- C: rarely met the criteria.

	Name of student	Assessment criteria 1	Assessment criteria 2	Assessment criteria 3	Assessment criteria 4	Comments
Group 1	Edith	A	B	B	A	
	Theresa					
	Gabby					
	Johel					

A summary sheet for students for a unit of work

A classroom setting that allows the teacher to be the facilitator of learning must allow for students to achieve individual outcomes at their own pace with a range of learning and assessment methods to choose from. The following recording method focuses on students taking some ownership of their own learning.

The record sheet could be given to students at the start of every unit of work. Students like to control what they do. This allows individual learners to manage their own learning. Give students the chance to choose from the range of activities. The order of learning activities should also be flexible where appropriate.

Individual students keep this sheet so that they can keep updated records of completed tasks and both the teacher and student are consistently monitoring information. Students can use the comments column to assess their achievements

Record sheet

Name _____ Class _____ Unit of work _____

Assessment Tasks	Tick each box as you complete activities, along with date finished.						Comments
Investigation							
Worksheets							
Practical work							
Textbook set							
Peer tutoring							
Assignment							
Poster							
Presentation							
Project (Making Model)							

Students may negotiate any of the following:

- timeframe for completing set tasks,
- number of set tasks to be completed,
- how assessment tasks will be presented.

Reporting

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

National Assessment and Reporting Policy (2003) .

Teachers can make judgements about students' demonstrations of learning outcomes when they are satisfied that they have sufficient evidence of such demonstrations.

When reporting on a student's demonstration of learning outcomes:

- there should be no reference made to the performance of other students,
- the teacher should only report that the outcomes have been achieved, when students have demonstrated the outcomes consistently, to a high standard and in a range of contexts,
- the teacher needs to base the report on evidence gathered from a variety of assessment methods.

Students, parents and guardians are entitled to receive feedback about students' progress towards achieving the learning outcomes. The information given to the students must be clear, accurate and fair so that all concerned can help students to improve their standard of achievements.

Some forms of reporting include:

- written report cards,
- record cards,
- certificates from both internal and external assessment,
- parent, student, teacher interviews.

Programming

A program is a detailed plan developed by teachers to manage teaching and learning activities for their students. The main purpose for programming in Science is to help teachers arrange the content of the course with a set of teaching and learning activities, organised on a yearly, term and weekly basis.

The whole school program

At the start of every year, each school has to decide on a number of systematic and organisational issues before delegating the task of programming to individuals or groups of teachers to develop specific subject programs.

Characteristics of a good program

An effective outcomes-based program:

- maintains a focus on learning outcomes, showing what students must know and do to achieve the outcomes,
- uses time flexibly, so that students with different needs can develop understandings and demonstrate specific outcomes over a period of time,
- uses a variety of teaching and learning strategies so that teachers act as facilitators of learning and cater for different learning styles and individual needs of students,
- emphasises the development of knowledge, skills and attitudes that promote life long learning,
- provides opportunities for students to become effective, self-directed learners,
- enables students to learn in a range of contexts,
- supports learning through the use of a variety of texts, media and real-life materials and resources,
- shows the links between the outcomes, teaching and learning activities and assessment tasks.

When programming, teachers should also take into consideration the following:

- providing a balance of activities including projects, practical work and assignments,
- students' needs and expectations,
- the community calendar and activities,
- unplanned events,
- holidays,
- major school activities.



A Science program

Teachers should use the whole school program to plan the units of work for the term so that a tentative program can be given to supervisors for information. A Science program should contain details of the following elements:

- Strands,
- Sub- strands,
- Outcomes,
- Units of work and topics,
- Timeframes,
- Teaching and learning activities,
- Assessment plans.

Syllabus considerations

The Syllabus is structured in a way that it allows for flexibility when planning the term or yearly program. The program you develop should cater for the needs of individual students, the school and community. It is essential that Science programs do the following:

- draw from all Strands in Science as well as other subjects in integrated units of work,
- build on knowledge, skills, attitudes, issues and general understanding of all Strands,
- promote Science processes and inquiry techniques to prepare students for becoming active participants in society.

Program samples

Yearly Program

The table below shows a sample format to organise a yearly program by terms. Insert Substrands into each column, showing how many weeks will be spent on each Substrand.

	Term 1	Term 2	Term 3	Term 4
Strand				
Living Things				
Science in the Home				
Earth and Beyond				

Time allocations

Some possible time allocations for lessons are given below to show how the 180 minutes per week can be programmed. Teachers will need to allocate lesson times according to the needs of the students and school. The Science weekly program could consist of:

- 2 x 60-minute and 2 x 30-minute lessons = 4 lessons per week
- 3 x 40-minute and 1 x 60-minute lesson = 4 lessons per week
- 4 x 30-minute and 1 x 60-minute lesson = 5 lessons per week
- 3 x 60-minute lessons = 3 lessons per week

Elaboration of outcomes

The elaborations of the outcomes are designed to help teachers understand the content of the outcomes so that they can develop teaching and learning activities that meet the needs of their students. The elaborations describe for each learning outcome:

- recommended knowledge,
- recommended processes and skills,
- suggested activities.

Recommended knowledge

Knowledge is what the students are expected to know and understand.

Science knowledge and concepts are identified from the outcomes and are given as short phrases or statements under 'Recommended knowledge'. The knowledge listed in the elaborations can be used by teachers to create units of work that are relevant to students' needs and local contexts.

Recommended processes, skills and suggested activities

The processes and skills section of the elaborations can be used by teachers to plan practical activities from the outcome statements where students apply the skills necessary for working scientifically. The list of skills for each outcome is not meant to be exhaustive, giving teachers the choice to incorporate other skills relevant to working scientifically.

For each of the outcomes there a list of teaching and learning activities that teachers can use to develop students' understanding of the outcome. These are best placed within the contexts of units of work. Again these lists are not exhaustive but simply provide a few suggestions for teachers.

Attitudes

The students should have a sense of identity and responsibility towards their environment and the resources that they have around them. They must conserve and value these resources and protect them as much as possible so that they are available for the future generation to use and enjoy.

The Science course should encourage students to:

- be responsible and self-reliant,
- think clearly and sensibly about the changes in the environment and then set their own goals and choose their own behaviours,
- demonstrate a willingness to work individually and as part of the group,
- show interest in the world around them and be curious to find out more about it,
- be able to cope with changes and make wise decisions about the things that are happening around them,



- take pride in their own culture and achievements, and show respect for themselves, their family and other individuals and groups,
- follow their individual interests,
- enjoy learning Science,
- see a variety of real purposes for their school work,
- appreciate their local environment and the traditional knowledge that relates to it,
- have confidence in their own problem-solving abilities,
- preserve and value their environment.

Processes and skills related to working scientifically

The table below lists recommended processes and skills associated with working scientifically, providing brief descriptions, examples and links to outcomes in the Science Syllabus. The outcome numbers are indicated. The skills and processes have been purposely grouped into *investigating*, *comprehending* and *communicating*.

The recommended processes and skills relate to the Strand Working Scientifically, described in outcomes 6.1.1, 7.1.1 and 8.1.1. The processes and skills have been organised under three main headings: investigation skills, comprehension skills, communication skills.

Skills	Descriptions	Examples of teaching and learning activities	Links to outcomes
1. Investigation skills			
Observing	The collecting of information using the senses: touch, smell, taste, sight and hearing.	Use the senses to make observations: <ul style="list-style-type: none"> • is the water warm?(touch), • is the lemon bitter?(taste), • describe the odour of a rotten egg (smell), • which leaf comes from the coconut palm? (sight), • identify these musical instruments from the sounds they produce (hearing). 	Grade 6: 6.2.1, 6.4.2 Grade 7: 7.2.1, 7.4.1, 7.4.2 Grade 8: 8.2.1, 8.3.2, 8.4.2
Classifying	The information collected is categorised according to properties.	Classify: <ul style="list-style-type: none"> • objects according to size and weight, • substances according to solubility, • substances as solid, liquid or gas, • things as living or non-living. 	Grade 6: 6.2.1, 6.3.1, 6.3.2 Grade 7: 7.2.1, 7.3.1, Grade 8: 8.3.1
Measuring	Measurements are taken to quantify size such as the <i>capacity</i> of a glass, <i>dimensions</i> of a box, <i>mass</i> of a brick, <i>energy</i> – temperature of water in a kettle.	Measuring: <ul style="list-style-type: none"> • height of a plant in its various stages of growth, • weight of an animal in different stages of growth, • temperature at different times of the day, • heat absorbed by different matter, • quantity of detergent or chemicals needed for washing. 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4.1, 6.4.2 Grade 7: 7.2.2, 7.3.1, 7.3.3, 7.3.4, 7.4.1, 7.4.2 Grade 8: 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.4.2

