Queensland Education Performance Review (Recommendation 1)

Re: Pre-registration testing in *Literacy, Numeracy and Science*

Defining content parameters – advice for test developers

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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 two 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.
   The requirement for this construct includes demonstration of knowledge and understanding (including application) of the content and processes of the priority area.

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*

Introduction

Literacy is the ability to read and write, and to use written information appropriately in a range of contexts. It involves the integration of reading and writing with speaking, listening, viewing and critical thinking. Literacy also includes a person's cultural knowledge that enables them to recognise and use language that is appropriate to different social situations. Teachers are responsible for ensuring that their students become literate in all areas of the curriculum.

The aspects of the literacy 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 literacy (and English) 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 literacy.

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 (English) • P— 9 Literacy and Numeracy Indicators • Scope and Sequence Grammar (1— 9) • Scope and Sequence Spelling (1— 9) • Year 10 Guidelines English Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html • Shape of the Australian Curriculum: English (May 2009) • Framing Paper Consultation Report: English (May2009)
Pedagogical content knowledge
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 (English) • P—9 Literacy and Numeracy Indicators • Scope and Sequence Grammar (1 — 9) • Scope and Sequence Spelling (1 — 9) • Year 10 Guidelines English Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html • Shape of the Australian Curriculum: English (May 2009) • Framing Paper Consultation Report: English (May2009)

Definition of test content: Literacy

Required knowledge and understanding (including application) of content and processes of Literacy

In his report, Masters recalls and centres attention on key findings from the *National Inquiry into the Teaching of Literacy.* This inquiry includes a recommendation *that the preparation of primary teachers include a strong focus on evidence-based findings relating to the teaching of reading, including the use of integrated approaches to the teaching of phonemic awareness, phonics, fluency, vocabulary knowledge and text comprehension*. Building on this direction, the definition of teacher knowledge offered here recognises that as students learn to become literate they need to have experience and be explicitly taught in the multiple aspects of literacy including reading.

The required knowledge that teachers must have, then, encompasses reading as well as writing, speaking, listening, viewing, and designing. Each of these aspects is addressed within four dimensions of knowledge that teachers need to have about the content of literacy below:

- knowledge of sociocultural aspect of literacy - literacy is a sociocultural practice and is experienced in the social and cultural aspects of the communities in which we live and work
- knowledge and understanding about language and texts - texts (and the language of texts) are recognised as a product of that sociocultural experience and as such are produced and consumed within those communities
- knowledge of the process of meaning making - students need to be explicitly taught the processes of making meaning as text users (listen, read and view) and text producers (speak, write and design)
- knowledge of "self" as literate practitioner - effective literacy learning occurs when students reflect on their strengths and weaknesses and consider areas of improvement.

Effective text users and text producers draw upon and use all four dimensions of knowledge to effectively make meaning. Teachers must have a sound knowledge of these dimensions to facilitate effective meaning making in their students.

Organiser	Required knowledge and understanding (including application) of content area
Knowledge and understanding (including application) of sociocultural aspect of literacy	• **Community participation and texts** – text users and text producers participate in the social and cultural activities within communities, including indigenous communities (as readers and writers for instance) and that such participation affects the nature of literacy practices gained. • **Texts are located and have influence** – texts are part of these communities (above) e.g. families, institutions and systems can influence meaning and language choices and community values and beliefs influence our understanding and ability to use and produce texts. • **Texts and points of view** – texts are representative of different points of view and these points of view can be challenged. • **Codes and structures around text/domains of knowledge** – the codes and structures that surround texts i.e. particular domains of knowledge, such as science and maths, have recognisable ways of sharing and communicating knowledge, and that different social and cultural groups may communicate in recognisable but different ways. • **Language and thinking** – language is indicative and representative of thought and is the communicative enactment of thinking.
Knowledge and understanding (including application) of language and texts **(through which knowledge is communicated**	• **Textual range and diversity** –texts (including multimodal) are diverse and various, as are their characteristics, nature and use, and that intertextuality is a feature of all literary and non-literary texts. • **Context and texts** – text producers and users use the purpose for reading and writing to determine the choices related to selection of subject matter (what is included and what is not), roles and relationships (author stance) and mode and medium. • **Textual features** – features of text that text producers and text users employ to code the socio-cultural decisions about subject matter, roles and relationships and mode and medium. These textual features include: o *generic structure of texts* – the ways different texts are organised and coded e.g. expository texts have a different structure to narrative texts as they serve different purposes o *grammar* – the structure of our language works to make meaning in texts - what grammatical concepts and terms student may be expected to recognise, understand, use and discuss at different junctures o *vocabulary* – the words we use to express our thoughts and ideas through language o *cohesion* – the links between ideas as well as use of nouns and pronouns to link ideas

