

***The pre-registration test for
aspiring primary teachers:***

**Guideline to Core Knowledge —
Numeracy**

January 2011

Numeracy

Introduction

The Queensland Government response to the report of the Queensland Education Performance Review (29.06.09) requires

That all aspiring primary teachers be required to demonstrate through test performances, as a condition of registration, that they meet threshold levels of knowledge about the teaching of literacy, numeracy and science and have sound levels of content knowledge in these areas.

This document defines the core knowledge requirements for teachers to successfully design and manage learning experiences in the key areas of literacy, numeracy and science. It embodies the three constructs around which the test will be developed:

- 1. *required knowledge and understanding of the content and processes*** of (literacy, numeracy and science)
This construct acknowledges the need for teachers to possess content knowledge at a considerably greater depth than the level being taught. The convergence of opinion in the research literature points to a consideration of what students need to learn as the starting point for defining teacher development needs. For this reason, the definition of test content developed here is explicitly anchored to the relevant national and state curriculum frameworks, advisory and reference documents. It is important to note that this definition is not redefining curriculum for students; rather, it is a representation of what teachers need to know in order to effectively teach the curriculum for literacy, numeracy and science.
- 2. *knowledge about the teaching of*** (literacy, numeracy and science)
The sound level of content knowledge prefaced above needs then to be supported by at least threshold levels of pedagogical content knowledge which enable the emerging professional to know and understand how students' understandings in a subject typically develop, how to engage students and sequence subject matter, the kinds of misconceptions that students commonly develop, and effective ways to teach a subject. For the purposes of this definition, pedagogical content knowledge for each area will be detailed using the following foci:
 - knowledge of curriculum frameworks
 - teaching literacy/numeracy/science
 - diagnosis, monitoring and assessment.
- 3. *personal literacy and numeracy skills***
The test will also require demonstration of core personal literacy and numeracy skills. These skills are a focus within the professional standards for teachers and their inclusion reflects the underpinning nature of literacy and numeracy across all curriculum areas including science. Their inclusion also recognises, differentiates and underlines the standing of science as a key curriculum area.

The table below summarises the configuration for the test:

Figure 1: Configuration for pre-registration testing in literacy, numeracy and science

1	<i>Required knowledge and understanding of content and processes to teach ...</i>	literacy numeracy science
2	<i>Knowledge about teaching of ...</i>	literacy numeracy science
3	Personal literacy and numeracy skills	literacy numeracy

The test will be enacted through three test instruments – one each for literacy, numeracy and science.

Further, it is critical to recognise that the performances against this testing program represent an independent source of evidence to be considered as a discrete and mandatory requirement alongside successful completion of an approved/acceptable preservice program. It is timely to remember that in being certified as completing requirements for approved preservice programs, graduands demonstrate achievement of the professional standards at graduate level. This judgement is made through a comprehensive and robust assessment program that targets all aspects of the program, including professional experience. The assessment program and its implementation is reviewed and monitored as part of the Queensland College of Teachers (QCT) program approval processes. It is not intended that this testing will or can canvass the same breadth of coverage, but will provide an additional and confirmatory source of evidence.

Numeracy

The parameters defined here align to and represent an explicit and specific drilling down for nominated priority areas of the knowledge of ‘the content, processes and skills of the areas they teach ...’ required by the *Professional Standards for Queensland Teachers* (at graduate level).¹

To be numerate one needs to use mathematics effectively. This means using mathematics to meet the general demands of life at home, in work and for participation in community and civic life. A numerate person solves everyday problems involving mathematics in effective, efficient and creative ways.

The aspects of the numeracy test include the following:

- Required knowledge and understanding of content area
- Pedagogical content knowledge
- Personal numeracy skills.

As noted earlier, this definition of content has been derived from a comprehensive examination of relevant Queensland and national Numeracy (and Mathematics) curriculum documentation and, as such, is anchored to those state and national curriculum frameworks and advisory and reference documents, as specified below. It is important to note that this definition of content is not redefining curriculum for students; rather, it is a representation of what teachers need to know in order to effectively teach mathematics for numeracy.

