9 Continuum of Learning in Mathematics K–10

ⓘ for your information

Stage outcomes and stage statements illustrate the continuum of learning in the *Mathematics K–10 Syllabus.*

9.1 Stage outcomes

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The K–10 Mathematics Scope and Continuum is an overview of the content descriptors in each of the content strands. These content descriptors are also integrated into the essential content that precedes the Scope and Continuum.

The concepts in each of these strands are developed across the Stages to show how understanding in the early years needs to precede understanding in later years. In this way, the Scope and Continuum provides an overview of the sequence of learning for particular concepts in mathematics and links content typically taught in primary mathematics classrooms with content that is typically taught in secondary mathematics classrooms. It illustrates assumptions about prior learning and indicates pathways for further learning.

In this syllabus, it is generally the case that content is not repeated. This is intentional and is not meant to suggest that review and consolidation are not necessary. When programming, it will be necessary for teachers to determine the level of achievement of outcomes in previous Stages before planning new teaching and learning experiences. Students may be at different Stages for different strands of the Scope and Continuum. For example, a student may be working on Stage 4 content in Number and Algebra but be working on Stage 3 content in the Measurement and Geometry strand.

It is not intended that the Scope and Continuum be used as a checklist of teaching ideas. Rather, a variety of learning experiences need to be planned and presented to students to maximise opportunities for achievement of outcomes. Students need appropriate time to explore, experiment and engage with the underpinning concepts and principles of what they are to learn.

Continuum of Outcomes ***Working Mathematically***

EARLY STAGE 1	STAGE 1	STAGE 2	STAGE 3
ES1.1 describes mathematical situations using everyday and mathematical language, concrete materials, imagery and informal recordings	1.1 describes mathematical situations using everyday and mathematical language, actions, materials, diagrams and symbols	2.1 uses appropriate terminology and symbols to describe and represent mathematical ideas	3.1 describes and represents mathematical situations using appropriate terminology and conventions
ES1.2 explores problems using appropriate representations, actions, technology and/or trial and error	1.2 investigates and describes methods to solve problems	2.2 selects and uses appropriate mental, written or technological strategies to solve problems	3.2 selects and applies appropriate strategies in undertaking investigations and solving problems, including using technology
ES1.3 supports conclusions using appropriate reasoning	1.3 supports conclusions by explaining or demonstrating how answers were obtained	2.3 explains the reasoning used to check the accuracy of a statement	3.3 gives a valid reason for supporting one possible solution over another

Continuum of Outcomes ***Working Mathematically***

STAGE 4	STAGE 5.1	STAGE 5.2	STAGE 5.3
4.1 represents mathematical ideas using appropriate terminology, diagrams and symbolism	5.1.1 communicates mathematical ideas using appropriate terminology, diagrams and symbolism	5.2.1 selects appropriate notations and conventions to communicate mathematical ideas and solutions	5.3.1 uses and interprets formal definitions and generalisations when explaining solutions and/or conjectures
4.2 applies appropriate mathematical techniques to solve problems	5.1.2 selects and uses appropriate strategies to solve problems	5.2.2 analyses mathematical or real-life situations, systematically applying appropriate strategies to solve problems	5.3.2 connects and generalises mathematical ideas and techniques to analyse and solve problems efficiently
4.3 recognises and explains mathematical relationships using reasoning	5.1.3 provides reasoning to support conclusions which are appropriate to the context	5.2.3 constructs arguments to prove and justify results	5.3.3 uses deductive reasoning in presenting arguments and formal proofs