Definition of test content: Literacy

Organiser	Required knowledge and understanding (including application) of content area
Knowledge and understanding (including application) of language and texts **(through which knowledge is communicated) continued**	o *orthography* – the correct sequence of letters, symbols and characters of the English spelling system which includes: - understanding and application of the four areas of knowledge (phonological, word function, meaning and word history) of the spelling system - inextricable linkage of spelling and writing in the act of encoding e.g. students write effectively when they have knowledge of how words are formed - inextricable linkage spelling and reading in the act of decoding, spelling knowledge relates to word knowledge in reading - abstract and progressive nature of the spelling system - punctuation is part of English orthographic system: it is used to mark word function, semantic units and non linguistic symbols and codes. **Phonological and phonemic awareness** – phonological awareness of sounds at three levels of structure in a word – syllables, onsets and rimes, and phonemes and phonemic awareness and the skills that form it – phoneme isolation, phoneme identity, phoneme substitution, oral segmenting, oral blending and onset-rime manipulation.
Knowledge and understanding (including application) of the process of meaning making (reading and writing)	**Text user (especially reading)** • **Process of meaning making (reading)** o strategic behaviours text users use to construct, critically evaluate and use meaning - *identify purpose* - *make connections* – text to self, text to other text and text to world - *question* – proficient readers have questions before, during and after reading - v*isualise* – visual imagery enhances understanding - *make inferences* (the intersection of what is known, gathering clues from the text, and thinking ahead to make a judgement, discern a theme or speculate on what is to come) - *determine importance* (closely related to the reader's purpose for reading the text and so is important for KLA texts) - *synthesise information* – combining new information with existing knowledge to form an original idea or interpretation o effective strategies text users apply before, during and after reading - *before reading* to create a shared context e.g. construct a goal, preview, predict the content and organisation of the text - *during reading* where explicit teaching is needed e.g. decode, self-correct, visualise, questioning, use of text structure, revision of predictions, draw inferences, identify main idea, identify alternative points of view - *after reading* where new knowledge is consolidated e.g. reflection and evaluation of author's point of view, quality of author's craft and accuracy or reliability of content. **Text producer (especially writing)** • **Process of meaning making – stages of writing** o strategic behaviours text producers use to construct, critically evaluate and make meaning - *pre-writing* – write about ideas (listing, researching, discussing, free writing, percolating etc), select an idea, develop that idea - *drafting* – composing a first draft - *sharing* – seeking feedback on first draft in terms of meaning making of contents and ideas - *revising and crafting* – making the ideas clearer, revising first draft to communicate clear meaning through strategies such as re-sequencing ideas, crafting leads, endings, transitions between ideas, adding details, using repetition, adjectives, striking verbs, variety of sentence lengths to achieve rhythmic effects, punctuation for communicating meaning e.g. parenthesis, dashes, ellipsis, quotation marks, various print and graphic effects - *editing for conventions* – correct use of grammar and spelling - *publishing.* • **Use of cueing system –** how text producers use cueing systems (semantic, syntactic, orthographic, morphemic and graphophonic) to communicate meaning e.g. spelling as a function of writing.

