General Mathematics

Upper Secondary

Teacher Guide

Papua New Guinea
Department of Education

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Contents

Secretary's message

This teacher guide is to be used by teachers when implementing the Upper Secondary General Mathematics syllabus (Grades 11 and 12) throughout Papua New Guinea. The General Mathematics syllabus identifies the learning outcomes and content of the subject as well as assessment requirements. The teacher guide gives practical ideas about ways of implementing the syllabus: suggestions about what to teach, strategies for facilitating teaching and learning, how to assess and suggested assessment tasks.

A variety of suggested teaching and learning activities provides teachers with ideas to motivate students to learn, and to make learning relevant, interesting and enjoyable. Teachers should relate learning in General Mathematics to real people, issues and the local environment. Teaching using meaningful contexts and making sure that students participate in appropriate practical activities assists students to gain knowledge and understanding, and to demonstrate skills in General Mathematics.

Teachers are encouraged to integrate General Mathematics activities with other subjects, where appropriate, so that students can see the interrelationships between subjects and that the course they are studying provides a holistic education and a pathway for the future.

I commend and approve the General Mathematics Teacher Guide for use in all schools with Grades 11 and 12 students throughout Papua New Guinea.

DR JOSEPH PAGELIO

Secretary for Education

Introduction

The purpose of this teacher guide is to help you to implement the General Mathematics syllabus. It is designed to stimulate you to create exciting and meaningful teaching programs and lessons by enabling you to choose relevant and purposeful activities and teaching activities. It will encourage you to research and look for new and challenging ways of facilitating students' learning in mathematics.

It is designed to support and assist you in planning your teaching strategies and learning activities and assessment tasks. It also encourages you to develop activities that are appropriate and relevant.

The teacher guide supports the syllabus. The syllabus states the learning outcomes for the subject and units, and outlines the content and skills that students will learn, together with the assessment requirements.

The teacher guide provides direction for you in using the outcomes approach in your classroom. The outcomes approach requires you to consider assessment early in your planning. This is reflected in the teacher guide.

This teacher guide provides examples of teaching and learning strategies. It also provides detailed information on criterion-referenced assessment, and the resources needed to teach General Mathematics. The section on recording and reporting shows you how to record students' marks and how to report against the learning outcomes.

The outcomes approach

In Papua New Guinea, the Lower Secondary and Upper Secondary syllabuses use an outcomes approach. The major change in the curriculum is the shift to what students know and can do at the end of a learning period, rather than a focus on what the teacher intends to teach.

An outcomes approach identifies the knowledge, skills, attitudes and values that all students should achieve or demonstrate at a particular grade in a particular subject (the learning outcomes). The teacher is responsible for identifying, selecting and using the most appropriate teaching methods and resources to achieve these learning outcomes.

Imagine the student is on a learning journey, heading to a destination. The destination is the learning outcome that is described in the syllabus document. The learning experiences leading to the learning outcome are to be determined by the teacher. The teacher uses curriculum materials, such as syllabus documents and teacher guides, as well as textbooks or electronic media and assessment guidelines, to plan activities that will assist students achieve the learning outcomes. The outcomes approach has two purposes. They are:

- to equip all students with knowledge, understandings, skills, attitudes and values needed for future success
- to implement programs and opportunities that maximise learning.

Three assumptions of outcomes-based education are:

- all students can learn and succeed (but not on the same day or in the same way)
- success breeds further success
- schools can make a difference.

The four principles of the Papua New Guinean outcomes approach are:

1 *Clarity of focus through learning outcomes*
This means that everything teachers do must be clearly focused on what they want students to be able to do successfully. For this to happen, the learning outcomes should be clearly expressed. If students are expected to learn something, teachers must tell them what it is, and create appropriate opportunities for them to learn it and to demonstrate their learning.

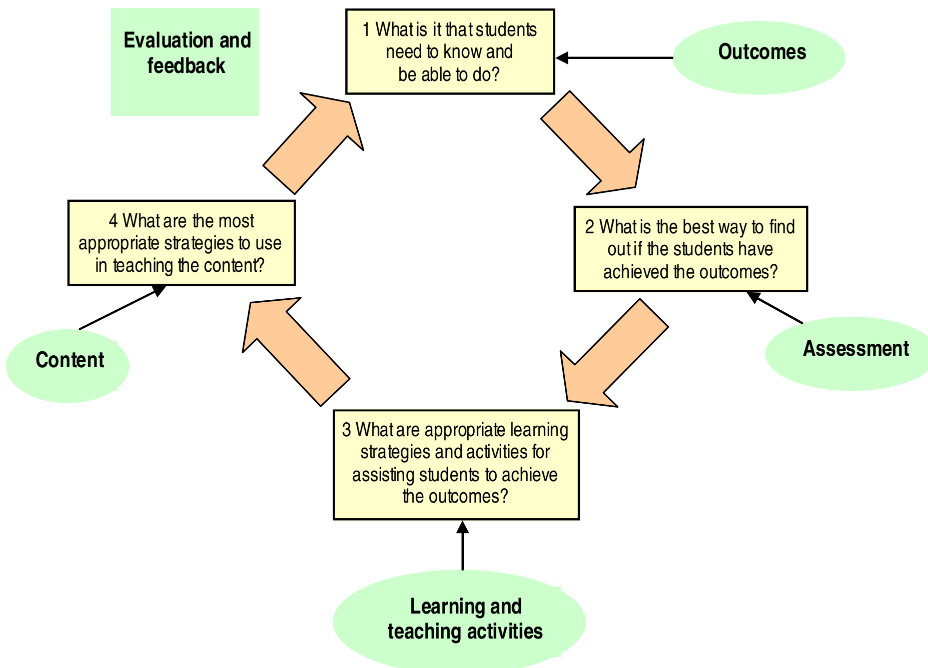
2 *High expectations of all students*
This means that teachers reject comparative forms of assessment and embrace criterion-referenced approaches. The 'principle of high expectations' is about insisting that work be at a very high standard before it is accepted as completed, while giving students the time and support they need to reach this standard. At the same time, students begin to realise that they are capable of far more than before and this challenges them to aim even higher.

3 *Expanded opportunities to learn*
This is based on the idea that not all students can learn the same thing in the same way in the same time. Some achieve the learning outcomes sooner and others later. However, most students can achieve high standards if they are given appropriate opportunities. Traditional ways of

organising schools do not make it easy for teachers to provide expanded opportunities for all students.

4 *Planning and programming by 'designing down'*
This means that the starting point for planning, programming and assessing must be the learning outcomes—the desired end results. All decisions on inputs and outputs are then traced back from the learning outcomes. The achievement of the outcome is demonstrated by the skills, knowledge and attitudes gained by the student. The syllabuses and/or teacher guides describe some ways in which students can demonstrate the achievement of learning outcomes.

Outcomes-based approach



Learning outcomes provide teachers with a much clearer focus on what students should learn. They also give teachers greater flexibility to decide what is the most appropriate way of achieving the learning outcomes and meeting the needs of their students by developing programs to suit local content and involve the community.

The outcomes approach promotes greater accountability in terms of student achievement because the learning outcomes for each grade are public knowledge; that is, they are available to teachers, students, parents and the community. It is not the hours of instruction, the buildings, the equipment or support services that are the most important aspect of the education process but rather, what students know and can do, as they progress through each grade.

The outcomes approach means that learning

- has a clearer purpose
- is more interactive—between teacher and students, between students
- has a greater local context than before
- is more closely monitored and acted upon by the teacher
- uses the teacher as a facilitator of learning as well as an imparter of knowledge.

Learning outcomes

The syllabus learning outcomes describe what students know and can do at the end of Grade 12. The level of achievement of the learning outcomes should improve during the two years of Upper Secondary study, and it is at the end of the study that students are given a summative assessment on the level of achievement of the learning outcomes. The learning outcomes for General Mathematics are listed below.

Students can:

1. use knowledge of numbers and their relationships to investigate a range of different contexts
2. identify, interpret, describe and represent various functional relationships to solve problems in real and simulated contexts
3. measure and use appropriate techniques and instruments to estimate and calculate physical quantities
4. interpret, describe and represent properties of relationships between 2-dimensional shapes and 3-dimensional objects in a variety of orientations and positions
5. demonstrate the application of statistical knowledge and probability to communicate, justify, predict and critically analyse findings and draw conclusions
6. describe and explain the interrelationships between mathematical concepts
7. apply mathematical procedures including technological resources to solve practical problems in familiar and new contexts
8. communicate mathematical processes and results
9. undertake mathematical tasks individually and/or cooperatively in planning, organising, and carrying out mathematical activities.

Learning and teaching

You, as a teacher, must teach the knowledge that is included in the syllabus documents. You have to be able not only to teach what students should know, but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support learning and teaching. You also need to give students some opportunities to apply their knowledge, to be creative and to solve problems.

Learning and teaching strategies

Students who participate in guided instruction learn more than students who are left to construct their own knowledge (Mayer 2004). You need to employ a variety of learning and teaching approaches because all students do not learn in the same way. The ‘auditory learner’ prefers to use listening as the main way of learning new material whereas a ‘visual learner’ prefers to see things written down. Students should be actively involved in their learning and therefore you need to design appropriate practical activities or experiments, using resources that can be found in your location.

In Grades 11 and 12, students will already have had a wide variety of experiences. You need to make use of your students’ experiences when designing and conducting learning in class, so that learning is connected to your students’ world. There are many learning and teaching strategies described in the Lower Secondary teacher guides. Teaching strategies include:

- fieldwork
- project work
- group work and cooperative learning
- classroom displays
- models
- using analogies and metaphors
- mind maps or concept maps
- reflective learning
- task cards

The most efficient and long-lasting learning occurs when teachers encourage the development of higher-order thinking and critical analysis skills, which include applying, analysing, evaluating and creating. Attention should also be paid to developing students’ affective and psychomotor skills. To make sure that this happens, you should encourage deep or rich—rather than shallow—coverage of knowledge and understandings.

Developing General Mathematics skills

Students need to develop mathematics skills and techniques. Skills development should happen as a part of students’ learning experiences and the learning and practising of skills needs to take place in the context of mathematics. Skills learning tends to be most effective when:

- students go from the known to the unknown
- students understand why it is necessary to master specific skills
- skills are developed sequentially at increasing levels of difficulty
- students identify the components of the skill
- the whole skill and the components of the skills are demonstrated
- there are frequent opportunities for practice and immediate feedback
- the skills being taught are varied in terms of amount and type, according to the needs of students
- the skill is used in a range of contexts.

What do students do in General Mathematics?

Research

Research is an essential activity in the study of General Mathematics. It allows students to search for and gather information, either within or outside of the classroom. It supplies students with past and present mathematical information and experiences. Research enables students to:

- gather information about General Mathematics through learning, reading and fieldwork.

Listening to guest speakers

Listening to guest speakers is an invaluable learning activity in the study of General Mathematics. This activity updates students on current mathematical issues, information and practices. It encourages students to develop a critical and enquiring mind. Listening to guest speakers will enable students to:

- acquire updated knowledge about financial institutions, skills on geometrical and statistical surveying, geometrical construction and traditional arts
- listen, analyse, synthesise and interpret disseminated information.

Awareness

Awareness is a useful activity in that it educates students on traditional knowledge and new information on hazards and or benefits. Students are better equipped to carry out their own awareness in turn (unit 12.5). Awareness enables students to:

- acquire knowledge and bring awareness to the community
- select, organise and communicate mathematical information.

Use of technology

Calculators, computers, computer software packages, the internet

Multimedia presentations

Multimedia is a tool that can be used to explain abstract mathematical processes, concepts and systems. It enhances teaching and learning skills through computer simulation software, audio and visual colour and motion in various ways. Multimedia presentations enable students to:

- acquire knowledge about General Mathematics through video, slide and print media
- expand their knowledge through the use of information and communication technology
- explore the macro and micro-worlds; for example, the planetary world.

Developing a program

A teaching program outlines the nature and sequence of learning and teaching necessary for students to demonstrate the achievement of the learning outcomes. The content of the syllabus describes the learning context and the knowledge required for the demonstration of each outcome. The relevant learning outcomes for each unit or topic are stated at the beginning of the unit and the requirements of the outcomes are elaborated.

Teachers must develop programs that include appropriate learning activities to enable students to develop the knowledge and skills identified in the outcome statements.

The content prescribed in the units indicates the breadth and depth with which topics should be treated. The sequence of teaching is prescribed by the sequence of content. The learning outcomes and assessment, however, must be central to the planning of the teaching program.

Planning and programming units

The main purpose of planning and programming is to help you to arrange the presentation of the unit in an organised manner. This will help you to know what to teach and when to teach it. It is strongly recommended that you make plans with the other teachers who teach the same subject. By planning together, you will *all* have better lessons and make better use of your limited resources.

Points to consider when programming

- Which outcomes are students working towards?
- What is the purpose of this unit or topic or learning experience?
- Which learning experiences will assist students to develop their knowledge and understandings, skills, values and attitudes, in General Mathematics?
- What are the indicators of student learning that you would expect to observe?
- How can the learning experiences be sequenced?
- How do the learning experiences in the unit relate to students’ existing knowledge and skills?
- How are individual learning needs to be catered for?

- What are the literacy demands of this unit or learning experience?
- What authentic links can be made with the content of other subjects?
- How can school events and practices be incorporated into the program?
- Do the assessment methods address the outcomes and enhance the learning?
- How can the assessment be part of the learning and teaching program?

The planning process

In this teacher guide, ideas for programming and organising have been provided. These have been arranged in steps to help you teach the unit. The steps follow the thinking processes involved in the outcomes approach.

Step 1: Interpreting the learning outcomes

The first step is to read the description in the syllabus. Then study the learning outcomes and what students do to achieve the learning outcomes, in order to determine what students will know and be able to do by the end of the unit. You need to look at the action verb, concept and context of each learning outcome. This will help you to see what skills and knowledge are embedded in the outcome.

Step 2: Planning for assessment

It is necessary to plan for assessment early to ensure that you teach the content and skills students need to achieve the learning outcomes. You will have to decide when to schedule assessment tasks to allow yourself time to teach the required content and time for students to develop the necessary skills.

You will also need time to mark the task and provide feedback. Practical tasks may, for example, be broken into a series of stages that are marked over several weeks as students progress with making their product. It is not appropriate to leave all assessment until the end of the unit.

This teacher guide provides performance standards and examples of a marking guide. You should develop marking guides when you are marking tasks to ensure consistency in your assessment. You must also develop clear and detailed instructions for completing the task and make sure all students know exactly what they have to do.

Step 3: Programming a learning sequence

This step requires you to develop a program outlining a sequence of topics and the time spent on each topic. If the unit involves a project, for example, you may plan to teach some theory at appropriate stages during the project, rather than teaching all the theory before students start the project.

To develop your program you need to study the topics listed in the syllabus. Think about which learning activities will best give students opportunities to learn the content and practise the appropriate skills, and how long the activities will take. You will have to think about some major activities that last several weeks and smaller activities that may be completed in a single lesson.

Step 4: Elaboration of activities and content

Once you have mapped out your program for the term, you must then develop more detailed plans for each topic in the unit. All units require students to be actively engaged in learning, not just copying from the board.

Make sure you develop a range of activities that suit all learning needs—some reading and writing, some speaking and listening, some observing and doing.

Browse through the textbooks and teaching resources you have access to and list the chapters, pages or items that you will use for each topic in your program. The textbooks should also provide you with ideas for activities related to the topic. You may have to collect or develop some resources for yourself.

Once you have sorted out your ideas and information, you can then develop your more detailed weekly program and daily lesson plans. This teacher guide gives some suggested learning and teaching activities for each unit and some suggested assessment tasks that you might like to use to ensure active learning

Using the internet for classroom activities

Planning

- Where appropriate, incorporate computer sessions as part of planned learning experiences.
- Be aware that computers can be time-consuming and may require extra teacher support at unexpected times.
- Consider methods of troubleshooting, such as having students with computer expertise designated as computer assistants.
- Design activities that provide the opportunity for students to access, compare and evaluate information from different sources.
- Check protocols, procedures and policies of your school and system regarding the use of the internet.