Skills	Descriptions	Examples of teaching and learning activities	Links to outcomes
Predicting	Examine a given situation and make a forecast as to what might happen next, based on observations, prior knowledge and experience.	This is done through extending trends or verifying patterns to predict events such as: <ul style="list-style-type: none"> when the wet season is likely to begin, when it is time for planting and harvesting certain food crops, tides and the best time for fishing, the life cycle of a living thing. 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4.2 Grade 7: 7.2.1, 7.2.2, 7.3.2, 7.3.3, 7.3.4, 7.4.1, 7.4.2 Grade 8: 8.2.1, 8.2.2, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.4.1, 8.4.2
Problem-solving	Problem solving involves the students suggesting a range of options to solve a problem. They then select the most suitable option by analysing collected information, testing the solution by experiment and drawing conclusions.	Formulating a hypothesis and designing a fair test or experiment. Examples include finding solutions to problems such as: <ul style="list-style-type: none"> lifting a heavy load onto the back of the truck, using environmentally friendly methods of removing waste materials, connecting an electrical circuit. 	Grade 6: All outcomes Grade 7: All outcomes Grade 8: All outcomes
Investigating	Experiments are designed to explore the hypothesis through verification. Data is collected, organised, analysed and conclusions are drawn. Conclusions reflect on the accuracy of the hypothesis.	Designing an investigation or experiment: <ul style="list-style-type: none"> that examines the effects of sunlight on plant growth, that demonstrates how shape of the boat and sails affects the speed of a lagatoi, that demonstrates how energy can change from one form to another, to find what type of soil is best for growing kaukau, to find out what material is best for making a saw dust stove. 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4.1, 6.4.2. Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.4.1, 7.4.2. Grade 8: 8.2.1, 8.2.2, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.4.1, 8.4.2.
Planning	Organising ideas, data and research materials into sequential or logical formats allowing for investigation, experimentation and research.	Appropriate processes for organising and presenting information when working scientifically include: <ul style="list-style-type: none"> demonstrations, research projects, discussions, designing and constructing models, experiments that use the inquiry method, scientific methods, 5Es Model and open investigations. 	Grade 6: All Outcomes Grade 7: All Outcomes Grade 8: All Outcomes <i>*Also use Section 3 on Teaching and Learning Strategies</i>

Skills	Descriptions	Examples of teaching and learning activities	Links to Outcomes
2. Comprehension skills			
Thinking critically	Develop the ability to think with purpose.	Formulate scientific responses as to why and how things happen in the living and non-living world. Some examples of activities that require students to think critically: <ul style="list-style-type: none"> • develop an explanation as to why moulds grow on bread, • develop a convincing argument that supports the use of friction in transport systems such as cars, • suggest new ways of generating electricity. 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4.2 Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.4.1, 7.4.2. Grade 8: 8.2.1, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.4.1, 8.4.2.
Drawing conclusions	Drawing conclusions requires students to examine a given situation and formulate reasonable conclusions, based on prior knowledge, experience, collected information and experimentation.	Students could draw the following conclusions after using the processes described: <ul style="list-style-type: none"> • a green and hard banana is unripe, • aching joints, fever and headaches are signs of malaria, • the sounds certain insects and birds make suggest the coming of rain according to traditional beliefs. 	Grade 6: All Outcomes Grade 7: All Outcomes Grade 8: All Outcomes
Working safely	When involved in experiments, excursions and field trips students should have knowledge of the hazards associated with these activities as well as the appropriate safety procedures and practices.	Hazardous activities need to be identified. If students are participating in activities that are potentially dangerous, their safety must be considered through a well thought out set of safety rules and procedures. Examples of activities that require safety rules: <ul style="list-style-type: none"> • all experiments involving potentially hazardous materials or substances, • role plays that involve extreme physical activity, • the use of tools, sharp instruments and simple machines, • bushwalking, • the use of electricity or flames to heat substances. 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.4.1 Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.3.4, 7.4.1, 7.4.2. Grade 8: 8.2.2, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.4.1, 8.4.2.
Developing Questions	Being able to reason and formulate questions that can be investigated and researched. Questions and questioning techniques become more complex as students progress to higher grades.	Asking why and how things happen. Deciding on a problem to investigate such as: <ul style="list-style-type: none"> • How does changing the wheel size on a wheelbarrow make it easier to push? • How does the position of a seed in soil affect the direction in which the roots grow? • Why would adding more batteries to an existing circuit make a torch bulb shine brighter? • Why would a tomato plant grow better if positioned on the sunny side of a fence? 	Grade 6: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.4.1, 6.4.2. Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.3.3, 7.3.5. Grade 8: 8.2.1, 8.2.2, 8.3.1, 8.3.2, 8.3.3, 8.3.5, 8.4.1, 8.4.2.

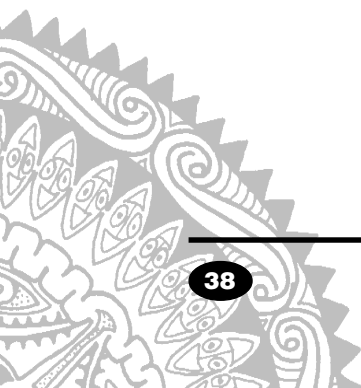
Skills	Descriptions	Examples of teaching and learning activities	Links to outcomes
Working Cooperatively	Having the capacity and skills to work in varied groups or as individuals in a classroom setting.	Students may be grouped in a range of ways in the classroom and will need to develop skills in working cooperatively such as: sharing equipment, listening to each other, making suggestions on what to do next, completing tasks allocated to them, providing feedback to other group members.	Grade 6: All Grade 7: All Grade 8: All
Initiating	Students need to be responsible for their own learning by putting self-confidence, commitment, knowledge and skills into best practice. They need to be proactive in their learning.	Students can initiate activities such as: <ul style="list-style-type: none"> • making and designing their own models of a volcano, racing cart or the solar system, • formulating traditional steps involved in herbal cures of diseases, • creating scientific games to illustrate a scientific concept, • formulating their individual portfolio, • planning and conducting an investigation. 	Grade 6: All Grade 7: All Grade 8: All

3. Communication skills

Oral skills	Communicate orally about a variety of scientific concepts using recognised scientific terminology.	Students may use oral communication skills to: <ul style="list-style-type: none"> • use vernacular and English to describe certain situations, • discuss ideas and findings with their peers, teachers and community members. 	Grade 6: All Grade 7: All Grade 8: All
Auditory skills	Develop highly tuned listening skills.	Students may use auditory skills to: <ul style="list-style-type: none"> • respond to instructions, • accurately collect information from verbal sources such as discussions or listening to guest speakers. 	Grade 6: All Grade 7: All Grade 8: All
Reading comprehension	Read and understand information from a wide variety of print materials.	Students read and understand concepts and ideas from books, newspapers, magazines, internet and other assorted print media and present these in different ways such as on posters, reports, reviews or debates.	Grade 6: 6.2.1, 6.2.2, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4.1, 6.4.2 Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.4.1, 7.4.2 Grade 8: 8.2.2, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.4.1, 8.4.2
Writing	Communicate scientific data in a range of written formats. <i>*Normal writing of notes is encouraged throughout</i>	Examples of written formats suitable for Science include: <ul style="list-style-type: none"> • scientific reports, • experiments, • projects, • reviews, • summaries, • diary entries, • student portfolios. 	Grade 6: 6.3.1, 6.3.2 Grade 7: 7.3.1, 7.3.2, 7.3.3 Grade 8: 8.3.1, 8.3.2, 8.3.3



Skills	Descriptions	Examples of teaching and learning activities	Links to outcomes
Organising Data	Being able to organise information in a scientific manner.	Examples of ways to organise data include: <ul style="list-style-type: none"> • constructing graphs and tables, • presenting information as posters, projects and reports, labelled illustrations and diagrams, • identify and use appropriate computer software. 	Grade 6: 6.2.1, 6.2.2, 6.3.4, 6.3.5, 6.4.1, 6.4.2. Grade 7: 7.2.1, 7.2.2, 7.3.4, 7.3.5, 7.4.1, 7.4.2. Grade 8: 8.2.1, 8.2.2, 8.3.4, 8.3.5, 8.4.1, 8.4.2.
Constructing Models	Design and construct models to communicate understanding of different Science concepts.	Examples of models include: <ul style="list-style-type: none"> • designing and constructing a model of a boat to investigate buoyancy, • constructing a model to clarify a research project such as a molecule, windmill, volcano. 	Grade 6: 6.2.1, 6.2.2, 6.3.3, 6.3.4, 6.4.1. Grade 7: 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.4.1, 7.4.2. Grade 8: 8.2.1, 8.3.1, 8.3.3, 8.3.4, 8.4.1, 8.4.2.