Definition of test content: Literacy

Organiser	Required knowledge and understanding (including application) of content area
Knowledge of "self" as text user and producer	• **Meta-knowledge of students as literacy learners** – to become effective text users and producers students need to develop a meta-knowledge of themselves as learners in this process. This means they: o develop thinking patterns (e.g. through top level structure) that work for them o know which strategies are effective for them personally and be cognizant of strategies and skills acquired and developed o identify and discuss a variety of strategies used to become a more effective reader and writer o recognise their own strengths and weaknesses o identify specific steps to take personally to further improve as a reader/writer o take responsibility for the construction of their own meaning making o have an understanding of how cultural diversity produces difference in the way that language is used.

Pedagogical Content Knowledge: Literacy

PCK construct	Required knowledge and understanding
Knowledge of curriculum frameworks	Teachers are required to have a working knowledge of the curriculum and the literacy implications for teaching that curriculum e.g. Scope and sequence charts, Essential Learnings (English and other KLAs), Literacy Indicators. This includes knowing: • what the students need to know and be able to do at respective junctures • the sequences of learning: how the concept/area develops in relation to learning junctures, for each of the literacy concepts/areas identified for student learning, by the relevant curriculum and reference documents • political and social understandings regarding literacy and schooling *e.g. what constitutes literacy at school and is it more than grammar and spelling?*
Teaching literacy	Teachers are required to have a working knowledge of how to plan and implement the literacy teaching in all curriculum areas. This includes knowing how to: • teach literacy through **a balanced approach** that includes the following: o integrated use of whole language, genre and socio-critical approaches o explicit teaching of grammar, spelling (see below teaching strategies) and other important textual features that help students make meaning from texts: phonics, vocabulary, and visual and digital codes o scaffolded and contextualised teaching of comprehension and composition of written, visual and spoken texts o focused teaching on how texts function to achieve a range of purposes in different social situations o purposeful teaching of ways language and texts are used to craft points of view, opinions and stereotypes o embedding of ICTs to create learning opportunities where students actively use ICTs to access, organise, research, interpret, analyse, create, communicate and represent knowledge e.g. digital journals and internet research from a critical stance. • teach literacy by **connecting reading with writing** – integration of reading and writing in teaching to help students internalise reading and writing as complimentary aspects of literate communication: o the Read Aloud as important teaching time for all writers o teaching students to read like writers – using literary and non-literary published texts and the class' shared writing texts to see how they organised the text, created imagery, developed tension, described characters, paced a narrative, used layouts and fonts for meaning, introduced and ended the text o writing strategies used in reverse as comprehension strategies o explicit instruction in expressive reading to improve understanding of conventions o studying the same forms in reading as we want students to write o reading and evaluating the writing of others. • **use teaching strategies to teach reading:** o *demonstrations* – about specific textual features such as vocabulary and visual images and background knowledge and subject matter to narrow the meaning during reading o *modelled reading* – demonstrate reading strategies using a range of texts to predict, confirm and evaluate meaning e.g. rereading, reading on, the use of images, textual features, pace, phrasing and fluency o *shared reading* – e.g. providing opportunities for students to engage with concepts or language patterns with which they are not yet familiar o *guided reading* – where teacher acts as an expert reader to whom students can access e.g. help students engage with more challenging texts o *independent reading* – ensures that a variety of quality and suitable texts are available o *independent literacy activities* – where teachers understand the links between reading and other forms of literacy – spelling, a functional aspect of writing, and word knowledge in reading and written and spoken texts. • **use teaching strategies to teach writing:** o *demonstrations* – by initiating, modelling, explaining, thinking aloud and writing aloud o *shared demonstrations* – e.g. teacher holding the pen and the students collaborating on the writing as much as possible o *guided practice* – having students attempt to apply what has been demonstrated, with the teacher close by to support, teach and give feed-back o *independent practice* – students are competent and confident enough to choose their own writing topics, problem-solve and self-monitor with minimal assistance.