Managing

- Ensure that all students have the opportunity to explore and familiarise themselves with the technologies, navigation tools, e-mail facilities and texts on the internet. It is likely that students will have varying degrees of expertise in searching for information and navigating the internet. Students will also have varying experiences of, and be more or less familiar with, the way texts are presented on the World Wide Web.
- Ensure that all students understand how to access the internet and how to perform basic functions, such as searching, sending and receiving e-mail.
- Students with more experience in using the internet may have information that will benefit the whole class. Provide opportunities for students to share their experiences, interests, information and understandings. As well as planning lessons to instruct students in these skills, pairing students and peer tutoring on the computer can enable more experienced students to assist other students.
- Ensure that students critically analyse mathematical information gathered on the internet, just as they would for any other text. They should be aware that material posted on the Web is not necessarily subject to the conventional editorial checks and processes generally applied to print-based publications. When evaluating information, students might consider:
    - the intended audience of the site

- bias in the presentation of information, or in the information itself, including commercial or political motives
- accuracy of information
- balanced points of view
- currency of information, including publishing dates
- authority of source or author (institution, private individual)
- ownership of the website (such as corporate, small business, government authority, academic)
- cultural or gender stereotyping.

- Ensure that software and hardware (computer, modem) are maintained in good working order.
- Ensure that all students are given equal opportunities to use the computer.

Assessing student work containing material from the internet

- Students can download large quantities of information from the internet. In itself, such information provides very little evidence of student effort or student achievement. Students must make judgements about the validity and safety of information when working from the Web. They must consider the purpose of the text, identify bias, and consider the validity of arguments presented and the nature and quality of the evidence provided.
- When assessing student work that includes material drawn from the internet, it is therefore important to recognise how students have accessed the information, what value they place on it and how they have used it for the topic being studied in class. It is useful to look for evidence of critical evaluation, and the development of students' capacities to access, manipulate, create, restore and retrieve information.

General Mathematics requirements

There are five units each in Grades 11 and 12, which all students must complete.

General Mathematics requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11.1	10	1	Number and Application	Bathroom scale, measuring instruments (analogue or digital), mass sets, metre ruler, conversion tables, grid papers
11.2	8	2	Managing Money 1	Scientific calculator, newspaper cuttings (foreign exchange rates), taxation tables, formula sheet
11.3	6	2 or 3	Statistics 1	Provide data from local level government (LLG), aviation, statistics on HIV and AIDS, hospitals or urban or rural clinics
11.4	8	3 or 4	Geometry	Protractor, compass, set square, pencils, rope and paper if no compass, global map, geo-blocks, 3-D blocks
11.5	8	4	Trigonometry	Clinometer, compass, metre ruler, trundle wheel, compass bearings
12.1	6	1	Measurement	Compass bearing, trundle wheel, tape measure, compass, survey field book, resource personnel: surveyors, civil engineers
12.2	8	1 or 2	Managing Money 2	Resource personnel; for example, bankers, accountants, stock analysts, underwriters, valuers
12.3	6	2	Probability and Statistics 2	Dominoes, deck of cards, marbles, dice, coins, chocolate board, dart board
12.4	6	3	Algebra and Graphs	Grid papers
12.5	4	3	Applying Geometry in Papua New Guinean Arts	Resource personnel, parents, guardians, village elders, traditional artefacts (for example, bilum, tapa cloth)

Assessing General Mathematics

Assessment is an important part of learning and teaching. It is used to:

- evaluate and improve learning and teaching
- report achievement
- provide feedback to students on their progress
- provide feedback to stakeholders.

Criterion-referenced assessment

Assessment in General Mathematics is criterion-referenced and measures students' achievement of the learning outcomes described in the syllabus. In criterion-referenced assessment, particular knowledge, skills or abilities are specified as criteria that must be achieved. The extent to which they are achieved is assessed and facilitated by the teacher.

Criterion-referenced assessment often takes on a problem-centred orientation, rather than a knowledge-based orientation. To achieve an outcome means having to demonstrate the attainment of skills and attitudes, not just write about them. Assessment then becomes more than just a means of judging knowledge and performance—it becomes an integral part of the learning process itself. Criterion-referenced assessment is:

- standards or criterion-referenced; that is, outcomes are judged against pre-defined standards (see table below)
- direct and authentic, related directly to the learning situation. This has the potential for motivating learning, since students can see a direct relevance between what is learnt and what is assessed.

Norm-referenced assessment

'Norm-referenced assessment' makes judgements on how well the student did in relation to others who took the test. It is often used in conjunction with a curve of 'normal distribution', which assumes that a few will do exceptionally well and a few will do badly and the majority will peak in the middle, normally judged as average.

Example of a criterion-referenced test

The driving test is the classic example of a criterion-referenced test. The examiner has a list of criteria, each of which must be satisfactorily demonstrated in order to pass; for example, completing a three-point turn without hitting either kerb. The important thing is that failure in one criterion cannot be compensated for by above-average performance in others; nor can a student fail in spite of meeting every criterion (as they can in norm-referenced assessment) simply because everybody else that day surpassed the criteria and was better than him or her. Criterion-referenced assessment has the following characteristics:

- a syllabus that describes what students are expected to learn in terms of aims, outcomes and content

- a syllabus that provides a clear sense of the syllabus standards through its aims, outcomes and content
- tasks designed to produce an image of what students have achieved at that point in the learning and teaching process relative to the outcomes
- standards of performance at different levels: the 'performance standards'
- a report that gives marks referenced to predetermined standards
- assessment tasks that refer to syllabus outcomes, content, assessment components and component weightings
- external examinations that are based on syllabus outcomes and content. External markers use standards-referenced marking guidelines developed by the Mathematics Examination Committee.
- assessment that is better-integrated with learning and teaching.

Criterion or standards-referenced assessment in General Mathematics

Learning outcomes performance standards					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
1.Use knowledge of numbers and their relationships to investigate a range of different contexts	Demonstrate a very clear understanding of use of number knowledge and its relationships in different contexts	Demonstrate a clear understanding of use of number knowledge and its relationships in different contexts	Demonstrate a fair understanding of use of number knowledge and its relationships in different contexts	Demonstrate limited understanding of use of number knowledge and its relationships in different contexts	Has failed to meet the minimum standard required
2. Identify, interpret, describe and represent various functional relationships to solve problems in real and simulated context	Exceptionally outstanding description, interpretation and representation of various functional relationships to solve real or simulated mathematical problems	Outstanding description, interpretation and representation of various functional relationships to solve real or simulated mathematical problems	Fair description, interpretation and representation of various functional relationships to solve real or simulated mathematical problems	Limited description, interpretation and representation of various functional relationships to solve real or simulated mathematical problems	Has failed to meet the minimum standard required
3. Measure and use appropriate techniques and instruments to estimate and calculate physical quantities	Excellent technical skills and use of instruments for measuring and calculating physical quantities	Very good technical skills and use of instruments for measuring and calculating physical quantities	Good technical skills and use of instruments for measuring and calculating physical quantities	Poor technical skills and use of instruments for measuring and calculating physical quantities	Has failed to meet the minimum standard required
4. Interpret, describe and represent properties of relationships between 2D shapes and 3D objects in a variety of orientations and positions	Exceptionally outstanding description and interpreting properties of relationships between 2D shapes and 3D objects in a variety of orientations and positions	Very good description and interpreting properties of relationships between 2D shapes and 3D objects in a variety of orientations and positions	Good description and interpreting properties of relationships between 2D shapes and 3D objects in a variety of orientations and positions	Limited description and interpreting properties of relationships between 2D shapes and 3D objects in a variety of orientations and positions	Has failed to meet the minimum standard required

Learning outcomes performance standards					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
5. Demonstrate the application of statistical knowledge and probability to communicate, justify, predict and critically analyse findings and draw conclusions	Critically analyse, evaluate and use statistical data and information to communicate, predict and justify recommendations or conclusions	Detailed analysis, evaluation and interpretation of statistical data and information to communicate, predict and justify recommendations or conclusions	Satisfactory analysis, evaluation and interpretation of statistical data and information to communicate, predict and justify recommendations or conclusions	Poor analysis, evaluation and interpretation of statistical data and information to communicate, predict and justify recommendations or conclusions	Has failed to meet the minimum standard required
6. Describe and explain the interrelationships between mathematical concepts	Exceptional description and explanation of interrelationships between mathematical concepts	Sufficient description and explanation of interrelationships between mathematical concepts	Satisfactory description and explanation of interrelationships between mathematical concepts	Limited description and explanation of interrelationships between mathematical concepts	Has failed to meet the minimum standard required
7. Apply mathematical procedures including technological resources to solve practical problems in familiar and new contexts	Exceptional use of technological resources and excellent application of mathematical procedures to solve practical problems in familiar and new contexts	Outstanding use of technological resources and outstanding application of mathematical procedures to solve practical problems in familiar and new contexts	Satisfactory use of technological resources and satisfactory application to mathematical procedures to solve practical problems in familiar and new contexts	Limited use of technological resources and limited application of mathematical procedures to solve practical problems in familiar and new contexts	Has failed to meet the minimum standard required
8. Communicate mathematical processes and results	Outstanding communication of mathematical procedures and results	Sound communication of mathematical procedures and results	Fair communication of mathematical procedures and results	Limited communication of mathematical procedures and results	Has failed to meet the minimum standard required
9. Undertake mathematical tasks individually and/or cooperatively in planning, organising, and carrying out mathematical activities	Undertakes mathematical tasks thoroughly individually and/or cooperatively in planning, organising, and carrying out mathematical activities	Undertakes mathematical tasks very well individually and/or cooperatively in planning, organising, and carrying out mathematical activities	Undertakes mathematical tasks well individually and/or cooperatively in planning, organising, and carrying out mathematical activities	Undertakes mathematical tasks poorly individually and/or cooperatively in planning, organising, and carrying out mathematical activities	Has failed to meet the minimum standard required

Assessment *for* learning

Assessment *for* learning is often called ‘formative assessment’ and is assessment that gathers data and evidence about student learning during the learning process. It enables you to see where students are having problems and to give immediate feedback, which will help your students learn better. It also helps you plan your program to make student learning, and your teaching, more effective. Often it is informal—students can mark their own work or their friend's. An example is a quick class quiz to see if students remember the important points of the previous lesson.

Assessment *of* learning

Assessment *of* learning is often called 'summative assessment'. Summative assessment is used to obtain evidence and data that shows how much learning has occurred, usually at the end of the term or unit. End-of-year examinations are examples of summative assessment. It is usually done for formal recording and reporting purposes.

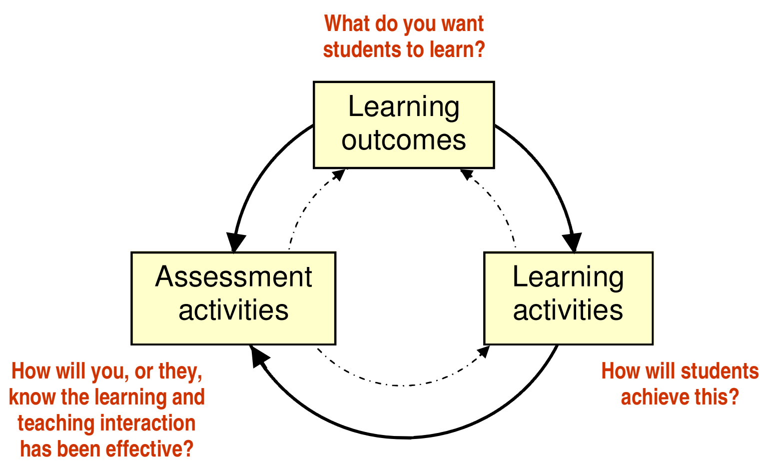
Assessing General Mathematics units

In General Mathematics the learning outcomes are assessed using the range of assessment methods specified in the syllabus. This teacher guide includes sample assessment tasks and assessment criteria that can be used to assess the outcomes of particular units. Teachers can use these samples to develop other assessment tasks, criteria and performance standards.

In deciding what to assess, the starting point is 'what do you want students to do and/or learn?' and following from this: 'how will the students engage with the material?', which in turn leads to the design and development of learning tasks and activities. It is crucial that at this point the assessment tasks clearly link back to the learning outcomes and are appropriate for the learning activities.

The assessment can be used for formative and summative purposes. Assessment can be represented as follows:

Assessment process



Once it is clear what needs to be assessed and why, then the form the assessment will take needs to be determined. There are many types of assessment tasks that can be implemented; the factors that will determine choices include:

- the students—how many are there, what is expected of them, how long will the assessment task take?

- the learning outcomes of the subject and how they might best be achieved.

During the year you must set assessment tasks that ensure that all the learning outcomes of the subject have been assessed internally. Each task you set must include assessment criteria that provide clear guidelines to students as to how, and to what extent, the achievement of the learning outcomes may be demonstrated.

Marking guides and assessment criteria help you with the marking process and ensure that your assessment is consistent across classes. It is important that marking guides and assessment criteria are collectively developed.

Students must complete the assessment tasks set. Each task must provide clear guidelines to students for how the task will be completed and how the criteria will be applied. When you set a task, make sure that:

- the requirements of the task are made as clear as possible to the student
- the assessment criteria and performance standards or marking guides are provided to students so that they know what it is that they have to do
- any sources or stimulus material used are clear and appropriate to the task
- instructions are clear and concise
- the language level is appropriate for the grade
- it does not contain gender, cultural or any other bias
- materials and equipment needed are available to students
- adequate time is allowed for completion of the task.

Assessment methods

Although assessment components and weightings are stipulated in the syllabus, you decide which assessment method to use when assessing the learning outcomes. You should use a variety of assessment methods to suit the purpose of the assessment. Assessment can be classified into four categories:

- tests
- product or project assessments
- performance assessments
- process skills assessments

Because each has limitations, maintaining a balance of assessment methods is very important.

Tests

A ‘test’ is a formal and structured assessment of student achievement and progress, which the teacher administers to the class. Tests are an important aspect of the learning and teaching process if they are integrated into the regular class routine and not treated merely as a summative strategy. Tests allow students to monitor their progress and provide valuable information for you in planning further learning and teaching activities.

Tests will assist student learning if they are clearly linked to the outcomes. Evidence has shown that several short tests are more effective for student progress than one long test. It is extremely important that tests are marked and that students are given feedback on their performance.

There are many different types of tests. Tests should be designed to find out what students know, and also to find out about the development of their thinking processes and skills. Open questions provide more detailed information about achievement than a question which has only one answer.

Principles of designing classroom tests

Tests allow a wide variety of ways for students to demonstrate what they know and can do. Therefore:

- students need to understand the purpose and value of the test
- the test must assess intended outcomes
- clear directions must be given for each section of the test
- the questions should vary from simple to complex
- marks should be awarded for each section
- the question types (true or false, fill-in-the-blank, multiple-choice, extended response, short answer, matching) should be varied.

Tests should:

- be easy to read (and have space between questions to facilitate reading and writing)
- reflect an appropriate reading level
- involve a variety of tasks
- make allowance for students with special needs
- give students some choice in the questions they select
- vary the levels of questions to include gathering, processing and applying information
- provide enough time for all students to finish.

Product or project assessments

A ‘project’ can be an assessment task given to an individual student or a group of students on a topic related to the subject. The project results in a ‘product’ that is assessed. The project may involve both in-class and out-of-class research and development. The project should be primarily a learning experience, not solely an assessment task. Because a great deal of time and effort goes into producing a quality product from a project assignment task, you should allow class time to work on the project. A product or project:

- allows the students to formulate their own questions and then try to find answers to them
- provides students with opportunities to use their multiple intelligences to create a product
- allows teachers to assign projects at different levels of difficulty to account for individual learning styles and ability levels
- can be motivating to students
- provides an opportunity for positive interaction and collaboration among peers
- provides an alternative for students who have problems reading and writing

- increases the self-esteem of students who would not get recognition on tests or traditional writing assignments
- allows for students to share their learning and accomplishments with other students, classes, parents, or community members
- can achieve essential learning outcomes through application and transfer.

Assignments

'Assignments' are unsupervised pieces of work that often combine formative and summative assessment tasks. They form a major component of continuous assessment in which more than one assessment item is completed within the term. Any of the methods of assessment can be set as assignments, although restrictions in format, such as word limits and due dates, are often put on the assessment task to make them more practical.

