Mathematics A

Senior
Syllabus
2001

Mathematics A Senior Syllabus

This syllabus is approved for general implementation until 2008, unless otherwise stated.

To be used for the first time with Year 11 students in 2002.

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1 RATIONALE

Mathematics is an integral part of a general education. It can enhance understanding of our world and the quality of our participation in a rapidly changing society. Mathematics pervades so many aspects of daily life that a sound knowledge is essential for informed citizenship. Through enhanced understanding of mathematics, individuals can become better informed economically, socially and politically in an increasingly mathematically oriented society.

Mathematics continues to develop in response to changes in society and, in turn, influences further societal development. Technology, including calculators, computers and electronic means of communicating information, has had a significant impact on this development. This will be increasingly reflected in future-oriented classrooms in the way mathematics is taught and learned.

Mathematics A aims to provide the opportunity for students to participate more fully in life-long learning. It involves the study of Financial Mathematics, Applied Geometry, Statistics, and Operations Research. These are used to develop:

- knowledge and skills of computation, estimation and measurement
- a capacity to interpret and analyse information presented in a variety of forms
- the ability to make judgments based on evidence and reasoning
- a capacity to justify and communicate results in a variety of forms.

This subject emphasises the development of positive attitudes towards the student's involvement in mathematics. This development is encouraged through the use of relevant and life-related learning experiences. There is also a focus on the development of mathematical knowledge and understanding via investigative and explorative approaches to learning. These approaches also provide opportunities to work collaboratively and cooperatively in teams as well as individually.

Mathematics A provides opportunities for the development of the key competencies in contexts that arise naturally from the general objectives and learning experiences of the subject. The seven key competencies are: collecting, analysing and organising information; communicating ideas and information; planning and organising activities; working with others and in teams; using mathematical ideas and techniques; solving problems; using technology. (Refer to *Integrating the Key Competencies into the Assessment and Reporting of Student Achievement in Senior Secondary Schools in Queensland*, published by QBSSSS in 1997.)

2 GLOBAL AIMS

Having completed the course of study, students of Mathematics A should:

- be able to recognise when problems in their everyday life are suitable for mathematical analysis and solution, and be able to attempt such analysis or solution with confidence
- be aware of the uncertain nature of their world and be able to use mathematics to assist in making informed decisions in real-life situations
- be able to manage their financial affairs in an informed way
- be able to visualise and represent spatial relationships in both two and three dimensions
- have positive attitudes to the learning and practice of mathematics
- comprehend mathematical information which is presented in a variety of forms
- justify mathematical results and/or procedures
- communicate mathematical information in a variety of forms
- be able to benefit from the availability of a wide range of technologies.

3 GENERAL OBJECTIVES

3.1 INTRODUCTION

The general objectives of this course are organised into four categories:

- Knowledge and procedures
- Modelling and problem solving
- Communication and justification
- Affective.

3.2 CONTEXTS

The categories of Knowledge and procedures, Modelling and problem solving, and Communication and justification incorporate contexts of application, technology, initiative and complexity. Each of the contexts has a continuum for the particular aspect of mathematics it represents. Mathematics in a course of study developed from this syllabus must be taught, learned and assessed using a variety of contexts over the two years. It is expected that all students are provided with the opportunity to experience mathematics along the continuum within each of the contexts outlined below.

Application

The opportunity to recognise the usefulness of mathematics through its application must be given to the students. Learning experiences and the corresponding assessment must include mathematical tasks across a variety of situations from real-world through to contrived or simplified life-related tasks. Whilst some purely mathematical situations may be needed, the emphasis should be on life-related tasks and activities.

Technology

A range of technological tools must be used in the learning experiences and the corresponding assessment. These range from pen and paper, compasses, measuring instruments and tables through to technologies such as Geographic Positioning Systems, graphing calculators and computers.

Initiative

Learning experiences and the corresponding assessment must provide students with the opportunity to demonstrate their capability in dealing with tasks that range from routine and well-rehearsed through to those that require demonstration of insight and creativity.

Complexity

Students must be provided with the opportunity to work on simple, single-step tasks through to tasks that are complex in nature. Complexity may derive from either the nature of the concepts involved or from the number of ideas or techniques that must be sequenced in order to produce an appropriate conclusion.

3.3 OBJECTIVES

The general objectives for each of the categories in section 3.1 are detailed below. These general objectives incorporate several key competencies. The first three categories of objectives, Knowledge and procedures, Modelling and problem solving, and Communication and justification, are linked to the exit criteria in section 7.3.

3.3.1 Knowledge and procedures

The objectives of this category involve recalling and using results and procedures within the contexts of Application, Technology, Initiative and Complexity (see section 3.2).

By the conclusion of the course, students should be able to:

- recall definitions and rules
- access and apply rules
- demonstrate number and spatial sense
- demonstrate an ability to use technologies such as computers, calculators, measuring instruments, geometrical drawing instruments and tables
- recall, select and use appropriate mathematical procedures
- apply mathematical procedures to situations that are similar to situations already encountered
- work accurately and manipulate simple formulae
- recognise that some tasks may be broken up into smaller components.

3.3.2 Modelling and problem solving

The objectives of this category involve the uses of mathematics in which the students will model mathematical situations and constructs, solve problems and investigate situations mathematically within the contexts of Application, Technology, Initiative and Complexity (see section 3.2).

In achieving these objectives, the emphasis should be on using observations, data, diagrams, formulae, graphical and other representations to investigate and model situations, and hence make informed decisions.

By the conclusion of the course, students should be able to demonstrate modelling and problem solving through:

- understanding that a mathematical model is a mathematical representation of a situation
- interpreting, clarifying and analysing problems
- identifying the variables of a simple mathematical model of a situation
- forming and/or selecting a mathematical model of a life-related situation
- deriving results from consideration of mathematical models
- interpreting results from a mathematical model in terms of the given situation
- examining the strengths and limitations of mathematical models
- developing strategies in modelling
- using a range of problem-solving strategies such as estimating, identifying patterns, guessing and checking, working backwards, using diagrams, considering similar problems and organising data

- understanding that there may be more than one way to solve a problem
- selecting the appropriate mathematical procedures required to explore, investigate and solve problems
- developing a solution consistent with the problem
- investigating open-ended situations
- reflecting on conjectures and making modifications if needed
- making decisions from a range of choices.

3.3.3 Communication and justification

The objectives of this category involve presentation, communication (both mathematical and everyday language), logical arguments, interpretation and justification of mathematics within the contexts of Application, Technology, Initiative and Complexity (see section 3.2).

Communication

By the conclusion of the course, students should be able to demonstrate communication through:

- organising and presenting information
- communicating ideas, information and results appropriately
- using mathematical terms and symbols accurately and appropriately
- using accepted spelling, punctuation and grammar in written communication
- understanding material presented in a variety of forms such as oral, written, symbolic, pictorial and graphical
- translating material from one form to another when appropriate
- presenting material for different audiences, in a variety of forms (such as oral, written, symbolic, pictorial and graphical)
- recognising necessary distinctions in the meanings of words and phrases according to whether they are used in a mathematical or non-mathematical situation.

Justification

By the conclusion of this course, the student should be able to demonstrate justification through:

- developing logical arguments expressed in everyday language, mathematical language or a combination of both, as required, to support conclusions, results and/or propositions
- evaluating the validity of arguments designed to convince others of the truth of propositions
- justifying procedures used and decisions made
- recognising when and why results of a given problem are clearly improbable or unreasonable
- use supporting arguments, when appropriate, to justify results obtained by calculator or computer.

Affective

Affective objectives refer to the attitudes, values and feelings which this subject aims at developing in students. **Affective objectives are not assessed for the award of exit levels of achievement.**

By the conclusion of the course, students should appreciate the:

- diverse applications of mathematics
- precise language and structure of mathematics
- contribution of mathematics to human culture and progress
- power and value of mathematics.

4 LANGUAGE EDUCATION

Language is the means by which meaning is constructed and shared and communication is effected. It is the central means by which teachers and students learn. Mathematics A requires students to use language in a variety of ways – mathematical, spoken, written, graphical, symbolic. The responsibility for developing and monitoring students' abilities to use effectively the forms of language demanded by this course rests with the teachers of mathematics. This responsibility includes developing students' abilities to:

- select and sequence information
- manage the conventions related to the forms of communication used in Mathematics A (such as short responses, reports, multi-media presentations, seminars)
- use the specialised vocabulary and terminology related to Mathematics A
- use language conventions related to grammar, spelling, punctuation and layout.

The learning of language is a developmental process. When writing, reading, questioning, listening and talking about mathematics, teachers and students should use the specialised vocabulary related to Mathematics A. Students should be involved in learning experiences that require them to comprehend and transform data in a variety of forms and, in so doing, use the appropriate language conventions. Some language forms may need to be explicitly taught if students are to operate with a high degree of confidence within mathematics.

Assessment instruments should use format and language that are familiar to students. They should be taught the language skills necessary to interpret questions accurately and to develop coherent, logical and relevant responses. Attention to language education within Mathematics A should assist students to meet the language components of the exit criteria, especially the Communication and justification criterion.

5 ORGANISATION

5.1 INTRODUCTION

The syllabus contains both core and elective topics. The core topics to be studied are arranged into strands and are listed below. Although the first topic listed in each strand contains material which is required in later topics, the order in which the topics are presented does not imply a teaching sequence.