Definition of test content: Literacy

PCK construct	Required knowledge and understanding
Teaching literacy continued	• **use teaching strategies to teach grammar** to help students understand how our language works to create meaning within texts e.g. o *explicit and systematic teaching of grammar* at the whole text level, sentence clause, and word o *teaching of grammar in context* where learning experiences identify, demonstrate and allow students to practise the decisions we make about grammar according to the cultural and situational level in which language occurs. • **use teaching strategies to teach spelling** as a functional component of writing related to vocabulary acquisition and word attack skills e.g. o *explicit and systematic teaching of spelling* based on a clear understanding of what knowledge and skills need to be taught and when they should be taught e.g. help students work towards a spelling conscience; a systematic monitoring process of the acquisition and needs for particular skills to be taught; and a planned spelling program that is integral to the classroom's language and learning environment o *a balanced spelling program* that teaches phonological, visual, morphemic and etymological spelling knowledge through modelled spelling, guided spelling and independent spelling. • **identify and explicitly teach literacy** in other curriculum areas e.g. o comparison of text types and their uses for specific domains of knowledge o exploration of the language demands of science as opposed to SOSE o how words change meaning in different contexts. • make explicit **links** between what is required to be taught (systemic literacy requirements), planning for teaching and learning, the enacted curriculum (learning experiences and teaching strategies) and assessment (using the Literacy Indicators). • **use resources effectively:** familiarity with, and use of, a wide range of resources, materials and technologies to enhance student outcomes in literacy – some examples - immersion in and experience with a range and balance of texts; appropriate selection of texts; in guided reading students need to be able to read about 90% of the words and images whereas in independent reading they need to be able to read about 95%.
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 literacy **assessment strategies** for gathering information and making judgements about students' literacy development: o observation – anecdotal records, rating scales, checklists, discussions o consultation – interviews, reading/writing conferences, parent interviews and surveys o focused analysis – running records, miscue analysis, cloze, retelling etc o peer and self assessment – reading logs. • **use assessment data** to evaluate student learning and review teaching and assessment practices e.g. assessment of **spelling** should provide information about students' spelling abilities and inform future spelling programs. It is collected by: o observation of spelling behaviours during modelled, guided and independent spelling instruction o using systematic records of student spelling strategies for analysis o closely examining student writing samples for evidence of application of the four spelling knowledges o using student self assessment through conferring with students and their independent spelling lists. • **determine students' prior learning and assess their current levels of proficiency:** o assessing prior knowledge e.g. where on the continuum of learning literacy, current student knowledge and understanding of literacy facts, concepts, ideas, and processes lie e.g. in early literacy decoding, students need to have extensive experience with initial letters and word shape, in visual, auditory and tactile form before they would be ready to identify all letters in the alphabet in upper or lower case o know and be able to recognise alternative conceptions e.g. student perception that spoken and written language are the same thing.

Introduction

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)

Required knowledge and understanding (including application) 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 (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 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 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.

Definition of test content: Numeracy

Organiser	Required knowledge and understanding (including application) of content area
Measurement continued	• 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.*
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. • identify the **language and literacy demands** for numeracy e.g. o the use of prefixes in quantifying measurements and the relationships between prefix terms o the language capabilities e.g. the contextual and precise meaning of probability words like *spread, range* and *extremes*, the use of positional language to describe location, ways to indicate addition – *altogether, total, sum* and *combine.*

Definition of test content: 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.

Introduction

The aim of the science curriculum is to provide students with a solid foundation in science knowledge, understanding, skills and values on which further learning and adult life can be built. In particular, the science curriculum should foster an interest in science and a curiosity and willingness to speculate about and explore the world. Students should be able to engage in communication of and about science, value evidence and scepticism, and question scientific claims made by others. They should be able to identify and investigate scientific questions, draw evidence-based conclusions and make informed decisions about their own health and wellbeing. Science is a human endeavour that students should learn to appreciate and apply to daily life. *(The Shape of the Australian Curriculum: Science, 2009)*

The aspects of the science test include the following:

- Required knowledge and conceptual understanding of the content area
- Pedagogical content knowledge.

