

Mathematics

**Lower Secondary
Syllabus**



Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

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Secretary's message

This Mathematics syllabus is to be used by teachers to teach Lower Secondary students (Grades 9 and 10) throughout Papua New Guinea. This syllabus builds upon concepts, skills and attitudes from Upper Primary and links to concepts, skills and attitudes in Upper Secondary. It provides a sound foundation for further learning.

The Lower Secondary Mathematics syllabus contributes to integral human development as it is based on the students' physical environments, societies and cultures. It links to the *National Education Plan's* vision which is that secondary education enables students to achieve their individual potential to lead productive lives as members of the local, national and international community and partake of further quality education and training by undertaking a broad range of subjects and work related activities that can be used in everyday life.

Traditional mathematics is part of Papua New Guinean society and at lower secondary level we need to build upon this. To be a part of the community students need to be functionally numerate. This syllabus encourages students to be literate and numerate.

Mathematics enables students to solve problems and motivates them to think analytically and rationally. Mathematics is very important to those who leave at the end of Grade 10 as well as those who go on to further studies.

Mathematics is a required subject for all Lower Secondary students.

I commend and approve this syllabus as the official curriculum for Mathematics to be used in all schools with Grades 9 and 10 students throughout Papua New Guinea.

DR. JOSEPH PAGELIO
Secretary for Education

Introduction

All Lower Secondary syllabuses use an outcomes approach. The Mathematics syllabus has been designed using learning outcomes which identify the knowledge, skills, attitudes and values that all students achieve or demonstrate by the end of Grade 10. It selects the essential knowledge and skills from syllabuses teachers have used in the past, and incorporates this with developments in mathematical learning and technology to ensure that the syllabus provides relevant mathematical competencies for students later in their lives. It is linked to the national curriculum learning areas and builds on the knowledge and skills students have learnt since elementary grades.

The syllabus links with Upper Primary Mathematics and focuses on developing numerical, analytical and investigative skills to solve real life problems likely to be encountered in the students' communities. Furthermore, it provides a sound foundation for further mathematical studies and provides the numeracy knowledge and skills necessary for Upper Secondary Mathematics.

Upper Primary Mathematics strands	Lower Secondary Mathematics strands	Lower Secondary Mathematics units
Number and application	Number and application	Mathematics in our Community
Space and shape	Shape and space	Patterns of Change
Measurement	Measurement	Working with Data
Chance and data	Chance and data	Design in 2D and 3D Geometry
Patterns and algebra	Patterns and algebra	Managing your Money
		Functions and Graphs
		Trigonometric Applications

Assessment is an important component of teaching for learning and is integrated into the teaching and learning activities of Mathematics. Continuous assessment in Mathematics provides feedback to students and the teacher on students' progress towards achievement of the learning outcomes. It helps students improve their standards of achievement by knowing what they need to do well and where they need to improve. In Mathematics, teachers will gather evidence from students' work during the course of the term and use continuous assessments to improve their teaching and students' learning.

The Mathematics syllabus has been designed to be relevant by providing topics that bring out knowledge, skills and values that are useful for all students. The syllabus is flexible as optional components are provided to allow students to study areas of interest. Units have academic and practical components, with some units emphasising the development of mathematical skills. School developed units can be written to suit local community needs and can be taught instead of some of the options as part of the syllabus.

HIV/AIDS is one of the greatest problems facing Papua New Guinea and all curriculum areas contribute in the fight against this disease. In mathematics much use is made of statistics and all teachers are asked to ensure that HIV/AIDS is one of the contexts used as a data source for statistical exercises. Similarly some students may be able to use simulation processes to model the growth of the epidemic. Mathematics is able to show students the exponential nature of the spread of AIDS and so help them better understand the scale of the problem.

Calculator and computer technology is becoming increasingly available in Papua New Guinea. Schools are encouraged to use efficiently any technology they have, and to enable students to become familiar with it so they can tackle problems which use real data and are difficult to solve.

Teachers will use the syllabus, teacher guide and additional resources to develop teaching programs to implement this syllabus.

Mathematics is to be timetabled for five periods per week in Grades 9 and 10.

Rationale

Within Papua New Guinea society traditional mathematics is used in the people's daily lives. The counting systems, barter systems, patterns we see in weaving or bilum making, traditional calendars, the measurement systems and navigational skills are all examples. As teachers we need to acknowledge the importance of traditional mathematics and build on it for the good of the student and the community.

The knowledge, skills and understanding associated with mathematics have always been important to society and everyday life and are increasingly important in the 21st century. Students need the ability to use mathematics to reason and communicate, to solve everyday problems and to conduct day-to-day activities such as trading, buying and selling, weighing, measuring and estimating. Therefore access to numeracy skills is a human right in itself.

Through the study of mathematics at the lower secondary level, students explore ways of solving problems using mathematical skills and processes. They use quantitative and spatial information in problem solving and decision making. Increasingly students will use calculator and computer technologies to help solve problems involving real world data. As students learn to enjoy and value mathematics, they grow more confident and motivated to think analytically and rationally and understand and appreciate the role of mathematics in everyday life.

Individuals who can think mathematically are empowered to operate effectively in our increasingly complex world. Being numerate enables people to better understand the vast amounts of quantitative information produced by modern society and to recognise when mathematical techniques are misused in order to produce misleading results. It also enables individuals to contribute meaningfully and with confidence to their communities after Grade 10. The Lower Secondary Mathematics syllabus makes mathematics more relevant and accessible for all students.

Mathematics is an integral part of the curriculum in that it assists learning across all learning areas. Integration with other subjects should be encouraged to enable students to see the application of these skills and the connections between mathematics and the solution of problems in the real world. Being mathematically competent enables individuals to undertake further studies in mathematics with confidence. The Lower Secondary Mathematics syllabus provides a sound foundation for students continuing their studies at Upper Secondary.

Curriculum principles

The *National Curriculum Statement* principles influence what students learn and how teachers teach. These principles are related to our way of life, integral human development and teaching and learning.

Our way of life

Cultural relevance

Cultural relevance focuses on the richness and diversity of Papua New Guinean cultures and language. Our traditional life is based on a holistic perspective that integrates the past, present and future. Papua New Guineans are the original inhabitants of Papua New Guinea and live in sophisticated, organized and self-sufficient societies. Our customs and traditions constitute a cultural mosaic, rich and diverse, which include different cultural groups. Our customs and traditions are unique. Mathematics therefore enables students to:

- demonstrate an understanding and appreciation of the traditional counting systems and measurement systems, traditional patterns, values, customs and traditions of Papua New Guinea
- demonstrate recognition of the importance of mathematics as a universal language which enhances the relationship between Papua New Guinea and the world around it.