Core topics

The core topics within each strand are:

Financial mathematics strand

- Managing money 1
- Managing money 2

Applied geometry strand

- Elements of applied geometry
- Linking two and three dimensions
- Maps and compasses -

Either

- Navigation *or*
- Land measurement

Statistics and probability strand

- Data collection and presentation
- Exploring and understanding data

Elective topics

The elective topics are:

- Operations research—linear programming
- Operations research—networks and queuing
- Introduction to models for data
- School elective

Achievement in an elective topic is a requirement for the award of High Achievement, and Very High Achievement.

The core and elective topics are discussed in detail in section 6.

Throughout the course, certain fundamental knowledge and procedures are required; some of these have been identified and listed under the heading "Maintaining Basic knowledge and procedures" in appendix 1. Time should be provided to revise these aspects within topics as the knowledge is required. Some relevant learning experiences are also listed in appendix 1. This maintenance takes time and should be allowed for in designing the sequence.

5.2 SELECTING THE TOPICS

The course of study (offered by a school) must consist of all core topics plus one elective topic. Schools will need to make decisions regarding Maps and compasses, i.e. Navigation or Land measurement, and the selection of one elective topic. Choices should be made so that they best suit the interests and needs of the particular cohort of students, the expertise and interests of the teaching staff and the resources and geographical location of the school. This might mean that different choices are offered for different classes within the one cohort, or that the choices differ from year to year. If the school wishes to allow for this flexibility, the possibilities should be detailed in the work program.

For some students, it may be advisable to spend the four semesters studying the Core, in which case the *highest level of achievement possible* will be Sound Achievement.

5.3 TIME ALLOCATION

The minimum number of hours of timetabled school time including assessment for a course of study developed from this syllabus is 55 hours per semester.

Although a notional time for each core topic has been given in brackets, it is expected that approximately 60 hours should be spent on each of the three strands. It is expected that approximately 30 hours should be spent on an elective topic.

5.4 SEQUENCING

After considering the subject matter and the appropriate range of learning experiences to enable the general objectives to be achieved, a *spiralling* and *integrated* sequence should be developed which allows students to see a link between the different strands of mathematics rather than seeing them as discrete. For example, costing, budgeting and financing a loan for house renovations provide an obvious link between the Applied geometry and Financial mathematics strands. As a means of sensibly ordering the subject matter to be studied, the syllabus presents the subject matter grouped into topics but it is not necessary, and often not desirable, to complete one topic before starting another. Obviously any prerequisite material in earlier topics must be covered before proceeding with material in later topics. As mentioned earlier, time should be allocated throughout the course for the maintenance of basic mathematics and mathematical techniques.

The following guidelines for the sequencing of the subject matter should be referred to when developing a sequence for the course.

- No subject matter should be studied before the relevant prerequisite material has been covered.
- To allow development in each area over time, no topic should be studied immediately after another topic in the same strand.
- Sequencing may be constrained by a school’s ability to provide physical resources.
- It is recommended that material be organised to encourage revisiting and spiralling of subject matter.
- Subject matter across topics should be linked when possible.
- Time will be needed for maintaining basic mathematics and mathematical techniques.

5.5 TECHNOLOGY

The advantage of mathematics-enabled technology in the mathematics classroom is that it enhances the exploration of the concepts and processes of mathematics. For example, graphing calculators let students explore and investigate; they assist students with the understanding of concepts and they complement traditional approaches to teaching.

More specifically the mathematics-enabled technology allows students to tackle more diverse, life-related problems. Spreadsheet technology enables the investigation of various financial models. It may be used in statistics to investigate larger datasets and rapidly produce a variety of graphical displays and summary statistics, thus freeing students to look for patterns, to detect anomalies in the data and to make informed comments.

The Mathematics A syllabus is rich in learning experiences based on mathematics-enabled technology, ranging from simple spreadsheets to the financial functions of graphing calculators. *Continuous access is not a requirement*, but access where appropriate to this technology is desirable to enable students to develop the full range of skills required for successful problem solving during their course of study.

6 TOPICS

6.1 INTRODUCTION

Each topic has a focus statement, subject matter and suggested learning experiences which, taken together, clarify the scope, depth and emphasis for the topic.

Focus

This section highlights the intent of the syllabus with respect to the topic and indicates how students should be encouraged to develop their understanding of the topic.

Subject matter

This section outlines the subject matter to be studied in the topic. All subject matter listed in the topic must be included, but the order in which it is presented is not necessarily intended to imply a teaching sequence.

Learning experiences

This section provides some suggested learning experiences which may be effective in using the subject matter to achieve the general objectives of the course. The numbers provided with the subject matter link to suggested learning experiences. Included are experiences which involve life-related applications of mathematics with both real and simulated situations, use of instruments and opportunities for modelling and problem solving. The listed learning experiences may require students to work individually, in small groups or as a class.

The learning experiences are suggestions only and are not to be seen as being prescriptive. Schools are encouraged to develop further learning experiences, especially those which relate to the school's location, environment and resources. Students should be involved in a variety of activities including those which require them to write, speak, listen or devise presentations in a variety of forms. A selection of learning experiences that students will encounter should be shown in the work program.

NB The learning experiences must provide students with the opportunity to experience mathematics along the continuum within each of the contexts.

Some of the key competencies, predominantly Using mathematical ideas and techniques, Solving problems, and Using technology are to be found in the learning experiences within the topic areas. Opportunities are provided for developing the key competencies in contexts that arise naturally from the general objectives and learning experiences of the subject. The key competencies: Collecting, analysing and organising information; Planning and organising activities; and Working with others and in teams, are also involved in some of the learning experiences.

6.2 CORE TOPICS

The order in which topics and items within topics are given should not be seen as implying a teaching sequence.

Managing money 1 (notional time 25 hours)

Focus

Students should be encouraged to develop a working knowledge of the types of financial transactions and decisions they are most likely to encounter.

Subject matter

- earnings, including salary, wages, overtime, commission, piece rate, and means-tested income; an industrial award should be used where appropriate (suggested learning experiences (SLEs) 1, 8, 10, 12, 13, 14)
- taxation, including gross, net and taxable income, goods and services tax, deductions, rebates, levies (SLEs 3, 5, 10)
- budgeting, including the preparation of a personal budget plan (SLEs 4, 6, 7, 9, 10, 11, 15)
- spending, including discount, profit, loss, mark-up and foreign exchange (SLE 2)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. use an industrial award which covers workers in the hospitality industry such as the cafe, restaurant and catering award, to determine the correct rates of pay and the conditions of work; identify the obligations of employers and employees
2. convert Australian dollars into another currency (and the reverse) using buy and sell tables
3. calculate taxation due from a taxation guide
4. reconcile a personal financial account; for example, a credit card account or a cheque account
5. follow the price of an article from its manufacture to the retail purchaser giving consideration to taxes applied
6. investigate the costs of owning a car, including insurance, registration, running costs, depreciation and maintenance; compare the estimated costs with those published by organisations such as the RACQ
7. formulate a simple mathematical model for the cost of hiring a car; consider initial fixed costs and per kilometre charges
8. investigate the effect of income and family size on family allowance payments
9. prepare a budget for a holiday in Australia or overseas
10. simulate financial experiences of students immediately on leaving school
11. adjust a given budget to allow for changed economic circumstances
12. survey ways in which incomes are derived

13. investigate the effects of students' part-time employment and parents' incomes on youth allowances
14. investigate a barter system where people exchange their skills instead of money—for example, teachers accrue credit by giving hours of teaching; farmers accrue credit with their produce such as apples, pigs or grain; skilled workers such as tilers, tailors and backhoe operators barter with their various skills
15. investigate the costs involved in living in a flat—rent, telephone, insurance, electricity, groceries.

Elements of applied geometry (notional time 15 hours)

Focus

Students should be encouraged to develop a working knowledge of some geometrical concepts and relationships in two and three dimensions. This is to be accomplished in life-related contexts.

Subject matter

- applications of trigonometry using sine, cosine and tangent ratios and Pythagoras' Theorem (SLEs 1, 2, 9, 10)
- area and volume in life-related situations (SLEs 3, 4, 5, 11–15, 17, 18)
- latitude, longitude and measurement of time (SLEs 6–10, 16)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. use trigonometric ratios and Pythagoras' Theorem in life-related situations such as the calculation of heights of trees, widths of valleys and rivers, and angles of elevation and depression
2. use shadow reckoning and triangulation in life-related situations such as the calculation of heights of trees, and widths of valleys and rivers
3. calculate areas of compound figures involving rectangles, trapeziums, triangles, circles, semicircles and quadrants in life-related situations
4. calculate surface areas of prisms and cylinders in life-related situations
5. calculate volumes of compound figures involving prisms, pyramids, cylinders, cones and spheres in life-related situations given necessary formulae, for example:
   - calculate the volume of water in swimming pools of different shapes
   - find the volume of earth which must be removed to construct a canal of given dimensions
   - calculate the number of cubic metres of soil to be ordered to top-dress a lawn
6. locate positions on the earth's surface given latitude and longitude, e.g. incorporating the use of GPS
7. find the time differences for a range of cities as given in the telephone directory and compare them with those predicted from the longitude
8. calculate the arrival time in a destination city in a different time zone, given the city of origin, flight duration and departure time; conversely, calculate flight time given departure and arrival times (flights that cross the international date line should be included); check using an airline's website

9. find the distance in kilometres between points on the earth's surface (same latitude or same longitude)
10. compare the distances e.g. on the equator and on 40° south latitude, between 50° east and 100° east longitude
11. consider the alternative two-dimensional sections that can be obtained by cutting objects such as an orange, kiwi fruit or melon
12. estimate the number of patches needed to complete a patchwork quilt of a given size
13. determine the cost of upkeep of circular above-ground pools of different diameters
14. calculate the dimensions required to construct a "fish ladder" that will enable fish, which are migrating in order to spawn, to climb up a weir or waterfall of a given height
15. use maps of different landholdings, e.g. Aboriginal, Torres Strait Islander, pastoral or National Parks, to determine the relative areas of different land uses
16. investigate the time systems (daily and seasonal) used by the indigenous people of Australia and compare them with those used by other people
17. investigate the issues to be considered in determining the optimum size of a rainwater tank
18. investigate the most effective sprinkler system for an oval, paddock or a home garden.