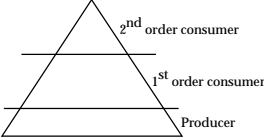


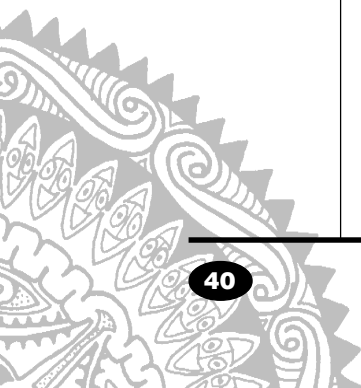
Elaboration of outcomes

Strand: Living Things

Substrand	Grade 6	Grade 7	Grade 8
Nature of Living Things	<p>6.2.1 Identify the basic structure of living things that allow them to function in their environment</p>	<p>7.2.1 Identify and compare the basic structure of living things and how they allow them to function in their environment</p>	<p>8.2.1 Describe and explain the processes of reproduction in living things and how the environment influences these processes</p>
	<p>Recommended knowledge</p> <p><i>Grouping of living things</i></p> <p>Living things are mainly grouped into two kingdoms: Plants and Animals</p> <p>Animals form two major groups invertebrates (those with no backbones such as snails, crabs, insects) and vertebrates (those with a backbone such as dogs, cuscus, humans). Vertebrates are grouped into birds, mammals, fish, reptiles, amphibians. Plants form two major groups: Flowering plants (those that produce flowers such as orchids) and non-flowering plants (those that do not produce flowers such as algae, fungi, mosses, ferns. Some living things are neither plant nor animal and are placed in a kingdom of their own</p> <p><i>Basic structure of living things</i></p> <ul style="list-style-type: none"> • all plants and animals are made up of cells • all cells have a nucleus that controls the cells and are made up of a complex substance called cytoplasm • animal cells are surrounded by a cell membrane • plant cells are surrounded by a cell membrane and a cell wall • some plant cells contain a green substance called chlorophyll <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • to communicate ideas illustrate structures by drawing posters and use scientific terminology to label plant and animal cells • design and make models of plant and animal cells • conduct simple experiment about senses and make observations • identify basic sources and research animals with senses and write reports, such as highly developed animal like sharks, whales, bats, eagles • discuss and describe ideas and plan and carry out an excursion to investigate a local animal 	<p>Recommended knowledge</p> <p><i>Basic structure of living things</i></p> <p>Include:</p> <ul style="list-style-type: none"> • sensory organs that detect changes in the environment such as skin (touch, temperature), eyes (sight), nose (smell), ears (hearing), tongue (taste). • vertebrates have internal skeletons (sometimes also external skeletons such as turtles) Some invertebrates have external skeletons such as crabs and beetles • animals' body coverings such as feathers, fur, shells and scaly skin to suit different surroundings. Some protect and keep animals warm; some detect changes in the environment. Plants are sometimes covered with hairs, some are sticky, some smooth and some are shiny. • specific adaptations include fish gills for oxygen, birds' wings and feathers for flight. Plants' leaves capture light energy. Roots collect water and minerals. Stems transport nutrients • fungi and bacteria help things decay and can be harmful to living things <p><i>Living things have special organs that help them function</i></p> <p>Including:</p> <ul style="list-style-type: none"> • digestion: physical and chemical break down of food Function of teeth, tongue, mouth, oesophagus, stomach, liver, small and large intestine, anus • respiration: function of nose, mouth, trachea, bronchi (air tubes), air sacs (alveoli) <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • select living things, collect data and research how body coverings are designed and prepare report to present to the class • investigate digestive systems, draw and label different parts and their functions, and note similarities and differences 	<p>Recommended knowledge</p> <p><i>Structure and function of male and female reproductive system</i></p> <ul style="list-style-type: none"> • female: labia, vagina, uterus, egg tubes (fallopian tubes) ovary, ovum, cervix • male: penis, urethra, scrotum, testis <p><i>Environment and reproduction</i></p> <ul style="list-style-type: none"> • sexual behaviours and patterns depend on the type of environment — the wet season is suitable for frogs to mate; plants produce flowers at particular times that attract insects or birds that pollinate flowers Seeds are produced at certain times and attract birds and insects that spread them <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • draw reproductive structures and describe parts and functions • explain fertilisation • compare and contrast a variety of reproductive structures of animals • describe interactions and relationships between plants and animals such as flowers and insects • identify and observe patterns of reproduction in an animal or plant and compile a folio of how it reproduces and when, reasons why and competitions for mates • plan and design a folio of reproductive structures • observe a life cycle of a living thing in order to produce a folio with observations and results to establish a pattern for other purposes such as breeding season • analyse information and find out about human life cycle: birth, growth, death and other animals' life cycles such as a frog or butterfly and the life cycle of a flowering plant



Substrand	Grade 6	Grade 7	Grade 8
Ecology Relationships and Interactions	6.2.2 Using a diagram describe how energy moves through the living and non-living community	7.2.2 Interpret and discuss relationships that exist in a community, using a food web to show human activity in that community	8.2.2 Draw conclusions regarding the effects of excessive use of non-biodegradable materials on food webs
	<p>Recommended knowledge</p> <p><i>Energy</i> Including:</p> <ul style="list-style-type: none"> forms of energy: sound, light, heat, chemical, kinetic sources of energy: food, wind, sun, fire, lantern, candle, match, torch, electricity energy relationships: solar (sun), chemical (from food), heat or kinetic (animals including humans) <p><i>Relationships between plants and animals</i></p> <ul style="list-style-type: none"> introduce the idea of a food chain. Emphasise all food chains start with a green plant because they make food, which contains energy for life track the passage of energy through a food chain starting with sunlight used by producers (green plants such as grass and corn) to consumers (animals such as grasshopper then frog) relationship in a food chain: grass > grasshopper > frog > snake > hawk <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> draw a poster to illustrate the steps in a food chain from producer to top consumer observe plants and animals in the grounds or near surroundings and construct a food chain from your observations. 	<p>Recommended knowledge</p> <p><i>Interactions between environment and organisms</i></p> <ul style="list-style-type: none"> plant kingdom includes all organisms that can make food from carbon dioxide and water, using the energy of sunlight producers (green plants) and consumers (animals) and their relationship introduce idea of pyramid of biomass that shows producers at the base leads to top order consumer at the peak  <ul style="list-style-type: none"> consider what would happen if the pyramid of biomass was reversed with the narrow peak at the bottom for producers, that is, not enough producers to feed all the consumers construct food webs – first combine simple food chains interactions within the environment such as competition for food, shelter, oxygen and space prey and predator relationships <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> identify members of a simple food web including humans and discuss the feeding relationships in the food web collect data and make a chart of a food web including humans place members of a food web in order from producer to top order consumer research feeding relationships in an environment such as school garden, forest, lake, swamp, creek, mountain, valley, treetop identify predators and prey in the school garden, forest, lake, swamp, creek, mountain, valley, treetop 	<p>Recommended knowledge</p> <p><i>Natural and processed materials</i></p> <ul style="list-style-type: none"> identify materials that are biodegradable– plants, animals, organisms’ wastes, chemicals, paper products, food and some plastics identify non-biodegradable materials – many plastics, glass, metals and chemicals: DDT, CFC identify non-biodegradable wastes from human activity such as insecticides and weedicides such as DDT that builds up in food chains and can harm organisms along the food chain <p><i>Man and environment</i></p> <ul style="list-style-type: none"> consider how the use of dangerous chemicals and wastes affects food webs including those with humans: insecticides, pesticides, chemicals for mining and factories, sewage into seas and water ways, smog in the air <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> plan and conduct a fair test on materials to find out if they are biodegradable or non-biodegradable, analyse the data, draw conclusions and then write a report about the findings plan and conduct a survey to collect data about the use of certain materials in the community Analyse these data and raise community awareness on the positive and negative impact of these materials invite a guest speaker to give a talk on the impact of biodegradable and non-biodegradable materials in the community invite a guest speaker to talk about what can be done to reduce the impact of human activities such as mining, fishing, logging, industrial activities, road building