Maintenance of vernacular language

The Department of Education's *Language Policy in all Schools* states that at the secondary level, lessons will be conducted in English, but teachers can use opportunities to further develop the students' oral and written vernacular (or lingua franca) skills, for example when a concept is better explained using the vernacular or lingua franca. Students must be encouraged to learn and use English, but secondary schools should not discourage free communication in vernacular languages that the students speak in and out of the school grounds.

Cultural diversity

Papua New Guinea is fortunate to have so many languages and cultures. The diversity of our cultures is the source of our knowledge, skills, attitudes and Melanesian values. As a multicultural society, we must protect, promote and respect our many different cultures and languages. There are many people from our own ethnic grouping and from other countries with their own cultures, living and working together in Papua New Guinea. We must ensure that we promote and share our cultures and in this way; multiculturalism will be maintained and enjoyed whilst learning experiences will be enriched.

Ethics, morals and values

Papua New Guinea is striving to create a society in line with democratic, liberal traditions. The citizens of Papua New Guinea should recognise appropriate social relationship based on sound human and religious ethics, morals and values. These are required for interaction with families, villages, wantoks and other groups, and people from other provinces and nations. The process of socialisation requires a belief in the ethics, morals and values of the Melanesian extended family, dialogue with and respect for others and a willingness to conserve and promote those aspects of our traditions, which are consistent with integral human development. Socialisation also requires an awareness of the interdependence of individuals, societies and nations in the modern world. It requires involvement with family, church, school, community and the world beyond.

Integral human development

Facilitating integral human development

The Mathematics syllabus is underpinned by integral human development which is described in the National Curriculum Statement as follows:

- *integral* in the sense that all aspects of a person are important
- *human* in the sense that social relationships are basic
- *development* in the sense that every individual has the potential to grow in knowledge, wisdom, understanding, skills and goodness.

Mathematics enables students to develop their potential so that each individual can solve his or her own problems, contribute to the common good of society, maintain, and promote and improve earning and living standards.

Papua New Guinea is a rapidly changing society and faces many challenges. To face these effectively, an individual must strive to become an integrated person and to work with others to create a better community. Functional literacy and numeracy are important components of this.

Catering for diversity

Gender

All Lower Secondary syllabuses are designed to cater for the educational needs and interests of both girls and boys. The Department of Education *Gender Equity in Education Policy* (2003) recommends that no student in the education system of Papua New Guinea will be disadvantaged on the basis of gender. The policy aims to prepare students for a satisfying life beyond school where:

- equal, non-violent relationships exist between females and males
- rights to personal respect and safety are reflected in everyday life
- positive cultural values and individual differences are acknowledged and respected.

There is a need for sensitivity to local cultural practices and values, with respect to traditional roles for males and females. To implement the policy, teachers have the responsibility to use and promote gender equity practices in their classrooms and with the wider community with sensitivity. This means teachers:

- use teaching and learning strategies that meet the needs and rights of all students
- use gender inclusive language, content, methodology and assessment
- respect positive cultural values and challenge unfair cultural practices
- respect the contributions of men and women to society
- promote positive attitudes and behaviours of social responsibility, empathy and sensitivity.

In Mathematics, students will be given equal opportunities to participate in all practical learning and assessment activities regardless of gender.

In gender sensitive classrooms:

- there is a safe, challenging learning environment which is socially and culturally supportive
- boys and girls have the right to equal power
- students take turns in being the leader and reporter
- students share and participate in activities involving different students
- students show respect for other students and their contributions
- teachers encourage students to challenge stereo-typed gender roles.

Students with special needs

Many students have special needs. This includes students who are gifted and those who are disadvantaged. Gifted students should be given opportunities to extend their learning. Students with physical or intellectual impairments and emotional or learning difficulties need special support in the classroom. Teachers have a responsibility to ensure that the learning needs of these students are met. All students are individuals and all have the right to quality education in order to reach their full potential.

Mathematics caters for the needs of all students. Teachers may need to adapt learning experiences and assessment tasks to cater for students with special needs.

Teaching and learning

Student-centred learning

A student-centred approach means that teaching and learning strategies need to be flexible to cater for individual differences and learning should be relevant and meaningful to the experiences and needs of students. A student-centred approach allows teachers to be more flexible in determining the most effective ways to help all students achieve the learning outcomes.

In Mathematics, students are encouraged to think critically about what they are learning and to take responsibility for their learning. They learn to teach each other and to learn from each other, to work cooperatively and to work individually. They know that learning has a serious purpose. They enjoy using a wide range of resources and playing appropriate mathematical games. Students learn how to communicate well with others, how to work things out for themselves and how to get the information they need. They need to learn to think in ways that make sense mathematically, using their experiences, their knowledge, their intelligence and their imagination. Learning will be done through projects and directed investigation; students will learn by problem solving, creative thinking and manipulating figures. As students progress through the formal education system they should realise in mathematics that process is more important than the answer.

Inclusive curriculum

All students are individuals and all have the right to quality education in order to reach their full potential. An inclusive curriculum uses content, language and teaching methods that take account of all students. All Lower Secondary syllabuses value the experiences and knowledge of all students, regardless of gender, ability, geographic location, religious and cultural background, or socio-economic status.

When interpreting and implementing syllabus learning outcomes, teachers must ensure that the learning and assessment activities are inclusive of all students. The following statements identify important requirements of an inclusive curriculum.

- All students have fair access to resources such as time spent with teacher, space in the classroom, books and equipment, outside space.
- All students have equal opportunity to participate fully in teaching, learning and assessment activities.
- The curriculum includes and addresses the needs and interests of all students; girls as well as boys, gifted students, students with disabilities and students from different cultural and religious backgrounds.
- The experiences and knowledge of all students are valued by teachers and are reflected in classroom practice.
- Teaching and learning methods cater for different learning styles by allowing students opportunities to learn in different ways.
- Teachers use a variety of assessment methods that give students opportunities to demonstrate achievement of learning outcomes.

Teachers have a responsibility to ensure that the curriculum they teach, and the classroom practices they use, give all students the opportunity to reach their full potential.