Continuum of Outcomes ***Number and Algebra***

EARLY STAGE 1	STAGE 1	STAGE 2	STAGE 3
Whole Numbers ES1.4 counts and represents numbers, combines, separates and groups collections of objects	**Whole Numbers** 1.4 counts, represents and uses numbers in a range of mental strategies involving the four operations	***Whole Numbers*** 2.4 counts, records and uses numbers in mental and written strategies involving the four operations	***Whole Numbers*** 3.4 selects and applies appropriate strategies to calculate using the four operations
Addition and Subtraction ES1.4 counts and represents numbers, combines, separates and groups collections of objects	***Addition and Subtraction*** 1.4 counts, represents and uses numbers in a range of mental strategies involving the four operations	***Addition and Subtraction*** 2.4 counts, records and uses numbers in mental and written strategies involving the four operations	***Addition and Subtraction*** 3.4 selects and applies appropriate strategies to calculate using the four operations
Multiplication and Division ES1.4 counts and represents numbers, combines, separates and groups collections of objects	***Multiplication and Division*** 1.4 counts, represents and uses numbers in a range of mental strategies involving the four operations	***Multiplication and Division*** 2.4 counts, records and uses numbers in mental and written strategies involving the four operations	***Multiplication and Division*** 3.4 selects and applies appropriate strategies to calculate using the four operations
Fractions and Decimals ES1.5 describes halves	***Fractions and Decimals*** 1.5 represents halves, quarters and eighths	***Fractions and Decimals*** 2.5 represents commonly used fractions and decimals	***Fractions and Decimals*** 3.5 calculates with simple decimals, fractions and percentages
Patterns and Algebra ES1.6 creates repeating geometric and number patterns that increase or decrease	***Patterns and Algebra*** 1.6 creates and completes a variety of patterns and builds number relationships	***Patterns and Algebra*** 2.6 generates number patterns and completes simple number sentences by calculating missing values	***Patterns and Algebra*** 3.6 analyses geometric and number patterns and completes number sentences involving the four operations

Continuum of Outcomes ***Number and Algebra***

STAGE 4	STAGE 5.1	STAGE 5.2	STAGE 5.3
Computation with Integers 4.4 operates efficiently with different representations of numbers and numerical relationships, including financial calculations			
Fractions, Decimals and Percentages 4.4 operates efficiently with different representations of numbers and numerical relationships, including financial calculations			
Financial Mathematics 4.4 operates efficiently with different representations of numbers and numerical relationships, including financial calculations	***Financial Mathematics*** 5.1.4 operates with numbers of any magnitude and performs calculations regarding earning, spending and investing money	***Financial Mathematics*** 5.2.4 performs calculations involving compound interest	
Proportion 4.4 operates efficiently with different representations of numbers and numerical relationships, including financial calculations		***Proportion*** 5.2.7 graphs and interprets a range of linear and non-linear relationships	***Proportion*** 5.3.7 uses and interprets appropriate formulae to graph and analyse linear and non-linear relationships
Algebraic Techniques 4.5 generalises number properties to operate with algebraic expressions and solves linear equations		***Algebraic Techniques*** 5.2.5 selects and applies appropriate algebraic techniques to simplify and operate with quadratic expressions and algebraic fractions	***Algebraic Techniques*** 5.3.5 systematically selects and applies appropriate algebraic techniques to operate fluently with algebraic expressions
Indices 4.4 operates efficiently with different representations of numbers and numerical relationships, including financial calculations	***Indices*** 5.1.5 generalises index laws to operate with algebraic expressions	***Indices*** 5.2.5 selects and applies appropriate algebraic techniques to simplify and operate with quadratic expressions and algebraic fractions	***Surds and Indices*** 5.3.4 operates with fractional indices, surds and logarithms
Equations 4.5 generalises number properties to operate with algebraic expressions and solves linear equations		***Equations*** 5.2.6 applies appropriate techniques to solve linear and simple quadratic equations, inequalities and simultaneous equations	***Equations*** 5.3.6 applies appropriate techniques to solve linear and non-linear equations
Linear Relationships 4.6 graphs and interprets linear relationships on the number plane	***Linear Relationships*** 5.1.6 calculates distance, midpoint and gradient on the number plane and graphs linear and simple non-linear relationships	***Linear Relationships*** 5.2.7 graphs and interprets a range of linear and non-linear relationships	***Linear Relationships*** 5.3.7 uses and interprets appropriate formulae to graph and analyse linear and non-linear relationships
	Non-linear Relationships 5.1.6 calculates distance, midpoint and gradient on the number plane and graphs linear and simple non-linear relationships	***Non-linear Relationships*** 5.2.7 graphs and interprets a range of linear and non-linear relationships	***Non-linear Relationships*** 5.3.7 uses and interprets appropriate formulae to graph and analyse linear and non-linear relationships
			Polynomials 5.3.7 uses and interprets appropriate formulae to graph and analyse linear and non-linear relationships
			Logarithms 5.3.4 operates with fractional indices, surds and logarithms
			Functions and Other Graphs 5.3.7 uses and interprets appropriate formulae to graph and analyse linear and non-linear relationships