Linking two and three dimensions (notional time 20 hours)

Focus

Students should be encouraged to develop a working knowledge of the practical considerations inherent in a variety of construction areas. Particular emphasis should be given to the representation of three-dimensional constructions in two dimensions.

Subject matter

- interpretation of scale drawings and plans (SLEs 1, 8–16, 20, 21)
- drawing simple scale drawings and plans (SLEs 2, 12, 13, 17, 18, 22)
- the geometry of bracing for rigidity (SLEs 3, 10, 18)
- practical tests for squareness, plumbness and levels (SLEs 4–7, 19)
- estimation of quantities and costs in a variety of construction areas (SLEs 8–11, 14–17)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. use a scale plan to obtain actual dimensions
2. draw a scale plan and use it to determine layouts, for example, placement of furniture in a room
3. study the method of cross-bracing for rigidity considering the range of angles involved

4. study the use of clear plastic tubing filled with water to obtain a level between posts on uneven ground
5. study the use of a builders plumb-bob to test whether a wall is vertical
6. study the use of a spirit level to test for squareness on a building corner and to test levels
7. study the use of Pythagoras' Theorem to test for squareness
8. calculate the amount of concrete required and the costs for the footings and the slab of a structure (include reinforcing)
9. calculate the cost of covering an open gable roof in metal and in tiles
10. estimate the cost of brickwork for a wall
11. determine the number of litres of paint and the minimum cost for painting a room given the scale plan
12. design an office layout given the staff and their functions, the furniture and the legal space requirements for each employee
13. investigate the design of airconditioning ducting and the placement of outlets within buildings
14. calculate the minimum number of rolls of wallpaper needed to paper a room
15. given a scale plan and carpet width, determine the number of metres of carpet required to carpet a house
16. prepare a quote for the construction of a simple shed including slab, footings, walls and roof.
17. design a single-level car park given the dimensions of vehicles and the size of the vehicles' turning circles
18. design and/or construct a small replica of a wall or gate
19. using a fixed number of paddlepop sticks or straws (say 40) and adhesive tape, construct a structure to support a marble at the greatest distance from the desktop—vertically and/or horizontally
20. visit an establishment that uses computer-aided design (CAD) packages
21. investigate houseplans and design packages available from real estate firms or building contractors
22. use a computer package to create a landscape design

Data collection and presentation (notional time 30 hours)

Focus

Students are encouraged to develop a working knowledge of the practicalities and concepts involved in collecting, handling, preparing, describing, presenting and summarising data, and of some elementary concepts in data quality and exploring data to describe key features. Students are encouraged to develop skills in recognising data quality and practical problems, and in commenting on data in context. It is expected that calculators (or computers) will be used routinely for calculations and graphical displays. The emphasis should be on the practicalities, concepts and interpretation of data. The emphasis should also be on students developing confidence through a range of scenarios.

Subject matter

- identification of types of data—continuous and discrete—and the types of discrete data (categorical, ordinal and count) (SLEs 1, 4, 5, 9, 14)
- identification of variables and their type as above(SLEs 1, 4, 5, 9, 14)
- practical aspects of collecting data in observation, experimentation, and survey (SLEs 1–5, 8, 9, 14)
- practical aspects of data preparation and entry, including possible data problems (SLEs 1–5, 7, 8, 9,14)
- choice and use in context of appropriate graphical and tabular displays, including pie charts, barcharts, tables, histograms, stemplots and boxplots (SLEs 5, 7, 10, 11, 12, 14, 17, 18,)
- use and interpretation of plots of data and of scatterplots of one variable against another (SLEs 6, 7, 10, 11, 14–17)
- choice and use, in context, of appropriate graphical displays using the same scale for comparing continuous data in two or more groups, such as back-to-back stemplots and adjacent boxplots (SLEs 7, 10, 11, 14, 17)
- use and/or misuse of sample means and medians as descriptors of central tendency (SLEs 8, 10, 12, 13, 14, 17)
- use and/or misuse of sample standard deviations and interquartile distances as descriptors of spread (SLEs 8, 10, 12, 13, 14, 17)
- description of key features of data with reference to suitable selections of graphical and tabular displays (SLEs 6, 7, 10–14, 16, 17)

Suggested learning experiences:

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. design a survey to collect data relevant to social questions of interest to teenagers such as study patterns, TV and film preferences and habits; decide on variables to be included in the survey, and how to record them (for example, should age be recorded as a continuous variable or grouped to give age categories?); propose, criticise and rewrite survey questions, trialling questions as necessary
2. look for leading or misleading questions in a survey
3. examine data collected by a survey to check for recording or other error, and to decide how to handle non-compliant responses and to prepare data for entry on a spreadsheet
4. design an observational study, such as a traffic study, or use of a computer lab or library, or prices of different brands and/or at different outlets, or use of public phones; decide on variables to be included, and design and trial the mechanisms or methods for taking the observations, in order to reduce problems and increase data quality
5. design an experiment, such as a tasting experiment, with experimental conditions either clearly accounted for or allowed for in the experiment so as to produce data of good quality with no hidden effects
6. research the graphical methods used by weather forecasters to predict daily temperatures and rainfall patterns

7. examine material presented in government publications such as year books and reports from the Australian Bureau of Statistics
8. identify the effect of different sampling situations in pursuit of a random sample e.g. Gallup poll compared with a phone-in poll
9. organise a set of real data for data entry on a spreadsheet, identifying the experimental or observational units for the rows, and the variables for the columns
10. organise a set of real data into an understandable form using a variety of approaches such as summary statistics and graphical displays
11. use graphical displays on the same scale to give an effective visual comparison between two or more datasets, and comment on general comparative features, making allowance for variation
12. examine the use of summary statistics in, for example, newspapers, articles, TV programs such as weather reports and advertisements, government reports
13. examine reports by the Real Estate Institute (e.g. house prices in different areas) and explain their choice of measure of central tendency
14. use a computer database to store, sort and graphically display data
15. correctly interpret a scatterplot, understanding the difference between plots of a number of variables, such as prices over time, and plots of one variable against another, such as daily prices of a commodity (e.g. petrol) at two outlets
16. examine the relationship between two variables; e.g. daily temperature and degrees from the equator and discuss factors which could affect the relationship
17. given a set of data, produce a concise summary of the main information in the data, referring to graphical displays and summary statistics
18. identify examples of misleading and/or ambiguous graphical displays

Maps and compasses

Either Navigation *or* Land measurement must be studied. The focus, subject matter and SLEs for both are described here.

Navigation (notional time 25 hours)

Focus

Students should be encouraged to develop a working knowledge of techniques needed for coastal navigation, air navigation or orienteering.

Subject matter

- compass bearings and reverse bearings (SLEs 1, 2, 3, 10, 13)
- magnetic variation (SLEs 1, 2, 3, 11)
- nautical miles and knots (SLE 3)
- use of maps and charts, compasses, dividers and parallel rulers or their equivalent (SLEs 1, 3, 4, 5, 8–12, 14, 15)
- methods of fixing position including bearing fix, dead reckoning, running fix (SLEs 3, 4, 7, 9, 10, 12–15)
- application to orienteering, air or coastal navigation (SLEs 3, 4, 6, 7, 9, 10, 12–17)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. explore the relationships between true north, magnetic north and grid north on several adjacent maps (1:50,000 scale is suggested)
2. explore the effects on bearings of magnetic variation; calculate true bearing given compass bearing and magnetic variation; calculate compass bearing given true bearing and magnetic variation
3. use coastal navigational techniques on charts to fix a position and to plot a given course
4. use tables or the rule of twelfths to estimate tide height
5. identify, by reference to atlases and other sources, examples of projections which preserve area and examples which preserve angles correctly; understand why both of these cannot be preserved simultaneously on a spherical surface
6. investigate the shortest distance on curved surfaces
7. research inertial, radio or satellite navigational systems
8. research the historical development of the compass or chronometers
9. research navigational methods used by voyagers such as Kay Cottee, Sir Francis Chichester, Amelia Earhart, Sir Charles Kingsford-Smith, Captain Cook, Indigenous groups
10. use coastal navigational techniques on charts including transit fix, cross-bearings, double the angle at the bow
11. investigate the effects on bearings of the change of magnetic variation over a century
12. follow, on the ground or on a map, an orienteering path where each station provides the directions to the next
13. consider the different problems that arise according to whether one is navigating on land, in the air, or at sea (within sight of land or with no land visibility)
14. hire a vessel and chart the course taken
15. research various navigational techniques (for example, dead reckoning, use of sextant and chronometer, horizontal sextant, doubling the angle on the bow and satellite navigation systems)
16. visit the bridge of a ship where a computerised navigational system is used
17. use an inflated balloon or a basketball to explore the concept of great circles

Land measurement (notional time 25 hours)

Focus

Students should be encouraged to develop a working knowledge of techniques used in land measurement, and procedures for interpreting various maps and plans which are used to represent portions of the earth's surface.