Relevance

The Mathematics syllabus should be relevant to the social, spiritual and resource development needs of the community. A key focus of this syllabus is to provide all students with real life and relevant learning experiences. There is a clear emphasis on the development of practical skills and knowledge that will ensure students are able to achieve and maintain a sustainable way of life beyond their school years. Learning in Mathematics

should provide students with opportunity to make connections and draw from their cultural, linguistic and everyday knowledge, skills and attitudes and apply this to what is being learnt in their classrooms. It is essential that students are aware of and value community and local knowledge and realise that learning takes place inside and outside the school context.

Most people in Papua New Guinea work in the informal economy. Students who leave at the end of Grade 10 may need to find work in the informal economy. These students will need to be prepared to work in the formal economy and undertake formal education if there are opportunities. All students will need applied and academic skills and knowledge. All students will need to be numerically literate and know how to adapt new technologies and knowledge appropriately to their environment.

Language development across the curriculum

All subject areas provide meaningful contexts for purposeful language learning. Mathematics has specific language requirements such as vocabulary and language features which must be explicitly taught in relevant contexts.

Lifelong learning

Mathematics is an important part of a student's education but learning continues throughout life. The experiences that students have in Mathematics are critical in encouraging them to continue learning throughout their lives. Students know many things when they come to school. They will learn many things outside of school and continue to learn after they leave school. The curriculum should build on what students already know. Important mathematical learning will continue throughout life. Increasingly, students who leave school will look for opportunities to continue their education and to return to school or other educational or training institutions in order to improve their qualifications and for that mathematical thinking skills are important.

Integration

Relevant and meaningful teaching and learning of mathematics can be provided by integrating knowledge and skills from a range of subjects so that practical activities or projects mimic real life situations.

The Mathematics syllabus will provide students with opportunities to be involved in decision making about their learning, such as the selection of projects and areas of interests. Students will have the opportunity to actively participate in a range of learning contexts, both school based and community based.

Safety

The National Department of Education requires all teachers to have a duty of care. All students have a duty to act responsibly and safely. Teachers and students must follow safety instructions and procedures at all times. The school must observe all safety requirements as instructed by the Secretary for Education.

Aims of Mathematics

Being mathematically literate enables students to contribute with confidence in society.

The teaching and learning of Mathematics aims to develop the following:

Knowledge and skills

- use number, length, area, weight, capacity, volume and time in a variety of operations
- estimate and measure as part of real life problem solving
- competently use a variety of measuring instruments
- use numerical information in presentations and interpret information presented numerically
- use mathematics in problem solving
- represent mathematical relationships
- manipulate algebraic expressions
- use, understand and know the limits of mathematical models
- broaden and refine mathematical skills and understanding.

Processes

- estimation
- problem identification
- problem solving
- investigation
- mathematical communication.

Attitudes

- appreciate mathematics as an essential and relevant part of life
- demonstrate confidence in applying mathematical knowledge, skills and understanding to everyday situations and the solution of everyday problems
- recognise that mathematics has been developed in many cultures in response to human needs
- show interest and enjoyment in inquiry and the pursuit of mathematical knowledge, skills and understanding
- develop and demonstrate perseverance in undertaking mathematical challenges
- appreciate the beauty and elegance of mathematical thought
- develop good work and study habits, cooperation and have respect for one another's ideas or opinions.

Content overview

Broad learning outcomes

The Mathematics broad learning outcomes are statements that identify the knowledge, skills, attitudes and values all students achieve or demonstrate by the end of Grade 10. The broad learning outcomes for Mathematics are listed below.

Students can:

1. demonstrate an understanding of traditional and contemporary mathematics in Papua New Guinea
2. identify and apply mathematical skills in everyday life
3. investigate and solve mathematical problems
4. communicate mathematical processes and results, both orally and in writing
5. undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

Strands

The strands describe the dimensions of the subject. They are broad, organising structures that define ways of approaching learning in mathematics. They incorporate cross-curriculum learning and skills and are woven through the units within Mathematics.

The content of the mathematics subject area is organised into five strands – number and application, shape and space, measurement, chance and data, and patterns and algebra. Each syllabus unit focuses on one or two of these strands. Students who complete the Lower Secondary Mathematics units will have achieved the broad learning outcomes in all of the strands.

Number and application

This strand encompasses the nature, properties and application of number in its various forms – natural numbers, integers, fractions, irrational numbers, decimals, percentages, indices, and irrationals. It extends to ratios of these numbers and to rates of change. Operations with these numbers, ratios, and rates are applied in both theoretical and applied contexts.

Shape and space

The geometry of plane figures is the focus of this strand. It includes the construction and properties of parallels and perpendiculars and the properties of similar figures, Pythagoras' theorem and applications of these properties in solving practical geometric problems. Trigonometry and its application is a major component of this strand.

Measurement

This strand covers the units and practice of measurement of length, area and volume of 2D and 3D figures, and of capacity, weight and time. It includes the calculation of surface areas of common solids and the design and construction of nets of common solids.

Chance and data

The organisation, display and interpretation of data is the focus of this strand. It includes statistical graphs and basic statistical survey techniques, introduces the elementary concepts of probability and develops the ideas of random and non-random variation. It also covers the recognition of trends in data and the application of these ideas to make interpretations of data drawn from the wealth of statistics produced by our society.