Continuum of Outcomes ***Measurement and Geometry***

EARLY STAGE 1	STAGE 1	STAGE 2	STAGE 3
Length ES1.7 describes and compares lengths, areas, volumes, capacities and masses	***Length*** 1.7 measures and estimates lengths, areas, volumes, capacities and masses using informal units	***Length*** 2.7 calculates lengths, areas, volumes, capacities and masses using formal units	***Length*** 3.7 selects appropriate units to calculate lengths, areas, volumes, capacities and masses
Area ES1.7 describes and compares lengths, areas, volumes, capacities and masses	***Area*** 1.7 measures and estimates lengths, areas, volumes, capacities and masses using informal units	***Area*** 2.7 calculates lengths, areas, volumes, capacities and masses using formal units	***Area*** 3.7 selects appropriate units to calculate lengths, areas, volumes, capacities and masses
Volume and Capacity ES1.7 describes and compares lengths, areas, volumes, capacities and masses	***Volume and Capacity*** 1.7 measures and estimates lengths, areas, volumes, capacities and masses using informal units	***Volume and Capacity*** 2.7 calculates lengths, areas, volumes, capacities and masses using formal units	***Volume and Capacity*** 3.7 selects appropriate units to calculate lengths, areas, volumes, capacities and masses
Mass ES1.7 describes and compares lengths, areas, volumes, capacities and masses	***Mass*** 1.7 measures and estimates lengths, areas, volumes, capacities and masses using informal units	***Mass*** 2.7 calculates lengths, areas, volumes, capacities and masses using formal units	***Mass*** 3.7 selects appropriate units to calculate lengths, areas, volumes, capacities and masses
Time ES1.8 sequences events, describes duration of activities using everyday language and reads clocks on the hour	***Time*** 1.8 describes, compares and orders duration of events and reads clocks on the half- and quarter-hour	***Time*** 2.8 reads, records and compares time in one-minute intervals and converts between time units	***Time*** 3.8 uses twenty-four hour time and twelve-hour notation, interprets timetables and constructs timelines
Three-Dimensional Space ES1.9 represents three- and two-dimensional figures, describes position and follows simple directions	***Three-Dimensional Space*** 1.9 investigates three- and two-dimensional figures, describes position and comprehends directions	***Three-Dimensional space*** 2.9 makes and compares three-dimensional objects, identifies two-dimensional shapes and angles, and uses simple maps and plans	***Three-Dimensional Space*** 3.9 identifies and constructs three-dimensional objects, applies properties of two-dimensional shapes, measures angles and uses grid reference systems
Two-Dimensional Space ES1.9 represents three- and two-dimensional figures, describes position and follows simple directions	***Two-Dimensional Space*** 1.9 investigates three- and two-dimensional figures, describes position and comprehends directions	***Two-Dimensional Space*** 2.9 makes and compares three-dimensional objects, identifies two-dimensional shapes and angles, and uses simple maps and plans	***Two-Dimensional Space*** 3.9 identifies and constructs three-dimensional objects, applies properties of two-dimensional shapes, measures angles and uses grid reference systems
Position ES1.9 represents three- and two-dimensional figures, describes position and follows simple directions	***Position*** 1.9 investigates three- and two-dimensional figures, describes position and comprehends directions	***Position*** 2.9 makes and compares three-dimensional objects, identifies two-dimensional shapes and angles, and uses simple maps and plans	***Position*** 3.9 identifies and constructs three-dimensional objects, applies properties of two-dimensional shapes, measures angles and uses grid reference systems