Strand: Science in the home

Substrand	Grade 6	Grade 7	Grade 8
Learning about Substances	6.3.1 Identify and organise common substances into groups according to physical properties	7.3.1 Explain the structure and behaviour of matter in terms of the particles from which it is made	8.3.1 Conduct investigations and use collected data to identify patterns in the physical interactions of substances
	<p>Recommended knowledge <i>Common Substances:</i> Including identifying:</p> <ul style="list-style-type: none"> • common substances used in factories or industries such as grease, lubricating oils • common manufactured substances such as detergents, make ups, perfumes, soap • common natural substances such as crude oil, palm oil, herbs, plant dyes, rubber <p><i>Use of Common Substances</i></p> <ul style="list-style-type: none"> • describe the properties of common substances such as cooking pots, detergents, cooking oil, perfumes, sprays, kerosene, petrol, wood, bush knives, plastic bags, newspaper, soap <p>Recommended processes and skills and suggested activities</p> <ul style="list-style-type: none"> • identify common substances in the home and discuss their properties • classify common substances into groups according to whether they are solids, liquids or gases • classify common substances according to their properties 	<p>Recommended knowledge <i>Structure and behaviour of matter</i> Explain that matter:</p> <ul style="list-style-type: none"> • is any thing that has mass such as a book, water • is made up minute particles called atoms that are always in motion • exists as a solid, liquid or a gas and occupies space in different ways and these can be changed from one form into the other, for example, water can be solid (ice), liquid (water) or gas (water vapour) <p>Explain:</p> <ul style="list-style-type: none"> • solids are made up of particles called atoms packed very tightly together These particles are so close together they can only vibrate - wood, cement, iron, paper, chemicals • liquids are made up of atoms with more space between them than solids and the particles have more space to move: water, cordial, kerosene, detergents, alcohol • gases are made up of atoms that are much further apart than in most liquids at normal temperature and pressure and the particles move about quite rapidly : oxygen, nitrogen, water vapour, carbon dioxide • what a solution is and types of solutions: saturated, unsaturated, strong and weak solutions <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • construct simple models using local materials such as clay to illustrate the particle structure of solids, liquids and gases • describe structure and behaviour of matter • compare physical properties of matter 	<p>Recommended knowledge <i>Physical properties of:</i> Solids:</p> <ul style="list-style-type: none"> • properties of solids such as different metals, wood for hardness, weight, density, does it bend or is it brittle, colour, solubility (will it dissolve in water), floating and sinking • most metals are lustrous (shiny), are good conductors of heat and electricity <p>Liquids:</p> <ul style="list-style-type: none"> • are fluid at normal temperature and pressure and other properties such as density, ability to dissolve solids, <p>Gases:</p> <ul style="list-style-type: none"> • vapour at normal temperature and pressure and other properties such as density, <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • observe the properties of solids, liquids and gases • test the properties of different materials

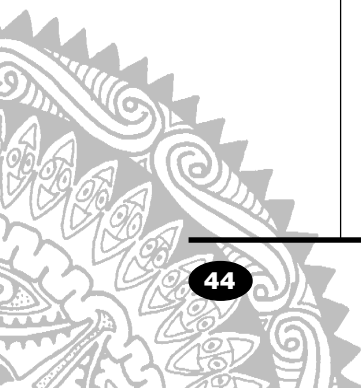


Substrand	Grade 6	Grade 7	Grade 8
Learning about substances	<p>6.3.2 Conduct practical investigations into the nature of mixtures and communicate their findings in a scientific way using available materials</p>	<p>7.3.2 Compare the properties of materials before and after physical and chemical changes and identify patterns in the types of changes that take place in the materials used</p>	<p>8.3.2 Identify and collect basic and acidic substances found in nature and use this data to elaborate on how these can be used to benefit the community</p>
	<p>Recommended knowledge</p> <p><i>Mixtures</i></p> <ul style="list-style-type: none"> identify types of mixtures and why they are called mixtures Mixtures are two or more substances that can be separated by physical means When substances combine they form compounds and these can only be separated by chemical means Mixtures can be formed by mixing solids with solids (sand and iron filings), solids with liquids (sand and water), liquids with liquids (water and cordial), liquids with gases (water and oxygen), gases with solids (soil), gases with gases (air) distinguish between solutions and suspensions conduct experiments to separate different mixtures using filtration, decantation, evaporation and magnetism <p><i>Important mixtures</i></p> <p>Include:</p> <ul style="list-style-type: none"> herbal paints and how to mix them traditional paints - lime, crushed rocks, clay, soil traditional and modern paints and dyes sago and water, tea and water <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> identify, collect and analyse common mixtures from the community conduct experiments on mixtures using various separation techniques design and describe a test on common mixtures -- detergents, lipstick, traditional dyes and paints research useful substances that can be mixed and used for certain purposes and occasions 	<p>Recommended knowledge</p> <p><i>Properties of materials</i></p> <ul style="list-style-type: none"> physical properties of materials - hardness, weight, density, bend easily, stretch into wire (ductile), lustre (shiny or dull) physical changes in matter: no new substance formed chemical changes in matter: new substance formed chemical changes require energy and may produce heat energy demonstrate physical and chemical changes <p><i>Simple word equations</i></p> <ul style="list-style-type: none"> equations such as - carbon + oxygen = carbon dioxide use correct signs and symbols in a word equation such as + reacts with, = produces, use of correct terms: reactants and products <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> collect materials and classify these according to their physical properties find out how different substances are combined chemically to produce new materials investigate substances that can be combined using heat 	<p>Recommended knowledge</p> <p><i>Basic and acidic substances in nature</i></p> <ul style="list-style-type: none"> test substance as basic: using litmus paper or home made plant dyes test substances as acidic: using litmus paper or home made plant dyes <p><i>Uses of basic and acidic substances</i></p> <ul style="list-style-type: none"> uses of acids and bases simple chart of pH values and scales and how these are used eg soil testing common laboratory acids and gases, HCl, H₂SO₄, NH₃, NaOH demonstrate neutralisation process: Acid + Base = Salt + Water <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> collect substances and use simple tests to determine whether they are acidic or basic research the usefulness and dangers of acidic and basic substances in the community conduct simple experiments and make observations about the reactions between diluted acids and bases

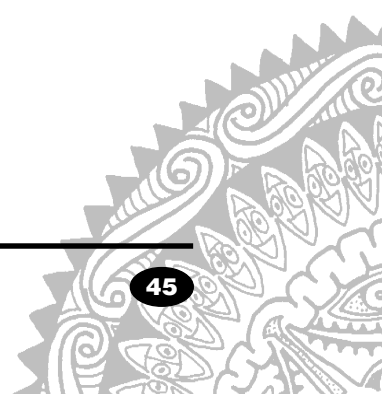
Substrand	Grade 6	Grade 7	Grade 8
Using Energy at Home	<p>6.3.3 Identify and describe the sources and the types of energy</p>	<p>7.3.3 Investigate how energy changes from one form to another</p>	<p>8.3.3 Apply their knowledge about energy to investigate electrical and heat energy in the home</p>
	<p>Recommended knowledge</p> <p><i>Sources of Energy</i></p> <ul style="list-style-type: none"> identify energy sources: sun, battery, fuel, chemical, electricity, fire, food <p><i>Types of Energy</i></p> <ul style="list-style-type: none"> heat: fire, sun, fuel, chemicals, electricity light: fire, sun, fuel, chemicals, electricity sound electricity kinetic and potential energy, generation of hydro electric power <p><i>Energy transformations, change at home</i></p> <ul style="list-style-type: none"> include burning wood, hydro-electricity, kerosene lanterns, candles, moving car, bow and arrow, man on bicycle, torch, various machines investigate the energy changes in each of the following steps: burning wood: chemical changes: heat and light <p><i>Uses of energy in the home</i></p> <ul style="list-style-type: none"> include light for reading, electricity for heating, light, communication, cooking, burning for cooking, warmth, making metals hot to shape them <p>Recommended processes and skills and suggested activities</p> <ul style="list-style-type: none"> identify energy sources collect information about effective machines for generating energy construct a simple model of hydroelectric power and label sources of energy identify and describe how simple machines can be used at home to assist with work identify the five types of machines such as levers, pulleys, inclined, planes and axle identify energy sources and explain how they can be used 	<p>Recommended knowledge</p> <p><i>Using heat, light and sound energy</i></p> <ul style="list-style-type: none"> investigate ways energy is used by humans such as light produced by the sun helps us to wake up in the morning; heat used in homes, factories, stores, gardens, workplace <p><i>Simple machines</i></p> <ul style="list-style-type: none"> consider simple machines make work easier in homes such as levers, wedges, spanner, tin snips, scrapers, hammer, tongs identify the energy changes that take place when using simple machines <p><i>Friction</i></p> <ul style="list-style-type: none"> friction is a force that opposes motion Consider machines and friction and the advantages and disadvantages of friction <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> observe and identify energy changes from one form to another in local community such as light in cooking research the beneficial and harmful effects of heat and light on things around them design and make simple machines to do work write a report to communicate about the impact of simple machines on others 	<p>Recommended knowledge</p> <p><i>Force, work and energy</i></p> <ul style="list-style-type: none"> qualities that can be measured using force meter, spring balance, scales taking measurements: 100g = 1 N (100 grams = 1 Newton) friction can be useful but costly: useful when striking a match or when applying a brake in a vehicle, costly because friction slows things down and energy use has to be increased to keep things moving against frictional force energy is measured in joules (J) <p><i>Methods of applying and controlling heat</i></p> <ul style="list-style-type: none"> heat in real life situations: cooking, burning, drying, smoking, solar heater methods of controlling heat measuring temperature using a thermometer (degrees Celsius) <p><i>Electrical circuits</i></p> <ul style="list-style-type: none"> electrical energy is generated from other sources of energy such as solar, hydro and used to produce light and heat sources of electricity: battery, solar, hydro, fuel make a simple circuit using wire, battery and light bulb simple electrical circuit: a circuit is a path through which electricity can flow. Not all matter conducts electricity. Most conductors of electricity are metals. The flow can be a direct current (DC) from a battery or alternating current (AC) from a generator like a motor <p>Recommended processes skills and suggested activities</p> <ul style="list-style-type: none"> research how simple machines work make a simple motor to generate an AC current describe how electricity is generated in a car, at a hydroelectric power station, by a windmill