Required knowledge and understanding of content area
Queensland Studies Authority (QSA) http://www.qsa.qld.edu.au/learning.html <ul style="list-style-type: none"> • Early Years Curriculum Guidelines • Year 1 Learning Statements • Years 3, 5, 7, 9 Essential Learnings (Mathematics) • P— 9 Literacy and Numeracy Indicators • Year 10 Guidelines Mathematics Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html <ul style="list-style-type: none"> • Shape of the Australian Curriculum: Mathematics (May 2009) • Framing Paper Consultation Report: Mathematics (May 2009)
Pedagogical content knowledge
Queensland Studies Authority (QSA) http://www.qsa.qld.edu.au/learning.html <ul style="list-style-type: none"> • Early Years Curriculum Guidelines • Years 1-7 Essential Learnings Mathematics • P— 9 Literacy and Numeracy Indicators • Year 10 Guidelines Mathematics Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html <ul style="list-style-type: none"> • Shape of the Australian Curriculum: Mathematics (May 2009) • Framing Paper Consultation Report: Mathematics (May 2009)
Personal numeracy skills
<ul style="list-style-type: none"> • Australian Core Skills Framework (DEEWR) - Numeracy

¹ Queensland College of Teachers, *Program Approval Guidelines for Preservice Teacher Education*

Knowledge and understanding of content and processes of Numeracy

This section of the test is organised according to the following:

- Number
- Algebra
- Measurement
- Geometry
- Statistics and probability

Organiser	Required knowledge and understanding of content
Number	<p>Using NUMBER to solve problems in everyday contexts</p> <ul style="list-style-type: none"> • Real world problem solving <ul style="list-style-type: none"> ○ understanding the contextual nature of mathematical problems ○ identifying the mathematics necessary to solve problems ○ applying appropriate strategies ○ checking for reasonableness of solution ○ reflecting on thinking and reasoning. • Structure of the number system and characteristics of numbers <ul style="list-style-type: none"> ○ equivalence, comparison and ordering of whole numbers, integers, rational (common and decimal fractions and percentages) and irrational numbers in different forms ○ representation of numbers in a variety of ways, for different purposes e.g. using scientific notation, fractions, decimals, percentages, exponents, powers of 10, square roots and that there are relationships between different types of numbers and their representations ○ rates, ratio and proportion ○ common language patterns used to express the structure and characteristics of numbers, including place value. • Selection of operations and strategies appropriate to the problem context <ul style="list-style-type: none"> ○ number and operation sense ○ mental computation strategies ○ estimation ○ multiplicative thinking and proportional reasoning ○ standard and non-standard algorithms ○ rounding. • Financial literacy <ul style="list-style-type: none"> ○ nature of income, savings and spending, budgeting ○ contemporary money transactions ○ financial decisions are influenced by a range factors e.g. value for money, discounts, payment method, available savings, borrowing, consumer credit, investments, assets, analysis of short-and long-term benefits and consequences.
Algebra	<p>Using ALGEBRA to solve problems in everyday contexts</p> <ul style="list-style-type: none"> • Real world situations can be represented and modelled with algebraic expressions, equations, functions, graphics, tables and diagrams <ul style="list-style-type: none"> ○ equivalence of whole numbers, integers, rational (common and decimal fractions and percentages) and irrational numbers. • Algebraic expressions, equations, functions, graphics, tables, diagrams can be manipulated or combined to solve complex problems using <ul style="list-style-type: none"> ○ appropriate strategies (<i>check and guess, substitution, simplify, collect like terms, expanding</i>) ○ laws of equivalence (distributive, commutative, associative and inverse property, e.g. <i>distributive law</i> $5(x + 3) = 5x + 15$) ○ order of operations.