Investigations

An 'investigation' involves students in a study of an issue or a problem. Teachers may guide students through their study of the issue; or individual students, or groups of students, may choose and develop an issue in consultation with the teacher. This assessment component emphasises the student's investigation of the issue in its context, by collecting, analysing, and commenting on secondary data and information. Students should be encouraged to consider and explore a variety of perspectives as they develop and state their position on the issue. Students may present the investigation for assessment in a variety of forms, including one or a combination of the following: a written report, an oral presentation, a website, linked documents, multimedia, a video or audio recording.

Criteria for judging performance

The student's performance in the investigation will be judged by the extent to which the student:

- identifies and describes the issue or problem
- describes and explains the causes and effects
- critically analyses information and outlines possible steps leading to a solution or recommendation.

Portfolios

Portfolios provide evidence for judgements of student achievement in a range of contexts. A portfolio contains a specific collection of student work or evidence. This collection of work should provide a fair, valid and informative picture of the student's accomplishments.

Computer-based tasks

Using computers to administer student assessment can provide flexibility in the time, location or even the questions being asked of students. The most common type of computer-based assessment is based on multiple-choice questions, which can assist teachers to manage large volumes of marking and feedback.

Process skills assessments

This method of the assessment component, the ‘process skills assessment’, involves assessing students’ understanding of concepts based on the practical skills that can be used, the evaluation of work done, and/or the reporting of information. These skills include, for example:

- interpretation skills
- evaluation skills
- reflection skills
- communication skills (such as writing, speaking and listening).

Types of assessment tasks

Using different assessment tasks is the way to make sure that students are able to demonstrate the range of their abilities in different contexts. Each category has advantages in assessing different learning outcomes. For example, a selected response assessment task, such as a series of multiple-choice questions, is able to assess all areas of mastery of knowledge, but only some kinds of reasoning.

Assessment ideas for individual students or groups

Tests	Products or projects	Performances	Process skills
Multiple-choice Matching Short answer Application or high-order problems	Document critiques Graphs, charts, tables Statistical reports Models Projects Proposals Research papers Results of surveys Recommendations	Activities Cooperative learning group activities Debates Discussions Field trips Oral histories of events or traditional artefacts Presentations Reports Surveys Warnings	Analysing Observing Evaluating Predicting Interpreting Hypothesising Investigating Explaining Classifying Estimating Communicating Researching Designing Manipulating Collecting data Synthesising Critiquing

Feedback

When you assess the task, remember that feedback will help the student understand why he or she received the result and how to do better next time. Feedback should be:

- *constructive*, so students feel encouraged and motivated to improve
- *timely*, so students can use it for subsequent learning
- *prompt*, so students can remember what they did and thought at the time

- *focused on achievement*, not effort. The work, not the student, should be assessed
- *specific to the unit learning outcomes*, so that assessment is clearly linked to learning.

Types of feedback

Feedback can be:

- *informal* or *indirect*—such as verbal feedback in the classroom to the whole class, or person to person
- *formal* or *direct*—in writing, such as checklists or written commentary to individual students, in either written or verbal form
- *formative*—given during the topic with the purpose of helping the students know how to improve
- *summative*—given at the end of the topic with the purpose of letting the students know what they have achieved.

Who assesses?

Teacher assessment

Assessment is a continuous process. You should:

- always ask questions that are relevant to the outcomes and content
- use frequent formative tests or quizzes
- check understanding of the previous lesson at the beginning of the next lesson, through questions or a short quiz
- constantly mark or check the students' written exercises, class tests, homework activities and so on
- use appropriate assessment methods to assess the tasks.

Frequency of assessment

You should schedule the specified assessment tasks to fit in with the teaching of the content of the unit that is being assessed. Some assessment tasks might be programmed to be undertaken early in the unit, others at the end of the unit. You should take care not to overload classes with assessment tasks at the end of the term.

Judging student performance

Student achievement is recorded and reported against standards. You must use performance standards or marking guides, examples of which are provided in this teacher guide, when making a decision about the achievement of your students in relation to the learning outcomes. The performance standards describe the level at which the student has to be working to achieve a particular standard or mark.

Students should always have access to a copy of the assessment criteria and the performance standards, so that they know what it is they have to know and be able to do to get a good mark in a particular task. The performance standards will help you in your marking and will help your students improve their performance in the future. They are useful when providing feedback to students, as they explain what it is the student needs to do to improve.

Moderation

To make sure that you are interpreting the performance standards correctly when assessing your students, it is important to undertake General Mathematics moderation of student work within your school and with teachers of nearby schools.

To moderate student work, a common assessment task must be used and a marking scheme developed so that all students complete the same task under the same conditions, and all teachers use the same marking scheme. Teachers can then compare (moderate) the students' work and come to a common understanding of the performance standards and the requirements for a particular mark or level of achievement.

Moderation enables you to be sure that your understanding of the required standards for levels of achievement is similar to the understanding of other teachers and that you are assessing students at the appropriate level.

Self-assessment and peer assessment

Self-assessment and peer assessment help students to understand more about how to learn. Students should be provided with opportunities to assess their own learning (self-assessment) and the learning of others (peer assessment) according to set criteria. Self-assessment and peer assessment:

- continue the learning cycle by making assessment part of learning
- show students their strengths and areas where they need to improve
- engage students actively in the assessment process
- enable students to be responsible for the learning
- help to build self-esteem through a realistic view of their abilities
- help students understand the assessment criteria and performance standards.

Managing assessment tasks for General Mathematics

Usually, the marking of assessment tasks is done by the teacher. To reduce the amount of work it is necessary to develop a strategic approach to assessment and develop efficiencies in marking. In General Mathematics there are some assessment tasks that may be new to teachers and students. Below are suggestions on how to manage some of these tasks to minimise marking or presentation time.

Develop efficiency in marking

Clarify assessment criteria

Plan the assessment task carefully, and make sure that all students are informed of the criteria before they begin. Discuss the task and its criteria in class, giving examples of what is required. Distribute a written copy of the instructions and the criteria, or put them on the board. Making the assessment criteria explicit speeds marking and simplifies feedback.

Supply guidelines on what is required for the task

Supplying guidelines reduces the amount of time wasted evaluating student work that is irrelevant.

Use attachment sheets such as marking guides

An assignment attachment sheet, which is returned with the assessed work, rates aspects of the task with a brief comment. Such a system enables each student's work to be marked systematically and quickly. This strategy can be applied to posters, presentations and performances.

Assess in class

Use class time to carry out and to assess tasks. Presentations or projects that are marked by you or the students enable instant developmental evaluation and feedback. Brief assessments of projects, stages of the design process, or practical work take less time to mark and are useful because they give immediate feedback to students on their progress and allow you to mark the project in stages with minimum effort.

Feed back to the whole class

Giving feedback to the whole class can cut down on the amount of individual feedback required. On returning assessed work, emphasise the criteria for judging the work, discuss the characteristics of good and bad answers, and highlight common strengths and weaknesses.

Set group-work alternatives

Assess one performance per group. The student's mark is the group mark, but may include a component based on the contribution of the individual. A strategy for allocating an individual mark includes each member of the group using criteria to evaluate the relative contributions of individuals, with the marks averaged for the individual.

Set clear deadlines

Set aside a time for marking. Be careful about extending this period (by allowing students to hand in work late).

Shift the responsibility

Introduce self-assessment and peer assessment

Develop in students the skills to evaluate their own work and that of their peers. With the students, use the assessment criteria against which work is judged, highlighting strengths and weaknesses. Self-assessment increases the amount of feedback students get. It can supplement or replace teacher assessment.

Treat each task differently

Every piece of work need not be evaluated to the same degree; a mark need not be the outcome in every case; and every piece of student work need not contribute to the final grade. Assessment is designed to enhance the learning and teaching experience for the teacher and the learner, not just to give marks.

Sample assessment tasks

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. The following are examples of assessment tasks and a marking guide.

Grade 11

Sample task: Sample data analysis (unit 11.3)

Students investigate published data on a topic and present a report using their statistical knowledge.

- This task includes setting a hypothesis to investigate, collecting relevant data, analysing the data, summarising the findings of the investigation and making recommendations for further research.

Learning outcomes

Students can:

5. demonstrate the application of statistical knowledge and probability to communicate, justify, predict and critically analyse findings and draw conclusions
8. communicate mathematical processes and results
9. undertake mathematical tasks individually and/or cooperatively in planning, organising, and carrying out mathematical activities.

Assessment criteria

Students will be assessed on the extent to which they:

- demonstrate statistical knowledge to analyse the data
- manipulate the data in order to confirm an argument or a hypothesis
- communicate recommendations, written or oral

Task specifications

This project is to be conducted in groups of three to five students. Students present their findings to the class or other groups after:

- asking: what is the purpose of the data analysis?
- identifying data source(s)
- collection of data
- organising the data
- analysis of the data
- producing relevant tabular and graphical displays
- producing a written report of the investigation including:

- findings
- discussion of the results
- graphical displays of results
- analysis of the data
- conclusions and recommendations

Students make an oral presentation of the investigation and written report to an audience of students and/or teachers.

Each student in the group should identify which part(s) of the project they will take primary responsibility for. Some roles individual students could take are:

- group coordination, including the selection of the data types
- data organisation and analysis
- preparation of the data analysis
- oral presentation of the findings.

This task is seeking evidence that students can collate data from a data sample, organise and analyse data, draw statistical graphs, make conclusions based on data and communicate the results.

The assessment task must be assessed using the following performance standards or marking guide based on the assessment criteria. Note that the assessment performance standards and marking guide should be made available to students at the beginning of projects.

Performance standards: Sample data analysis

Criteria	Very high achievement	High achievement	Satisfactory achievement	Low achievement
Demonstrate appropriate investigation skills	• Consistently stays focused on the task • Very self-directed • Actively collects information and creates insightful solutions to problems • Uses wide range of resources	• Focused on the task most of the time • Collects information and finds standard solutions to problems • Uses at least two different resources	• Focused on the task some of the time • Collects information and finds solutions to problems with some assistance • Uses at least two different resources	• Rarely focuses on the task • Collects some information without providing adequate solutions • Uses at most one resource
Choose and apply relevant mathematical techniques	• Appropriate and efficient mathematical techniques used at all times • Solution contains no mathematical errors, or almost none	• Usually uses appropriate and effective mathematical techniques • Solution contains few mathematical errors	• Sometimes uses appropriate and effective mathematical techniques but does not do it consistently • Solution contains some major mathematical errors	• Rarely uses appropriate mathematical techniques • Solution contains many mathematical errors
Make an effective communication of the survey results	• Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand • All project results communicated clearly	• Work is presented in an organised fashion and is mostly easy to read and understand • Most project results communicated	• Work is presented in a reasonably organised fashion but is not always easy to read or understand • Some project results communicated	• Work appears sloppy and unorganised • Hard to know what information goes together • Few if any project results communicated

Use the following marking guide to mark the written work the students have completed for the assessment task. You can tick the appropriate box and then look at the students' overall achievement and give an on-balance assessment. If, for example, the student gets a tick in the SA (Satisfactory Achievement) box for every component of the assessment, then you would give the students a Satisfactory Achievement. Students should have access to a copy of the marking guide.

Sample marking guide: Sample data analysis					
		VHA	HA	SA	LA
Demonstrate statistical knowledge	Excellent statistical knowledge demonstrated				
	Excellent use of resource				
	Consistently stays focused on information given				
	Uses mathematical ideas, processes or strategies				
Manipulation of data	Ability to analyse and/or interpret results and information				
	Appropriate graph use and skills				
	Relevance of recommendations or hypothesis				
	Provides solutions or mathematical arguments and communicates them clearly and accurately using appropriate forms of representations, notations or terminology				
Communication	Contributes positively or productively to the group's progress				
	Results communicated clearly				
	Organised materials and presentation				

Grade 12

Sample task: Research project

Students do a research project involving some aspect of traditional life; for example, making a bilum. In this project, students are required to:

- select a suitable traditional activity
- identify the mathematics involved
- explain the use of the mathematics involved
- write a report on the investigation, which includes:
  - introduction (your traditional society)
  - pictorial representation of activity or design
  - the relevant mathematical concepts involved
  - conclusions
  - references and/or resources
  - acknowledgements.

Learning outcomes

Students can:

4. interpret, describe and represent properties of relationships between 2-dimensional shapes and 3-dimensional objects in a variety of orientations and positions
6. describe and explain the interrelationships between mathematical concepts.

Assessment criteria

Students will be assessed on the extent to which they:

- demonstrate appropriate mathematical techniques or algorithms
- choose and apply relevant mathematical process in one's traditional society
- effectively communicate the project results.

Task specifications: Research project

This project is to be conducted individually. Students submit the finished project to the teacher. For this task, students:

- describe their traditional activity
- explain the appropriate mathematical concepts used
- produce a written report of the research that includes:
  - originality
  - pictorial representation of activity or design
  - the relevant mathematical concepts involved
  - conclusions
  - references and/or resources
  - acknowledgements.

This task seeks the relevance of mathematics in our Papua New Guinean culture and assesses how students can identify the mathematics used in their traditional activities. This enables students to appreciate mathematics in their everyday traditional activities.

This assessment task must be assessed using the following performance standards or marking guide based on the assessment criteria. Note that the assessment performance standards and marking guide should be made available to students at the beginning of the projects.

Use the following marking guide to mark the written work the students have completed for the assessment task. You can tick the appropriate box and then look at the students' overall achievement and give an on-balance assessment. If, for example, the student gets a tick in the SA (Satisfactory Achievement) box for every component of the assessment, then you would give the students a Satisfactory Achievement and a mark between 30 and 41. Students should have access to a copy of the marking guide.

Performance standards: Research project				
Assessment criteria	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**
Demonstrate appropriate investigation skills	• Consistently stays focused on the task • Very self-directed • Actively collects information and creates insightful solutions to problems • Uses a wide range of resources	• Focused on the task most of the time • Collects information and finds standard solutions to problems • Uses at least two different resources	• Focused on the task some of the time • Collects information and finds solutions to problems with some assistance • Uses at least two different resources	• Rarely focuses on the task • Collects some information without providing adequate solutions • Uses at most one resource
Choose and apply relevant mathematical techniques	• Appropriate and efficient mathematical techniques used at all times • Solution contains no mathematical errors, or almost none	• Usually uses appropriate and effective mathematical techniques • Solution contains few mathematical errors	• Sometimes uses appropriate and effective mathematical techniques but does not do it consistently • Solution contains some major mathematical errors	• Rarely uses an appropriate mathematical techniques • Solution contains many mathematical errors
Make an effective communication of the survey results	• Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand • All project results communicated clearly	• Work is presented in an organised fashion and is mostly easy to read and understand • Most project results communicated	• Work is presented in a reasonably organised fashion but is not always easy to read or understand • Some project results communicated	• Work appears sloppy and unorganised • It is hard to know what information goes together • Few if any project results communicated

Sample marking guide: Research project					
		VHA	**HA**	**SA**	**LA**
Description of activity or design	Originality				
	Accuracy, relevance and clarity of information presented				
	Evidence used to support points made				
	Coherence and organisation of ideas				
Mathematical concepts used	Ability to identify and interpret the mathematics used				
	Uses mathematical ideas and processes				
	Pictorial representation of design or activity using 2-D or 3-D shapes				

Learning activities and assessment tasks

Examples of learning activities and assessment tasks for each of the General Mathematics units are provided in the following sections. Some examples are explained in detail.