Continuum of Outcomes ***Measurement and Geometry***

STAGE 4	STAGE 5.1	STAGE 5.2	STAGE 5.3
Length 4.7 calculates time durations, lengths and areas of plane shapes, and volumes of prisms and cylinders			
Area 4.7 calculates time durations, lengths and areas of plane shapes, and volumes of prisms and cylinders	***Area & Surface Area*** 5.1.7 selects and applies appropriate formulae to calculate areas and surface areas of prisms, and uses trigonometry	***Area & Surface Area*** 5.2.8 selects and applies appropriate formulae to calculate surface areas and volumes of cylinders and composite solids, and applies bearings to right-angled triangles	***Area & Surface Area*** 5.3.8 calculates surface areas and volumes of pyramids, cones, spheres and their composites
Volume 4.7 calculates time durations, lengths and areas of plane shapes, and volumes of prisms and cylinders		***Volume*** 5.2.8 selects and applies appropriate formulae to calculate surface areas and volumes of cylinders and composite solids, and applies bearings to right-angled triangles	***Volume*** 5.3.8 calculates surface areas and volumes of pyramids, cones, spheres and their composites
Time 4.7 calculates time durations, lengths and areas of plane shapes, and volumes of prisms and cylinders	***Numbers of Any Magnitude*** 5.1.4 operates with numbers of any magnitude and performs calculations regarding earning, spending and investing money		
Right-Angled Triangles (Pythagoras) 4.7 calculates time durations, lengths and areas of plane shapes, and volumes of prisms and cylinders	***Right-Angled Triangles (Trigonometry)*** 5.1.7 selects and applies appropriate formulae to calculate areas and surface areas of prisms, and uses trigonometry	***Right-Angled Triangles (Trigonometry)*** 5.2.8 selects and applies appropriate formulae to calculate surface areas and volumes of cylinders and composite solids, and applies bearings to right-angled triangles	***Trigonometry & Pythagoras*** 5.3.9 uses and graphs trigonometric relationships and calculates attributes of non-right-angled triangles
Angles & Geometric Reasoning 4.8 identifies and uses angle relationships and properties of plane shapes, including transformations and congruent figures			
Properties of Geometrical Figures 4.8 identifies and uses angle relationships and properties of plane shapes, including transformations and congruent figures	***Properties of Geometrical Figures*** 5.1.8 recognises and applies the properties of similar figures and scale drawings	***Properties of Geometrical Figures*** 5.2.9 calculates the angle sum of any polygon and applies results for proving triangles are congruent or similar	***Properties of Geometrical Figures*** 5.3.10 determines properties of plane shapes using deductive reasoning and formulates proofs using formal geometric arguments
			Circle Geometry 5.3.10 determines properties of plane shapes using deductive reasoning and formulates proofs using formal geometric arguments

Continuum of Outcomes ***Statistics and Probability***

EARLY STAGE 1	STAGE 1	STAGE 2	STAGE 3
Data ES1.10 represents and interprets data displays made from objects and pictures	***Data*** 1.10 gathers and organises data, represents data in column and picture graphs and interprets the results	***Data*** 2.10 selects effective data collection methods, and constructs, compares and interprets data displays	***Data*** 3.10 uses appropriate data collection methods, constructs and interprets a range of data displays and analyses small data sets
Chance ES1.11 recognises and labels the elements of chance in familiar activities	***Chance*** 1.11 recognises and describes the elements of chance in everyday events	***Chance*** 2.11 describes and compares chance events in social and experimental contexts	***Chance*** 3.11 orders the likelihood of simple events on a number line from zero to one

Continuum of Outcomes ***Statistics and Probability***

STAGE 4	STAGE 5.1	STAGE 5.2	STAGE 5.3
Single Variable Data Analysis 4.9 collects, represents, analyses and interprets single data sets using appropriate statistical displays and measures of location	***Single Variable Data Analysis*** 5.1.9 investigates and evaluates techniques of large-data collection, and compares data sets using statistical displays and measures	***Single Variable Data Analysis*** 5.2.10 represents, describes and compares single variable and bivariate data sets using statistical displays and measures	***Single Variable Data Analysis*** 5.3.11 compares and quantifies statistical relationships for single variable and bivariate data sets, evaluating the usefulness of statistics in prediction and planning
		Bivariate Data Analysis 5.2.10 represents, describes and compares single variable and bivariate data sets using statistical displays and measures	***Bivariate Data Analysis*** 5.3.11 compares and quantifies statistical relationships for single variable and bivariate data sets, evaluating the usefulness of statistics in prediction and planning
Probability 4.10 represents and calculates probabilities of simple and compound events	***Probability*** 5.1.10 calculates relative frequencies to estimate probabilities of simple and compound events	***Probability*** 5.2.11 describes and determines probabilities for multi-step events	

9.2 Stage Statements

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Stage statements are summaries of the knowledge, understanding, skills, values and attitudes that have been developed by students as a consequence of achieving the outcomes for the relevant stage of learning.

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Early Stage 1

Students ask questions and use known facts to explore mathematical problems and develop fluency with mathematical ideas. They use everyday language, materials and informal recordings to demonstrate understanding and link mathematical ideas.

Students count to 30 and represent numbers to 20 with objects, pictures, numerals and words and read and use ordinal numbers to at least 'tenth' place. They manipulate objects to model addition and subtraction, multiplication and division. Students divide objects into two equal parts and describe them as halves. They recognise coins and notes. Students recognise, describe and continue patterns that increase or decrease.

Students identify length, area, volume, capacity and mass and compare and arrange objects according to these attributes. They name the days of the week and the seasons and they order events in a school day, telling the time on the hour. Students manipulate, sort and describe 3D objects using everyday language. They manipulate, sort and describe 2D shapes, identifying circles, squares, triangles and rectangles. Students give and follow simple directions and describe position using everyday language.