Patterns and algebra

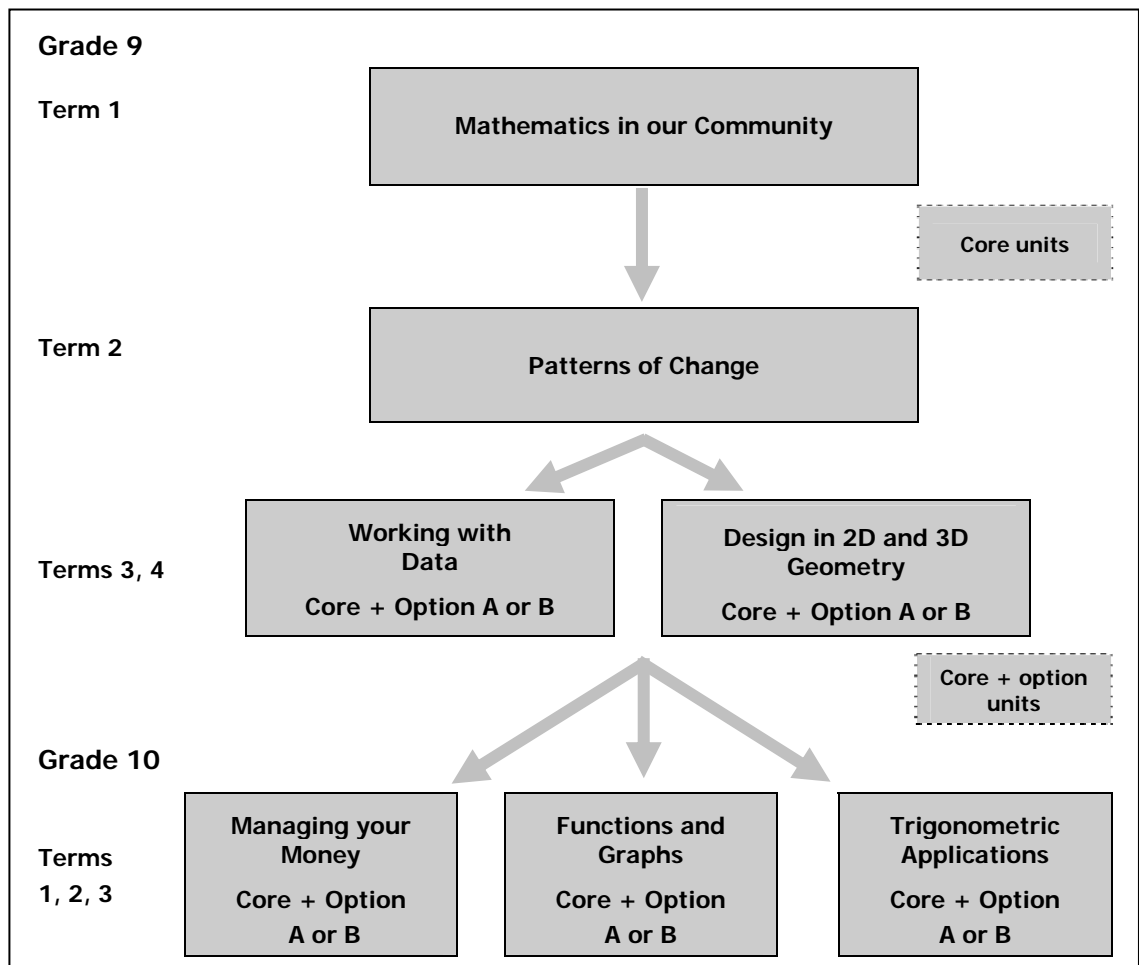
The generalisation of number patterns to algebraic expressions and equations is the basis of this strand. It extends to algebraic operations and to methods of solving linear and quadratic equations, in both theoretical and applied contexts. It includes the geometric representation of linear functions on the Cartesian coordinate plane.

Units

The content for this syllabus is organised into units. Each unit has specific learning outcomes which link with the broad learning outcomes, topics and indications of what must be studied in each topic, assessment criteria and assessment tasks.

Unit sequence and structure

(10 weeks per unit)



In Grade 9 the Mathematics in our Community unit is to be taught first, followed by the Patterns of Change unit. Schools may program the remaining units as they see fit. In Grade 10 there is no recommended order for the three units.

To meet local needs and resources teachers may choose to teach more than one unit at a time, mixing and matching the material from two or more units.

There are two core units in Grade 9 of ten weeks each. There are also two core units of five weeks each and two optional components of five weeks each within the core-option units.

In Grade 10 there are three core units of five weeks each and three optional components of five weeks each within the core-option units.

All students must complete all the core units and one of the optional components within each of the core-option units (five options).

School developed units

Teachers are encouraged to develop school based options (of about five weeks) and use them instead of the syllabus options provided. These school developed options should be relevant to the focus of the unit, and need to be formally approved by the Secondary Board of Studies.

School developed options must be developed within the nationally accredited curriculum framework and use the broad learning outcomes.

Unit learning outcomes mapped against broad learning outcomes					
Broad Learning Outcomes	1 Demonstrate an understanding of traditional and contemporary mathematics in Papua New Guinea	2 Identify and apply mathematical skills in everyday life	3 Investigate and solve mathematical problems	4 Communicate mathematical processes and results both orally and in writing	5 Undertake investigations individually and cooperatively in which mathematics can be applied to solve problems
9.1	9.1.3 identify everyday situations where traditional operations can be applied	9.1.1 identify everyday situations where basic operations can be applied 9.1.2 make calculations using a range of methods and be aware of whether or not the result is reasonable		9.1.4 communicate mathematical processes and results	9.1.5 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems
9.2		9.2.1 identify and create representation of patterns to solve equations	9.2.2 create, investigate and interpret equations, explain the effect of order of operations, and justify solutions to equations	9.2.3 communicate mathematical processes and results in writing	9.2.4 undertake investigations individually in which mathematics can be applied to solve problems
9.3		9.3.2 estimate and calculate probabilities	9.3.1 represent, interpret, analyse and solve problems using discrete and continuous data	9.3.3 communicate mathematical processes and results both orally and in writing	9.3.4 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems
9.4	9.4.1 identify situations where patterns and measurement are applied traditionally	9.4.2 classify shapes into families and their subgroups and justify reasoning	9.4.3 interpret, analyse and solve measurement problems and justify selections and applications of formulae	9.4.4 communicate mathematical processes and results in writing	9.4.5 undertake investigations individually in which mathematics can be applied to solve problems
10.1		10.1.1 apply percentages in a range of financial transactions and be aware of whether or not the result is reasonable	10.1.2 determine the costs and benefits of simple credit and investment or saving schemes	10.1.3 communicate mathematical processes and results both orally and in writing	10.1.4 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems
10.2		10.2.1 interpret and develop linear and quadratic equations from information provided in a given context 10.2.2 plot and sketch graphs of linear and quadratic equations		10.2.3 communicate mathematical processes and results in writing	10.2.4 undertake investigations individually in which mathematics can be applied to solve problems
10.3		10.3.3 identify and apply calculations and be aware of whether or not the result is reasonable	10.3.1 demonstrate understanding of the basic concepts of similar figures and trigonometric ratios 10.3.2 apply Pythagoras' theorem and trigonometric ratios to solve right-angle triangles and find lengths and angles in simple real problems	10.3.4 communicate mathematical processes and results	10.3.5 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems

Unit sequence and content

Grade 9 units		10 weeks
Core		
9.1 Mathematics in our Community <ul style="list-style-type: none"> • Numbers and operations • Ratio and percentage • Rates • Money • Measurement • Data 		
9.2 Patterns of Change <ul style="list-style-type: none"> • Directed numbers • Indices • Equations 		
9.3 Working with Data <ul style="list-style-type: none"> • Recording data • Sorting and organising data • Measures of central tendency and spread • Misleading statistical graphs • Experimental probabilities • Probabilities based on symmetry 	Option A Random Events and Simulation <ul style="list-style-type: none"> • Random number generation • Simulating simple random situations • Simple capture – recapture experiments • Games of chance 	Option B Statistical Surveys <ul style="list-style-type: none"> • Sampling • Survey design and administration • Organising/presenting data • Sample means/averages • Population means
	9.4 Design in 2D and 3D Geometry <ul style="list-style-type: none"> • Properties of plane figures • Angles and lines • Surface area and volume 	Option A Construction <ul style="list-style-type: none"> • Lines of symmetry • Construction of angles, parallel lines, regular polygons, nets and solids • Identifying similar shapes • Enlarging figures • Scale diagrams

Unit sequence and content continued

Grade 10 units		10 weeks
Core		
10.1 Managing your Money <ul style="list-style-type: none"> • Percentages and money • Spending money • Saving money • Borrowing money • Earning money 	Option A	Option B
	Personal Budgeting <ul style="list-style-type: none"> • Income/expenditure • Cash flow 	Obtaining a Mini-Loan <ul style="list-style-type: none"> • Loans and interest rates • Interest and capital payments • Financial planning
10.2 Functions and Graphs <ul style="list-style-type: none"> • Directed number • Indices, scientific notation • Basic algebra • Graphs 	Option A	Option B
	Algebra and Graphs <ul style="list-style-type: none"> • Lines of best fit • Story graphs • Rates of quantities 	Quadratic Equations <ul style="list-style-type: none"> • Binomial expressions • Quadratic expressions • Simultaneous and quadratic equations • Parabolic graphs
10.3 Trigonometric Applications <ul style="list-style-type: none"> • Triangle properties and terminology • Similar triangles • Pythagoras theorem • Introduction to the trigonometric ratios • Solving right triangles using trigonometry 	Option A	Option B
	Surveying <ul style="list-style-type: none"> • Apparatus for measuring angles • Measurement of inaccessible distances and heights • Map and/or plan construction • Offset and/or plane table surveying 	Navigation <ul style="list-style-type: none"> • Applying the area formula • Non-right triangles • Sine and cosine rules • Map bearings and angles of elevation and depression • Navigation routes • Map course construction

Grade 9 units

9.1 Mathematics in Our Community

10 weeks

This unit focuses on the mathematics used every day in our communities to count, measure, compare and present information numerically. There is a particular emphasis on the development of numeracy skills and their application in everyday life. The content of the unit is drawn from the number and application, measurement and chance and data strands and it links to all the broad learning outcomes. Teachers are strongly encouraged to use their local environment as the context for most of the application problems their students undertake. Investigations can be conducted as projects for small teams of two to five students.

The unit learning outcomes should be developed and assessed in the context of real problems. The unit is assessed using tests and a group project.

Unit learning outcomes

Students can:

- 9.1.1 identify everyday situations where basic mathematical operations can be applied
- 9.1.2 make calculations using a range of methods and be aware of whether or not the result is reasonable
- 9.1.3 identify everyday situations where traditional mathematical methods can be applied
- 9.1.4 communicate mathematical processes and results
- 9.1.5 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

Content

Students acquire mathematical knowledge and skills through this content.

Numbers and operations

- ordering positive integers, positive fractions and positive decimals
- comparing traditional number systems with the modern system
- using the basic operations $+$, $-$, \times , \div
- estimating, rounding and simplifying.

Ratio and percentage

- recognising and writing ratios in their simplest form as a fraction, decimal or an integer
- identifying equivalent ratios

- using proportion to solve problems
- converting percentages to fractions and decimals and vice versa
- estimating and finding percentages of quantities
- expressing a quantity as a percentage.

Rates

- estimating and interpreting everyday rates
- reading information from rate graphs
- comparing tables and graphs of quantities which change uniformly over time.

Money

- estimating and adding, subtracting, multiplying and dividing amounts of money
- estimating and calculating discounts and taxes
- drawing up and interpreting personal budgets
- estimating.

Measurement

- estimating and measuring lengths
- comparing units of measurement and their relationships
- comparing metric versus traditional systems
- estimating and calculating perimeters and areas of simple plane figures (triangles, quadrilaterals and circles).

Data

- collecting discrete data
- organising data by grouping
- representing data graphically using histograms and pie graphs
- estimating and calculating mean, median and mode.

Assessment

Assessment task one

Tests focusing on basic skills and routine applications used every day in communities to count, measure, compare and present information numerically:

- basic operations with numbers, ratios and percentages
- estimation and calculation involving money
- simple costing/budgeting
- measurement of length and area
- simple organisation and graphical representation of data
- calculation of the arithmetic mean (average), median and mode.

This task will assess unit learning outcomes 9.1.1, 9.1.2 and 9.1.3.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

60 marks

Assessment task two

A group project on either rates, money, measurement or data.

The project is to be conducted in groups of three to six students and the results presented in writing.

Assessment task two will assess unit learning outcomes 9.1.4 and 9.1.5.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

40 marks

Total: 100 marks

9.2 Patterns of Change

10 weeks

This unit focuses on number, indices and equations. Its content is drawn from the measurement, and number and application strands. It addresses all the aims of the Mathematics curriculum area, with a particular emphasis on posing questions, modelling and investigating problems and knowing and applying mathematical skills in everyday situations. The local environment is used as the context for most of the application problems.

Skills are developed and assessed in the context of real problems. This unit is assessed using tests and an individual directed investigation.

Unit learning outcomes

Students can:

- 9.2.1 identify and create representations of patterns to solve equations
- 9.2.2 create, investigate and interpret equations, explain the effect of order of operations and justify solutions to equations
- 9.2.3 communicate mathematical processes and results in writing
- 9.2.4 undertake investigations individually in which mathematics can be applied to solve problems.

Content

Students acquire mathematical knowledge and skills through this content.