Key questions	Suggested teaching and learning activities	Assessment tasks
Unit 11. 1 Task: Basic numeracy		
• Why know the development of real numbers system? • What are the properties of real numbers?	• Discuss the historical development of the real number system • Solve exercise on surds, significant figures, indices, logarithms, applying the properties or laws given • Convert standard index form (SIF) to ordinary numbers and vice versa, and recurring decimals to fractions • Explain that properties of real numbers also appear in other mathematics topics, such as set theory – rational numbers (Q) such as positive integers (natural, N or counting), negative integers, zero, and fraction (a/b) where $a \in Z$, $b \in N$ – irrational numbers (Q') that is, surds – counting the non-zero digit from left, then all digits must be counted, including any zeros)	Supervise test questions on • real numbers and surds, recurring decimals, SIF, indices and logarithms and errors; and a question on • identifying the actual properties used to solve an algebraic equation: – (for example, $2x - 4 = 10$: closure – $2x - 4 + 4 = 10 + 4$: additive identity – $2x = 14$, : closure – $2x \bullet ½ = 14 \bullet ½$: multiplicative identity – $x = 7$: closure)

Key questions	Suggested teaching and learning activities	Assessment tasks
Unit 11. 1 Task: Measurement		
• Which units are appropriate for measuring in a given situation? • Why convert units of measurement?	• Hold a discussion of the most appropriate units for measuring in a given situation and then estimate the measure of, for example, fabric, basketball court, weight of an exercise book, volume of soft drink can or bottle, classroom door • Discuss the need to convert	Research work • List and convert all possible traditional ways of measuring length, mass and capacity to metric and imperial measures • Discuss importance of estimation and accuracy in measurement; for example, use body parts (pace≈1 m)
Unit 11. 2 Task: Earnings and spending		
• How and on what do you spend your money? • What is a good budget?	• Explore what kinds of things people spend their money on, and what their expenses might be in the near future. Discuss questions like: – What would you like to buy? – How much money will you need? – How will you know if you have a bargain and have spent your money wisely?	• Keep a record of money received in a month and list all expenses • State whether you kept a good budget or was a heavy spender of all your earnings
Unit 11. 2 Task: Taxation and loans		
• What are taxation and loans?	• Discuss why the public and private servants' salary is taxed by the government • List other types of tax and the purposes of taxing	• Debate the advantages and disadvantages of taxing salaries, goods and services

Unit 11. 3 Task: Exploring data		
• Where can the data be found? • What type of data? • How can you read the data? • What can you do with the data? • Does the presentation of data achieve its purpose?	Students work in groups of four or five to: • Discuss and consider the data source, such as census data from district office, people infected with HIV and AIDS from National Aids Council, research institutes, and hospitals • Collect data, having in mind the type of data they are going to work with • Organise data using table or graph • Compare ,contrast and explain the importance of investigating this data • Write an account of findings, which includes tables, graphs, arguments, suggestions and recommendations	• Students' performance in using statistical knowledge and skills may be judged according to the extent of the analysis, interpretation and presentation done • See specified assessment task in the 'Sample tasks' section

Unit 11.3 Task: Analysis of data		
• List data as continuous or discrete, grouped or ungrouped • What is the measure of central tendencies?	• Calculate the central tendencies from any given data • Discuss why data is categorised as discrete, continuous, grouped and ungrouped	

Unit 11.4 Task: Shapes and solids		
• What is a line and angle? • What are 2-D and 3-D? • Why are 2-D and 3-D properties different?	• Identify shapes as 2-D or 3-D from common items brought to class by teacher • Students use the language and techniques of coordinated geometry to investigate, describe and derive properties of 2-D and 3-D shapes	Mini project • Construct a 3-D shape from A4 paper as a mini project.

Unit 11.4 Task: Circles		
• What is a circle? • Earth as the 'great circle' • What does 'cyclic quadrilateral' mean?	• Solve problems involving planet Earth such as: – Find the distance between two points on the same meridian with latitude $19^{o}15'$N and $35^{o}25'$S – Find arc length on the great circle subtending the angle of 60^{o} at the centre of the earth	Project • Construct any cyclic object that uses tangents or chords, which can be useful in or out of the classroom (such as a loud hailer or road cones)

Unit 11.5 Task: Trigonometry and vectors		

• What is a right-angled triangle?
• How do you solve problems in which triangles are not right-angled?
  – solving triangles where two sides and the included angle are known
  – cosine rule
• What is a vector?
	• Discuss Pythagorean theorem
	• Emphasise the need for tools to deal with non-right angle triangles by posing problems in context such as surveying, building, navigation and design. Students can be asked to find how their grandparents in traditional societies sailed across islands, built houses and so on
	• Derivation of the cosine rule using Pythagoras' theorem could be demonstrated
	• Solve contextual problems drawn from recreation and industry from an unknown side or angle using the cosine rule.
	• Discuss parallel lines and angles
	• Differentiate between scalar and vector physical quantities
	• Discuss the instruments to measure the vector and scalar quantities
	• Perform simple vector addition exercise
		Directed investigation in pairs
		• From the point on the river bank directly opposite the tree run the tape measure back perpendicular to the river as far as it can go. From the end of the tape by the river (O) and from the other two points of your choosing along tape (A and B) take clinometer readings to the top of the tree. Record the reading on both tape and the angle in each case
		• Draw a diagram using your measurements for O and A. Use it to calculate both width of the river and height of the tree (don't forget to take your height into consideration)
		• Repeat the procedures with your measurement from O and B
		• Compare the answers from both sets of calculations. Which do you think are reliable?

Unit 12.1 Task: Measurement		

• How does a scale factor work?
  – Calculation of an actual and scale length and distances
• How can knowing the perimeter, area and volume of a 2-D or 3-D shape help solve a problem?
• How can we find the area of regular and non-regular shapes?
  – Relationship between perimeter and area
  – Use of grid to estimate and calculate area
	• Use small objects and common objects like a table, chair or shelf to explain scale factor
	• Use scale factor on maps and plans of different scale to calculate actual lengths or distances. Some revision of ratio and rounding off may be necessary. Construct maps or plans of a new classroom for new students
	• Maps or plans of the school environment (buildings and natural surroundings)
	• Use grids to estimate regular and non-regular areas
	• Survey the actual site for the building or sporting field or court games using field book
	• Use appropriate units of measure such as metres, kilometres or hectares
	or,
	• How can you measure the coastline of Papua New Guinea or local area of the school?
		• Prepare a proposed sports court (basketball, volleyball, netball courts) all in the same site for the school. The scale drawing for each of the courts
		or,
		• Prepare a proposed playing field (soccer, rugby union and touch or netball courts) all in the same site for the school. This may include space for spectators sitting or standing. Costing could be included for school administration to consider
		• Prepare a proposed recreation hall including space for spectators sitting or standing. Costing could be included for school administration to consider

Unit 12.1 Task: Surface area and volume		
• How can the volume of an object affect the sound produced in a traditional instrument?	• Discuss and measure the surface area and volume of common 3-dimensional shapes and those truncated solids also	• Make a traditional sing-sing instrument by calculating its volume (for example, kundu drum, garamut, bamboo flute, bamboo pipe) – Identify the 3-D shape in the chosen item. Discuss the factors in the quality of sound produced

Unit 12.2 Task: Interest and inflation		
What are interest, inflation and consumer credit?	• Discuss what interest and inflation are in the business world • Discuss types of consumer credit in the world • List commodities that appreciate and those that depreciate • Get some appreciation figures of a commodity and try to plot a graph of appreciation against time	• Design an investigation to interview some businessmen and women or business houses and see whether their commodity(s) have appreciated significantly over the years • Interview motor vehicle dealers on the depreciation rate of cars, trucks and buses. Using that information interview PMV bus owners and calculate current value of their PMV buses. State if they are roadworthy

Unit 12.2 Task: Investment		
What is investment?	Discuss different types of investment	Backyard investment project • Map a piece of land you can use as an investment • Plan what you would do to develop this land to generate income • Submit a written proposal of how you would invest in this land. Include costs of development

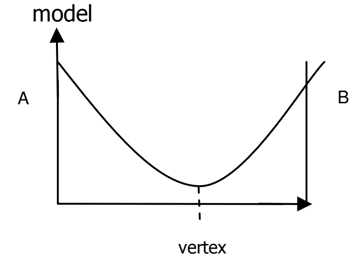
Unit 12.3 Task: Probability		
What is probability?	• What are trials, outcomes, sample space, events? • Simple experiments to determine probabilities: – Example 1: Deck of 52 cards. What is the probability that the card drawn is i) an ace ii) a club iii) a red card? – Example 2: Throwing a dice – Example 3: Tossing a coin	

Unit 12.3 Task: Correlation and regression		
• Define a scatter diagram • What is correlation and regression? • How does one identify linear and non-linear relationships?	• Discuss the given sample data. The table below shows the number of questions solved by each student on a test, and the corresponding total score on that test	

Qn #	2	4	7	10	5	2	6	3	9	4	8	3	6
Tot %	22	39	69	100	56	18	60	36	87	45	84	32	63

- Construct a scatter plot of the data
- What type of correlation does the scatter plot suggest?
- Give a possible explanation as to why the scatter plot is not perfectly linear

Unit 12.4 Task: Graphs and functions		
• What is algebra? • What is an asymptote? • What is exponential and logarithm graphs or functions?	• Discuss and sketch types of curves like hyperbola, exponential and logarithm • State the asymptotes for the curves above • What conclusions can you draw from exponential or logarithmic graphs? • How can an exponential be reduced to a linear? – for example, population growth of bacteria, weight of a baby – (W = 3log10(8t +10)), money investment, strength of earthquake (use Richter scale)	• Go to a clinic or hospital and collect data on changing weight of an infant or, • Find an infant near your residence and keep records of its monthly weight or, • Keep a record of the height of a young plant you have planted or from your backyard

Unit 12.4 Task: Parabola and quadratic equations		
Define parabola or quadratic equation	• Teacher demonstrates a projectile motion by throwing a ball over a distance. State that *a* is negative from the general quadratics equation $ax^2 + bx + c = 0$ • Clinometer or tape measure can be used to measure the length and maximum height of the ball reached	Compound project • Produce a quadratic equation that models the hammock shape from point A through the vertex to point B. The x and y axes have to be included in the diagram to assist your model development. Your model must have these features: – the structure 2 metres above the ground level – the vertex of the parabola is a few centimetres above the ground (students measure the vertex to the ground) • Find the equation of the parabola. The length of AB depends on your choice of model 

Unit 12.5 Task: Tessellation		
Consider the definition of a tessellation: A pattern which is formed from regular polygons only, in which each side of each polygon is also a side of exactly one other polygon, where the same set of polygons occur in the same order around every vertex. where the sum of measures of the angle which together form the vertex is 360°	Activity 1 • Sketch tessellations using the following – square tiles in staggered rows – parallelograms in staggered rows – a hexagon and equilateral triangle in one tessellation – an equilateral and a square in one tessellation – a star made from equilateral triangles and a hexagon	Non-examinable unit

Unit 12.5 Task: Isometric		
What is an isometric? • Create isomeric graph papers	Activity 2 • On a sheet of isometric paper, use each of the 3 patterns given to form 3 tessellation patterns (see figures A, B and C below)	See Activity 3

Unit 12.5 Activity 2

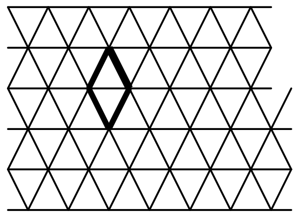


Figure A

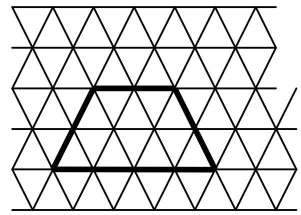


Figure B

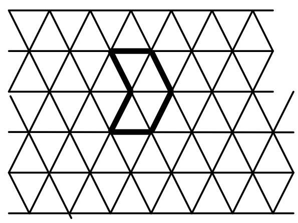
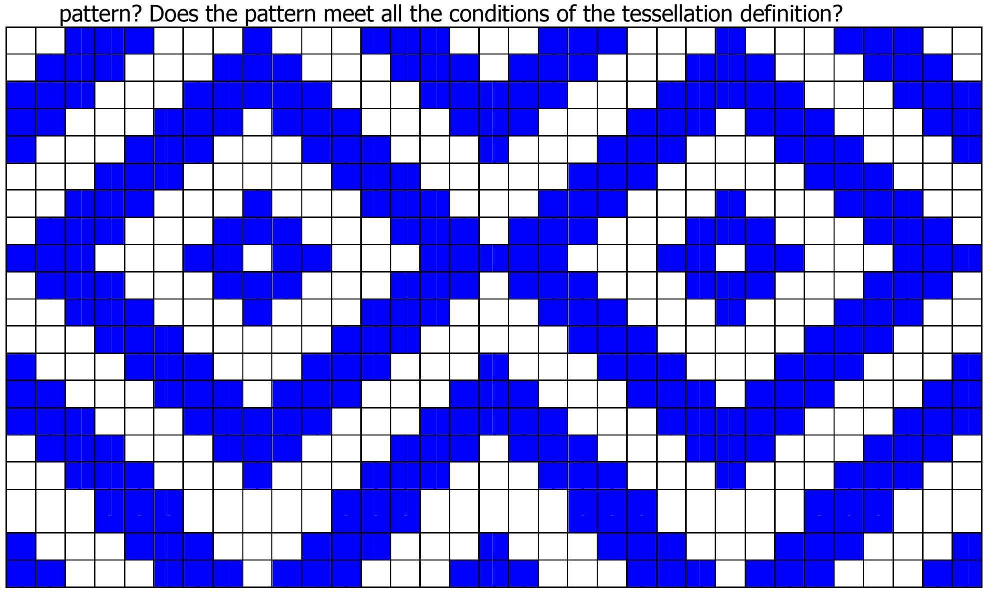


Figure C

Unit 12. 5 Activity 3

1. Identify a design from Papua New Guinea. For example, it may be a bilum pattern, a bamboo wall pattern or a tattoo design.
2. Identify the basic shapes that make up the pattern
3. Re-design it to make it a tessellation pattern
4. See the bamboo wall pattern from Enga (Simon Wali 2004, UOG). Is it a tessellation pattern? Does the pattern meet all the conditions of the tessellation definition?



Recording and reporting

All schools must meet the requirements for maintaining and submitting student records as specified in the Grade 12 *Assessment, Examination and Certification Handbook*.

Recording and reporting student achievement

When recording and reporting student achievement you must record the achievement of the students in each unit and then, at the end of the year, make a final judgement about the overall achievement, or progress towards achievement, of the learning outcomes. To help you do this, descriptions of the levels of achievement of the learning outcomes are provided in the 'Learning outcome performance standards' table.

When reporting to parents, the school will determine the method of recording and reporting. In an outcomes-based system, student results should be reported as levels of achievement rather than marks.

Remember that the final school-based mark will be statistically moderated using the external exam results. The students' overall level of achievement may change.

Levels of achievement

The level of achievement of the learning outcomes is determined by the students' performance in the assessment tasks. Marks are given for each assessment task, with a total of 100 marks for each 10-week unit, or 50 marks for each 5-week unit. The marks show the students' level of achievement in the unit, and hence their progress towards achievement of the learning outcomes. There are five levels of achievement:

- Very high achievement
- High achievement
- Satisfactory achievement
- Low achievement
- Below minimum standard

A **very high achievement** means overall that the student has an extensive knowledge and understanding of the content and can readily apply this knowledge. In addition, the student has achieved a very high level of competence in the processes and skills and can apply these skills to new situations.

A **high achievement** means overall that the student has a thorough knowledge and understanding of the content and a high level of competence in the processes and skills. In addition, the student is able to apply this knowledge and these skills to most situations.

A **satisfactory achievement** means overall that the student has a sound knowledge and understanding of the main areas of content and has achieved an adequate level of competence in the processes and skills.

A **low achievement** means overall that the student has a basic knowledge and some understanding of the content and has achieved a limited or very limited level of competence in the processes and skills.

Below the minimum standard means that the student has provided insufficient evidence to demonstrate achievement of the learning outcomes.