Students use objects and pictures to create a data display and interpret data.

Stage 1

Students ask questions and use known facts, objects, diagrams and technology to explore mathematical problems and develop mathematical fluency with mathematical ideas. They link mathematical ideas and use everyday language, some mathematical language and diagrams to explain strategies used.

Students count, order, read and write two- and three-digit numbers and use a range of mental strategies, informal recording methods and materials to add, subtract, multiply and divide, and solve problems. They model and describe objects and collections divided into halves, quarters and eighths. Students sort, order and count money. Students describe, create and continue a variety of number patterns and build number relationships. Students relate addition and subtraction facts to at least 20.

Students estimate, measure, compare and record using informal units for length, area, volume, capacity and mass. They recognise the need for formal units of length and use the metre and centimetre to measure length and distance. Students use a calendar to identify the date and name and order the months and the seasons of the year. They use informal units to compare and order the duration of events and tell the time on the half- and quarter-hour. Students identify, describe, sort and model particular 3D objects and 2D shapes. They represent and describe the position of objects.

Students gather, organise, display and interpret data using column and picture graphs. Students recognise and describe the element of chance in everyday events.

Stage 2

Students ask questions and use efficient mental and written strategies with increasing fluency to solve problems. They use technology to investigate mathematical concepts and check their solutions. They use appropriate terminology to describe and link mathematical ideas, check statements for accuracy and explain and justify reasoning.

Students count, order, read and record numbers of any size and use mental and written strategies, including the formal written algorithm, to solve addition and subtraction problems. They use mental strategies to recall multiplication facts up to 10×10 and related division facts and use informal written strategies for multiplication and division of two-digit numbers by one-digit numbers. Students model, compare and represent simple fractions in everyday situations and they model, compare, represent, add and subtract decimals to two decimal places. Students perform simple calculations with money. Students generate, describe and record number patterns and relate multiplication and division facts.

Students estimate, measure, compare and record length, area, volume, capacity and mass using formal units. They read and record time in hours and minutes in digital and analogue notation and make comparisons between time units. Students name, describe and sketch particular three-dimensional objects and two-dimensional shapes. They compare angles using informal means and describe a ‘right angle’. Students use coordinates to describe position and compass points to give and follow directions.

Students gather and organise data to create and interpret tables and graphs and conduct simple chance experiments.

Stage 3

Students ask questions and undertake investigations, selecting appropriate technological applications and problem-solving strategies to demonstrate fluency in mathematical techniques. They use mathematical terminology and some conventions and they give valid reasons when comparing and selecting from possible solutions, making connections with existing knowledge and understanding.

Students select and apply appropriate mental, written or calculator strategies for the four operations. They compare, order and perform calculations with simple fractions, decimals and percentages and apply the four operations to money in real-life situations. Students record and describe geometric and number patterns using tables and words. They construct, verify and complete number sentences involving the four operations.

Students select and use the appropriate unit to estimate, measure and calculate length, area, volume, capacity and mass. They use 24-hour time in real-life situations and construct timelines. Students construct and classify three-dimensional objects and two-dimensional shapes and compare and describe their properties. They measure, construct and classify angles and make simple calculations using scale.

Students draw and interpret a variety of graphs using a scale. Students place the likelihood of simple events in order on a number line from 0 to 1.

Stage 4

Students use mathematical terminology, algebraic notation, diagrams, text and tables to communicate mathematical ideas, and link concepts and processes within and between mathematical contexts. They apply their mathematical skills and understanding in analysing real-life situations and in systematically exploring and solving problems using technology where appropriate. In solving particular problems, they compare the strengths and weaknesses of different strategies and solutions.

Students have developed a range of mental strategies to enhance their computational skills. They operate competently with directed numbers, fractions, percentages, mixed numerals and decimals and apply these in a range of practical contexts, including problems related to discounts and profit and loss. They are familiar with the concepts of ratio and rates, and apply these when solving problems. They investigate divisibility tests and use index notation for numbers with positive integral indices and explore prime factorisation, squares and related square roots.

Extending and generalising number patterns leads students into an understanding of the use of variables and the language of algebra. Students simplify algebraic expressions, substitute into algebraic expressions and formulae, and expand and factorise algebraic expressions. They solve simple linear equations and apply equations to solve word problems. They develop tables of values from simple relationships and illustrate these relationships on the number plane with and without the use of ICT technology.