Substrand	Grade 6	Grade 7	Grade 8
Using Energy at Home	<p>6.3.4 Identify and describe the nature of force as being a push or a pull</p>	<p>7.3.4 Investigate how we use force in everyday life</p>	<p>8.3.4 Apply their knowledge about force to investigate simple machines</p>
	<p>Recommended knowledge</p> <p><i>Force</i></p> <ul style="list-style-type: none"> • a force is a pull or a push • types of forces • a force can make objects move • push, pull <p><i>Forces in action</i></p> <ul style="list-style-type: none"> • applying forces: model car, tug of war, holding a flag, pulling up an anchor, flying a kite • pushing forces (what is doing the pushing?) • pulling forces (what is doing the pulling?) • balance and unbalanced forces (tug of war) <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • demonstrate that force is needed to move something • demonstrate that force can make things change direction • draw pictures and explain how and why applying force can have effects on an object • investigate force and ways of reducing force • differentiate between forces • design and perform experiments to distinguish between forces • play with objects to discover forces • research the nature of forces 	<p>Recommended knowledge</p> <p><i>Forces in everyday life</i></p> <ul style="list-style-type: none"> • gravitational force • atmospheric pressure • forces that slow things down • forces that speed things up • forces that change direction of a moving object <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • discuss different types of forces • design a series of experiments to test forces • research different types of forces and the positive and negative effects on the lives of people in the community • investigate nearby places to find out where forces are applied such as in factories, stores, workshops, roadwork sites, wharves, local communities, local river or sea 	<p>Recommended knowledge</p> <p><i>Simple machines</i></p> <ul style="list-style-type: none"> • mechanical advantages: energy not lost or gained but only changed to another form • calculating mechanical advantages • measuring forces: forces and formula ($W = F \times D$) • pulleys and forces <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • problem solving • calculate mechanical advantages • describe how forces are applied • use formula correctly • design experiment and test how lever is applied to move a heavy object: label and give distances in order to calculate moving formula • design and test experiments to test how objects can move and change directions: with values or measurements given for calculation • excursions to such places as wharves or garages to see how pulleys are applied



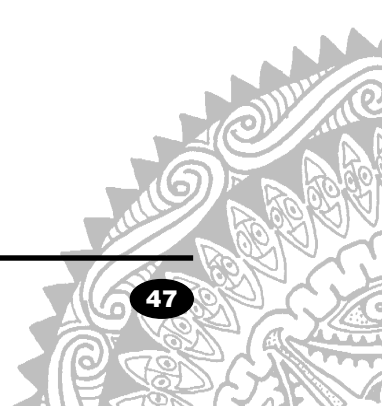
Substrand	Grade 6	Grade 7	Grade 8
Using Energy at Home	<p>6.3.5 Identify and explain how simple machines can be used in homes and the community to do work</p>	<p>7.3.5 Identify and make recommendations on how simple machines can make life easier through community field study</p>	<p>8.3.5 Conduct investigations on simple machines and use problem-solving skills to establish the efficiency of the machine as a tool to do work</p>
	<p>Recommended knowledge <i>Types of Simple Machines</i></p> <p>how the following simple machines are used in the home and community</p> <ul style="list-style-type: none"> levers: how used, what is it pulleys: how used and function axle: how used and function gears: how used and function <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> draw posters or make models of types of simple machines and explain how they are used 	<p>Recommended knowledge <i>Application of simple machines</i></p> <ul style="list-style-type: none"> conduct a survey of the local community and list all the simple machines that are being used such as gardening tools, lights, different motors. Identify how these machines make life easier for the community <p>Recommended processes and skills and suggested activities</p> <ul style="list-style-type: none"> carry out a survey on the way simple machines are used to do work at home 	<p>Recommended knowledge Machines and efficiency</p> <ul style="list-style-type: none"> identify the parts of machines and their functions explain how the efficiency of machines can be calculated <p>Recommended processes skills and suggested activities</p> <ul style="list-style-type: none"> calculate the mechanical advantage of simple machines using equations and formulae



Strand: Earth and Beyond

Substrand	Grade 6	Grade 7	Grade 8
Our Earth and its Origin	<p>6.4.1 Investigate the Earth's structure and describe the formation, composition and the cycling of rocks</p>	<p>7.4.1 Collect data of the sedimentation process and observe the presence of fossils to explain the living past, using a variety of sources, including first hand experiences</p>	<p>8.4.1 Demonstrate the formation of igneous and metamorphic rocks and relate findings about the properties of rocks to the ways they are used</p>
	<p>Recommended knowledge</p> <p><i>Formation of the Earth</i></p> <ul style="list-style-type: none"> • how the Earth was formed – legends, myths, stories, scientific facts <p><i>Structure and composition of the Earth</i></p> <ul style="list-style-type: none"> • crust: soil, rocks, plants, oceans, mountains, continents • mantle: molten rocks (magma) • outer core: solid rocks • inner core: liquid rocks <p><i>Soil formation</i></p> <ul style="list-style-type: none"> • how are soil formed? Sand, silt, mud, remains of plants and animals <p><i>Rock formation</i></p> <ul style="list-style-type: none"> • how different rocks are made shape, colour, size, hardness, weight (rock cycle): obsidian, clay, limestone, stone axe <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • draw structure of the Earth and label • design and make a model of the Earth • collect rock samples • describe rock and soil samples • define scientific terminology • interview and compile stories, legends and myths related to the formation of the Earth • design and make model of the Earth and identify layers by labelling • investigate how soil is made using models of road cuttings, hill sides or along rivers • collect and make rock profiles of their physical characteristics • carry out an excursion to a mountain side, road side or volcanic site to observe different types of rocks and how they are formed 	<p>Recommended knowledge</p> <p><i>Sedimentation process</i></p> <ul style="list-style-type: none"> • weathering • erosion • transportation • deposition <p><i>Past evidence in rocks</i></p> <ul style="list-style-type: none"> • sedimentary, metamorphic rocks • fossils <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • draw and design models of the sedimentation process • carry out experiments to test models • identify types of rocks • describe how fossils are formed • design and make models of the fossilisation process • research, design, make models to explain the process of sedimentation • investigate how fossils are made over a long period of time • research for evidence to explain the living past 	<p>Recommended knowledge</p> <p><i>Formation of rocks</i></p> <ul style="list-style-type: none"> • igneous, metamorphic, sedimentary <p><i>Rock classification</i></p> <ul style="list-style-type: none"> • basic groupings of rocks: minerals, tools, others <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • explain rock components • examine structures of rocks • classify rocks • identify uses of rocks • research on Papua New Guinea's precious minerals • design a model to explain how rocks are formed and label steps • investigate how rocks change from one form to another • research the usefulness of rocks and relate their uses to everyday lives including roads, buildings, soil • research Papua New Guinea's mineral wealth