Achievement level					
Total marks	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
600	540–600	420–539	300–419	120–299	0–119
500	450–500	350–449	250–349	100–249	0–99
400	360–400	280–359	200–279	80–199	0–79
300	270–300	210–269	150–209	60–149	0–59
200	180–200	140–179	100–139	40–99	0–39
100	90–100	70–89	50–69	20–49	0–19
60	54–60	42–53	30–41	12–29	0–11
50	45–50	35–44	25–34	10–24	0–9
40	36–40	28–35	20–27	8–19	0–7

Sample format for recording General Mathematics assessment task results over two years

Student name:

Grade 11 assessment task results			
Unit	**Assessment task**	**Mark**	**Student mark**
11.1	Adjustment period – however need to assess students, keep marks internally for separating into two mathematics –general and advanced		
11.2	Task 1: Investigation (personal budget)	20%	
	Task 2: Test	10%	
11.3	Task 1: Statistical survey (group work)	10%	
	Task 2: Test	10%	
11.4	Task 1: Mini project (individual research)	10%	
	Task 2: Project (individual research)	15%	
11.5	Task 1: Directed investigation (in pairs)	10%	
	Task 2: Exam (term 3–4 unit) 20%	15%	
	Total marks Grade 11	**300**	

Student name:

Grade 12 assessment task results			
Unit	**Assessment task**	**Marks**	**Student mark**
12.1	Group project (write a proposal for a basketball court or playing field for the school)	25%	
12.2	Task 1: Research (individuals design an investigation)	13%	
	Task 2: Individual project (backyard investment project)	12%	
12.3	Task 1: Test 1	12%	
	Task 2: Test 2	13%	
12.4	Task 1: Project (research baby weight, plant height or collect data from clinic individually)	10%	
	Task 2: Test	15%	
	Total marks Grade 11	**300**	
	Total marks Grade 11 and 12	**600**	

Learning outcomes and levels of achievement

Levels of achievement in Grade 11 and Grade 12 are recorded and reported against the learning outcomes. The performance standards for the levels of achievement are described on pages 13 and 14.

Steps for awarding final student level of achievement

1. Assess unit tasks using unit performance standards and assessment criteria.
2. Record results for each task in each unit.
3. Add marks to achieve a unit result and term result.
4. Add term marks to get a year result.
5. Determine the overall achievement using the achievement level grid.
6. Report results using the learning and teaching learning outcome performance standards.

The following is an example of reporting using the learning outcomes performance standards descriptors.

Using the learning outcomes performance standards descriptors

Student Subject School-based assessment	**Max** **General Mathematics** **High achievement**
This means Max can:	
Demonstrate a clear understanding of use of number knowledge and its relationships in different contexts	
Gives outstanding description, interpretation, and representation of various functional relationships to solve real or simulated mathematical problems	
Shows very good technical skills and use of instruments for measuring and calculating physical quantities	
Gives very good description and interpreting properties of relationships between 2-D shapes and 3-D objects in a variety of orientations and positions	
Gives detailed analysis, evaluation and interpretation of statistical data and information to communicate, predict and justify recommendations or conclusions	
Gives sufficient description and explanation of interrelationships between mathematical concepts	
Demonstrates outstanding use of technological resources and outstanding application of mathematical procedures to solve practical problems in familiar and new contexts	
Shows sound communication of mathematical procedures and results	
Demonstrates good planning and organising to carry out a range of mathematical activities	

Resources

General Mathematics becomes more interesting and meaningful when you use a variety of resources and local or traditional materials in your teaching. You should always try to adapt, improvise, make, find or write material that will be useful for lessons. General Mathematics can be taught without expensive equipment by making use of what is around you, though there are some equipment and materials that are essential to teach the General Mathematics syllabus.

Types of General Mathematics resources

Materials and equipment

- calculators
- measuring cylinder, electric or analogue balance
- compass, protractors
- clinometer, tape measure
- statistical data or information
- bank loan rates
- traditional sound instruments
- textbooks, reference books
- worksheets, information sheets
- computer software
- newspapers
- made or found objects
- proposal template(s) or documents
- scientific report template(s)

Natural and human resources

- bankers, statisticians, demographers, medical officers
- consumer price index officers
- stockmarket brokers
- national standard measurement (NIST) officers
- village elders or grandparents
- environment sites:
  - rivers, creeks, springs, drains, beaches, sea
- stakeholders
  - community elders
  - teachers
  - parents
  - public servants
  - small-scale businessmen and women
  - resource developers

Useful formulas 1

FORMULAE SHEET

Area of an annulus

$A = \pi\left(R^2 - r^2\right)$

R = radius of outer circle
r = radius of inner circle

Area of an ellipse

$A = \pi ab$

a = length of semi-major axis
b = length of semi-minor axis

Area of a sector

$A = \frac{\theta}{360}\pi r^2$

θ = number of degrees in central angle

Arc length of a circle

$l = \frac{\theta}{360}2\pi r$

θ = number of degrees in central angle

Simpson's rule for area approximation

$A \approx \frac{h}{3}\left(d_f + 4d_m + d_l\right)$

h = distance between successive measurements
d_f = first measurement
d_m = middle measurement
d_l = last measurement

Surface area

Sphere $A = 4\pi r^2$

Closed cylinder $A = 2\pi rh + 2\pi r^2$

r = radius
h = perpendicular height

Volume

Cone $V = \frac{1}{3}\pi r^2 h$

Cylinder $V = \pi r^2 h$

Pyramid $V = \frac{1}{3}Ah$

Sphere $V = \frac{4}{3}\pi r^3$

r = radius
h = perpendicular height
A = area of base

Sine rule

$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Area of a triangle

$A = \frac{1}{2}ab\sin C$

Cosine rule

$c^2 = a^2 + b^2 - 2ab\cos C$

or

$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

Useful formulas 2

FORMULAE SHEET

Simple interest

$I = Prn$

P = initial quantity

r = percentage interest rate per period, expressed as a decimal

n = number of periods

Compound interest

$A = P(1+r)^n$

A = final balance

P = initial quantity

n = number of compounding periods

r = percentage interest rate per compounding period, expressed as a decimal

Future value (A) of an annuity

$$A = M\left\{\frac{(1+r)^n - 1}{r}\right\}$$

M = contribution per period, paid at the end of the period

Present value (N) of an annuity

$$N = M\left\{\frac{(1+r)^n - 1}{r(1+r)^n}\right\}$$

or

$$N = \frac{A}{(1+r)^n}$$

Straight-line formula for depreciation

$S = V_0 - Dn$

S = salvage value of asset after n periods

V_0 = purchase price of the asset

D = amount of depreciation apportioned per period

n = number of periods

Declining balance formula for depreciation

$S = V_0(1-r)^n$

S = salvage value of asset after n periods

r = percentage interest rate per period, expressed as a decimal

Mean of a sample

$$\bar{x} = \frac{\sum x}{n}$$

$$\bar{x} = \frac{\sum fx}{\sum f}$$

$\bar{x}$ = mean

x = individual score

n = number of scores

f = frequency

Formula for a z-score

$$z = \frac{x - \bar{x}}{s}$$

s = standard deviation

Gradient of a straight line

$$m = \frac{\text{vertical change in position}}{\text{horizontal change in position}}$$

Gradient–intercept form of a straight line

$y = mx + b$

m = gradient

b = y-intercept

Probability of an event

The probability of an event where outcomes are equally likely is given by:

$$P(\text{event}) = \frac{\text{number of favourable outcomes}}{\text{total number of outcomes}}$$

General guidelines for selecting and using resources

How effective a resource is depends on whether it is suitable for the knowledge or skill to be learned and the attitude of the students. Classroom organisation is the key to using resources successfully. You need to:

- prepare thoroughly. Make sure that you are familiar with the resource so that you use it with confidence and assurance. If equipment is involved, check that it is in working order, make sure that you know how to operate it and that it is available when you need it.
- use the resource at the right place and time—it should fit in with the flow and sequence of the lesson and serve a definite teaching purpose.
- (if the resource is radio, film, video or television), introduce the program by outlining the content. You might also set some questions to guide listening or viewing. Follow up after using the resource, by discussing and drawing appropriate conclusions.

Useful books and websites

The list of references on the following pages contains books and websites that are also useful teacher resources.

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Simpson, N and Rowland, R 2003, *Maths Quest Year 12 Maths B for Queensland (Advanced),* Jacaranda Wiley, Milton Qld.

SSABSA 2002, *Stage 2 Mathematical Methods. Curriculum Statement 2007*, SSABSA, Adelaide.

SSABSA 2002, *Stage 2 Mathematical Studies. Curriculum Statement 2007*, SSABSA, Adelaide.

SSABSA 2005, *Mathematics Learning Area Manual 2005*, SSABSA, Adelaide.

Useful websites

http://education.pwv.gov.za

http://forum.swarthmore.edu/

http://nrich.maths.org/public/viewer.php?obj id=1885

http://www.eaa.unsw.edu.au/eaa/mathematics resources

http://www.boardofstudies.nsw.edu.au

http://www.cut-the-knot.org/index.shtml

http://www.incompetech.com/graphpaper

http://www.learner.org/exhibits/dailymath/

http://www.mmp.maths.org.uk/

http://www.scimas.sa.edu.au/scimas/pages/Links/17600

http://www.shu.ac.uk/schools/ed/maths/model.htm

http://www.srl.rmit.edu.au.mav

http://www.aamt.edu.au

http://www.abacus.com.au

http://www.lat-olm.com.au

http://www.oac.sa.edu.au

http://www.OxfordSecondary.co.uk

http://www.sacsa.sa.edu.au

http://www.ssabsa.sa.edu.au/maths

Glossary for General Mathematics

Absolute value	The value of a number when the sign is not considered
Algebra	That part of mathematics that deals with properties and relations of numbers and sets, using symbols to represent unknown quantities
Algorithm	A given series of steps for reaching a solution to a mathematical problem
Alternate angles	A pair of equal angles formed by a straight line crossing a pair of parallel lines. The alternate angles are between the parallel lines, one on either side of the transversal
Analogue clock	A traditional clock with minute and hour hands
Arithmetic	The study of numbers, from the Greek *arithmos*. It involves computations with whole numbers, fractions and decimals using the operations of addition, subtraction, multiplication and division
Associative law or property	The property of an operation which allows for the operation to be carried out by grouping the terms differently (as for addition of real numbers: $(a+b)+c=a+(b+c)$ and for multiplication (a x b) x c = a x (b x c)
Average	A single measure that tries to show the 'middle' of a group of numbers
Bar graph	A graph that uses bars to represent information. The height or the length of the bars is scaled to show size or quantity. Another name for bar graph is bar chart
Base (number)	The number on which a place-value system is built. The base of our number system is ten
Bearing	The angle on the ground measured from the north or south direction that fixes the direction of an object
Bias	A distortion of the data in a set due to irregularities in the collection of the data; an unjustified tendency to favour a particular point of view
Bivariate data	Two dimensions (of each object under observation) that are recorded as a pair of variables (usually to investigate or describe an association or correlation or relationship between the variables). Numerical bivariate data are often presented visually as a scatter plot on a Cartesian plane where one variable (such as height) is read on the vertical axis and another variable (such as mass) is read on the horizontal axis
Box plot	A summary graph. The box represents 50% of the data. The lines at each end of the box represent the top 25% of the data
Capacity	The amount a container can hold. It refers to a measure of things that can be poured. The standard metric measures of capacity are the millimetre (mL), litre (L), cubic centimetre (cm^3) and cubic metre (m^3)
Cardinal compass points	The four key directions on a compass: north, south, east and west
Chord	A straight line that joins two points on a circle. The chord divides the region inside a circle into two segments. A chord that passes through the centre of a circle is called a 'diameter'. Diameters are the longest chord

Commutative law or property	The property of an operation which allows for the order of the values operated with to be interchanged (such as for the addition of real numbers $a+b=b+a$ and for multiplication a x b = b x a)
Compound interest	The calculation of the new amount A when the original amount (the principal), P, of money is subjected to being calculated on interest at the end of a period according to the following formula $A = P(1+i)^{n.}$
Cummulative frequency	For data that has been ordered (from minimum to maximum values) the successive values can be assigned frequencies. The cumulative frequency for a value x is the total count of all the data values that are less than or equal in value to x
Data	A set of facts, numbers, or information
Experiment	A repeatable activity or process for which each repetition gives rise to exactly one outcome drawn from the sample space (statistical experiment); for example, the observed face of a die. The number of trials observed in the sample size n
Extrapolate	To estimate an unknown quantity by projecting from the basis of what is already known, but outside the limits of the known data
Function	A relationship between two sets of variables such that each element of the one set (the domain) is associated with a unique element of the second set (the range)
Global positioning system (GPS)	A system using satellite and electronic technology, whereby a particular location on the earth's surface is determined in terms of its latitude and longitude
Independent events	The idea that two events do not connect with each other in any observable pattern, and hence that neither event can give any useful information about the other event
Inflation rate	A quantitative measure which indicates the rate at which the price of consumer goods are increasing over time
Interpolate	To estimate an unknown quantity within the limits of what is already known
Mortgage bond	A loan from a bank, usually for the purchase of property. The loan is subject to the payment of compound interest and is paid off in regular instalments which include interest and capital
Outcome	The result of an experiment (in statistics); for example, the outcome of an experiment in which a die is rolled can be any one of the natural numbers 1 through to 6
Percentiles	Values of ranked data separated into one hundred groups of equal size, especially when sample size n is very large
Probability	For equally likely outcomes, the number of favourable outcomes divided by the total number of possible outcomes of an experiment
Quartiles	Three values which split the ordered sample calues into four groups of equal size. The second quartile is the median
Relative frequency	(of a particular outcome in a statistical experiment) the number of occurrences of a particular outcome divided by the number of trials
Sample	In statistics, a group of data chosen from all the possible data
Significant figures	The number of digits in a number, starting from the first non-zero digit and including final zeros; for example, 0.0012340 has 5 significant figures
Solution	Answers to problems, investigations, research or questions

Standard deviation	A measure of the spread of statistical data given by the square root of the variance of the data
Stem-and-leaf graph	A bar graph made by arranging numerical data in a display, using the first part of the number as the stem and the last part as the leaf. Data 16, 31, 25, 33, 27, 24, 14, 26,31 1 4 6 2 4 5 6 7 3 1 1 3
Tessellation	A covering of the plane with shapes, often polygons and in a repetitive manner
Truncate	Having the vertex (of a cone or pyramid) cut off by a plane surface (usually parallel to the base)
Variables	Quantities which can take many values, for example, the number of cars which may cross a bridge in the next hour, or the numbers which could replace the l;etter (s) or pronumeral (s) in an algebraic expression
Variance	A measure of the spread of data in a sample or population involving the squares of the deviations of data values from the mean .

Glossary for assessment

Syllabus outcomes, criteria and performance standards, and examination questions all have key words that state what students are expected to be able to do. A glossary of key words has been developed to help provide a common language and consistent meaning in the syllabus and teacher guide documents.

Using the glossary will help teachers and students understand what is expected in response to examinations and assessment tasks.

Glossary of key words for assessment

Account	Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship between them; draw out and relate implications
Apply	Use, utilise, employ in a particular situation
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Calculate	Ascertain or determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes or categories
Compare	Show how things are similar or different
Construct	Make; build; put together (items or arguments)
Contrast	Show how things are different or opposite
Critically (analyse, evaluate)	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis or evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note or indicate as being distinct or different from; to note differences between
Evaluate	Make a judgement based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer from what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about

Justify	Support an argument or conclusion
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example, a point of view, idea, argument, suggestion) for consideration or action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express, concisely, the relevant details
Synthesise	Putting together various elements to make a whole

Appendixes

Mathematics in everyday life: Student projects

Appendix A: House making (Morobe Province)

TOPIC: HOUSE MAKING

INTRODUCTION

Mathematics was and is seen as being culture free and universal. For these reasons, people, basically the people of PNG see mathematics as a subject /course that is not applicable and so has no meaning back in the villages. People don't realise that mathematics plays a part in their everyday life. So the emergence of an area of mathematics called ethnomathematics recognises that mathematics can be identified in social and cultural context.

I would be writing about the way the people of Dedua in Finschhafen, Morobe Province build traditional houses and the names given to different types of houses. In addition, identify mathematics that can be used in teaching and learning from this cultural activity.

DESCRIPTION OF THE CULTURAL ACTIVITY

Dedua is a small area in the inland of Finschhafen in the Morobe Province. It is in the Sialum District in the Tewai-Siassi Electorate. The language spoken is the Dedua language.

People of the Dedua in Finschhafen, Morobe have different names given to different houses. These houses have different uses too. The name itself would identify the houses and the way it is built differentiates one building from another.

