The pre-registration test for aspiring primary teachers:

Guideline to Core Knowledge — Numeracy

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Numeracy – guideline to core knowledge

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 (including application) 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.

The table below summarises the configuration for the test:

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

1	*Required knowledge and understanding (including application) of content and processes to teach …*	literacy numeracy science
2	*Knowledge about teaching of …*	literacy numeracy science

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.

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]

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

Numeracy – guideline to core knowledge

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 (including application) of content area
- Pedagogical content knowledge.

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 (including application) of content area
Queensland Studies Authority (QSA) http://www.qsa.qld.edu.au/p-9.html • 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 • 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/p-9.html • 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 • Shape of the Australian Curriculum: Mathematics (May 2009) • Framing Paper Consultation Report: Mathematics (May 2009)

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

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

Organiser	Required knowledge and understanding (including application) of content area
Number	**Using NUMBER to solve problems in everyday contexts** • Real world problem solving o understanding the contextual nature of mathematical problems o identifying the mathematics necessary to solve problems o applying appropriate strategies o checking for reasonableness of solution o reflecting on thinking and reasoning. • Structure of the number system and characteristics of numbers o equivalence, comparison and ordering of whole numbers, integers, rational (common and decimal fractions and percentages) and irrational numbers in different forms

Required knowledge and understanding (including application) of the content and processes of Numeracy

Organiser	Required knowledge and understanding (including application) of content area
	o 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 o rates, ratio and proportion o 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 o number and operation sense o mental computation strategies o estimation o multiplicative thinking and proportional reasoning o standard and non-standard algorithms o rounding. • Financial literacy o nature of income, savings and spending, budgeting o contemporary money transactions o financial decisions are influenced by a range of 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	**Using ALGEBRA to solve problems in everyday contexts** • Real world situations can be represented and modelled with algebraic expressions, equations, functions, graphics, tables and diagrams o 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 o appropriate strategies *(check and guess, substitution, simplify, collect like terms, expanding)* o laws of equivalence (distributive, commutative, associative and inverse property, *e.g. distributive law 5(x + 3) = 5x +15* o order of operations.
Measurement	**Using MEASUREMENT to solve problems in everyday contexts** • Measurement sense o measurement attributes e*.g. length, area, volume, mass, time, angles, duration, time zones* can be perceived, compared and measured using non-standard and standard units of measure o the need for a standard measure to compare and communicate about measurement and to think logically through measurement problems. • Application of measurement o appropriate unit to measure particular items in particular contexts *e.g. you wouldn't use a ruler to measure how much your suitcase weighs when packing for an overseas trip* o appropriate level of precision that matches the context when measuring and estimating *e.g. a heart surgeon would use measurements that are more precise than a surveyor planning a new road* o personal referents to approximate unknown measures *e.g. hand spans* o the relationships between units of measure – judgements involving measurement to solve everyday problems using the relationships between and within units of measure *e.g. 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?* o instruments, technologies and conversions o the limitations of measurement and that all measurements contain error o known measures and formulas can be used to derive other measurements *e.g. 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.*

Required knowledge and understanding (including application) of the content and processes of Numeracy

Organiser	Required knowledge and understanding (including application) of content area
Geometry	**Using GEOMETRY to solve problems in everyday contexts** • The properties of geometric shapes and objects can be used to solve everyday problems in one, two and three dimensions o everyday language and geometric conventions (e.g. dimensions, angle size, relationships) o identify, describe and classify 2D shapes and 3D objects purposefully within problem contexts o visualisation (including transformations) to reason about problems involving shapes and objects o instruments and software can be used to investigate geometric properties and objects o 3D objects drawn, sketched and constructed using plans, nets and isometric diagrams to solve everyday problems o the notion of congruency to superimpose shapes and objects through transformations – reflections, rotations and translations *e.g. when making a video conference call your reflection is reversed* o symmetry *(points, lines and planes of symmetry can be identified in shapes and objects and related to transformations and tessellations).* • Maps and plans can be used to identify specific location, plan movement and calculate distance o use mapping conventions (co-ordinates, compass and scale) to specify and identify locations on maps and plans.
Statistics and probability	**Using STATISTICS and PROBABLITY to solve problems in everyday contexts** • Situations involving uncertainty can be investigated using concepts of statistics o process of statistical investigation: posing questions, planning and collecting data, analysing and interpreting data and communicating conclusions. o the way that data can be organised, represented and analysed depends on the structure of the data *e.g. categorical data can be represented with a bar graph and continuous data can be represented with a box plot.* o 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 o the likelihood of uncertain events can be expressed numerically or through language *e.g. there is a 70% chance that it will rain or "it will probably rain".* o theoretical probability can be estimated and compared to experimental data to make or investigate claims *e.g. if you don't wear a seat belt, the probability of being hurt in a car accident is increased*. o probability can be expressed in terms of percentage (%), common and decimals fractions.

Pedagogical Content Knowledge: Numeracy

PCK construct	Required knowledge and understanding
Knowledge of curriculum frameworks	Teachers are required to have a working knowledge of the curriculum e.g. Scope and Sequence charts, Essential Learnings, Numeracy Indicators. This includes knowing: • 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. *how is numeracy different from maths?*
Teaching strategies	Teachers are required to have a working knowledge of how to plan and implement the curriculum. This includes knowing how to: • **teach mathematics for numeracy** using the following approaches e.g. o teach mathematics for numeracy as a fundamental component of learning across all areas of the curriculum, using a combination of: - 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. o use an investigative approach to exploring mathematical concepts and ideas through the following techniques: - identifying and analysing - planning and posing questions - implementing (understanding and applying) - communicating and reflecting. o teach mathematical and numerical concepts and ideas through multiple representations that utilise - concrete materials - visual representations *e.g. diagrams, pictures, sketches, tables, maps etc* - oral and written processes *e.g. using journals and narrative to record and talk about learning* - symbolic (using mathematical conventions). o embed ICTs where students actively use ICTs to access, organise, research, interpret, analyse, create, communicate and represent knowledge *e.g. using technology software to manipulate simulated 3D objects*. • **use teaching strategies to teach mathematics for numeracy** e.g. o choose and use mathematics in a range of contexts e.g. using numbers in games, deciding what is fair in games of chance. o 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 - 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. o in science, comparing the capacity of various containers. o in SOSE, measuring and comparing distances to determine shortest route.

Pedagogical Content Knowledge: Numeracy

PCK construct	Required knowledge and understanding
Diagnosis, monitoring and assessment	Teachers are required to have a working knowledge of how to assess student learning. This includes knowing how to: • use **authentic numeracy assessment strategies** for gathering information and making judgements about students' numeracy development: o mathematical investigations and associated task analysis o mathematics journals o observation (anecdotal records, checklist, discussions) o 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: o observing student performance in completing tasks o closely examining student work samples in problem-solving tasks to identify correct applications o using student self assessment through conferring with students about their tasks requiring numeracy. • **determine students' prior learning and assess their current levels of proficiency:** o 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. o 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.