Directed numbers

- revising ordering, adding, subtracting, multiplying and dividing with directed numbers
- estimating operations with directed numbers
- revising the order of operations with directed numbers.

Indices

- revising finding squares and square roots
- using index notation in multiplication, division, negative, zero indices and powers of powers calculations
- estimating and indices
- representing numbers and expressions in index form
- working with the index laws as applied to numbers and algebraic expressions
- solving problems involving scientific notation and estimation.

Equations

- completing and describing number patterns
- removing grouping symbols
- factorising expressions
- forming and solving an equation
- solving equations that have grouping symbols
- changing the subject of a formula
- using mathematical formulas to predict values.

Assessment

Assessment task one

Tests focusing on number, indices and equations:

- operations with directed numbers
- operations with indices and scientific notation
- forming of simple algebraic expressions and equations
- simplifying algebraic expressions
- solving linear equations.

This test will assess unit learning outcomes 9.2.1 and 9.2.2.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

60 marks

Assessment task two

An investigation on either directed numbers, indices or equations.

Assessment task two will assess unit learning outcomes 9.2.3 and 9.2.4.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

40 marks

Total: 100 marks

9.3 Working with Data

Core 5 weeks

Option A or B, 5 weeks

This unit focuses on everyday data and how it is collected, presented, analysed and interpreted. People in many situations use data and statistics in order to make informed decisions. To help build ideas of random sampling, the basic concepts of probability are introduced. The local environment is used as the context for most of the application problems. The content of this unit is drawn from the chance and data and the number and application strands.

The core component of this unit will take five weeks according to need and one of the option units will take the remaining five weeks. Skills are developed and assessed in the context of real problems. This unit is assessed using a group project and tests.

Unit learning outcomes

Students can:

- 9.3.1 represent, interpret, analyse and solve problems using discrete and continuous data
- 9.3.2 estimate and calculate probabilities
- 9.3.3 communicate mathematical processes and results both orally and in writing
- 9.3.4 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

Core content

Students acquire mathematical knowledge and skills through this content.

Recording data

- revise methods of recording data (e.g. lists, tallies, tables).

Sorting and organising data

- distinguishing between categorical data, continuous numerical and discrete numerical data
- presenting data using bar/column graphs, pie charts, histograms
- sorting data into classes and display as a histogram
- drawing cumulative frequency tables and graphs.

Measures of spread

- calculating and estimating the range of a set of data.

Measures of central tendency

- calculating and estimating the mean, median, mode
- describing the distribution of a set of data in words.

Misleading statistical graphs

- recognising biased data and misleading features on a graph such as:
 - having a displaced axis
 - use of area or volume
 - using an irregular scale
 - drawing unsuitable graphs.

Experimental probabilities

- carrying out experiments and recording the outcomes
- giving estimated probabilities to the answers (outcomes) of questions posed using 'experimental' (observed) data.

Probabilities based on symmetry

- defining outcomes and sample spaces
- counting equally likely outcomes in order to apply the $Probability = \frac{n}{N}$ formula.

Application in simple cases

- experimenting with one or two dice, one card draw, circular spinners etcetera.

Option A - Random events and simulation

- generating sets of random numbers, for example
 - selecting marbles from a bag
 - tables of random numbers
- simulating simple random situations. For example:
 - gender of children
 - results of simple chance games
 - shared birthdays
- conducting simple capture – recapture experiments
- games of chance.

Option B - Statistical surveys

- choosing random samples
 - random selection methods
- designing a survey
 - importance of avoiding ambiguity
- administering the survey
 - importance of consistency
- organising/presenting data
 - importance of readability
- calculating sample means/ averages
- predicting population means
 - interpretation of results
 - factors affecting the accuracy of estimates.

Assessment

Assessment task one

Tests focusing on discrete and continuous data, estimation and calculation of probabilities:

- describing statistical distributions
- production and interpretation of statistical graphs (including misleading graphs)
- calculations of means, medians, modes
- calculations of ranges
- the concepts of randomness and chance events
- operations involving large amounts of money
- calculation of probabilities in simple cases.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

40 marks

Assessment task two

Project

Option A

- the design and analysis of a simple game of chance, and the analysis of a given random situation

Option B

- a statistical survey of a selected characteristic of a local population.

The project is to be conducted in groups of three to six students. Students present their findings in a variety of ways, for example a board game, a report, an illustrated chart using graphs, a poster or an article.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

60 marks

Total: 100 marks

9.4 Design in 2D and 3D Geometry

Core 5 weeks

Option A or B, 5 weeks

This unit focuses on mathematics that deals with shapes and properties of planes and solid figures. Mathematical skills are developed and assessed mainly in an applied context and the local environment is used as the context for most of the application problems that students undertake. Students examine, for example, the application of traditional patterns and measurement and expand their shape classification skills. The content is drawn from the space and shape, measurement and number and application strands.

The core component of this unit will take approximately five weeks according to need and one of the option units will take the remaining five weeks of the term. This unit is assessed using an individual directed investigation and tests.

Unit learning outcomes

Students can:

- 9.4.1 identify situations where patterns and measurement are applied traditionally
- 9.4.2 classify shapes into families and their subgroups and justify reasoning
- 9.4.3 interpret, analyse and solve measurement problems and justify selections and applications of formulae
- 9.4.4 communicate mathematical processes and results in writing
- 9.4.5 undertake investigations individually in which mathematics can be applied to solve problems.

Core content

Students acquire mathematical knowledge and skills through this content.

Properties of plane figures

- investigating and applying the properties of triangles to solve related problems
- investigating and applying the properties of quadrilaterals to solve related problems
- applying the triangle angle sum property to the other polygons.

Angles and lines

- identifying co-interior, complementary and supplementary angle relationships (revision)
- estimating the size of an angle
- measuring angles
- applying properties of parallel lines.

Surface area and volume

- calculating and estimating total surface area of prisms
- calculating and estimating volume of prisms
- finding the relationship between surface area and volume.

Option A - Construction

- finding lines of symmetry and the centres and orders of rotational symmetry (revision)
- constructing angles and parallel lines
- constructing regular polygons
- constructing nets and solids
- identifying similar shapes
- enlarging figures using an enlargement factor
- drawing diagrams to scale and applying these to maps.

Option B - Deductive reasoning

- calculating the missing angles at a point, and at a point on a straight line
- using the properties of parallel lines to determine angles
- using triangle angle sum and exterior angle properties to solve triangles
- using the angle sum of a quadrilateral to find geometrical properties of figures.