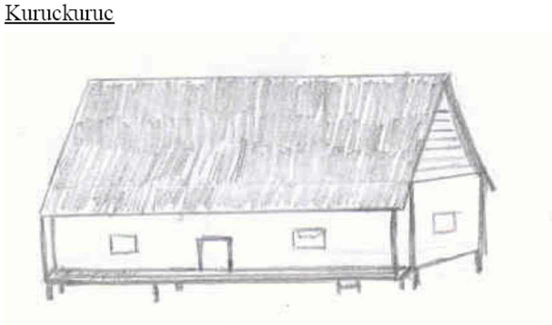
Ama is the general name for house but is recognised as the houses that families live in and would be build especially in the villages. *Ama* itself means 'house' or can be referred to as 'the place where you come from'.

Kuruckuruc[*] is another name of a house but comparing *Ama* and *Kuruckuruc*, *Ama* would be a house on longer post than *Kuruckuruc* even though they both are recognised as houses that people live in. *Womong* is the name given to the 'haus man'. However, it can be built either as an Ama or as Kuruckuruc. So, it won't be mentioned a lot.

Ama and Kuruckuruc are built quite the same but can be distinguished by the way, it is built as shown in the diagram.

Ama

Kuruckuruc



[*] Pronounced as kuru-kuru with a silent but brake like 'c'.

The once that are built for other purposes are called *bezo.*

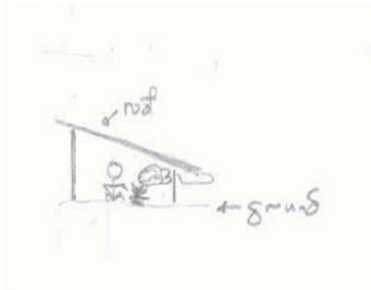
When men go out hunting at night times they had to built *bezos* before night falls so that they could have some shelter during the times out hunting. And for gardening the women and men built *bezos* near the garden or near the coffee gardens so when it is time for harvesting or planting the gardens they people have shelter from the sun as well as to sleep during the nights, because sometimes the garden would be to far from the village and it would be time consuming to walk to and fro at this times.

Bezos are also built in the villages to store firewoods and food.

There are two types of *bezos* and they can be differentiated by the way it is built. The one that is built in such a way that people have to sit directly on the ground with a roof above there head is called *bezo* but the ones that has a platform that people can sit on or sleep on, with a roof above the head is called *nong bezo.*

Bezo and *nong bezo* are similar in some ways as shown in the diagram below.

Bezo



Nong-bezo

MATHEMATICS THAT CAN BE INDENTIFIED.

In this House Making measuring and designing is involved which are two of the Bishop's six fundamental mathematical activities found in all cultures.

There is a lot of mathematics that can be derived from this house making. The Ama and the Kuruckuruc can be an example to the Measurements and shapes and trigonometry. Bezos and nong bezo can also be used as an example to trigonometry and measurements.

Below is the summary of all the mathematics that can be derived from this cultural activity.

Activity	Identified mathematics topics that can be used in teaching and learning
House making	Measurements Volume of cuboid, Volume of prism, Surface Area, Trigonometry & Pythagoras Theorem

The school mathematics topics that can be used conjunction with the mathematical topics.

Identified mathematics topics that can be used in teaching and learning	To teach at what level /Grade
Measurement • -Volume of cuboid, Volume of prism • - Surface Area	Grade 11- Measurement-11.4 Grade 9- Volume (9B)- 9.11 Grade 10 –Surface Area (10B)-10.11
Trigonometry & Pythagoras Theorem	Grade 10- Pythagoras & Trigonometry (10B)-10.10 Grade 11- Trigonometry 11.4

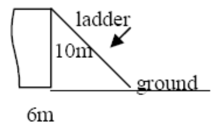
	Grade 12- Measurements & Applied Trigonometry 12.3

DETAILED LESSONS THAT CAN BE TAUGHT.

Pythagoras & Trigonometry

Example

1. 10m ladders of an Ama leans against a vertical veranda. The bottom of the ladder is 6m from the verandas post. How high does the ladder reach?



Answer: Using Pythagoras Theorem

> Pythagoras Theorem
>
> In any right-angled triangle, the area of the square, on the length side (hypotenuse) is equal to the sum of the areas of the squares on the other two sides.
>
> We can write this as: $c^2 = a^2 + b^2$
>
> We can use this rule to solve right- angle triangle.

Data: c = 10m, a = 6 m & b =?

Therefore, $= c^2 = a^2 + b^2$

$= 10^2 = 6^2 + b^2$

$= b^2 = 10^2 - 6^2$

$= b^2 = 100 - 36$

$= b = \sqrt{64}$

Thus, b= 8 m

Check: $c^2 = a^2 + b^2$

$10^2 = 6^2 + 8^2$

$100 = 36 + 64$

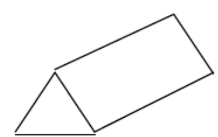
$100 = 100$

Measurements

Volume

Examples:

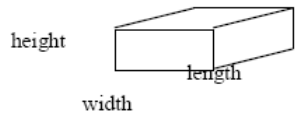
> Volume of prism = area of end face X height
>
> or = area of end face X length



1. Why are such shapes as the roof of the Ama and kuruckuruc called triangular Prism?

Answer: Because of its triangular end -face.

2. Calculate the volume of the wall of the ama and kuruckuruc excluding the roof. Where the length is 7cm and the width is 3 cm and the height is 5cm.



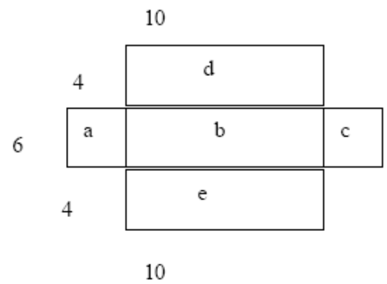
Volume of cuboid= l x w x h

Answer: volume = l x w x h
= 7 x 3 x 5 = 105 cm^3

Surface area

Calculate the total area of each of the following shapes (all measurement are in cm)

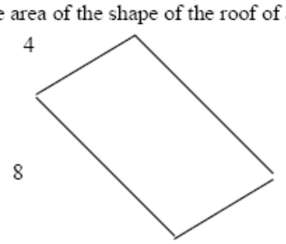
(a) The walls of the kuruckuruc and ama all flat on the ground.



a = l x w = 4 x 6 = 24 cm^2
b = l x w = 10 x 6 = 60 cm^2
c = l x w = 4 x 6 = 24 cm^2
d = l x w = 10 x 4 = 40 cm^2
e = l x w = 10 x 4 = 40 cm^2

Total Area = 24 + 60+ 24 + 40 + 40 = 188 cm^2

(b) Calculate the area of the shape of the roof of a bezo and nong bezo (All measurements are in cm)



Answer:
Area of a rectangle = l x w = 4 x 8 = 32cm^2

LESSON PLAN

SUBJECT: MATHEMATICS SCHOOL: DREGERHAFEN HIGH SCHOOL

UNIT: 9.11 VOLUME TOPIC: PRISM GRADE: 9 DATE: 16^{TH} SEPTEMBER 2005

Objective: By the end of this lesson students should be able to identify and differentiate the Prisms.

Time 40 minutes.

PHASE TIME	CONTENT	TEACHING PROCEDURE	STUDENT ACTIVITY	MATERIAL
INTRODUCTION 10 MINUTES	Topic: Prism	• Show them a picture of Ama or Kuruckuruc. • Ask them to name different shapes in the picture and list them on the b/board • Write the topic on the b/board and state the objective.	• Observe closely. • Engage in the activity • Pay attention	Secondary School mathematics 9B Diagram Chalk Duster Blackboard
BODY **20 MINUTES**	Prism have: • 2 identical parallel end faces. • Rectangular side faces Prisms • Rectangular prism • Triangular prism • Hexagonal prism	• Explain the term Prism and its main ideas • Discuss the different prisms and differentiate them. • Write the discussion and an example exercise on the board. • Together with student do the exercise relating it to the diagram.	• Pay close attention and participate. • Pay attention and participate in the discussion. • Copy notes • Discuss and answer questions.	
CONCLUSION **10 MINUTES**	Home work Mathematics 9B • Exercise 1(pg 116) • Exercise 2 (pg 117) • Exercise 6(pg 120)	• Summarise main points about prisms with quick questions • Give homework.	• Answer questions • Copy home work	

Appendix B: Bamboo weaving and bilums (Highlands Region)

Introduction

In PNG most of the traditional activities especially the handiwork that is practised involves mathematics. In our everyday situations mathematics is involved without realising that it is mathematics itself that we are doing. We can derive many mathematical ideas from those cultural activities. However, those activities are not taken into consideration, therefore most learners think that there is no relevance in the cultural activities that are practised. They only value the school mathematics which makes the learners think that school maths is a foreign thing, which is introduced. In this project I firstly identify the cultural activity in PNG and secondly correlate this to the mathematical concepts and ideas involved in classroom situation.

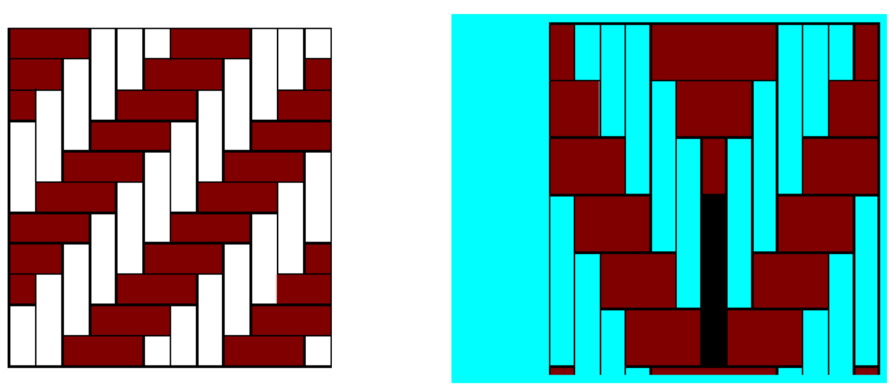
Identification of Cultural Activity

PNG is a multicultural country with diverse activities in its individual cultural groups. Most of these activities somehow involve mathematics. I have decided to work on the weaving of bamboo walls (blind weaving) using bamboo strips and the making of string bags (bilum). Basically these two activities are practise in the Highlands region. They are also done in other parts of the country but mine is based on Highlands bilum and the walls.

Activity (1) Weaving bamboo strips

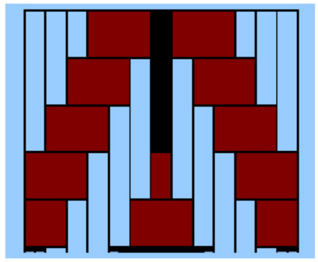
Blind weaving comes in many forms. It is mostly done by man only and they have their own reasons for waving differently form each other. However, the type of patterns form is similar. They form the same pattern but they vary from small to big or narrow to wide in terms of the size of the pattern. The type of patterns formed are not printed or painted. These patterns are anticipated before they are woven. The type of patterns exist in the minds of the person and the person use different styles such as ;one over one, two over two, three over three and four over four that will produce different patterns. One over one, etc means one bamboo strip over and fewer than one strip and so on.

Figure (1)

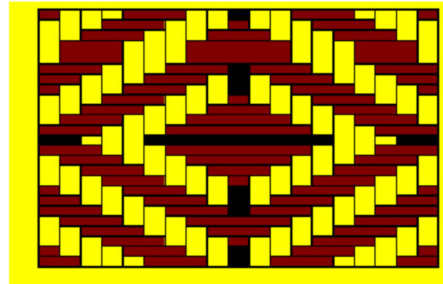


(a) Three under three
No symmetry line

(b) V-pattern
One line of symmetry



(c) Chevron pattern
One line of symmetry



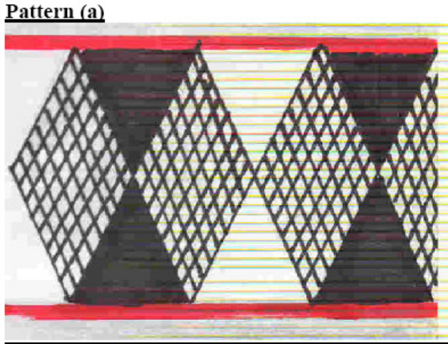
(d) Blocking pattern
Two lines of symmetry

Activity (2) Making string Bags (Bilum)

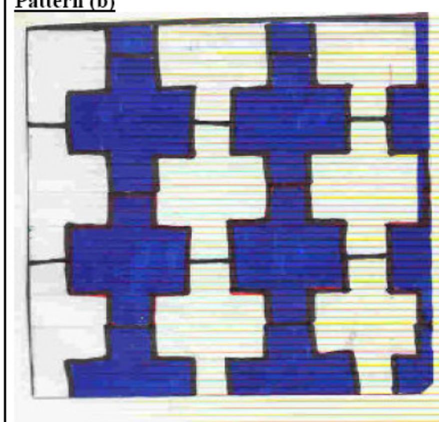
Making of billums are done in most parts of the country but most complicated patterns are done in the Highlands region by women. They use different types of coloured wools so the patterns formed are obvious. There are over hundred patterns and styles that can be formed by those women. Just by looking at those patterns you can imagine how intelligent they are. Those geometrical patterns are mostly to do with mathematics. Before starting a bilum they would work out how the pattern will be with in their mind. So when starting the bilum they know how many loops or the number of loops they will take so the shape of the patterns formed are all the same from bottom to top. If the number of loops taken are not the same then the shapes would vary from small to big or narrow to wide.

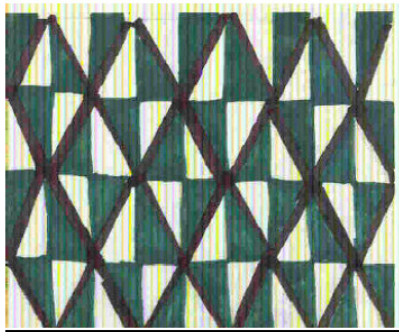
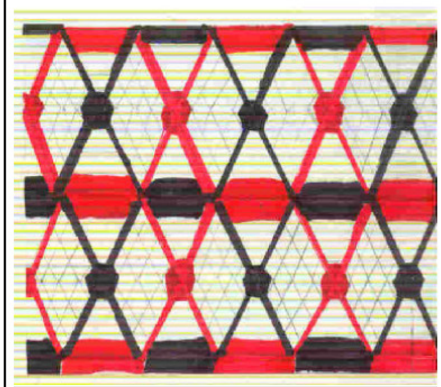
Figure (2)

Pattern (a)



Pattern (b)



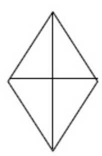
Pattern (c)	Pattern (d)
	

Derivation of Mathematical Ideas

The lines of Symmetry

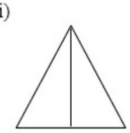
When you teach the topic "Symmetry and Construction" in grade nine mathematics you could use the examples of these cultural activities has mentioned to explain symmetry in patterns. From the figures, you can see clearly the line of symmetry. In figure (1); pattern (b) and(c) have one line of symmetry, pattern (d) has two lines of symmetry and pattern (a) has none. In figure (2), you can see the line of symmetry in all the patterns. In pattern (a) we can separate the pattern into different shapes then count the number of symmetry lines.

a) I)



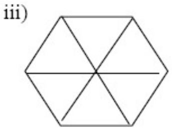
Two lines of symmetry

ii)



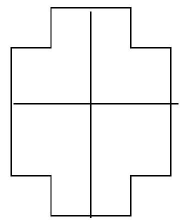
One line of symmetry

iii)



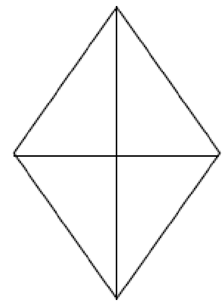
Three lines of symmetry

b)



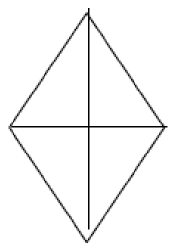
Two lines of symmetry

c)



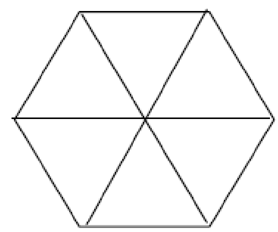
Two lines of symmetry

d) I)



Two lines of symmetry

ii)



Three lines of symmetry

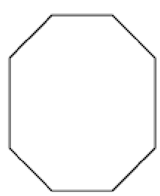
Geometrical shapes from weaving bamboo strips and bilums

It is evident that many geometrical shapes can be seen from the two figures. V bilum there are many shapes formed to make up the pattern of the bag. Figure shows some of the shapes derived from bamboo patterns and Figure (4) shows of the shapes derived from string bags (bilum making)

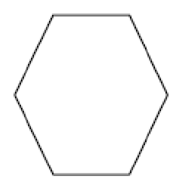
<u>Figure (3)</u>

Some polygons from weaving bamboo.