The content of these two aspects have been anchored to both state and national curriculum frameworks for science as specified in the table below:

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 (Science) • Implementing the Essential Learnings and Standards • Planning - Using the Essential Learnings and Standards • Year 10 Guidelines (Science) • P— 9 Literacy and Numeracy Indicators Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html • Shape of the Australian Curriculum: Science (May 2009) • Framing Paper Consultation Report: The Science (May 2009)
Pedagogical content knowledge
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 (Science) • Implementing the Essential Learnings and Standards • Planning - Using the Essential Learnings and Standards • Year 10 Guidelines (Science) • P—9 Literacy and Numeracy Indicators Australian Curriculum Assessment and Reporting Framework (ACARA) http://www.acara.edu.au/publications.html • Shape of the Australian Curriculum: Science (May 2009) • Framing Paper Consultation Report: The Sciences (May 2009)

Definition of test content: Science

Required knowledge and understanding (including application) of content and processes of Science

Knowledge of the way scientists work and the science discipline conceptual knowledge and understandings which underpin the primary school science curriculum have been identified. The ways of working is an integral component of the science curriculum. It is intended that the ways of working processes are incorporated and embedded into all other organisers.

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

- Ways of working
- Science as a human endeavour
- Earth and beyond
- Energy and change
- Life and living
- Natural and processed materials.

Organiser	Required knowledge and understanding (including application) of content area
Ways of working	Working scientifically involves active participation, both individually and collaboratively, in genuine endeavours that help to construct personal scientific understandings. This includes: • **Investigating** o Inquiry based learning (investigating) involves the following steps: posing questions, predicting, designing and planning an investigation, collecting, working with and presenting data, analysing data, evaluation the investigation and drawing conclusions. o Inquiry based learning (investigating) underpins and is embedded in the learning in all the curriculum strand organisers. o How to use science equipment for classroom activities safely and accurately is required. Practical activities require risk assessment procedures to be known and applied. This includes knowledge of storage and use of chemicals. o Use of models, simulations and scaled replicas can be used to support learning in the ways of working strand. • **Communicating** o Science is communicated orally, in written mode and using different mediums and multimodal technologies. • **Reflecting** o Reflecting on the learning and the processes is critical for constructing and confirming current understandings and developing new concepts.
Science as a human endeavour	Science may help to influence society through the posing and responding to social and ethical issues and science research is influenced by societal challenges or social priorities. This organiser highlights the need for informed, evidence-based decision making about real-world current and future applications of science. • **Science in every day life** o Science has applications in daily life, including at home, at school, at work and in leisure time. Scientific ideas can be used to explain the development and workings of everyday items and phenomena. • **Science and ethics** o Science can help to make natural, social and built environments sustainable at a scale ranging from local to global and may influence personal human activities. o Responsible, ethical and informed decisions about real-world issues and social priorities may benefit from the application of scientific understanding. • **Contributions of the past** o Scientific knowledge including from Australia has been accumulated and refined over time, and can be used to change the way people live. o Cultures from around the world, including those of Aboriginal people and Torres Strait Islander people, have contributed to scientific understanding and scientific practice. o Immediate and long-term consequences of human activity can be predicted by considering scientific understandings of past and present events, discoveries, inventions and innovations.

Definition of test content: Science

Organiser	Required knowledge and understanding (including application) of content area
Earth and beyond	The earth and beyond knowledge organiser recognises that scientific understanding about the earth and universe can be used to model the past and make predictions. • **Key concepts** o Our lives depend on air, water and materials from the ground; the ways we live depend on landscape, weather and climate. o The earth is composed of materials that are altered by forces within and upon its surface. o The earth and life on earth are part of an immense system called the universe. • **Weather and Climate** o temperature and winds o the water cycle o the seasons o the changing atmosphere - natural - human impacts o using models to make predictions • **Structure of the earth and its atmosphere** o features of the layers of the earth o tectonic plates, volcanoes, earthquakes and tsunamis o the surface of the earth changes o the atmosphere • **Using the earth's resources** o the resources include, air, water, minerals (iron ore and coal) o human use of resources • **The solar system, stars and galaxies** o the sun is a star and supplies light and heat energy to the earth o planets and the solar system o the moon, tides o using technology to investigate • **Space travel and exploration** o the new knowledge and benefits of space research and travel.
Energy and change	This physical sciences knowledge organiser recognises forces and energy concepts. They are identified and analysed to help understand and develop technologies, and to make predictions about events in the world. • **Key concepts** o Energy is vital to our existence and our quality of life as individuals and as a society. o Interaction and change involve energy transformations and transfers; control of energy transfer enables particular changes to be achieved. o Observed change in an object or system is indicated by the form and amount of energy transferred to or from it. • **Forces** o pushes and pulls o weight o buoyancy and density o friction o simple machines o gravity • **Motion** o speed o acceleration • **Energy** o forms and sources of energy o energy transfer and transformation o sustainability of energy sources • **Electricity and Magnetism** o static electricity o electric currents and circuits o magnets o motors and generators