Assessment

Assessment task one

Tests focusing on shapes and properties of planes and solid figures.

- properties of plane figures
 - triangles
 - quadrilaterals
 - other polygons
- angle sizes – estimated, measured and deduced
- surface area and volume of simple prisms – estimated and calculated.
 -

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

40 marks

Assessment task two

Individual directed investigation

Option A

- construction of angles, lines, regular polygons and nets and solids

Option B

- the explanation of the deductive steps given in proving a particular result.

Students present their findings in writing through, for example, a report, an illustrated chart, a poster, a flow chart or an article.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

60 marks

Total: 100 marks

Grade 10 units

10.1 Managing your Money

Core 5 weeks

Option A or B, 5 weeks

This unit focuses on the mathematics that deals with money – spending money, earning money, saving money and borrowing money. There is a particular emphasis on the development of mathematical knowledge and application of mathematical skills in an applied context using the local environment. Students develop practical mathematical skills such as calculating discounts, drawing up budgets and calculating interest payable on loans. The content is drawn from the number and application, chance and data and patterns and algebra strands.

The core component of this unit takes approximately five weeks according to need and one of the option units will take the remaining five weeks of the term. This unit is assessed using a group project and tests.

Unit learning outcomes

Students can:

- 10.1.1 apply percentages in a range of financial transactions and be aware of whether or not the result is reasonable
- 10.1.2 determine the costs and benefits of simple credit and investment or saving schemes
- 10.1.3 communicate mathematical processes and results both orally and in writing
- 10.1.4 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

Core content

Students acquire mathematical knowledge and skills through this content.

Percentages and money

- revise calculating percentage profit and loss
- estimating percentages and money
- calculating discounts.

Spending money

- applying percentages to situations of specials such as discounts, buying at sales and best buys
- estimating costs
- calculating costs of living in a village and town
- interpreting and drawing up personal budgets
- interpreting and drawing up business budgets
- knowing assets that depreciate and appreciate
- calculating appreciation and depreciation.

Saving money

- describing some of the different types of savings account
- calculating and estimating simple interest
- calculating and estimating compound interest.

Borrowing money

- calculating interest and repayments on personal loans and house loans
- calculating and estimating the cost of buying items on credit and hire purchase.

Earning money

- calculating pay rates and scales
- solving problems involving piece wages, hourly rate, overtime and salary
- solving problems involving commission and piece work
- calculating income tax payable using tax tables.

Option A - Budgeting

- recording basic income/expenditure
- estimating monthly expenses
- estimating monthly income
- explaining basic ideas of cash flow.

Option B - Obtaining a mini-loan

- explaining the types of loans and interest rates
- finding out how interest and capital are repaid by simulating the starting of a small business project
- devising a financial plan for the project.

Assessment

Assessment task one

Tests focusing on complex skills and applications using money:

- calculations of percentages
- application of percentages to problems
- earning and saving money
- operations involving large amounts of money
- basic ideas of budgeting
- basic ideas of borrowing money
- calculating discounts, interest, repayments.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

50 marks

Assessment task two

Project

Option A

- research resulting in the presentation of at least three monthly budgets, for example, personal, family, school canteen, local organisation budgets.

Option B

- obtaining and using a mini loan (K100 – K500).

The research project is to be conducted in groups of three to six students. Students present their findings to the class or other groups through a written report and an oral presentation.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

50 marks

Total: 100 marks

10.2 Functions and Graphs

Core 5 weeks

Option A or B, 5 weeks

This unit focuses on indices, algebra and graphs and quadratic equations. Mathematical skills are developed and assessed as far as possible in the context of the local environment and real problems. Students start the unit by revising knowledge and skills in directed number and basic algebra before proceeding to quadratic equations. The content of the unit is drawn mainly from the patterns and algebra, and the number and applications strands.

The core component of this unit will take five weeks according to need and one of the options components will take the remaining five weeks of the term. This unit will be assessed using an individual directed investigation and tests.

Unit learning outcomes

Students can:

- 10.2.1 interpret and develop linear and quadratic equations from information provided in a given context
- 10.2.2 plot and sketch graphs of linear and quadratic equations
- 10.2.3 communicate mathematical processes and results in writing
- 10.2.4 undertake investigations individually in which mathematics can be applied to solve problems.

Core Content

Students acquire mathematical knowledge and skills through this content.

Directed number

- adding, subtracting, multiplying and dividing with directed numbers (revision).

Indices, scientific notation

- simplifying using index laws especially with negative and zero indices (revision)
- ordering and solving problems involving scientific notation (revision).

Basic algebra

- solving simple equations (revision)
- rearranging formulas and substituting to find values of the unknown (revision)
- removing grouping symbols and simplifying expressions (revision).

Graphs

- plotting points on a set of Cartesian axes
- researching practical application of graphs
- graphing linear relations
- finding the equation of a given straight line
- applying linear relations to modelling problems.

Option A - Algebra and graphs

- finding the line of best fit on a graph using experimental data
- interpreting and drawing scatter graphs
- interpreting and producing story graphs
- comparing rates
- calculating and using rates of quantities which change uniformly over time (i.e. constant rates of change)
- drawing and comparing different graphs.

Option B - Quadratic equations

- multiplying binomial expressions
- finding the square of a binomial expression
- factorising a quadratic expression
- solving simultaneous equations
- solving problems using quadratic equations
- drawing and interpreting parabolic graphs
- solving problems using parabolas.

Assessment

Assessment task one

Tests focusing on indices, algebra, graphs and quadratic equations.

- operations with directed numbers
- operations with indices especially negative and zero indices
- solving problems involving scientific notation
- solving simple equations
- removing grouping symbols and simplifying expressions
- graphing linear equations
- finding the equations of a given straight line.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

50 marks

Assessment task two

Directed investigation on algebra, graphs or quadratic equations.

Option A

- drawing and interpreting a story graph from their local context.

Option B

- drawing and interpreting parabolic graphs.

Students present their findings through a written report.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

50 marks

Total: 100 marks

10.3 Trigonometric Applications

Core 5 weeks

Option A or B, 5 weeks

This unit focuses on the geometry and trigonometry used in a wide range of activities in modern society - mapping, planning, designing, surveying and navigation. Its content is drawn mainly from the shape and space and the number and applications strands. It emphasises the development of the skills of mathematically modelling environmental situations such as land areas and navigation routes and the skills of communicating mathematical information in a variety of ways

The core component of this unit will take five weeks according to need and one of the option units will take the remaining five weeks of term. As far as possible teachers should use their local environment as the context for the application problems set for students. This unit will be assessed using a group project and tests.