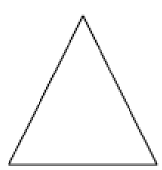
i) Octagonal shape



ii) Hexagonal shape



iii) Triangle



iv) Diamond

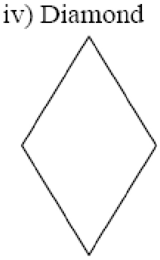
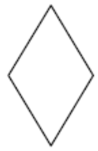


Figure (4)

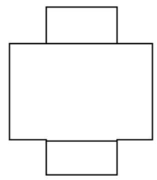
i) Diamond



ii) Triangle

iii) Hexagon

iv) This shape is made up of rectangles



All of these geometrical shapes are in the mathematical textbooks. Instead of students drawing the shapes in to their exercise book to find the lines of symmetry or the angles of the shapes, they should derived those shapes form their bags (bilums) or create those figures using paper strips instead of bamboo strips. Constructing their own shapes would give them some idea on how these shapes came about and also in doing this students are not only using their hands but also their minds to calculate the number of strips going over or under to form the wall shapes or the number of bilum loops to take each time that will form the pattern required.

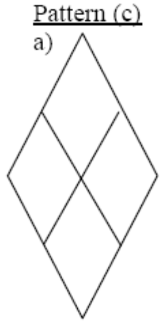
Similar Shapes

In the grade (9) topic on similar figures, some of these shapes can be used as examples because as you can see from figure (2) you can figure out some of the similar shapes. When you look at the shapes derived from pattern (c) there is a big diamond with four smaller ones that make up that big one. When the shape is cut in half it forms a big triangle with (4) equal triangles inside which compose of (8) right-angled triangles. The same idea applies to pattern (d) with a big hexagon with a smaller one in the centre and a big diamond with (4) small equal diamonds inside the big one.

Figure (5)

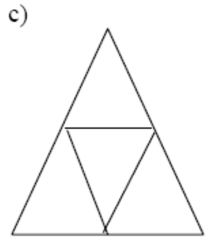
Pattern (c)

a)

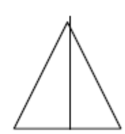


b)

c)



d)



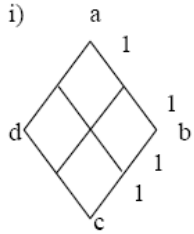
(a) Similar to (b)

(c) similar to (d)

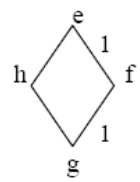
Side-side similarity

If two figures have their corresponding sides in the same ratio, they are similar.
For example:

i)



ii)

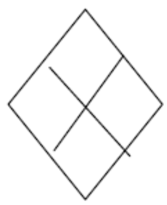


Ratio: ef/ab = fg/bc = gh/cd = he/da
1/2 =1/2 = 1/2 =1/2

ANGLES AND DEDUCTIONS

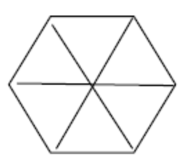
Simple Deductive Reasoning

In the grade (9) topic on angle and deductions students should be able to derive the shapes as shown already to reason out the angles. After reasoning they should use the protector to confirm the angles. For example;

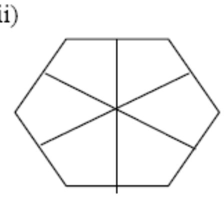


Finding the total interior angle of the polygons without using a protractor
Excluding the triangles the other types of polygons that are discussed, the teacher can teach the students on how to calculate the total interior angle of any polygon by using the idea of symmetric lines. Example for these figures you can calculate the angles without using the protector.

I)



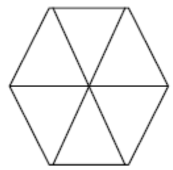
ii)



a) Lines subtended from corners or b) Lines subtended from sides

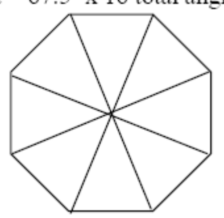
From this hexagon, the students should be able to calculate the total interior angle just by looking at the shapes. The triangles formed from this shape are all equal therefore, to find the angles the line of symmetry should give some ideas to go about calculating the angles.

There are six equilateral triangles formed from this hexagon. From the inner angles (the angle of a circle) there are six equal angles therefore;
$360^o/6 = 60^o$
Let $x = 60^o$ be one of the angles of a triangle, then $2x = 2 \times 60^o = 120^o$.



Since there are six sides to this shape the total angle would be
$120^o \times 6 = 720^o$. or $60^o \times 12$ (angles formed at the corners) $= 720^o$

Octagon:
When we look at the full revolution there are 8 equal angles therefore, $360^o/8 = 45^o$
A triangle of a octagon; $45^o+2a = 180^o$
$a = 67.5^o \times 16$ total angles formed at the corners $= 1080°$



Conclusion

In Papua New Guinea there are many cultural activities done without realising that in one way or another mathematics is involved. Most of the time we think that we only learn mathematics when we go to school. However, mathematics is done everyday without knowing it. In this project we have discussed only two activities;1) Blind weaving and (2) Bilum making. From these two activities many mathematical ideas were derived. Mostly they are geometry shapes, angles and deduction, similar shapes and lines of symmetry and many more can be derived from these activities. In the actual classroom situation, teachers when coming across such topics should refer to those activities as examples. Thus, students will not take mathematics as a foreign thing but have the idea that mathematics is present in our culture.

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Appendix C: Tattoo (Central Province)

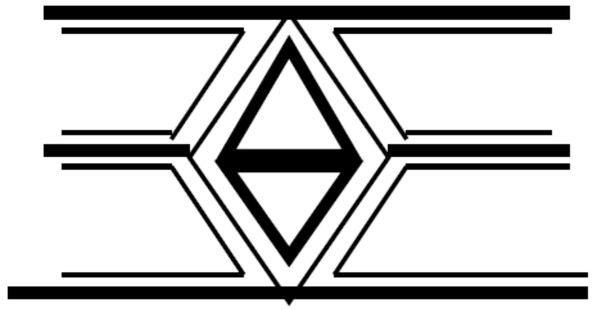
The activity I'm going to write about is an activity about that originated in Babaka village. The village is located in the Rigo District of central province. Babaka comprises approximately six thousand people inhabiting coastal areas between Hula and Kalo. It is about two hours drive from port morseby. Like any other villages, people of babaka has their own culture and tradition. They believe in certain things and survive in their own means and ways according to their surrounding

They also have different ceremonies for different occasions. For example, there were occasions like death, Bride price (the most common one) Initiation and thanks giving. They also dressed themselves differently according to the type of occasion it was which leads to what I'm going to write about in this report.

The women especially dressed uniquely and had different skin tattoo on their skin. The tattoo design I'm going to write about is a specific tattoo worn especially during an initiation ceremony. The women had this tattoo when they reached their puberty stage. Any women that had this tattoo, it indicated that have reached womanhood. The tattoo was specifically placed on their stomach or thighs using charcoal and thorns

Before the tattoo was penetrated into the skin, they drew the design on the skin and then penetrated the charcoal into the skin by poking the skin with the thorns. This made the tattoo permanent on the skin.

Figure 1 illustrates the tattoo.



Relation to mathematics

Focussing back to mathematics, we can derive some mathematics topics or concepts ou of this traditional tattoo design. It did show any mathematics relation to these people however as teachers we can be able derive mathematics ideas behind the tattoo design

Firstly by just observing the design we can see topics or concepts like geometry, trigonometry, parallel lines, trapeziums, areas and other things that are related to mathematics. However the main concept derived from this design is the geometry concept. The basic pattern is the triangle shape drawn inside the diamond.

Fig a)

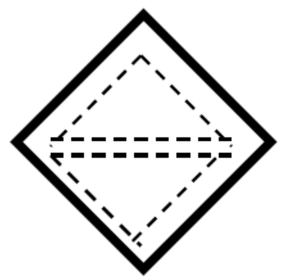
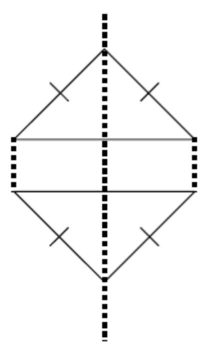


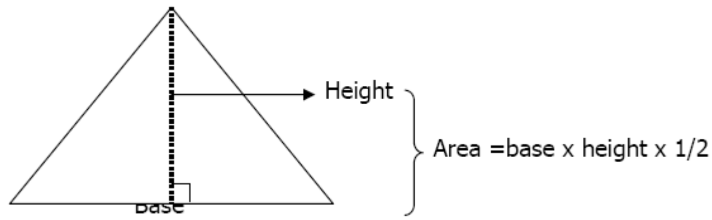
Figure a shows the isosceles triangles in the diamond. We can observe these triangles by the dotted line. It is said to an isosceles triangle because the triangles in the both sides are in equal length.

Figure b) illustrate how an isosceles is derived



The diagram clearly shows that the both triangles are isosceles because the dotted line in between the two triangles indicates that that they both are equal because it cuts them right at the centre or in halves. And the two dotted lines on the sides, indicates that their bases are also same or are in equal in length. Now we can assume that from the traditional tattoo design we were able to obtain isosceles triangles. However, that is not the only thing that can be derived. From these triangles we now can work out or se‹ another topic, which is the area of a triangle. This leads to another topic to look at which is trigonometry.

Figure c)



This diagram illustrates that from the triangles that we obtained from the traditional tattoo design we can also obtain areas.

Conclusion

Papua new guinea is known for its tradition and culture. There are many traditional activities found around Papua new guinea. This activities were done for specific purpose according to them. However today we can be able to derive mathematics concepts out it. Teachers in Papua new guinea should relate their topics back to the examples of traditional activities to make students really understand mathematics well. As we have observed this report, we discovered that the people of Babaka village in the central province did not deliberately design this tattoo according to mathematics however by observing the tattoo design we were able to discover some mathematics concepts and ideas.

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Appendix D: The fish trap (East New Britain Province)

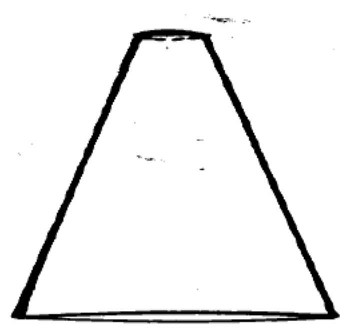
INTRODUCTION

In this project, we will look at one of the environmental phenomena, materials and practises in the traditional settings that could be used in the teaching of mathematics in Papua New Guinea. The traditional that will be discussed in this text is a fish trap called the "vup"used by some of the Tolai village along the coast of East New Britain province.

THE VUP

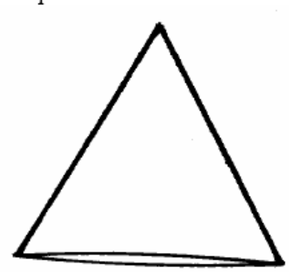
The vup is similar to the fish traps used in the lakes and rivers by other societies in PNG. The main differences is that it is bigger in size and is used to catch a lot of fish such as a school of fish where as the smaller version of it used in the rivers and lakes only have capacity to catch one to two fish. The materials used to make the vup are also different.

The vup is only used during certain times of the year when a particular type of fish call the malabur in the tolai language come out in schools to breed (reproduce) and feed. During this breeding season, the fish trap is taken out to sea and placed. Normally it is sunk some distance away from the edge of the reefs. The fishermen know exactly where to put the vup base upon their previous experience. It is sunken side ways with a rope tied to the side facing up, to floater and another rope tied to the bottom side, to an anchor to secure the vup so that it does not float away.



Picture of a village on the behive (picture 1)

Different villages build their vups differently. Some of which would have a round or ircular base like the ones shown in the picture above. They are hung on the poles near the rock just next to the beach. Taking a closer look, they would look something like the picture below.

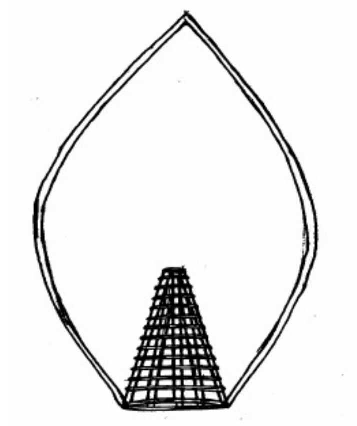


A close up of the vups shown in the picture above (picture 2)

The one we are going to look at is the on shown in the diagram below which is commonly used by the north coast villages. It has a cone shape base.

The vup is made up of two materials; bamboo strips and bush ropes, taken from strong vines from the forest but nowadays people tend to prefer the manufactured ropes because they are much stronger. The entrance of the vup is made in way that it allows easy access for fish. The entrance of the vup is large and circular in shape. It gradually gets smaller as you move inside. This makes it easy for fish to enter but very hard for them to get back out.

(picture 3)



Picture of the interior of the vup (PICTURE 4)

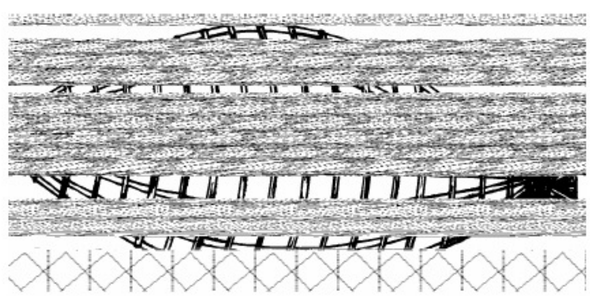


Diagram of the entrance(PICTURE 5)

CONCEPTS AND PRACTISES

As stated by Asher, mathematical ideas are embedded in most of our cultural activities. The vup is a clear example of an activity in the culture that mathematical idea can be derived. This project will look at some of the mathematics that can be derived from the vup and in which topics in the grade 10 mathematics they can be used to facilitate maths teaching.

If the bottom end of the vup is cut, it would produce a cone and if only one side of the one is looked at it would look like a triangle.

(PICTURE 6) (PICTURE 7)

The triangle can be used in grade 10 units such as Pythagoras and trigonometry while they both can be used in the topic area and volume.

The entrance of the vup itself, which is a cone with both sides open plus the two circles that make the entrance, can be used in the same unit.

(PICTURE 8)

All the shapes mention can all be use in the unit geometry as well and lastly the whole fish trap can be used in statistics where the catches done at different times can be used.

Part of the vup	Mathematical concept	Unit	Topic
The bottom end part of the vup	Triangle	Pythagoras	The right-angled triangle, Investigating right-angled triangles, Using Pythagoras Theorem to find the hypotenuse, Using Pythagoras Theorem to find the shorter sides, Problem solving and Pythagoras.
	Triangle	Trigonometry	Naming sides in right-angled triangles, Similar triangles, The sine ratio, Using the sine ratio to find lengths, The cosine ratio, Using the cosine ratio to find lengths, The sine and cosine ratio, The tangent ratio, Using the tangent ratio to find lengths, The tangents of Complementary angles, Mixed problems, Finding angles, Trigonometry problem solving
	Triangle	Area and volume	Area
	Cone	Area and volume	Area, Volume, Capacity, Surface area, Surface area and problem solving, Surface area and volume
The entrance of the vup	Cone with both sides open	Area and volume	Area, Volume, Capacity, Surface area, Surface area and problem solving, Surface area and volume
	Circles	Geometry	Cords, tangents, deductive reasoning
The vup itself	Numbers (records of the catches	Statistics	Problem solving and statistics and in the drawing of different graphs

CONCLUSION

As you can see in the vup a lot of mathematical ideas can be derived and this mathematical can be used in the teaching of mathematics in the grade 10 topics. The fish trap is something that is found within the environment of PNG. It is something that for most students is their everyday life or activities, so if utilized properly it would make the lessons true to life and meaningful to the students.