Knowledge and understanding of content and processes of Numeracy

Organiser	Required knowledge and understanding of content
Measurement	<p>Using MEASUREMENT to solve problems in everyday contexts</p> <ul style="list-style-type: none"> • Measurement sense <ul style="list-style-type: none"> ○ measurement attributes e.g. <i>length, area, volume, mass, time, angles, duration, time zones</i> can be perceived, compared and measured using non-standard and standard units of measure ○ the need for a standard measure to compare and communicate about measurement and to think logically through measurement problems. • Application of measurement <ul style="list-style-type: none"> ○ appropriate unit to measure particular items in particular contexts e.g. <i>you wouldn't use a ruler to measure how much your suitcase weighs when packing for an overseas trip</i> ○ appropriate level of precision that matches the context when measuring and estimating e.g. <i>a heart surgeon would use measurements that are more precise than a surveyor planning a new road</i> ○ personal referents to approximate unknown measures e.g. <i>hand spans</i> ○ the relationships between units of measure – judgements involving measurement to solve everyday problems using the relationships between and within units of measure e.g. <i>picking up 50kg of potting mix from Bunnings—can you lift it and will it fit into your small car, or how long will my hose have to run to fill my fish pond and can I do it within the current water restrictions?</i> ○ instruments, technologies and conversions ○ the limitations of measurement and that all measurements contain error ○ known measures and formulas can be used to derive other measurements e.g. <i>knowledge of the relationship between volume and area would help one decide on the size and shape of a water tank to be located in a small back yard.</i>
Geometry	<p>Using GEOMETRY to solve problems in everyday contexts</p> <ul style="list-style-type: none"> • The properties of geometric shapes and objects can be used to solve everyday problems in one, two and three dimensions <ul style="list-style-type: none"> ○ everyday language and geometric conventions (e.g. dimensions, angle size, relationships) ○ identify, describe and classify 2D shapes and 3D objects purposefully within problem contexts ○ visualisation (including transformations) to reason about problems involving shapes and objects ○ instruments and software can be used to investigate geometric properties and objects ○ 3D objects drawn, sketched and constructed using plans, nets and isometric diagrams to solve everyday problems ○ the notion of congruency to superimpose shapes and objects through transformations – reflections, rotations and translations e.g. <i>when making a video conference call your reflection is reversed</i> ○ symmetry (<i>points, lines and planes of symmetry can be identified in shapes and objects and related to transformations and tessellations</i>). • Maps and plans can be used to identify specific location, plan movement and calculate distance <ul style="list-style-type: none"> ○ use mapping conventions (co-ordinates, compass and scale) to specify and identify locations on maps and plans.

Knowledge and understanding of content and processes of Numeracy

Organiser	Required knowledge and understanding of content
Statistics and probability	<p>Using STATISTICS and PROBABILITY to solve problems in everyday contexts</p> <ul style="list-style-type: none"> • Situations involving uncertainty can be investigated using concepts of statistics <ul style="list-style-type: none"> ○ process of statistical investigation: posing questions, planning and collecting data, analysing and interpreting data and communicating conclusions ○ the way that data can be organised, represented and analysed depends on the structure of the data <i>e.g. categorical data can be represented with a bar graph and continuous data can be represented with a box plot</i> ○ statistical conclusions are based on evidence (both data-based and contextual); judgements contain uncertainty, can be biased, subjective and/or misleading and therefore have limitations. • Situations involving uncertainty can be investigated using concepts of probability <ul style="list-style-type: none"> ○ the likelihood of uncertain events can be expressed numerically or through language <i>e.g. there is a 70% chance that it will rain or “it will probably rain”</i> ○ theoretical probability can be estimated and compared to experimental data to make or investigate claims <i>e.g. if you don't wear a seat belt, the probability of being hurt in a car accident is increased</i> ○ probability can be expressed in terms of %, common and decimals fractions.