Students construct and interpret dot plots, stem-and-leaf plots, and frequency tables and histograms. In analysing data, they consider both discrete and continuous variables, sampling versus census, prediction and possible misrepresentation of data, and calculate the mean, mode, median and range. Students calculate the probability of simple, complementary and non-mutually exclusive events, including using Venn diagrams and two-way tables.

Their knowledge of the properties of two- and three-dimensional geometrical figures, angles, parallel lines, perpendicular lines, congruent figures enables them to apply logical reasoning to solve numerical exercises on finding unknown lengths and angles in figures.

Students find the area and perimeter of a variety of polygons, circles, and simple composite figures, and the volume of right prisms and cylinders. Pythagoras' theorem is used to calculate the distance between two points. They describe the limit of accuracy of their measures, calculate time duration, and apply their understanding of Australian and world time zones to solve problems.

Stage 5

5.1 pathway

Students explain and verify mathematical relationships, select and use appropriate strategies to solve problems and link mathematical ideas to existing knowledge and understanding. They use mathematical language and notation to explain mathematical ideas, and interpret tables, diagrams and text in mathematical situations.

Students apply their knowledge of percentages, fractions and decimals to problems involving financial contexts related to earning and spending money, and simple and compound interest. They simplify and evaluate arithmetic expressions using index laws, round numbers to a specified number of significant figures and express numbers in scientific notation using both positive and negative powers of ten. Students apply the index laws to simplify algebraic

expressions. They determine the midpoint, length and gradient of intervals on the number plane and draw graphs of linear and simple non-linear relationships.

Their statistical skills are extended to include considering shape and skewness, comparing data and their displays, and evaluating the reliability of statistical claims. Students also determine relative frequency and theoretical probability.

Skills in measurement are further developed to include finding the surface areas of prisms. Students apply right-angled triangle trigonometry to practical situations including those involving angles of elevation and depression. They investigate conditions for triangles to be similar and solve problems involving scale factors.

5.2 pathway

Students use mathematical arguments to reach and justify conclusions. When communicating mathematical ideas, they use appropriate mathematical language and algebraic, statistical and other notations and conventions in written, oral or graphical form. Students use suitable problem-solving strategies which include selecting and organising key information and they extend their inquiries by identifying and working on related problems.

Students apply their knowledge of percentages, fractions and decimals to problems involving conversion of rates, direct proportion and consumer situations related to compound interest, depreciation and successive discounts.

Students solve non-routine problems in algebra and apply the index laws to simplify, expand and factorise algebraic expressions. They solve linear equations and simple quadratic equations, inequalities and simultaneous equations. On the number plane they draw and interpret graphs of straight lines and simple parabolas, circles, and exponentials. Formulae are used to find distance, gradient and midpoint.

Statistical skills are extended to include the construction of box-and-whisker plots and calculation of interquartile range to analyse and compare data sets. Students investigate bivariate data sets and use scatter plots to describe relationships between variables. In probability, students record and determine probabilities for multi-step events and examine conditional language.

Students extend their skills in measurement to calculations of the area and perimeter of complex composite figures, the volume of cones, spheres and composite solids, and the surface area of cylinders and composite solids. In geometry, they use deductive reasoning in numerical and non-numerical problems drawing on their knowledge of the properties of congruent triangles, the angle properties of polygons and the properties of quadrilaterals.

5.3 pathway

Students use deductive reasoning in problem solving and in presenting arguments and formal proofs. They interpret and apply formal definitions and generalisations and connect and apply mathematical ideas within and across substrands.

Students operate with irrational numbers and extend their knowledge of the number system to include all real numbers. They apply algebra to analysing and describing physical phenomena and rates of change. Algebraic skills are extended to expanding binomial products, factorising quadratic expressions, and solving literal equations, inequalities, quadratic and simultaneous equations. They generate, describe and graph equations of straight lines, parabolas, cubics, hyperbolas, circles and exponential functions.

Students use standard deviation to analyse data, and extrapolate and interpolate from bivariate data using lines of best fit. They use digital media to examine the reporting of variability.

Students calculate the surface areas and volumes of pyramids, cones and spheres and explore and use similarity relationships for area and volume. They determine exact trigonometric ratios for 30°, 45° and 60°, extend trigonometric ratios to obtuse angles and sketch sine and cosine curves. Students apply the sine and cosine rules for finding unknown angles and/or sides in non-right-angled triangles.