Substrand	Grade 6	Grade 7	Grade 8
Space Exploration	<p>6.4.2 Identify and describe familiar events such as star patterns and moon phases</p>	<p>7.4.2 Investigate the interactions between the Earth, Moon and Sun</p>	<p>8.4.2 Collect information about human exploration into space</p>
	<p>Recommended knowledge</p> <p><i>Stars in the sky</i></p> <ul style="list-style-type: none"> • traditional beliefs of creation, myths, stories • star patterns: traditional names, patterns, movements • observing the night sky: movement of groups of stars, shooting stars <p><i>Phases of the Moon</i></p> <ul style="list-style-type: none"> • moon phases: gibbous, new, crescent, full • tides and gravity: low, high • effects of moon phases on daily lives • traditional calendar: navigation, fishing, hunting, feasting, harvesting, planting <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • tell and write traditional stories about the stars and night sky • research traditional beliefs about how the Earth and stars were formed • write a report about the effects of the moon on the Earth • plan and draw traditional calendar that includes seasonal changes and the phases of the moon • groups discuss and report on the shared results of a traditional beliefs and stories about sky and stars • investigate the moon phases and how this affects the livelihood of the community, hunting, fishing • design a traditional, school or community calendar to monitor seasonal activities and events and relate this to the way of life 	<p>Recommended knowledge</p> <p><i>The planet Earth</i></p> <ul style="list-style-type: none"> • origin of the Earth - traditional beliefs, scientific explanation (Big Bang Theory and Condensation Theory) <p><i>The Solar System</i></p> <ul style="list-style-type: none"> • compositions of our solar system: sun, moons, comets, meteors and planets • interactions between heavenly bodies and their appearance - Milky Way Galaxy, Earth, Sun and Moon and other heavenly bodies: distance, size, shape, weather, rotation, orbiting, life span <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • draw posters to show the nine planets and their distance from Earth • discuss and interpret traditional beliefs about the formation of the stars and Earth • design scaled models of our Earth, Sun and Moon • identify and compare distances in our Solar system • research, draw posters and write descriptions to explain the Earth's origin • design scaled diagram and make models to explain the composition of the solar system 	<p>Recommended knowledge</p> <p><i>Models and inventions</i></p> <ul style="list-style-type: none"> • into space: telescopes, rockets, spaceships, satellites • communications: radio, telephone, televisions, computers, internet <p><i>Communication and information</i></p> <ul style="list-style-type: none"> • sound and vibration: sending and receiving information through: speech (voice, ear), guitar (strings vibration), radio (voice, ear), telephone (mouth piece, ear piece) TV (voice, vision), internet (satellite, computer) <p>Recommended processes, skills and suggested activities</p> <ul style="list-style-type: none"> • research for information • draw diagrams of some of the instruments used to study space • select an instrument or machine listed above and conduct research to explain how this instrument or machine works • research and write report on how human beings communicate using voices and ear • investigate space travel and write a report on how humans travel into space: space suits, food, oxygen, water, tools, information equipment



Units of Work

What is a unit of work?

A unit of work is a set of sequenced teaching and learning activities with assessment tasks designed to help students achieve selected learning outcomes within a specific time frame.

Components of a unit of work

Each unit of work that you develop should contain these components:

1. Title
2. Grade
3. Time frame
4. Strands and Substrands
5. Learning outcomes
6. Teaching and learning activities
7. Assessment methods and tasks
8. Links to other subjects where necessary
9. Resources and equipment required

Considerations when planning a unit of work

When planning a unit of work, the following should be considered:

- limit the number of outcomes selected as the focus for the unit of work to three or four outcomes to keep it manageable,
- decide if it is appropriate to integrate the Science learning with other subjects,
- clearly identify the content of the unit of work in terms of knowledge, skills and attitudes that are derived from the learning outcomes,
- plan the assessment tasks while you are planning the unit of work,
- where possible use up to date references and resources,
- take account of the learning needs of your students,
- address gender issues and cultural norms by making sure that the unit of work is inclusive and fair for all your students.



Developing a unit of work

Planning from outcomes

Because primary teachers have to manage all of the outcomes for all seven subjects, you will need to work out ways of making teaching and learning manageable. One way of doing this is to cluster outcomes that link naturally together and then plan a unit of work that allows you to teach several outcomes within a set period of time. You can cluster the outcomes in a number of ways:

- within one Strand of Science,
- across several Strands in Science,
- across several subjects within one grade,
- across several grades if you are teaching a multigrade class.

Process for developing a unit of work

This is a general process which can be modified to develop integrated or subject based units of work, or units of work for a single outcome. For example in the event where an outcome cannot be linked or clustered with other outcomes and you decide to teach it separately, step 2 will have to be ignored.

Steps for developing a unit of work

Step 1: Study the content overview from the Syllabus that shows the Strands and Substrands.

Step 2: Identify 2 to 4 outcomes that link naturally together. Brainstorm possible themes, issues or topics that link the outcomes and identify a relevant theme or issue from this list to use in this unit of work.

Step 3: State the purpose for the unit of work.

Step 4: Identify the unit content, the knowledge, skills and attitudes that you want students to demonstrate. Use the outcomes and indicators in the Science Syllabus and elaborations of the outcomes in the Teachers Guide to help you.

Step 5: Develop and sequence teaching and learning activities and identify the teaching and learning strategies and resources to be used.

Step 6: Develop an assessment plan with assessment methods, assessment tasks and criteria and methods of recording.

Step 7: Estimate the time frame required to complete the unit of work.

Step 8: Develop a weekly program for the unit of work.

Sample format for developing a unit of work from outcomes

You should use the process described above and the sample format given below as a guide when developing units of work. You can adapt the process and sample format to suit your needs or the needs of the school.

A Unit of Work

For each unit of work use the following headings:

- Title of the unit of work
- Strands
- Substrands
- Science learning outcomes
- Learning outcomes from other subjects
- Theme, topic or issue that links the outcomes
- Purpose of the unit of work
- Knowledge and skills (Use the indicators and elaborations as a guide.)
What knowledge do you want students to know at the end of this unit of work?
What skills do you want the students to be able to do during this unit of work?
- Working Scientifically
Which skills do you want the students to apply during the unit of work from the *Working Scientifically* Strand?
A. Process Skills
B. Comprehension Skills
C. Communication Skills
D. Attitudes
- Teaching and learning activities
- Assessment tasks and assessment criteria for the unit of work
- Resources

Using the Format

This format is applicable for developing a unit of work using one or more of the following methods:

Method A: a unit of work focusing on one outcome for a particular grade,

Method B: a multi grade unit of work in one subject across two or more grades.

Samples of each of these types of units of work appear below.

Method A: A sample unit of work for one outcome and one grade

This sample unit of work is project-based. Some steps have been modified to suit a project-based approach.

Step 1: It is not necessary to read the overview of Strands from the Syllabus because only one outcome is used in this unit of work. This unit of work is for a Grade 6 class.

Step 2: Identify the learning outcomes from the Strand.

Strand: Earth and Beyond

Substrand: Our Earth and its Origin

Outcome: 6.4.1. Investigate the earth’s structure and describe the formation, composition and the cycling of rocks.

Step 3: Select a title and develop the purpose of the unit of work.

Title: Earth formation and structure

Purpose: Students describe and make a model of the earth’s structure, collect rock and soil samples and make a model showing how soil erosion occurs.

Step 4: Identify knowledge, skills and attitudes for this unit of work.

Check the Syllabus for relevant indicators for the selected outcome and the Teachers Guide for Elaborations of outcomes that show recommended knowledge, processes and sk and attitudes for the selected outcome.

The following identifies possible knowledge, processes, skills and attitudes foutcome.

Knowledge	Skills	Attitudes
<p>Formation of the Earth How the Earth was formed - <i>legends, myths, stories</i></p> <p>Structure and composition of the Earth Crust: <i>soil, rocks, plants, oceans, continents</i> Mantle: <i>molten rocks (magma)</i> Outer Core: <i>solid rock</i> Inner Core: <i>liquid rock</i></p> <p>Soil Formation How is soil formed? <i>Sand, silt, mud, remains of plants and animals,</i></p> <p>Rock Formation How different rocks are made <i>shape, colour, size, hardness, weight (rock cycle), obsidian, clay, limestone, stone axe</i></p>	<p>Investigating investigate describe research draw label design collect information</p> <p>Comprehending tell stories listen</p> <p>Communicating write compare define make models</p>	<p>Check the general list of attitudes in the key features section of this Teachers Guide</p>

Step 5: Develop and sequence teaching and learning activities.

1. Invite guest speakers to tell stories and legends on how the world was made from their cultural point of view or beliefs.
2. Research and present evidence to show that Papua New Guinea was once attached to other continents such as Australia and Asia.
3. Research and describe the internal structure of the Earth. Make a model of the Earth's structure.
4. Describe the effects of wind, rain, sun and ocean waves on the landscape.
5. Identify variations between soils from different locations and investigate how they were formed.

Step 6: Develop assessment tasks and criteria.

There will be one assessment task for this unit of work:

- make a model of the Earth's structure and label it.

Use the following table to develop the assessment tasks and criteria.

Assessment task	Assessment criteria	Recording method

Step 7: Identify and list the resources and equipment required for the unit of work.

The resources for this unit of work include:

- local elders,
- world map,
- samples of different types of soil such as clay, sand and loam.

Step 8: Estimate timeframe for the unit of work.

This unit should take 1 week of Science teaching time and will require 4 lessons: 1 x 60minute lesson or 3 x 40 minute lessons. You can structure the lesson durations in other ways to suit the teaching and learning activities and needs of the school.

Step 9: Develop a weekly program and lesson plans for the unit of work.

Method B: A sample unit of work for a multigrade class

This method is applicable for the teacher who is teaching more than one Grade. For example a teacher may be teaching Science to a Grade 6 and 7 class. Although the teacher is using one unit of work to teach, aspects of the lessons should be planned specifically for each of the Grades taken. This includes teaching and learning activities, language level, resources used and types of assessment methods and tasks.