Pedagogical Content Knowledge: Numeracy

PCK construct	Required knowledge and understanding
Knowledge of curriculum frameworks	<p>Teachers are required to have a working knowledge of the curriculum e.g. Scope and Sequence charts, Essential Learnings, Numeracy Indicators. This includes knowing:</p> <ul style="list-style-type: none"> • the sequences of learning: how the concept develops in relation to learning junctures, for each of the numeracy concepts identified for student learning by the relevant curriculum documents • range of resources, materials and technologies to enhance student outcomes in numeracy • political and social understandings regarding numeracy and schooling e.g. <i>how is numeracy different from maths?</i>
Teaching strategies	<p>Teachers are required to have a working knowledge of how to plan and implement the curriculum. This includes knowing how to:</p> <ul style="list-style-type: none"> • teach mathematics for numeracy using the following approaches e.g. <ul style="list-style-type: none"> ○ teach mathematics for numeracy as a fundamental component of learning across all areas of the curriculum, using a combination of: <ul style="list-style-type: none"> - underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical and algebraic) - mathematical thinking and mathematical strategies - general thinking skills - a grounded appreciation of context. ○ use an investigative approach to exploring mathematical concepts and ideas through the following techniques <ul style="list-style-type: none"> - identifying and analysing - planning and posing questions - implementing (understanding and applying) - communicating and reflecting. ○ teach mathematical and numerical concepts and ideas through multiple representations that utilise <ul style="list-style-type: none"> - concrete materials - visual representations e.g. <i>diagrams, pictures, sketches, tables, maps etc</i> - oral and written processes e.g. <i>using journals and narrative to record and talk about learning</i> - symbolic (using mathematical conventions). ○ embed ICTs where students actively use ICTs to access, organise, research, interpret, analyse, create, communicate and represent knowledge e.g. <i>using technology software to manipulate simulated 3D objects.</i> • use teaching strategies to teach mathematics for numeracy e.g. <ul style="list-style-type: none"> ○ choose and use mathematics in a range of contexts e.g. using numbers in games, deciding what is fair in games of chance ○ mathematical applications and problem solving i.e. for promoting higher-order thinking skills, imagination, creativity, intellectual risk taking, reflection and problem solving in the context of the relevant content area, curriculum area or developmental phase <ul style="list-style-type: none"> - use real world problems to illustrate mathematical concepts and ideas - contexts for children/students - problem solving strategies - focus questions - reflection on thinking and reasoning. • make explicit links between: what is required to be taught (systemic numeracy requirements), planning for teaching and learning, the enacted curriculum (learning experiences and teaching strategies) and assessment (using the Numeracy Indicators). • identify and explicitly teach mathematics for numeracy in other curriculum areas e.g. <ul style="list-style-type: none"> ○ in science, comparing the capacity of various containers ○ in SOSE, measuring and comparing distances to determine shortest route.

Pedagogical Content Knowledge: Numeracy

PCK construct	Required knowledge and understanding
	<ul style="list-style-type: none"> • identify the language and literacy demands for numeracy e.g. <ul style="list-style-type: none"> ○ the use of prefixes in quantifying measurements and the relationships between prefix terms ○ the language capabilities e.g. the contextual and precise meaning of probability words like <i>spread</i>, <i>range</i> and <i>extremes</i>, the use of positional language to describe location, ways to indicate addition – <i>altogether</i>, <i>total</i>, <i>sum</i> and <i>combine</i>.
Diagnosis, Monitoring and assessment	<p>Teachers are required to have a working knowledge of how to assess student learning. This includes knowing how to:</p> <ul style="list-style-type: none"> • use authentic numeracy assessment strategies for gathering information and making judgements about students' numeracy development: <ul style="list-style-type: none"> ○ mathematical investigations and associated task analysis ○ mathematics journals ○ observation (anecdotal records, checklist, discussions) ○ peer and self-assessment. • use assessment data to evaluate student learning and review teaching and assessment practices e.g. assessment of operations should provide information about students' abilities and inform future teaching. It is collected through: <ul style="list-style-type: none"> ○ observing student performance in completing tasks ○ closely examining student work samples in problem-solving tasks to identify correct applications ○ using student self assessment through conferring with students about their tasks requiring numeracy. • determine students' prior learning and assess their current levels of proficiency: <ul style="list-style-type: none"> ○ assessing prior knowledge e.g. where on the continuum of learning numeracy, current student knowledge and understanding of numeracy facts, concepts, ideas, and processes lie e.g. early numeracy learning in measurement needs lots of concrete experience in using non-standard units before standard units are utilised ○ know and be able to recognise misconceptions e.g. if you multiply a number it gets bigger, volume conservation, roles of numerator and denominator in fractions.