Subject matter

- compass bearings and reverse bearings (SLE 3)
- calculation of perimeters and areas (SLEs 4, 9)
- appropriate use of units (SLEs 3, 4, 10, 14, 15, 19)
- drawing and interpreting site plans (SLEs 6, 15, 16, 20)
- position fixing using directions, and vertical and horizontal measurements in relation to a datum (SLEs 5, 12, 14, 17)
- calculation of grades (gradient of the land) (SLEs 7, 8)
- interpretation of contour, topographical, detail, cadastral and land-use maps (SLEs 1, 2, 3, 7, 8, 11, 12, 13, 18, 20).

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. from a point on top of a hill, sketch a map of the local area
2. check the validity of a sketch map by comparing it with a published one
3. follow, on the ground or on a map, an orienteering path where each station provides the directions to the next
4. determine the area of a polygonal piece of land by subdividing it into triangles
5. have a surveyor demonstrate the use of a range of surveying instruments
6. draw a plan from surveying field notes
7. determine the steepest hill in the district
8. view and analyse a flood-risk map of your local area
9. determine the cost of fencing a given piece of land by first finding the dimensions of the land using suitable instruments
10. research the history of the use of different units for land measurements including those used by the indigenous people of Australia
11. compare survey maps for your area over the past 200 years
12. research the use of aerial photography or satellite imagery in land surveying
13. use a local authority or cadastral map to locate a piece of land
14. collect data using a theodolite and write the field notes
15. draw the site plan for the foundations of a house, by hand or using a CAD package
16. obtain the site plans for the school from the local authority and locate objects marked on the plans; compare the plan with actual positions of objects (accuracy)

17. research the tasks carried out by a surveyor
18. obtain a satellite map of the local area and identify the features on the map
19. by measurement and calculation, find the difference in height between two distinctive local landmarks
20. obtain the drainage plan for the school or a domestic site and locate features marked on the plan.

Managing money II (notional time 35 hours)

Focus

Students should be encouraged to develop a working knowledge of the mathematics involved in financial transactions and be aware of their underlying conditions to enable them to make informed decisions on credit and investments. Students' learning will be enhanced by using electronic technology.

Subject matter

- simple and compound interest for various compounding periods, effective and nominal rates (SLEs 1, 2, 3, 5, 6, 10, 18, 22)
- inflation, appreciation and depreciation (SLEs 5, 6, 7, 8)
- notion of present value of a lump sum payment (SLEs 5, 6, 9)
- consumer credit including personal loans, credit cards, debit cards, housing loans (including fees and charges) (SLEs 1, 2, 4, 5, 6, 11, 17, 18, 20–22)
- investments including savings accounts, term deposits, real estate and stock market (SLEs 11–15, 16, 19)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. use a repayments table to investigate the effects of different interest rates and varying terms of a loan
2. use a calculator and/or computer package to produce part of a repayment schedule for a loan with interest calculated on a reducing balance, and demonstrate the effects of changing interest rates during the period of the loan
3. use the printout from a spreadsheet to compare the mathematical models describing simple and compound interest
4. investigate and compare the relative cost of finance for a vehicle from a bank, credit union and finance company
5. use the simple interest formula to solve problems involving interest, amount, principal, interest rate and time
6. use the compound interest formula to solve for interest, amount and principal
7. compare the straight-line and diminishing value methods of calculating depreciation
8. investigate the effect of inflation on the value of money, income and goods
9. compute present values for superannuation and life insurance lump sum payouts

10. investigate the accuracy of the formula $n = \frac{70}{r}$, where n is the number of years taken to double the principal if invested at a compound interest rate of r%
11. compare the effects of various conditions quoted on credit cards from different financial institutions
12. calculate the percentage return from a stock market transaction taking into account brokerage fees, dividend and yield
13. calculate the percentage return from real estate transactions taking into account commission, legal costs and stamp duty
14. calculate the percentage return from an investment with a financial institution taking into account establishment costs, commission and interest rates
15. gain an awareness of the effects of taxes connected with investment in the stock market, real estate and financial institutions
16. compare the percentage return from a fixed investment in a savings bank account, a building society account, debentures in an insurance company and a unit trust
17. investigate the benefits of making repayments weekly instead of monthly
18. convert the bankcard daily interest rate to a yearly one and compare with the quoted annual rate
19. simulate investment in the stock market over a period of time
20. investigate the value of graphs used by financial institutions
21. investigate the efficient use of credit cards
22. use a graphing calculator and/or computer package to produce a repayments table and demonstrate the effect of changing interest rates
23. use a graphing calculator and/or computer package to investigate the growth of an investment over time

Exploring and understanding data (notional time 30 hours)

Focus

Students are encouraged to develop a working knowledge of some elementary concepts in exploring and interpreting data, and they are encouraged to develop skills in recognising different types of data situations. In developing this knowledge, students will become aware of some fundamental concepts used in models for data, including the roles of probability and estimating probabilities. It is expected that calculators (or computers) will be used routinely for calculations and graphical displays. The emphasis is on exploration, not inference, and should be from the point of view of the recipient rather than the presenter. The emphasis should also be on students developing confidence through a range of life-related scenarios.

Subject matter

- what a sample represents, and whether it is appropriate (SLEs 4, 5)
- summary statistics as sample statistics and estimates of parameters, including the interpretation and use of sample averages and medians as estimates of underlying population values or of values in a model (SLEs 1, 2, 3)

- interpretation and use of relative frequencies to estimate probabilities of individual values for discrete variables (including categories) and of intervals for continuous variables (SLEs 6, 7, 9,10, 11 *)*
- interpretation and use of probability as a measure of chance in a range of practical and theoretical situations *(*SLEs 6, 7, 9,10, 11)
- interpretation in context of row and column percentages for a contingency table (two-way table of frequencies) (SLEs 8, 9)
- misuse of probabilities, including misinterpretation of row and column percentages in contingency tables (SLEs 5–9)
- use of areas in histograms to estimate probabilities (SLEs 11)
- exploration of relationships through modelling data with lines and curves, and using lines and curves to interpolate, extrapolate and interpret (SLEs 12, 13)

Suggested learning experiences:

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. compare two sets of data using a variety of statistics including the range, maximum value, mean, median, standard deviation and interquartile distance
2. examine reports (e.g. house prices in different areas) and explain the choice of measure of central tendency
3. compare the effects of an outlier on a variety of summary statistics
4. discuss different sampling situations and possible difficulties and sources of bias, e.g, due to such things as poor questionnaire design, a lack of random sampling or to practical difficulties such as survey interviewer influence
5. discuss why it is easier to estimate parameters such as the proportion of women who work full-time rather than the proportion of full-time workers who are women
6. estimate probabilities using relative frequency in simple life-related situations; example: the weather bureau estimates that in any year in Katoomba, 90 days are rainy days, 60 days are cloudy, 38 days are snowy and the remainder of the days are sunny; a tourist visits Katoomba by randomly choosing a day in a year (this ensures that each day is equally likely to be chosen)—what is the probability that the day of the visit is a sunny day in Katoomba? or a rainy or snowy day? what is the probability that it is not a sunny day?
7. identify words used in English as expressions of probability (for example, *unlikely*, *certain*, *impossible*, *good chance*) and place these on a scale from zero to one; identify everyday events which fit into these descriptions (for example, it is *unlikely* that it will snow in Brisbane in December; there is a *good chance* that there will be at least one good new movie released over the school holidays)
8. consider responses to pairs of questions on a survey, with numbers of types of responses summarised in a two-way table (a contingency table); for example, the responses to a question on approving daylight saving organised according to gender or longitude; interpret row and column percentages
9. discuss the importance of identifying the reference for percentages; for example, the difference between the percentage of teenagers who own a pet, and the percentage of pet-owners who are teenagers—or the difference between the percentage of residents in a regional area who approve of daylight-saving, and the percentage of those in favour of daylight saving, who live in the regional area

10. identify discrete variables and estimate probabilities of their values from data; e.g. the number of girls in families of two or three children; the number of pets in a family
11. identify continuous variables and estimate probabilities of intervals of values from data; e.g. maximum temperatures, travelling times, pulse rates
12. discuss the suitability of using straight line relationships between variables such as weight and height, running times and distance, income and education level
13. consider how humidity varies with temperature over the seasons

6.3 THE ELECTIVE TOPICS

Operations research—linear programming (notional time 30 hours)

Focus

Students should be encouraged to develop a working knowledge of the methodology of linear programming, and to see how it is used to solve life-related situations. Problems with non-integer solutions are not appropriate for this section.

Subject matter

- graphing two dimensional linear inequalities (SLEs 1, 4)
- recognition of the problem to be optimised (maximised or minimised) (SLEs 1, 2)
- identification of variables, parameters and constraints (SLEs 1, 3, 5–9)
- construction of the linear objective function and constraints with associated parameters (SLEs 1, 3, 5, 6, 8, 9)
- graphing linear functions associated with the constraints and identification of the regions defined by the constraints (SLEs 1, 3, 4)
- recognition that the area bounded by the constraints gives the feasible (possible) solutions (SLEs 1, 3, 6)
- recognition that different values of the objective function can be represented by a series of parallel lines (SLEs 5)
- use of a series of parallel lines to find the optimal value of the objective function (parallel or rolling ruler, graphical method) (SLEs 5)
- observation that the feasible region always bulges outwards and thus the optimal solutions occur at an edge or a corner point of the feasible region (SLEs 3, 6, 7, 8, 9)
- interpretation of mathematical solutions in English relating back to the original problem being solved (SLEs 3, 5–9)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. take a real problem given in English, formulate it into a linear programming problem, solve by the graphical method and interpret the solutions in terms of the original English problem

2. explore how linear programming is used to assist management decisions in areas such as manufacturing, transport, primary industries and environmental management
3. consider optimal solutions of simple problems such as balancing diets
4. use a computer software package to graph linear functions
5. use parallel rulers to identify optimal solutions
6. change parameters or constraints in a given problem and investigate the effect on optimal solutions
7. consider the composition of a fleet of vehicles necessary to do a particular job at minimum cost
8. consider the allocation of two crops to the areas available on a farm in order to optimise profit when there are constraints on the labour and finances available
9. consider the design of an optimal sized solar powered home which is to be competitive in the marketplace; constraints will apply through the size of solar cells, living area and total cost of construction
10. research the history of linear programming.