When planning a unit of work for a multi-grade class, a teacher should do the following:

- use different outcomes for students from different Grades within the class,
- select outcomes that address common concepts.

Planning a multigrade unit of work

Suggested steps to develop a multigrade unit of work.

1. Identify the grade levels you will program for and study the content overview from the Syllabus.
2. Identify and select relevant Substrands and outcomes that will be suitable for your multigrade class.
3. Identify and write suitable themes or topic that link the outcomes.
4. Identify the purpose for the unit of work.
5. Develop and sequence teaching and learning activities.
6. Develop a variety of assessment tasks with specific assessment criteria.
7. List resources.

Sample unit of work for a multigrade class

Step 1: Identify the grade levels you will program for and study the content overview from the Syllabus.

For the purpose of this sample unit of work, the grades selected are Grades 6, 7 and 8. For the content overview, refer to Science Syllabus.

Step 2: Identify and select relevant Substrands and outcomes that will be suitable for a Multi-grade class that link well.

Strand: Living things

Substrand: Nature of living things

Outcomes

6.2.1 Identify the basic structure of living things that allow them to function in their environment.

7.2.1 Identify and compare the basic structure of living things and how they allow them to function in their environment.

8.2.1 Describe and explain the processes of reproduction in living things and how the environment influences these processes.

Step 3: Identify suitable themes or issues or topics that link the outcomes.

The theme selected for this multigrade unit of work should be relevant to each of the three outcomes stated above. Here are some possible themes for this unit of work:

- living things,
- basic structure of living things,
- plants and animals.

Step 4: Identify the purpose for the unit of work.

Examples:

- identify patterns, groupings, classifications, and the main characteristics of living things,
- research how living things function and reproduce in their environment.

Step 5: Identify the knowledge, skills and attitudes that you want the students to demonstrate.

Refer to the relevant outcomes and indicators in the Science Syllabus and Elaboration of outcomes in the Teachers Guide.

Step 6: Develop and sequence teaching and learning activities.

The knowledge, skills and attitudes will be used to decide which activity belongs to which grade:

- identify common features of living things that can be used to classify them into groups and give names to the groups identified,
- identify, describe and list similarities and differences of cells from certain plants and animals,
- explain how some living things interact in relation to each other as well as their immediate environment, addressing topics such as animal behaviour, courtship, aggression and caring for young,
- describe responses to the environment that help living things to survive,
- select a living thing, explain the group it belongs to, its structure, function, how it reproduces and state how you protect that species for future generation.

Step 7: Develop assessment methods and tasks you will use for assessing each grade.

Example

Below are some examples of the activities that teachers could use as a guide in developing assessment tasks in this unit of work.

Select a living thing in the school area and keep a record of the following:

- the group to which it belongs,
- its structure,
- its function,
- method of reproduction,
- how you can protect that species for future generations.

The table below may help you in planning your assessment tasks.

Grade	Assessment method	Specific tasks	Recording method
1.	Focused analysis	Comparing planning and report sheets	Checklist
		Making models	
2.	Observation	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Teachers can use the information on assessment section to complete this. </div>	
3.	Observation		

Step 8: List resources

Examples include samples of living things from around the school area and community.

Step 9: Programming

You will need to work out how many lessons needed to teach your unit of work and how much of your time will be involved in working with students from each grade.

These suggested activities above have been organised as follows using the 5 Es approach.

The 5E approach

Engage	Plan and conduct an excursion to a site to observe the environment. List all the necessary resources needed for the excursion and state the purpose of the excursion. For example: to observe and list as many living things as possible from the selected site. Before the excursion, brainstorm what they are likely to find in an environment.
Explore	Investigate the environment, collect or list as many living things seen or observe from the given time. Identify and list some similarities and differences from their observations.
Explain	Identify features of living things that can be used to classify them into groups. Draw a chart to show the different groups of living things, for example show how animals and plants are classified. Explain how some living things behave such as animals, courtship, aggression and caring for the young.
Elaborate	Describe responses to the environment that help living things to survive. Select a living thing, explain the group it belongs to, its structure, function, how it reproduces and state how you protect that species for future generations. Identify and list similarities and differences of cells from various parts of plants and animals.
Evaluate	Give a brief two-minute talk on a selected topic related to living things. Suggested topics could include 'characteristics of an animal, animals and their needs,' 'plants and their needs,' 'animals and their young'. During the talk, students express their ideas, beliefs and understandings to support the evidence gathered from their discoveries on the topic. State how they want to either promote the use or protection of that particular living thing. List things they know and have learned and ask more questions or carry out further research on the different topics their peers have talked about in their presentations.

Resources

You are encouraged to be resourceful when selecting teaching materials and try working with other teachers to share the load. Most importantly you should select materials relevant to the Science Syllabus and learning outcomes. You are also encouraged to identify, improvise and use materials readily available in their own school area and communities.

Recommended resource materials

The following resource materials in the table below have been produced by the Department of Education and are relevant to the Science Syllabus for Upper Primary. All Secondary schools and some Primary schools have these. You are encouraged to locate these resources in your own or nearby schools.

The resources have also been listed under each Strand from the Syllabus. Materials listed in the other materials list are expected to be easy to find within the school area or nearby community. These are not listed under each Strand because they are general materials and can be used in any of the three Strands and Substrands.

The following resources may be useful sources of information. Care should be taken to make sure the content of these resources is relevant to the Science Syllabus.

Department of Education publications

Strand: Living Things	Strand: Science in the Home	Strand: Earth and Beyond
Grade 8 Science Syllabus and Teacher Guide	Geology	Fundamental Science, Book 4 Answer Book
Growth and Reproduction, Unit 5	Electricity Item Bank	Earth and Beyond, Book 3
Living Things, Grade 7	Matter: Student Resource Book	Science Item Bank, Grade 7
Life in the Sea, Grade 7, Unit 4B	Matter: Teacher Guide	Sun and the Earth Teacher Guide, Grade 7
Reproductive and Sexual Health: Supplementary Text	Science Skills	Sun and the Earth Resource Book, Grade 7
Video – Kisim Save Series 1 – 2	Electricity: Teacher Guide	
Into Space Supplementary Text	Radio Science, Grade 5	
Lower Primary Environment Studies Syllabus, Grades 3-5	Radio Science, Grade 4	
Lower Primary Environment Studies Resource Book, Grades 3-5	Radio Science Teacher Guide	
	Science Teacher Guide, Grade 6	
	Fundamental Science for Melanesia Book 3	
	Science in Process, Part 1	
	Science in the Classroom, Books 1 and 2	
	Earth and Beyond for Thinking Scientists Books, 1 – 4	
	Science in the Classroom, Books 1 – 2	
	Science Work Books 1- 2	

Other materials for the three Strands that may be available in the community

Utensils and containers such as spoons, knives, strainer, funnel, cups, jars, jugs, empty plastic containers and plastic bags, empty tins, matchboxes, empty cartons and boxes

Household items such as stoves-kerosene, gas or electric, cushions, old wire, torch, batteries, string, cotton, gauze, rubber hose, hollow tubes, tyres and tubes, old light bulbs and tubes, radio cassette players, video players, toys, marbles, clothing materials, hammer, paint, scale, tape measure, nail, saw, pliers, spanner, screwdriver, hair comb and brush, hair cream, grass knife, spade, telephone, watch or clock

Substances such as steel wool, scraps of food, milk, salt, sugar, vinegar, ice, water, oil, chalk dust, cordial, petrol, detergents, bleach, disinfectants, metals, betelnut, lime, mustard, yeast, flour, dyes, grease

Stationery items such as rulers, pens, ink, white and coloured paper, chalk, rubber bands, old newspapers, magazines

Human resources such as a traditional healer, musician, local navigator, tradesperson, craftsperson, weather person, electrician, mechanic

Community resources such as canoes, boats, sails, water tanks, hydroelectric power stations, guitar, ukulele, organ, keyboard or computer

Teaching aids such as advertisements, posters, charts

Items from the environment such as wood, twigs, insects, flowers, fruit, nuts, food types, bones and herbal plants

Other textbooks for Upper Primary Science

These resources are produced in other countries but are still useful in this course. Teachers and schools can use the addresses given below and other information given in the table to order these books.