Personal Numeracy Skills

Analyses and synthesises mathematical information in a broad range of tasks

- Extracts and analyses relevant information from a text or activity, and, where necessary gathers additional information from additional sources
- Comprehends texts or tasks that include formal mathematical symbolism, abbreviations, language, mathematical conventions and unfamiliar information that can be highly embedded in complex texts or stimuli
- Interprets concepts and techniques from specialist areas of mathematics relevant to everyday and workplace needs.

Selects and flexibly applies a wide range of highly developed mathematical knowledge and strategies, including problem solving in a broad range of everyday and workplace contexts

- Draws on prior mathematical knowledge and experience, diagrammatic and other mathematical processes to:
 - organise and represent the mathematical information in a form that is personally useful as an aid to problem solving e.g. table, summary, sketch
 - select appropriate methods of solution from an expanding range of mathematical processes
 - use estimation and other assessment skills to check the outcomes and decide on the appropriate degree of accuracy for the outcome
 - reflect on and evaluate own performance, the mathematics used and outcomes obtained relative to internal mathematical knowledge and understanding, and personal and real world problems.
- Employs mathematical knowledge and skills to:
 - use mathematical processes flexibly and interchangeably selecting from pen and paper and mental and technologically assisted processes, including using a range of calculator functions and spreadsheet software
 - use and apply ratio, rates and direct and inverse proportion
 - calculate with whole numbers, fractions, decimal fractions, and percentages and flexibly uses equivalent values for fractions, decimal fractions and percentages
 - calculate with relevant signed numbers and numbers given in index or scientific notation form
 - evaluate significant financial situations involving interest rates and savings, purchasing and investing
 - develop criteria and categories for budgeting and the financial management of an activity/task including income and revenue from different sources and expenses
 - develop, interpret and use formulae and algebraic representations to describe relationships between variables in relevant contexts
 - use and solve a range of equations using a variety of algebraic techniques
 - describe, predict and generalise patterns in mathematics
 - estimate, accurately measure and calculate quantities including circumference, area, volume, capacity, surface area, density, weight, time using strategies and formulae using appropriate measuring instruments and formulae including accurate conversion between units
 - recognise the effect of compounding error in calculations of measurement
 - use knowledge about space and shape including angle properties, symmetry and similarity to describe, draw and construct relevant 2D and 3D shapes
 - use, calculate and interpret information based on maps including scales, bearings, travel distances, speeds and times and time zones to identify locations and describe movements
 - use and apply the concepts of probability
 - collect, represent, summarise and interpret a range of types of data appropriately in a variety of ways e.g. tables, spreadsheets, graphs, plots, averages (such as mean, median, mode) and simple measures of spread.

Mathematical knowledge and skills including number, algebra, measurement, geometry and probability and statistics

Personal Numeracy Skills

Uses a wide range of mainly formal, and some informal, oral and written mathematical language and representation to communicate mathematically

- Uses a combination of formal written specialised mathematical and general language and representation to document, interpret and communicate the mathematical thinking, problem-solving processes, outcomes and implications of the mathematical investigation
- Uses a combination of oral specialised mathematical and generalised language to discuss, explain and interpret the processes, results and implications of the mathematical investigation
- Flexibly uses mathematical symbolism, diagrams, algebraic representation, graphs and conventions relevant to mathematical knowledge outlined above.