Their knowledge of a wide range of geometrical facts and relationships is used to prove general statements in geometry, extending the concepts of similarity and congruence to a more generalised application. Students prove known properties of triangles, quadrilaterals and circles.

10 Assessment

10.1 Standards

The Board of Studies *K–10 Curriculum Framework* is a standards-referenced framework that describes, through syllabuses and other documents, the expected learning outcomes for students.

Standards in the framework consist of two interrelated elements:

- outcomes and content in syllabuses showing what is to be learned
- descriptions of levels of achievement of that learning.

Exemplar tasks and student work samples help to elaborate standards.

Syllabus outcomes in Mathematics contribute to a developmental sequence in which students are challenged to acquire new knowledge, understanding and skills.

The standards are typically written for two years of schooling and set high, but realistic, expectations of the quality of learning to be achieved by the end of Years 2, 4, 6, 8 and 10.

Using standards to improve learning

Teachers use standards in Mathematics as a reference point for planning teaching and learning programs and for assessing and reporting student progress. Standards in Mathematics help teachers and students to set targets, monitor achievement, and, as a result, make changes to programs and strategies to support and improve each student's progress.

10.2 Assessment for Learning

Assessment for learning is designed to enhance teaching and improve student learning. It gives students opportunities to produce work that leads to development of their knowledge, understanding and skills. Teachers decide how and when to assess student achievement, as they plan the work students will do, using a range of appropriate assessment strategies including self-assessment and peer assessment.

Teachers of Mathematics provide students with opportunities in the context of everyday classroom activities, as well as planned assessment events, to demonstrate their learning.

In summary, *assessment for learning*:

- is an essential and integrated part of teaching and learning
- reflects a belief that all students can improve
- involves setting learning goals with students to encourage growth and development
- involves students in self-assessment and peer assessment
- provides feedback that helps students understand the next steps in learning and plan how to achieve them
- involves teachers, students and parents reflecting on assessment data.

Quality Assessment Practices

Effective assessment for learning informs teachers and students about past, present and future learning. The quality of assessment practices and materials can be judged using the following *assessment for learning* principles. The following Assessment for Learning Principles provide the criteria for judging the quality of assessment materials and practices.

Assessment for learning principles

Assessment for learning:

- promotes learning by emphasising the interactions between learning and manageable assessment strategies
  - teachers reflect on the purposes of assessment and on their assessment strategies
  - assessment activities allow for demonstration of learning outcomes
  - assessment is embedded in learning activities and informs the planning of future learning activities
  - teachers use assessment to identify what a student can already do
- clearly expresses the goals of the learning activity
  - students know and understand the learning goals and the criteria that will be applied to judge the quality of their achievement
  - students receive feedback that helps them make further progress
- helps students learn better, rather than just achieve a better mark
  - assessment is an integral component of the teaching–learning process rather than a separate activity
  - teachers design and select tasks that assess, and therefore encourage, deeper learning
  - feedback motivates the learner and helps students to understand that engagement with feedback can lead to improvement
- provides meaningful and constructive feedback
  - feedback is directed to the achievement of standards and away from comparisons with peers
  - feedback is clear about strengths and areas for further development
  - feedback is individualised and provides strategies for improvement
- encourages students to take responsibility for their own learning
  - assessment includes strategies for self-assessment and peer assessment, emphasising the next steps needed for further learning
- is inclusive of all learners
  - assessment against standards provides opportunities for the diverse range of learners to achieve their best
  - assessment activities are accessible and free of bias.

Assessment for students with special education needs

Some students with special education needs will require adjustments to assessment practices in order to demonstrate what they know and can do in relation to syllabus outcomes and content. These may be:

- adjustments to the assessment process, for example additional time, rest breaks, quieter conditions, or the use of a reader and/or scribe or specific technology
- adjustments to assessment tasks, for example rephrasing questions, using simplified language, fewer questions or alternative formats for questions
- alternative formats for responses, for example written point form instead of essays, scaffolded structured responses, short objective questions, multimedia presentations.

Further examples of adjustments to assessment for students with special education needs can be found in *Life Skills Years 7–10: Advice on Planning, Programming and Assessment.*

Life Skills assessment

Each student undertaking the Mathematics Years 7–10 Life Skills course will study selected outcomes and content. The syllabus outcomes and content form the basis of learning opportunities for students.

Assessment should provide opportunities for students to demonstrate achievement in relation to the outcomes and to apply their knowledge, understanding and skills to a range of situations or environments, including the school and the wider community.