Operations research—networks and queuing (notional time 30 hours)

Focus

Students should be encouraged to develop a working knowledge of the procedures involved in two types of operations research—networks and queuing. Students should become familiar with the shortest path and minimum spanning tree algorithms, and in the applications of these techniques to modelling and solving life-related problems which involve directed networks. They should also develop an intuitive understanding of simple critical path analysis. Students should become familiar with the graphical and tabular methods involved in investigating queuing problems such as occur in a variety of life-related situations.

Subject matter

- network terminology including *node*, *branch*, *path* and *tree* (SLE 1)
- shortest path algorithm (SLEs 1, 2, 9)
- minimum spanning tree algorithm (SLEs 1, 3)
- the effect of a critical step in critical path analysis from an intuitive point of view (SLEs 1, 4)
- slack time in a critical path analysis (SLEs 1, 4, 7)
- single- and multiple-server queues with constant arrival and service times (SLEs 5, 6, 8)
- the effects on a queuing system of random arrival and service times (SLE 6)

Suggested learning experiences

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. consider a life-related problem expressed in everyday language, formulate it into a network problem, solve and interpret the solutions in terms of the original problem
2. consider a road map showing two places connected by a network of roads and find the shortest path between them
3. a complicated rail system connecting a number of towns is to be rationalised; investigate which lines should be removed so that a minimum amount of line will be left to service all the towns
4. consider the times taken for different activities involved in the following problems; determine the critical steps and consider the effects of changing the time taken for certain activities on the critical path:
   - constructing a house
   - using a recipe
   - planning a 21st birthday party
5. using tabular and graphical methods, investigate the percentage server idle time and average waiting time for a supermarket queue with a single server and constant arrival and service times; investigate the first time the queue becomes empty
6. using the tabular method, investigate the percentage server idle time and average waiting time for:
   - a ticket outlet with a single server and random arrival and service times simulated using a random number table
   - a bank queue with two servers and constant arrival and service times
7. examine the way critical path analysis could be used by surveyors, architects, engineers, chefs and physiotherapists.
8. research methods which are used to determine how long a given traffic light remains green
9. a sales representative is to visit a series of stores; determine the shortest paths the sales representative can take from home base to each of the stores

Introduction to models for data (notional time 30 hours)

Focus

Students are encouraged to develop a working knowledge of some elementary concepts in statistical modelling and the interaction of models and data, and use these in life-related applications. In considering real-world implications of statistical models and the notions of probability, students will become aware of fundamental issues involved in data collection, data modelling and interpretation of models in context. It is expected that calculators (or computers) will be used routinely for calculations and graphical displays.

Subject matter

- probability distributions and expected values for a discrete variable (SLEs 1, 2)
- uniform discrete distribution; random numbers (SLEs 3, 4, 5, 8)
- identification of binomial situations, binomial expected values and binomial probabilities using tables or calculators (SLEs 5, 8)
- discrete data that could be uniform or binomial; comparison of relative frequencies with theoretical probabilities (SLEs 2, 3)
- the normal distribution model, standardisation and use of standard normal tables (SLEs 6–10)
- data that could be normally distributed; comparison of relative frequencies with normal probabilities, using the sample average and the sample standard deviation as estimates of the mean and standard deviation in the normal distribution model (SLEs 6–10)
- use of percentage points of normal distribution model in practical applications (SLEs 11, 12)
- basic probability rules of complements and unions (SLEs 13, 14)
- odds as an application of probabilities (SLEs 13,14)

Suggested learning experiences:

The following suggested learning experiences may be developed as individual student work, or may be part of small-group or whole-class activities.

1. identify situations with events that could be assumed to be equally likely such as birthdays, month of birth, male/female births
2. identify discrete variables and estimate probabilities of their values from data and/or model probabilities from assumptions, for example, the number of girls in families of two or three children by listing probabilities
3. use the tabled information given in the newspaper about previous Gold Lotto draws to determine whether the numbers are drawn at random; i.e. whether the numbers follow a uniform probability distribution model
4. ask a group of people to try to generate random numbers between, say, 0 and 50, and use graphical displays to investigate how successful they were, e.g. use a histogram to check rectangular shape, and plot numbers in order of generation to check on trends or patterns
5. examine a number of situations for which the binomial is appropriate and use tables of binomial probabilities; for an example with $n = 3$ or 4, write down, from the binomial tables, the probability of each value of the variable, calculate the expected value and relate it to the example
6. consider a number of life-related situations where a normal distribution may be assumed; standardise variables and use standard normal tables
7. use a statistical model with known mean, standard deviation and a normal distribution, to simulate a sample of data, for example, create a sample of "DDT levels in cows' milk" by assuming that the DDT level, in standard concentration units, is a random normal variable with a mean of 2.3 and a standard deviation of 0.23; calculate the sample statistics and compare them with the parameters used to create the data (the normally distributed random components could be generated using a table of random normal numbers or a computer package)

8. use a computer package to simulate a number of samples of data from the same distribution and look at the variation in the summary statistics that are estimating population parameters
9. compare probabilities obtained from normal distribution tables with those estimated from data that looks nearly normal
10. use a normal model to obtain probabilities of, for example, the maximum temperature in Toowoomba exceeding 35º
11. use a normal distribution model for lifetimes of, for example, tennis racquets or car batteries, to obtain guarantee times that limit the proportion of replacements under guarantee
12. use a normal distribution model for water level in a creek or river that will be exceeded with a given probability
13. investigate strategies used by bookmakers to avoid large losses
14. investigate the use of odds and probabilities in forensic science and court cases

School elective (notional time 30 hours)

Schools may develop a single elective topic of their own choice subject to these guidelines:

- the school elective must be consistent with the rationale and global aims of the course
- the school elective should contain subject matter ensuring a level of challenge comparable to that provided by the other elective topics
- the school elective must *not* consist of a combination of subject matter from other topics within this syllabus
- in addition to specifying the subject matter, work programs will need to indicate a focus and state the range of likely learning experiences.

7 ASSESSMENT

7.1 INTRODUCTION

The purpose of assessment is to make judgments about how well students meet the general objectives of the course. In designing an assessment program, it is important that the assessment tasks, conditions and criteria are compatible with the general objectives and the learning experiences. Assessment then, both formative and summative, is an integral and continual aspect of a course of study. The distinction between formative and summative assessment lies in the purpose for which that assessment is used.

Formative assessment is used to provide feedback to students, parents, and teachers about achievement over the course of study. This enables students and teachers to identify the students' strengths and weaknesses so that, by informing practices in teaching and learning, students may improve their achievement and better manage their own learning. The formative techniques used should be similar to summative assessment techniques, which students will meet later in the course. This provides students with experience in responding to particular types of tasks under appropriate conditions. It is advisable that each assessment technique be used formatively before it is used summatively.

Summative assessment, while also providing feedback to students, parents, and teachers, provides information on which levels of achievement are determined at exit from the course of study. It follows, therefore, that it is necessary to plan the range of assessment instruments to be used, when they will be administered, and how they contribute to the determination of exit levels of achievement (see section 7.8). Students' achievements are matched to the standards of exit criteria, which are derived from the general objectives of the course (see section 3). Thus, summative assessment provides the information for certification at the end of the course.

7.2 PRINCIPLES OF ASSESSMENT

The Board's policy on assessment requires consideration to be given to the underlying principles below when devising an assessment program. These principles are to be considered together and not individually in the development of an assessment program.

Underlying principles of assessment

- Exit achievement levels are devised from student achievement in all areas identified in the syllabus as being mandatory.
- Assessment of a student's achievement is in the significant aspects of the course of study identified in the syllabus and the school's work program.
- Information is gathered through a process of continuous assessment.
- Exit assessment is devised to provide the fullest and latest information on a student's achievement in the course of study.
- Selective updating of a student's profile of achievement is undertaken over the course of study.
- Balance of assessment is a balance over the course of study and not necessarily a balance over a semester or between semesters.

Mandatory aspects of the syllabus

Judgment of student achievement at exit from a school course of study must be derived from information gathered about student achievement in those aspects identified in a syllabus as being mandatory. The assessment program, therefore, must include achievement of the general objectives of the syllabus.

Significant aspects of the course of study

Significant aspects refer to those areas included in the course of study, determined by the choices permitted by the syllabus, and seen as being particular to the context of the school and to the needs of students at that school. These will be determined by the choice of learning experiences appropriate to the location of the school, the local environment and the resources selected.

The significant aspects of the course must reflect the objectives of the syllabus.

Achievement in both mandatory and significant aspects of the course must contribute to the determination of the student's exit level of achievement.

The assessment of student achievement in the significant aspects of the school course of study must not preclude the assessment of the mandatory aspects of the syllabus.

For Mathematics A, the "significant aspects" are the subject matter of each topic.