ISBN	Publication Title	Publisher	Type
	Earth and Beyond-Activities for thinking scientists, Book1	Macmillan	Student Resource Book
073294779 0	Earth and Beyond, Activities for thinking scientists, Book 2	Macmillan	Student Resource Book
073294780 4	Earth and Beyond,Activities for thinking scientists, Book 3	Macmillan	Student Resource Book
058272113 x	Fundamental Science for Melanesia, Book 1	Longman	Teacher text, Student Resource Book
058272122 9	Fundamental Science for Melanesia, Book 2	Longman	Teacher text, Student Resource Book
0 86901 059 x	Basic Science Series, Books 1 – 16 New Ed.	Great Western Press	Student Resource Book
01955 4162 6	Oxford Science for the Pacific, A- Z of Essential Terms	Oxford	Student Resource Book
01955 0824 6	Science in the classroom, Book 1	Oxford	Student Resource Book
01955 0825 4	Science in the classroom Book 2	Oxford	Student Resource Book
01955 3681 9	Science Works, Book 2	Oxford	Student Resource Book

Excursions and field trips

Science activities can be carried out to places outside the usual classroom. Excursions and field trips are a valuable and positive addition to any Science program. It is important for Science teachers to take every opportunity to study and increase their knowledge of local resources and issues.

Use the local environment, both natural and built, outside the school as an inspiration, focus or setting for learning experiences where appropriate. Contact, and where possible, obtain the support of local community agencies, local government departments, conservation groups and local industries.

Consider local resources and landscape such as geological formations, rivers, mining sites, fisheries, hydroelectric plants and wildlife as a part of the extended Science classroom.

Discuss and find out from students what issues concern their communities. Examine the recommended knowledge, processes and skills and suggested activities in the Teachers Guide to establish opportunities where students and teachers can get out of the classroom and explore their local environment.

Getting organised

A good excursion or field trip is a well-planned trip where aims and objectives are identified and the activities conducted are intended to achieve the learning outcome. Consider these key points when planning an excursion.

- What is the aim of the excursion?
- What work do you expect the students to complete at the site? Is it to be submitted before the end of the visit or is it part of an ongoing project or will it be completed for homework?
- Are the students clear about what is expected of them?
- What are some of the risks involved in the excursion and what steps are you going to take to minimise or stop these from happening?
- Do you know the site well yourself or have you organised management at the site to provide security and assistance when required?
- Have you obtained approval from relevant authorities and parents or guardians?
- How long will it take: a lesson, a day or longer and will you require necessities such as food, shelter and sleeping materials?
- How are you travelling to the site and have you arranged this?
- Do your students have everything they need such as pencils, books, questionnaires and worksheets?
- How are your students carrying out the tasks; in groups, pairs or individually?
- Will you need support from other staff members as well?

Being safety conscious

It is the responsibility of the teacher to ensure that the classroom is a safe working environment for students. An untidy, littered classroom encourages attitudes that may themselves result in accidents. Science teachers have a duty to:

- research the chemicals associated with any class experiments or demonstrations,
- demonstrate experiments using safe procedures and chemicals before allowing the students to try it themselves,
- warn students about the potential dangers associated with an experiment and demonstrate proper techniques in dealing with these,
- supervise students at all times and ensure that safe techniques are followed throughout.

The basic first aid kit

Every school should have a first aid kit readily available during demonstrations or experiments. All Science teachers are expected to be familiar with simple first aid procedures. Prompt action is essential in first aid situations. The kit should contain cotton wool, a mild antiseptic solution, eye wash bottle, scissors, tweezers, gauze, small plastic or metal bowl, burn cream, bandages of various sizes, sticking plasters, band aids, safety pins.

Addresses for materials, equipment or chemicals

The addresses listed are for the schools that are able to secure funds to purchase resources and equipment for their respective schools. The Education Department does not supply these resources.

PNG Suppliers: Chemicals

Belltek Chemicals
PO Box 2358, Boroko
Fax 3250949, Phone 3257079

Spring International Holdings
PO Box 6880, Boroko
Fax 3253411, Phone 3255734

Pacific Scientific Instrumentation
PO Box 384, Madang
Phone/Fax 9822693

Methods and Measurements
PO Box 974, Boroko
Fax 3258886

Zampolle Pacific PNG Ltd
Fax 3201128

Silkwood Business International
PO Box 1455, Lae
Phone/Fax 472 6329

PNG Suppliers - Books

Gordon & Gotch (PNG) Ltd
PO Box 107, Boroko, NCD
Phone 3254855, Fax 3250950
Email ggpng@online.net.pg

La Galamo Office and Schools Supplies Pty Ltd
PO Box 1405, Lae
Phone 4722588

Web Books
PO Box 1385, Port Moresby
Phone 3252508 Fax 3230737

Oxford PNG
PO Box 7979 Boroko,
Phone 3235611 Fax 3235615

Overseas Suppliers: Chemicals

Serrata Pty Ltd
PO Box 73, Galstone, NSW 2159 AUS
Fax 0561 2651 2031 Phone 0561 2 651 3033

Biolab Scientific,
Private Bag 36900, Northcote Auckland, NZ,
Phone 0564 9 418 3039 Fax 0564 9 480 3430

Philip Harris International Ltd, Lynn Lane,
Shenstone, WS14 OEE, Staffordshire, UK

Q Stores (Chemicals),
4-6 Huntley St
PO Box 77, Alexandria,
NSW 2015, AUS,
Phone 0561 2 3187 888
Fax 0561 2 3187 886

Overseas Suppliers: Books

Macmillan, Macmillan Education Australia
627 Chapel Street, South Yarra, Victoria,
Australia 3141
Phone (03) 9825 1095 Fax (03) 9825 1010

Ofarrel & White, Book Publishing Services,
Oxford University Press,
34 Godfrey Avenue, East St Kilda, Victoria,
Australia 3183,
Phone/Fax (03) 613 9534 4401

Longman Cheshire Pty Limited
Longman House Kings Gardens,
95 Coventry Street, Melbourne,
Australia 3205

Heinemann Australia Pty Ltd, 22 Salmon
Street, Port Melbourne, Victoria, Australia
3207

Glossary

Adaptation	changing based on the changes taking place in the environment
Atom	the smallest part of an element
Anecdotal notes	notes taken about individual students during lessons that record significant or interesting observations
Assessment Criteria	statements that are used to judge the quality of student performance or achievement
Categorise	put into groups
Characteristics	common features of living or non-living things
Classification	a process of grouping things in a systematic way
Contrast	to describe the differences between two things
Criterion-referenced assessment	criterion-referenced assessment uses specific assessment criteria derived from the learning outcomes to judge a student's individual performance. It does not compare the performance of one student to another
Conventional	the accepted view about something
Concepts	these are ideas, thoughts or understandings about something
Conclusion	a definite outcome derived from evidence gathered from experiments or an accumulation of research evidence
Context	the surrounding conditions or situations where something is likely to take place
Decanting	separating mixtures by carefully pouring off the liquid from the solids such as separating a mixture of water and sand by pouring off the water leaving the sand behind
Diversity	a range of different things such as diversity of living things
Explicit	clear, accurate, specific
Food chain	the simple links between a producer and consumers that show the transfer of energy from one to the other
Food Web	the many links between producers and consumers that involves more than one food chain within an ecosystem and that shows the transfer of energy within an ecosystem
Hypothesis	a statement that proposes an explanation that can be investigated and proven true or shown to be false
Inferences	making suggestions to explain evidence collected during investigations. These suggestions may not be correct but are based on the available evidence

Interaction	an action between two or more objects or events.
Investigation	processes of finding out about something. Scientists investigate by conducting experiments
Inclusive	including everything or everyone
Journals	daily records of events
Matter	physical material that has mass and occupies space
Model	a concrete representation of something
Molecule	a chemical combination of two or more atoms to form the smallest part of a compound
Non-biodegradable	matter that cannot be caused to rot or be broken down by living things
Norm-referenced Assessment	assessment that compares students' achievements with achievements of a representative sample of other students. This sample is usually a national sample. The purpose of norm-referenced assessment is usually to sort and rank students
Open Investigation	an investigation where the outcome is not known
Particles	very small parts that together form matter
Progression	moving forward or developing continuously or in stages
Phenomena	changes taking place in nature
Relationship	connection between things
Rote Learning	learning that takes place by repeating steps over and over again rather than learning by doing
Sublimation	direct physical change from solid to gas or gas back to solid
Sustainability	to be able to maintain something in the future without needing additional support or resources
Transmission	a process of passing information from the sender to receiver: consider transmission of energy
Sedimentation	the depositing of suspended particles in layers from large particles to small particles

Appendix

Time allocations for Upper Primary subjects

In Upper Primary the subjects to be taught and their time allocations per week are:

Arts	180 minutes
Language	180 minutes
Making a Living	360 minutes
Personal Development	240 minutes
Social Science	180 minutes
Science	180 minutes
Mathematics	180 minutes

All subjects are core subjects and must be allocated the required number of minutes per week. Each subject is equally important for Integral Human Development. Making a Living and Personal Development have more time allocated because of their practical orientation.

All subjects can be externally assessed (*National Assessment and Reporting Policy, 2003*).