Unit learning outcomes

Students can:

- 10.3.1 demonstrate understanding of the basic concepts of similar figures and trigonometric ratios
- 10.3.2 apply Pythagoras' theorem and trigonometric ratios to solve right-angle triangles and find lengths and angles in simple real problems
- 10.3.3 identify and apply calculations and be aware of whether or not the result is reasonable
- 10.3.4 communicate mathematical processes and results
- 10.3.5 undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

Core content

Students acquire mathematical knowledge and skills through this content.

Triangle properties and terminology

- naming triangles, angles and sides (revision)
- identifying acute, obtuse and right angles
- recognising the triangle inequality ($a < b + c$).

Similar triangles

- identifying similar triangles by proportionality of sides (revision)
- identifying similar triangles by congruence of angles
- calculating and estimating enlargement factors.

Pythagoras Theorem

- investigating the right-angled triangle
- finding the distance between points plotted on a Cartesian co-ordinate system
- applying Pythagoras' theorem to practical situations
- using Pythagoras' theorem to find length of sides in shapes containing right-angled triangles.

Introduction to the trigonometric ratios

- identifying similar right-angled triangles
- recognising the sine, cosine, tangent ratios.

Solving right triangles using trigonometry

- calculating and estimating unknown sides of a right-angled triangle using the trigonometric ratios

$$\sin x = \frac{O}{H}, \cos x = \frac{A}{H}, \tan x = \frac{O}{A}$$

- calculating and estimating unknown angles and sides
- solving practical problems applying trigonometric relations to modelling problems.

Option A - Surveying

- constructing simple apparatus for measuring angles in the environment
 - clinometer
 - plane table
- measuring and estimating inaccessible distances and heights
 - angles of elevation / depression
 - for example: width of river, height of tree
- reading, constructing maps and/or plans
- surveying using offset and/or plane table surveying exercise.

Option B - Navigation

- applying the area formula $A = \frac{1}{2}ab \sin c$ and applications
- extending trigonometry to solving non- right triangles
- applying the sine and cosine rules in non-right triangles
- reading bearings on maps with true bearings as well as compass bearings
- using bearings and angles of elevation and depression
- finding bearings and distances
- constructing map courses.

Assessment

Assessment task one

Tests focusing on geometry and trigonometry:

- similar triangles
- Pythagoras' theorem
- trigonometric ratios
- right-angle triangles
- non-right-angle triangles.

Assessment criteria

Assessment task one will be assessed on the extent to which the student can:

- demonstrate understanding of mathematical concepts
- correctly choose and apply mathematical techniques.

50 marks

Assessment task two

Project

Option A

- a survey of a local area such as the school grounds

Option B

- the charting of a navigation route.

The research project is to be conducted in groups of three to six students. Students present their findings in writing.

Assessment criteria

Assessment task two will be assessed on the extent to which the student can:

- demonstrate appropriate investigation skills
- choose and apply relevant mathematical techniques
- make an effective communication of the project results.

50 marks

Total: 100 marks

Assessment, examination and certification

Assessment and reporting practices described here are detailed further in the *National Assessment and Reporting Policy* for Papua New Guinea (2003) and in other support materials produced by the Department of Education.

Assessment

The main purpose of assessment is to improve student learning.

Assessment needs to be for learning as well as of learning. It is used to evaluate and improve teaching and learning, report achievement and provide feedback to students on their progress.

Assessment measures students' achievement of learning outcomes as described in the syllabus. It is the ongoing process of identifying, gathering and interpreting information about students' achievement of the learning outcomes.

Teaching and learning using an outcomes approach requires teachers to plan their teaching and assess learner performance in relation to outcomes using criteria derived from those outcomes. Assessment involves focusing less on whether a learner has "passed" or "failed" and more on what outcomes a learner has achieved and in which areas further support is required.

Assessment in Mathematics

A student's achievement in Mathematics at the end of Grade 10 will be assessed against the broad learning outcomes. Assessment of student progress towards achieving these broad outcomes is cumulative throughout Grades 9 and 10 using specific outcomes for each unit. The matrix on page 14 of the syllabus shows how the unit learning outcomes are linked to the broad learning outcomes.

During the course of each unit students must complete the tasks specified for the unit. Teachers will expand each task and provide clear guidelines to students for how the task will be completed and how the criteria will be applied.

The assessment tasks and criteria in each unit ensure that there is a common focus for internal assessment in the subject across schools while allowing for flexibility in the design of tasks. A variety of tasks are specified to give students the opportunity to demonstrate all the broad learning outcomes in different ways and to improve the validity and reliability of the assessment.

It is important that teachers plan the teaching and learning sequence so that there is a balanced spread of assessment during the unit. Some tasks, such as investigations or case studies can be designed so that they are completed over a period of time rather than at the end of the unit. Other tasks can be done immediately the relevant section of the unit has been covered.

Assessment for the School Certificate

A student's overall achievement in Mathematics will be both internally and externally assessed. The mark awarded to each student for the School Certificate will be a combination of the internal assessment mark provided by the school and the examination mark.

Internal assessment

Internal assessment provides a measure of a student's achievement based on a wider range of syllabus content and outcomes than may be covered by the external examination alone.

For Mathematics, the internal assessment marks will provide a summation of each student's achievements in Grades 9 and 10. The assessment tasks used to determine the internal assessment mark must comply with the types of tasks and assessment criteria specified in each of the units.

All schools must meet the requirements for internal assessment as specified in the *Grade 10 Assessment, Examination and Certification Handbook*.

External examination

The external examination provides a measure of student achievement of those aspects of the broad learning outcomes that can be reliably measured in an examination setting. Questions for the external examination in Mathematics will be developed using the outcomes, knowledge and skills in the core components of the units.

Recording

All schools must meet the requirements for maintaining and submitting student records as specified in the *Grade 10 Assessment, Examination and Certification Handbook*.

Certification

Candidates will be awarded a School Certificate only if they meet all requirements for internal and external assessment. Eligibility rules for the award of the School Certificate are specified in the *Grade 10 Assessment, Examination and Certification Handbook*.