Continuous assessment

This is the means by which assessment instruments are administered at suitable intervals and by which information on student achievement is collected. It requires a continuous gathering of information and the making of judgements in terms of the stated criteria and standards throughout the two-year program of study.

Levels of achievement must be arrived at by gathering information through a process of continuous assessment at points in the course of study appropriate to the organisation of the learning experiences. They must not be based on students' responses to a single assessment task at the end of a course or instruments set at arbitrary intervals that are unrelated to the developmental course of study.

Fullest and latest information

Judgments about student achievement made at exit from a school course of study must be based on the fullest and latest information available.

'Fullest' refers to information about student achievement gathered across the range of general objectives. 'Latest' refers to information about student achievement gathered from the latest period in which the general objectives are assessed.

Fullest and latest information consists of both the most recent data on developmental aspects together with any previous and not superseded data. Decisions about achievement require both to be considered in determining the student's level of achievement.

The information used to determine a student's exit level of achievement is to be the 'fullest and latest' available. The 'fullest' refers to the collection of assessment information that covers the full range of objectives. The 'latest' refers to information obtained through selective updating.

The assessment instruments for summative purposes are used to determine a student's exit level of achievement. Any formative assessment of knowledge, processes and skills through the program of study becomes a learning experience for the student, whose achievement should therefore benefit when similar assessment techniques are applied for summative purposes.

Selective updating

Selective updating is related to the developmental nature of the two-year course of study. It is the process of using later information to supersede earlier information. Information about student achievement should, therefore, be updated continually when objectives and criteria are revisited.

As the criteria are treated at increasing levels of complexity, assessment information gathered at earlier stages of the course may no longer be typical of student achievement. The information should therefore be selectively updated to reflect student achievement more accurately. Selective updating operates within the context of continuous assessment.

A student profile should be maintained to allow the selective updating of student data. By increasing the amount of information available, the student profile more accurately indicates overall student achievement.

Balance

Balance of assessment is a balance over the course of study and not necessarily a balance within a semester or between semesters. The assessment program must ensure an appropriate balance over the course of study as a whole.

Appropriate balance is established through determining suitable variety, quantity and timing in the assessment conditions, criteria and techniques.

7.3 EXIT CRITERIA

Student achievement will be judged on the following three exit criteria:

- Knowledge and procedures
- Modelling and problem solving
- Communication and justification.

The exit criteria reflect the categories of general objectives, and have been defined in section 3.3 of the syllabus.

7.4 ASSESSMENT REQUIREMENTS

A school's assessment plan must enable students to demonstrate their achievement across the full range of the general objectives in the first three categories in section 3.3.

The assessment plan must be designed to cover the continuum of each of the contexts.

All three exit criteria must be adequately represented in assessment data to enable the overall quality of a student's achievement in each criterion to be determined.

Some points which must be taken into account in assessment are given below:

- Assessment instruments must provide students with the opportunity to demonstrate achievement in the general objectives along the continuum within each of the contexts (see section 3.2).
- In a well-balanced assessment plan there should be many items that allow information to be collected on more than one criterion. It is not appropriate to set items which collect information only on Communication and justification.
- Information on student achievement in Knowledge and procedures, and Communication and justification may be obtained from items assessing student achievement in Modelling and problem solving.
- It is not appropriate to record on a profile separate information on each aspect of a criterion.
- Information on student achievement in each criterion may be provided by a global consideration of the student response to a task or set of tasks. Such information must be supported by comparison with task-specific descriptors based on the general objectives of the syllabus.

7.4.1 Special consideration

Guidance about the nature and appropriateness of special consideration and special arrangements for particular students may be found in the Board's policy statement on special consideration: *Special Consideration: Exemption and Special Arrangements in Senior Secondary School-Based Assessment*. This statement also provides guidance on responsibilities, principles and strategies that schools may need to consider.

To enable special consideration to be effective for students so identified, it is important that schools plan and implement strategies in the early stages of an assessment program and not at the point of deciding levels of achievement. The special consideration might involve alternative teaching approaches, assessment plans and learning experiences.

7.5 ASSESSMENT TECHNIQUES

It is expected that appropriate technology use will be incorporated in assessment tasks.

A balanced assessment plan that has validity in assessing achievement across the full range of the general objectives includes a variety of assessment techniques such as those described below.

Extended modelling and problem-solving tasks

This form of assessment may require a response that involves mathematical language, graphs and diagrams, and could involve a significant amount of conventional English. It will typically be in written form, a combination of written and oral forms, or multimedia forms.

The activities leading to an extended modelling and problem-solving task could be done individually and/or in groups, and the extended modelling and problem-solving task could be prepared in class time and/or in students' own time.

Reports

A report is typically an extended response to a task such as:
- an experiment in which data are collected, analysed and modelled
- a mathematical investigation
- a field activity
- a project.

A report could comprise such forms as:
- a scientific report
- a proposal to a company or organisation
- a feasibility study.

The activities leading to a report could be done individually and/or in groups and the report could be prepared in class time and/or in students' own time. A report will typically be in written form, or a combination of written and oral multimedia forms.

The report will generally include an introduction, analysis of results and data, conclusions drawn, justification, and when necessary, a bibliography, references and appendices.

Supervised tests

Supervised tests commonly include tasks requiring quantitative and/or qualitative responses. Supervised tests could include a variety of items such as:

- multiple-choice questions
- questions requiring a short response:
  - in mathematical language and symbols
  - in conventional written English, ranging in length from a single word to a paragraph
- questions requiring a response including graphs, tables, diagrams and data
- questions requiring an extended answer where the response includes:
  - mathematical language and symbols
  - conventional written English, more than one paragraph in length
  - a combination of the above.

Assessment tasks other than tests must be included at least twice each year and should contribute significantly to the decision making-process in each criterion.

7.5.1 Authorship of tasks

In order to attest that the response to a task is genuinely that of the student, procedures such as the following are suggested:

- the teacher monitors the development of the task by seeing plans and a draft of the student's work
- the student produces and maintains documentation of the development of the response
- the student acknowledges all resources used; this will include text and source material and the type of assistance received
- the school develops guidelines and procedures for students in relation to both print and electronic source materials/resources, and to other types of assistance (including human) that have been sought.

7.6 RECORDING INFORMATION

Information on student achievement in each criterion may be recorded in various ways. However, the methods of recording and the frequency with which records will be updated must be clearly outlined in the work program.

7.7 DETERMINING EXIT LEVELS OF ACHIEVEMENT

On completion of the course of study, the school is required to award each student an exit level of achievement from one of the five categories:

Very High Achievement

High Achievement

Sound Achievement

Limited Achievement.

Very Limited Achievement.

The school must award an exit standard for each of the three criteria (Knowledge and procedures, Modelling and problem solving, Communication and justification), based on the principles of assessment described in this syllabus. The criteria are derived from the general objectives and are described in section 3.3. The minimum standards associated with the three exit criteria are described in table 2. When teachers are determining a standard for each criterion, the extent to which the qualities of the work match the descriptors *overall* should strongly influence the standard awarded.

For Year 11, particular standards descriptors may be selected from the matrices in table 2 and/or adapted to suit the task. These standards are used to inform the teaching and learning process. For Year 12 instruments, students should be provided with opportunities to understand and become familiar with the expectations for exit. The exit standards are applied to the summative body of work selected for exit.

Of the seven key competencies, the five that are relevant to this subject[1] are embedded in the descriptors in table 2. Elements of some of the key competencies are embedded within the standards associated with the exit criteria. The key competencies of “Using mathematical ideas and techniques” and “Using technology” are to be found within the “Knowledge and procedures” criterion. The “Modelling and problem-solving” criterion involves elements from “Collecting, analysing and organising information”, “Using mathematical ideas and techniques”, and “Solving problems”, whereas “Collecting, analysing and organising information”, “Communicating ideas and information”, and “Solving problems” are involved in the “Communication and justification” criterion.

When standards have been determined in each of the three criteria, table 1 is used to determine the exit level of achievement, where *A* represents the highest standard and *E* the lowest.

[1] KC1: collecting, analysing and organising information; KC2: communicating ideas and information; KC5: using mathematical ideas and techniques; KC6: solving problems; KC7: using technology.

Table 1: Minimum requirements for exit levels

VHA	Standard *A* in any two exit criteria and no less than a *B* in the remaining criterion
HA	Standard *B* in any two exit criteria and no less than a *C* in the remaining criterion
SA	Standard *C* in any two exit criteria, **one of which must be the Knowledge and procedures criterion**, and no less than a *D* in the remaining criterion
LA	Standard *D* in any two exit criteria, **one of which must be the Knowledge and procedures criterion**
VLA	Does not meet the requirements for Limited Achievement

NB For a student to be awarded an HA or a VHA, an elective topic must be studied and contribute to summative assessment.