Appendix E: Armband weaving (Manus Province)

The traditional activity that I derived the mathematics knowledge originated from the Philippines. I learnt it from one of my courses at the Design & Technology, Science Faculty. Though the activity originated from another country, it has some resemblance to our traditional activities that we do here in Papua New Guinea.

The activity is a weave and is known in English as *3 Strand Weaver*. The weave is made out of pandanus leaves that are striped to the required size for weaving. The width of the weave is about 15 – 40cm and the length of it depends on whoever is weaving. When weaving, the shapes that appear must all look uniform so as to make it look attractive. The weave is used for the outsides of the baskets, trays, and also is sown into lady handbags, fans, caps, hats, etc.

In most parts of Papua New Guinea people do the similar kind of pattern, but maybe the way of weaving is different. For example, some may start weaving in the middle and move outwards while others may start from the corner and onwards.

The pattern of *3 Strand Ric-Rac Weaver* can be seen on the corners of rectangular mats like those made by the Milne Bay Province. As for the Manus Province, the people use the same pattern to make what we call *Paspas* or *armbands,* which is worn as bilas. However, the material used is different and is much stronger that the pandanus leaf. This material is extracted from a rope-type plant that is called *Nah* in the Manus language.
The armband and the mat looks something like this in Figure 1.

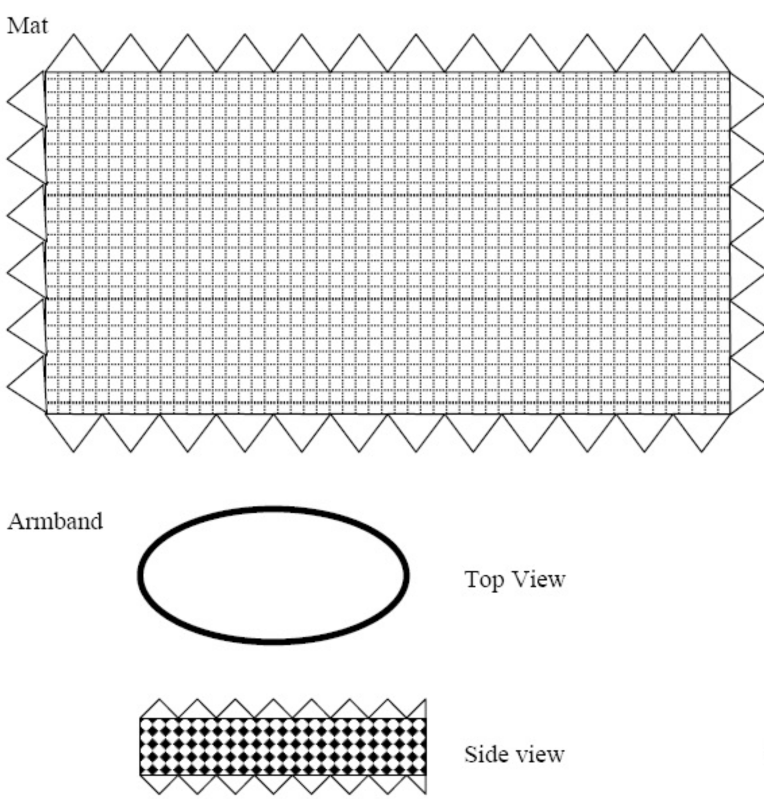


Figure 1

Mathematics of 3-strand weaver (ric-rac)

Geometry

Line of Symmetry
By definition the line of symmetry is a line that divides things or an object in two or more equal parts. See figure 2.

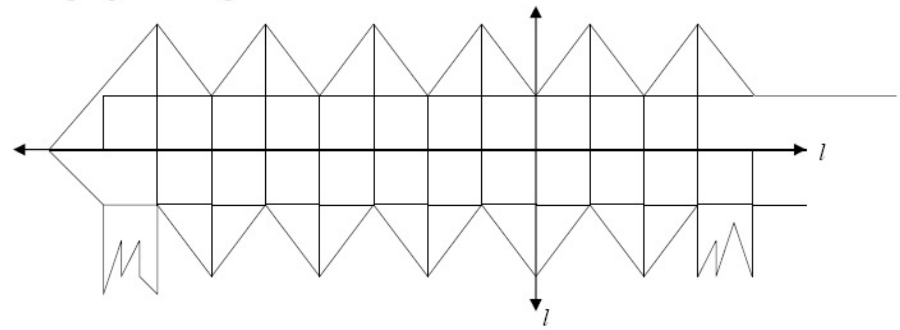


Figure 2

In figure 2 we can see two lines l , l . Which line l or l can be said to be the line of symmetry?

Name all the geometrical shapes you can see.

How many small cubes can make one big cube in the figure

Translation
To slide a shape, especially a geometrical shape, in any direction without twisting it. See figure 3.

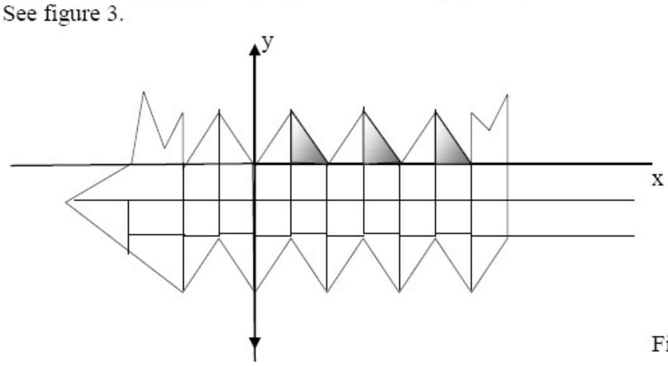


Figure 3

In the figure 3 the triangle is the translation. As you keep on weaving the triangle shape is repeated lengthwise. The same thing happens on the opposite side of the weave, but on different points of the x-axis.

Rotation
By definition rotation is to turn at a fixed point. If we take *c* to be the fixed position in figure 4 you will see that we rotate the square either clockwise or anti-clockwise. The small square fits exactly in its original shape. The fixed point is called the *axis* or *rotation.* And also if we rotate triangle A and B they'll appear as triangle A' and B'

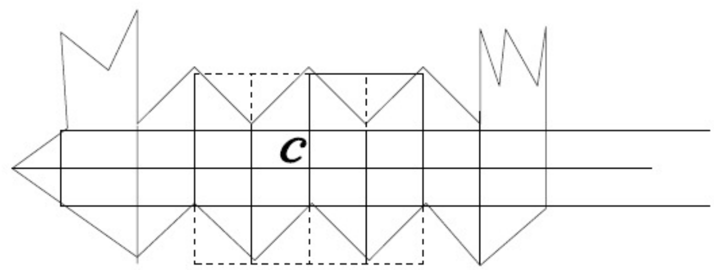


Figure 4

Reflection
When we say reflection we think about mirrors. When we put an object in front of the mirror its mirror image will be reflected in the mirror. All these points of the object will have a corresponding image, which will be equal in distance from the mirror line. See figure 5. If we take *l* to be the mirror line, the shaded triangle will have its mirror image on the right. As we go on weaving we make reflections, and it is repeated lengthwise. The same thing also happens on the opposite side.

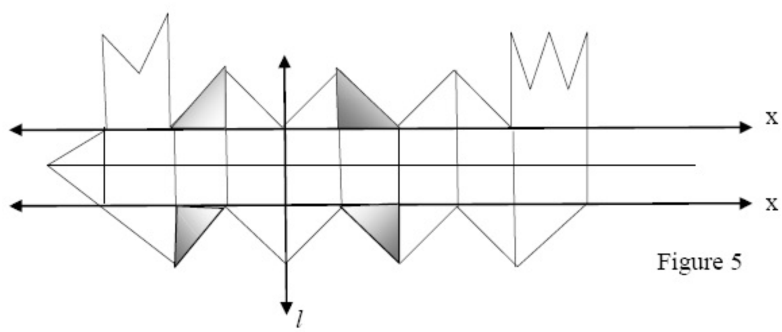
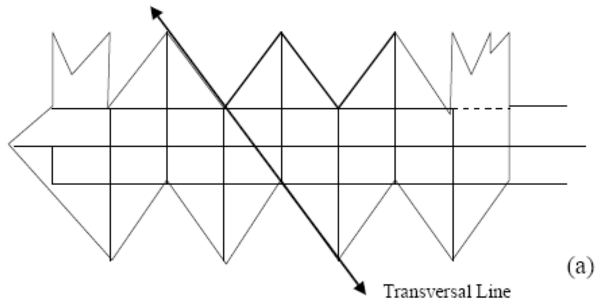


Figure 5

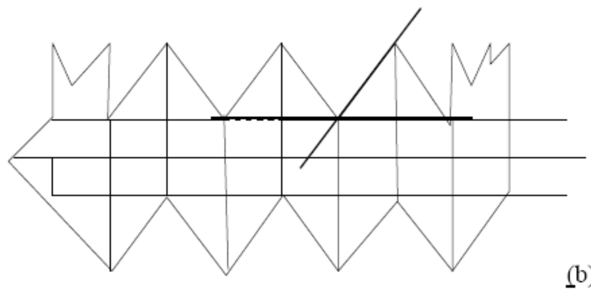
Trigonometry
Angles:
In this weave you can also see different angles, like alternate angles, adjacent angles, co-interior angles, corresponding angles as well as right angles. See figure 6 a-c

The angles occur and must be equal because we want a uniform shape right across the Weave. If for example, one triangle was made bigger than the others the weave won't look good and therefore the angles exist in order for the weave to be uniform

Alternate angles
Angles, which are between the parallel lines but on opposite sides of the *transversal line*. Alternate angles are equal. Example: angle P = angle Q



Adjacent angles
Two angles lying next to each other in the same plane.
Example: angle P is adjacent to angle Q. Angle R is adjacent to angle S.



Co-interior angles
Angles between parallel lines and on the same side of the *transversal line.* The sum of co-interior angles equals 180°. Example: angle X + angle Y = 180°

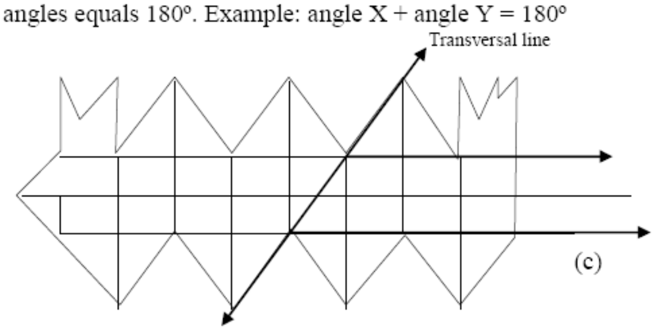
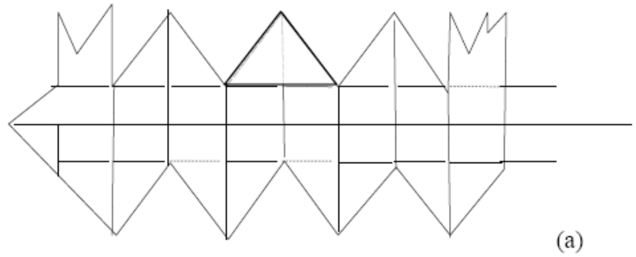


Figure 6

Triangles:
As you can see, there are plane figures or polygons with three sides, three angles and three vertices. These are triangles
There are equilateral triangles, which all three sides and angles are of equal measure and right angle triangles with a 90°. They should all look the same when weaving in order to keep the weave uniform. See Figure 7 a-b

Equilateral Triangles

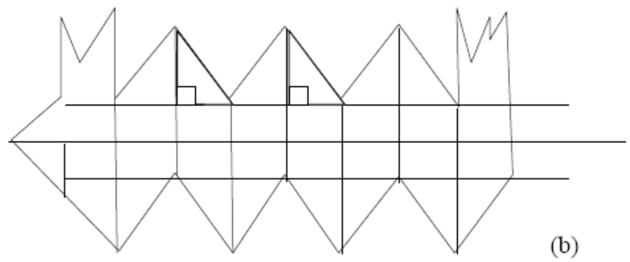
A triangle, which has all three-side angle of equal measure.



(a)

Right angle Triangles

A triangle that has a 90º-angle measure and all three sides of different lengths.



(b)

Figure 7

<u>Exercise</u>

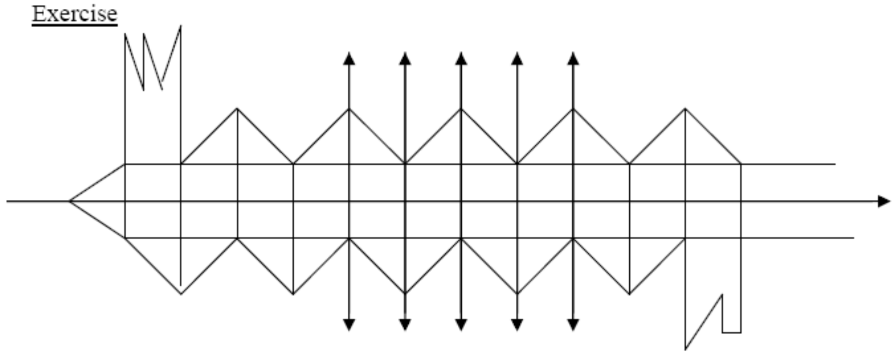


Figure 8

Refer to figure 8 and answer the following question

1. What can l be, a translation or a reflection?

You know what reflection and translation is. Using the diagram:

2.What do you think is the composite of:

a) Three successive reflection through l ,l and l ?

b) Four successive reflection through l ,l , l and l ?

3. If a= 50º, what is the measure of angle of θ ?

SOLUTION

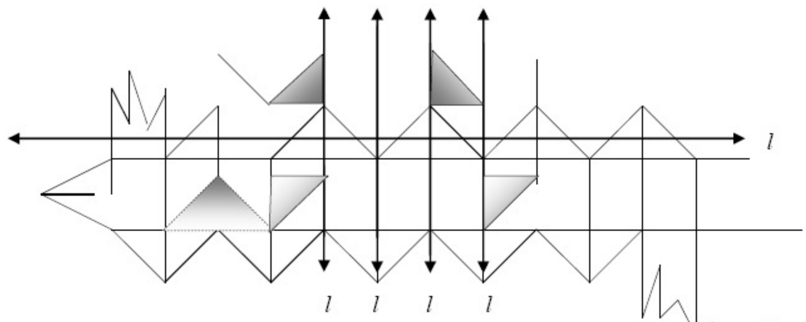


Figure 9

1. l is a translation. See figure 9. If we extend a line from A to B we have created a triangle as shaded and by translation it appears at the top.

2. a) the composite of three successive reflection through l l l is a reflection. See the shaded right angle triangles at the top of the figure.

   b) the composite of four successive reflection through l l l l is a translation. See the shaded triangles at the bottom of the figure.

A formula can be derived from this exercise i.e. when the **number of the mirror line *l* is odd** then it is the **reflection** and when the **number mirror line *l* is even** then it is the **translation.**

3. If **a** = 50° then angle measure of **θ** is also 50° because **a** and **θ** make an alternate angle and therefore by definition alternate angles are equal

As you can see mathematical knowledge derived from the weave are just the basic concepts of the mathematics learned in schools. We can call it the foundation of mathematics learning. With that kind of foundation, the people or especially the children can use to build up more solid mathematics.
If the mathematical knowledge found in an activity, practices and so on are familiar to the students; I believe the student will be just as competitive as the students of the developed countries. And also they will be successful in terms of the content and the process of the derived mathematical knowledge. As a result the student will be able to take in or build up new and in-depth knowledge of mathematics.
Therefore in the light of these, I would say that Ethno mathematics is the best way to start or bring up the best mathematician of our country. This in a way we are telling our people and children that mathematics is not something that belongs to the western countries only but it also right in front of us.

Appendix F: Isometric graphing paper