Students may demonstrate achievement in relation to Mathematics Years 7–10 Life Skills outcomes independently, in some cases with adjustments, or with support. The type of adjustments and support will vary according to the particular needs of the student and the requirements of the activity.

Further information about the assessment of students undertaking Life Skills outcomes and content can be found in *Life Skills Years 7–10: Advice on Planning, Programming and Assessment.*

10.3 Reporting

Reporting is the process of providing feedback to students, parents and other teachers about student progress.

Teachers use assessment evidence to extend the process of *assessment for learning* into their *assessment of learning*. In a standards-referenced framework teachers make professional judgements about student achievement at key points in the learning cycle. These points may be at the end of a year or stage, when schools may wish to report differentially on the levels of knowledge, understanding and skills demonstrated by students.

Descriptions of student achievement in Mathematics provide schools with a useful tool to report consistent information about student achievement to students and parents, and to the next teacher to help plan the next steps in the learning process.

The A–E grade scale provides a common language for reporting by describing observable and measurable features of student achievement at the end of a stage, within the indicative hours of study. Teachers use the descriptions of the standards to make a professional, on-balance judgement, based on available assessment information, to match each student's achievement to a description. The Common Grade Scale (A–E) is used by teachers to report student levels of achievement from Stages 1 to 5.

For students with special education needs, teachers may need to consider, in consultation with their school and sector, the most appropriate method of reporting student achievement. In particular, for those students who are undertaking a special program of study, it may be appropriate to report against the student's individual education plan.

10.4 Choosing assessment strategies

The range of assessment strategies should gather information about the depth of students' understanding, the development of skills as well as the extent of content knowledge. Assessment strategies should allow for flexibility in the design of tasks.

A collaborative approach to assessment develops a shared understanding of syllabus standards and helps teachers make consistent judgements of evidence of student achievement.

When choosing assessment strategies, teachers should consider whether the tasks:

- ensure a variety of types of task that cater for the full range of students
- show a clear relationship between the outcomes, what has been taught and the content being assessed
- inform students about the nature of the task and marking guidelines
- demonstrate validity and reliability, and are free from prejudice, discrimination and stereotyping
- provide constructive feedback about what students are able to do and what they need to do in order to improve their level of performance
- allow opportunities for self-assessment and peer assessment.

✍ consult

In Years K–10 Mathematics, assessment of student learning should incorporate measures of students':

- mathematical proficiency
- knowledge, understanding and skills related to Number and Algebra, Measurement and Geometry, and Statistics and Probability.

Students indicate their level of understanding and skill development in what they do, what they say, and what they write and draw. The most appropriate method or procedure for gathering assessment information is best decided by considering the purpose for which the information will be used, and the kind of performance that will provide the information. Consequently there are a variety of ways to gather assessment information in Mathematics. Tasks given to students for the purpose of gathering assessment information include projects, investigations, oral reports or explanations, tests and practical assignments. For example, practical tasks would often be an appropriate strategy for the assessment of achievement of outcomes for measurement and statistics.

Teachers have the opportunity to observe and record aspects of students' learning in a range of situations. When students are working in groups, teachers are well placed to determine the extent of student interaction and participation. By listening to what students say (including their responses to questions or other input) teachers are able to collect many clues about students' existing understanding. Through interviews (which may only be a few minutes in duration), teachers can collect specific information about the ways in which students think in certain situations. The students' responses to questions and comments will often reveal their levels of understanding, interests and attitudes. Records of such observations form valuable additions to information gained using other assessment strategies, and enhance teachers' judgement of their students' achievement of outcomes.

Consideration of students' journals or their comments on the process of gaining a solution to a problem can also provide valuable insight into the extent of students' mathematical thinking.

Possible sources of information for assessment purposes include the following:

- samples of students' work
- explanation and demonstration to others
- questions posed by students
- student-produced overviews or summaries of topics (Years 7-10 only)
- practical tasks such as measurement activities
- investigations and/or projects
- students' oral and written reports
- short quizzes
- pen-and-paper tests [In Years 7-10 pen-and-paper tests involve multiple choice, short-answer questions and questions requiring longer responses, including interdependent questions (where one part depends on the answer obtained in the preceding part); some tests may be open-book tests if appropriate]
- comprehension and interpretation exercises
- student-produced worked examples
- teacher/student discussion or interviews
- observation of students during learning activities, including listening to students' use of language
- observation of students' participation in a group activity
- consideration of students' portfolios
- students' plans for and records of their solutions of problems
- students' journals and comments on the process of their solutions.