Table 2: Minimum standards associated with exit criteria

	Standard *A*	Standard *B*	Standard *C*	Standard *D*	Standard *E*
Criterion: Knowledge and procedures	The **overall quality** of a student's achievement across the full range within the contexts of application, technology and complexity, and across topics, **consistently demonstrates**: • accurate recall, selection and use of definitions and rules • appropriate use of technology • appropriate recall and selection of procedures, and their accurate and proficient use.	The **overall quality** of a student's achievement across a range within the contexts of application, technology and complexity, and across topics, **generally demonstrates**: • accurate recall, selection and use of definitions and rules • appropriate use of technology • appropriate recall and selection of procedures, and their accurate use.	The **overall quality** of a student's achievement in the contexts of application, technology and complexity, **generally demonstrates**: • accurate recall and use of basic definitions and rules • appropriate use of some technology • accurate use of basic procedures.	The **overall quality** of a student's achievement in the contexts of application, technology and complexity, sometimes **demonstrates**: • accurate recall and use of some definitions and rules • appropriate use of some technology.	The **overall quality** of a student's achievement rarely **demonstrates** knowledge and use of procedures.
	Standard *A*	**Standard *B***	**Standard *C***	**Standard *D***	**Standard *E***
Criterion: Modelling and problem solving	The **overall quality** of a student's achievement across the full range within each context, and across topics **generally demonstrates** mathematical thinking which includes: • interpreting, clarifying and analysing a range of situations, and identifying variables • selecting and using effective strategies • informed decision making …*and* in some contexts and topics, **demonstrates** mathematical thinking which includes: • selecting and using appropriate procedures to solve a wide range of problems • initiative in exploring the problem • recognising strengths and limitations of models.	The **overall quality** of a student's achievement across a range within each context, and across topics, **generally demonstrates** mathematical thinking which includes: • interpreting, clarifying and analysing a range of situations, and identifying variables • selecting and using strategies …*and* in some contexts and topics **demonstrates** mathematical thinking which includes: • selecting and using procedures to solve a range of problems • informed decision making.	The **overall quality** of a student's achievement in all contexts **generally demonstrates** mathematical thinking which includes: • interpreting and clarifying a range of situations • selecting strategies and/or procedures to solve problems.	The **overall quality** of a student's achievement sometimes **demonstrates** mathematical thinking which includes following basic procedures and/or using strategies to solve problems.	The **overall quality** of a student's achievement rarely **demonstrates** mathematical thinking which includes following basic procedures and/or using strategies required to solve problems.

	Standard *A*	Standard *B*	Standard *C*	Standard *D*	Standard *E*
Criterion: Communication and justification	The **overall quality** of a student's achievement across the full range within each context **consistently demonstrates**: • accurate and appropriate use of mathematical terms and symbols • accurate and appropriate use of language • collection and organisation of information into various forms of presentation suitable for a given use or audience • use of mathematical reasoning to develop logical arguments in support of conclusions, results and/or decisions • justification of procedures.	The **overall quality** of a student's achievement in the range of contexts **generally demonstrates**: • accurate and appropriate use of mathematical terms and symbols • accurate and appropriate use of language • collection and organisation of information into various forms of presentation suitable for a given use or audience • use of mathematical reasoning to develop simple logical arguments in support of conclusions, results and/or decisions.	The **overall quality** of a student's achievement in some contexts **generally demonstrates**: • accurate and appropriate use of basic mathematical terms and symbols • accurate and appropriate use of basic language • collection and organisation of information into various forms of presentation • use of some mathematical reasoning to develop simple logical arguments.	The **overall quality** of a student's achievement sometimes **demonstrates** evidence of the use of the **basic** conventions of language and mathematics.	The **overall quality** of a student's achievement rarely demonstrates use of the **basic** conventions of language or mathematics.

Contexts are explained in section 3.2.

7.8 REQUIREMENTS FOR VERIFICATION FOLIOS

A verification folio is a collection of a student's responses to assessment instruments on which the level of achievement is based. Each folio should contain a variety of assessment techniques demonstrating achievement in the three criteria, Knowledge and procedures, Modelling and problem solving, and Communication and justification, over the range of topics. This variety of assessment techniques is necessary to provide a range of opportunities from which students may demonstrate achievement.

In the verification folio requirements for the subject, the minimum and maximum number of assessment instruments are stipulated. Schools must ensure that the verification folios presented in October contain all summative assessment instruments and corresponding student responses upon which judgments about interim levels of achievement have been made to that point.

It is necessary that a student's achievement in the three criteria is monitored throughout the course so that feedback in terms of the criteria is provided to the student. The review folio is an ideal medium through which students and teachers can monitor progress throughout the course.

For verification purposes, schools must submit student folios which contain:

- student achievement data profiled in the three exit criteria
- the student responses to *all* summative assessment instruments (in the case of non-written responses, the minimum requirement will be a student criterion sheet completed by the teacher along with supporting material provided by the student)
- a minimum of four instruments from Year 12 with at least one of these being a report, extended modelling and problem-solving task, or similar
- student responses to the assessment of elective topics studied.

A verification folio must consist of a minimum of 4 to a maximum of 10 pieces of summative work. These should represent a range of assessment techniques (see section 7.5) and provide adequate information on which to substantiate the school's judgments regarding student achievement in each criterion.

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8 DEVELOPING A WORK PROGRAM

The work program is a formal expression of the school's interpretation of this syllabus. It has three primary functions. First, it provides guidance to the teachers of the subject as to the nature and requirements of the Mathematics A course at the school. Second, it provides similar guidance to the school's students, and their parents, in relation to the subject matter to be studied and how achievement of the syllabus objectives will be assessed. Third, it provides a basis for accreditation by the Board for the purposes of including students' results for the subject on the Senior Certificate.

The school's work program should be a document which does not require reference to other documents to be understood. The work program must contain the following components:

Table of contents

Facilitates the readability of the document; pages must be numbered.

Rationale

Provides justification for including the subject in the school curriculum. The rationale may be derived principally from the syllabus statement but should also include information on the school's philosophy, student population, resources and any other factors which may influence the decisions made in designing a course of study to cater for the special characteristics of the school and its students. This may be an appropriate place for the school to provide any additional information such as:

- whether students are able to study both Mathematics A and Mathematics B
- whether there is a provision for students to study core-only or core-revisit
- whether any Board-registered subjects in mathematics are offered.

Global aims

Statements of the long-term achievements, attitudes and values that are to be developed by the students in studying the subject but which are not directly assessed by the school. These should include the global aims listed in this syllabus.

General objectives

As indicated in this syllabus.

Contexts

As indicated in this syllabus. The contexts must be incorporated in the sample of the sequence of work as required in the "Learning experiences" section.

Course organisation

Provides:

- a summary of the spiralling and integrated sequence developed by the school to give an overview of the topics to be offered
- details of the sequence, indicating:
  - the subject matter to be taught in each unit of work (the subject matter listed in the syllabus is the minimum to be included)
  - time allocations for each unit.

If the school wishes to offer different topics to different groups of students, details should be included here. The provision for students to study core-only or core-revisit, if applicable, should be clearly outlined in this part of the work program. In the case of core-revisit, the work program should clearly indicate that a substantial amount of work from each strand will be revisited with significantly different assessment instruments administered to provide students with opportunities to demonstrate a Sound level of achievement. The sequence must be developed in accordance with section 5 of this syllabus.

Language statement As indicated in this syllabus.

Educational equity A statement must be included by the school indicating that due consideration has been given to the issues associated with the educational equity statement in this syllabus.

Learning experiences A commitment to use a variety of learning experiences which are appropriate to the age group concerned and consistent with the objectives of this syllabus.

A sample of a sequence of work must be included in the work program. This should be of sufficient length to demonstrate that the general approach by the school is consistent with the intent of this syllabus. It should show how the choice of subject matter is to be taught, and the variety of learning experiences that will provide opportunities for students to achieve the general objectives within the contexts of the course.

Assessment Including:

- an assessment plan which:
  - provides a balanced assessment program in which techniques other than formal written tests or examinations are to be included at least twice each year, constitute a meaningful contribution to exit levels of achievement
  - clearly indicates the summative tasks—data gathered as a result of implementing the assessment plan should allow fullest and latest information to determine exit levels of achievement
  - allows sufficient information to be available for the recommendation of interim levels of achievement; for example, for monitoring and verification purposes
  - while allowing for flexibility within the school, contains sufficient information to show that there will be enough data gathered to enable valid judgments to be made on student achievement in each of the three criteria
  - indicates the criteria associated with tasks and the conditions of implementation of tasks; a general statement on the conditions of implementation of assessment will suffice;
    (An example of such a statement is "To ensure validity and reliability of assessment instruments, this school will use a variety of implementation conditions for assessment of student achievement e.g. assignments undertaken in class time, assignments undertaken at home, and group projects. The conditions appropriate to the actual instruments will be supplied at monitoring and verification.")
  - avoids over-assessment.
- a commitment to include as much assessment as possible from Semester 4 for each of the three criteria in the verification submission
- an example of the individual student profile to be included in the verification folio
- how assessment data are combined to reach an overall standard in each criterion (a completed student profile may help to clarify the explanation); fullest and latest information is not obtained by an arbitrary 'weighting' of semesters or by using Semester 1 assessment instruments as summative in a well-sequenced course
- the procedure for awarding exit levels of achievement which are consistent with the criteria and standards of this syllabus (section 7); the school should indicate a commitment to ensure that the achievement of students identified as near a threshold (either above or below) is matched to the verbal descriptors of the criteria of the syllabus before a level of achievement is awarded.

9 EDUCATIONAL EQUITY

Equity means fair treatment of all. In developing work programs from this syllabus, schools are urged to consider the most appropriate means of incorporating the following notions of equity.

Schools need to provide opportunities for all students to demonstrate what they know and what they can do. All students, therefore, should have equitable access to educational programs and human and material resources. Teachers should ensure that the particular needs of the following groups of students are met: female students; male students; Aboriginal students; Torres Strait Islander students; students from non–English-speaking backgrounds; students with disabilities; students with gifts and talents; geographically isolated students; and students from low socioeconomic backgrounds.

The subject matter chosen should include, where appropriate, the contributions and experiences of all groups of people. Learning contexts and community needs and aspirations should also be considered when selecting subject matter. In choosing suitable learning experiences teachers should introduce and reinforce non-racist, non-sexist, culturally sensitive and unprejudiced attitudes and behaviour. Learning experiences should encourage the participation of students with disabilities and accommodate different learning styles.

It is desirable that the resource materials chosen recognise and value the contributions of both females and males to society and include the social experiences of both sexes. Resource materials should also reflect the cultural diversity within the community and draw from the experiences of the range of cultural groups in the community.

Efforts should be made to identify, investigate and remove barriers to equal opportunity to demonstrate achievement. This may involve being proactive in finding out about the best ways to meet the special needs, in terms of learning and assessment, of particular students. The variety of assessment techniques in the work program should allow students of **all** backgrounds to demonstrate their knowledge and skills in a subject in relation to the criteria and standards stated in this syllabus. The syllabus criteria and standards should be applied in the same way to all students.

Teachers may find the following useful for devising an inclusive work program.

Australian Curriculum, Assessment and Certification Authorities 1996, *Guidelines for Assessment Quality and Equity* 1996, Australian Curriculum, Assessment and Certification Authorities, available through QBSSSS, Brisbane.

Department of Education, Queensland 1991, *A Fair Deal: Equity guidelines for developing and reviewing educational resources*, Department of Education, Brisbane.

Department of Training and Industrial Relations 1998, *Access and Equity Policy for the Vocational Education and Training System*, DTIR, Brisbane.

[Queensland] Board of Senior Secondary School Studies 1994, *Policy Statement on Special Consideration*, QBSSSS, Brisbane.

[Queensland] Board of Senior Secondary School Studies 1995, *Language and Equity: A discussion paper for writers of school-based assessment instruments*, QBSSSS, Brisbane.

[Queensland] Board of Senior Secondary School Studies 1995, *Studying Assessment Practices: A resource for teachers in schools*, QBSSSS, Brisbane.

APPENDIX 1

MAINTAINING BASIC KNOWLEDGE AND PROCEDURES

Basic knowledge and procedures

The following skills will be required throughout the course and must be learned or maintained as required:

- calculation and estimation including
  - basic operations
  - powers
  - roots.

This could involve numbers in various notations including

- integer
- fraction
- decimal
- standard (scientific)

(with or without access to calculating devices as required)

- metric measurement of
  - length
  - area
  - volume
  - mass
- rates, percentages, ratio and proportion
- simple algebraic manipulations
- graphs and tables.

Maintaining mathematical procedures

The following learning experiences are included as suggestions.

Suggested learning experiences

- prepare a seminar revising prerequisite material (e.g. revising trigonometry before Land measurement)
- solve a new problem requiring previously learned skills
- help students in a lower year with their mathematics
- work without a calculator for a time
- complete a test given to a lower year, have another student mark it and then discuss anomalies
- design some questions to help others revise a topic
- each member of a group writes a summary of a topic, then students share the summaries.

APPENDIX 2

EXPLANATION OF SOME TERMS

Cadastral

Pertaining to maps or surveys which primarily describe artificial boundaries, e.g. property boundaries, as well as prominent natural features.

Categorical data

Data which are qualitative rather than quantitative; the observations represent categories rather than measurements.

Contingency table

A table which contains the frequencies arising from the cross-tabulation of data consisting of two or more qualitative variables.

Data (and variables)

Data (and variables) can be of two broad types: discrete and continuous.

Discrete variables take individual or separated values.

Discrete variables are further divided into categorical (or nominal), ordinal, and count.

Categorical (or nominal) variables have categories. Each observation can be assigned to one of the categories. The categories can be described in words or by arbitrarily assigned codes e.g. male, female, which could have numerical codes assigned to them. Numerical codes assigned to the categories or classes of a categorical variable have no meaning in themselves—they are nothing other than labels.

Ordinal variables are categorical variables with coded categories for which the order of the codes matters but not their actual values e.g. 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

Count variables count a number of items/people. If a count variable can take a wide range of very large numbers, the methods of continuous variables are often used for it. For example, traffic flow at a city location would be in terms of number of vehicles per fixed time interval, but if it involves counts in the thousands or even hundreds, it would tend to be treated as continuous—hence the term "flow"

Continuous variables take values from a "continuum" or in intervals, and can take any real value e.g. time, distance, height, weight. Their measurement almost always involves at least some form of rounding, and observations are often quoted as correct to a certain number of decimal places, or "to the nearest … ". Amounts of money are also usually treated as continuous variables because there is a sense in which they involve rounding, but also because the scale of measurement is extensive and very fine—it is possible to use a very small unit of measurement.

Dead reckoning

The process of determining position using calculated information.

Designed research

Research which is carried out according to a plan which ensures that the data are collected so that good estimates can be obtained of the statistics involved.

Five-number summary

The combination of the *median*, Q_2, the *lower* and *upper quartiles*, Q_1 and Q_3, and the two extreme values (that is, the *minimum* and the *maximum*).

Frequency plot

A diagrammatic presentation of the frequency distribution of the observations, e.g. a bar chart, a pie chart, a histogram, a frequency polygon or an ogive.

Inference

Conclusions made about a population from the observations in a sample taken from that population.

Justification of procedures

Justification of procedures may include:

- providing evidence (words, diagrams, symbols, etc.) to support processes used
- stating a generic formula before using specifically
- providing a reasoned, well formed, logical sequence within a response.

Mathematical model

Any representation of a situation which is expressed in mathematical terms. It should be noted that models may be as simple as expressing simple interest as $I = \frac{Prt}{100}$ or showing the relationship between two variables as a scattergram.

Median boxplot (box-and-whisker plot)

A graphical presentation of some main features of a dataset. The simplest version of a box-and-whisker plot is formed by drawing a box extending from the lower to the upper quartiles, marking the median within that box, and drawing lines (called whiskers) from the box to the smallest and largest data points.

There are slight variations in the possible ways of identifying the median and quartiles of data: these variations make very little difference except for small or sparse datasets. A very sound and popular method enables the data to be divided into four groups with exactly the same number of observations in each group. The technique is illustrated in the following example:

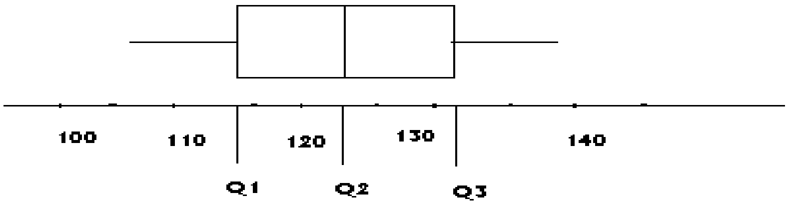
Example: Consider the following 18 systolic blood pressures (bp)

110, 130, 108, 125, 111, 122, 126, 119, 114,
134, 120, 132, 134, 130, 107, 137, 120, 136

These data are ordered and numbered from the smallest to largest below.

x:	107	108	110	111	114	119	120	120	122	125	126	130	130	132	134	134	136	137
order:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

The median, Q2, is taken to be 123.5. The lower quartile, Q1, is the median of the lower 9 observations, viz. 114, and the upper quartile, Q3, is the median of the upper 9 observations, viz. 132. Thus there are exactly four observations below Q1, between Q1 and Q2, between Q2 and Q3, and above Q3.



With this technique, datasets with 16, 17, 18 or 19 observations all have exactly four observations below Q1, above Q3 and between Q1, Q2, Q3.

Note 1: A more informative version of the box plot, particularly with larger datasets, that is also often provided by statistical computer packages, takes the whiskers out to the last data points within a certain distance of the quartiles and then marks individual data points beyond the whiskers.

Note 2: A box-and-whisker plot can be presented vertically or horizontally.

Minimum spanning tree

The minimum spanning tree of a network is a collection of arcs which:

- is connected
- has no loops
- covers all nodes
- is of total minimum length.

Observational studies

Studies in which observations are obtained without using a predetermined statistical design in the method of data collection.

Operations research

A systematic application of quantitative methods, techniques and tools to solve problems.

Outlier

An extreme value in the observations, for example, an observation which lies beyond the box in the box-and-whisker plot, or a point which is well away from the line of best fit.

Random normal numbers

Numbers which are selected at random from a population of numbers which have a standard normal distribution; that is, a population with a mean of zero, a standard deviation of 1 and the characteristics of a normal distribution.

Residual

The difference between an observed value of the variable and the corresponding value predicted by the statistical model.

Reverse bearing

The bearing of a line is the angle it makes, measured in a clockwise direction, with the meridian, or north–south line. Every line has two bearings according to the direction in which it is regarded. For example, if the bearing of a line from A to B is 45 degrees, its *reverse bearing*, from B to A, will be 225 degrees.

Running fix

A measure of position, taken while in motion, with reference to a fixed point.

Stemplot (stem-and-leaf plot)

An exploratory technique that simultaneously ranks the data and gives an idea of the distribution.

Example: The following 16 average daily temperatures have been recorded to the nearest degree Celsius:

31	21	35	30	22	23	9	24
13	41	30	21	29	24	18	28

Preliminary stem-and-leaf plot of the temperatures:

Example: 2 | 1 represents 21

Unit = 1

0	9
1	3, 8
2	1, 2, 3, 4, 1, 9, 4, 8
3	0, 0, 1, 5
4	1

Final stem-and-leaf plot of the temperatures:

Unit = 1

0	9
1	3, 8
2	1, 1, 2, 3, 4, 4, 8, 9
3	0, 0, 1, 5
4	1

Summary statistics

Characteristics which describe the sample of observations, for example, the mean, median or standard deviation.

Variation

The way in which the observations differ (vary) from each other, often measured by the standard deviation or range.