Definition of test content: Science

Organiser	Required knowledge and understanding (including application) of content area
Energy and change continued	• **Light and Sound** o white light and colours o reflection and refraction o vibrations and sound.
Life and living	This biology based knowledge organiser recognises there is a relationship between the structure and function of living things and this is the basis for understanding life-maintaining processes. All living things in an environment are interdependent, and changing one aspect of the environment will affect other organisms. • **Key concepts** o Organisms in a particular environment are interdependent. o Living things can be understood in terms of functional units and systems. o Life on earth has a history of change and disruption, yet continues generation to generation • **Cells** o plant and animal cell structures o tissues, organs and systems (respiratory and digestive) • **Life cycles** o growth o reproduction • **Natural selection** o fossils o adaptation o classification o natural selection/evolution • **Ecosystems** o living and non living environment o food chains o recycling of matter o flow of energy • **Impact of humans** o introduction of species o changing the environment.
Natural and processed materials	This chemistry based knowledge organiser recognises the properties, changes and uses of materials are determined by their structure and their interaction with other materials. • **Key concepts** o The properties of materials determine their uses; properties can be modified. o The substructure of materials determines their behaviour and properties. o Patterns of interaction of materials enable us to understand and control those interactions • **Particles** o atoms, elements, compounds and mixtures o common substances and formula (e.g. water (H_20), carbon dioxide (CO_2) and salt (NaCl) • **States of matter** o gases, liquids and solids o the particle model • **Materials and their uses** o properties (colour, texture, state, density, texture, heat and electrical conductivity) o new molecules (including polymers for use as drugs, building materials) • **Changes** o physical and chemical o conservation of matter o rates of reaction o chemical reactions which impact on life (respiration and photosynthesis).

Pedagogical Content Knowledge: Science

PCK construct	Required knowledge and understanding
Knowledge of Curriculum Frameworks	• What the students need to know and be able to do at respective junctures. • The sequences of learning: how the concept progressively develops. • The curriculum standards associated with student learning. • How to judge student work with respect to curriculum standards.
Teaching Science	• Use curriculum frameworks for undertaking short, medium and long-term planning for class/es. • How to select, design, plan and implement the appropriate learning experiences and teaching strategies which clearly link to what is required to be taught (*Essential Learnings*) AND to what will be assessed and how it will be assessed (using the *Standards).* • Select appropriate science contexts which: o Engage students due to identified interests or connectivity o Relate to everyday life experiences (and have implications for the application of the knowledge and skills being learnt) o Provide opportunities for hands on engagement/ investigations (underpin content strands with ways of working). • Use appropriate strategies to develop science understandings including: o Questioning and other diagnostic tools which identify current student understandings o Thinking strategies like: POE (Predict, Observe, Explain) during investigations to help student focus on the task and process o Inquiry based learning, analogies, models and simulations. o Modelling "working scientifically" and "fair testing". o Modelling appropriate ways to represent knowledge and understanding. o Develop metacognition skills so students understand how they learn. o Evaluating sources of information. • Teach students to become cooperative and collaborative learners; to understand the role each team member plays and oversee these processes including: o Gathering equipment o Conducting the investigation (sharing and assisting) o Communicating – reflecting and reporting the results (like working scientists). • Conduct risk assessment - assess risks associated with the environment, the distribution and safe use of equipment and materials used in investigations. This includes planning for effective movement and interaction of students and equipment in a productive and safe manner and accessing children's health records where necessary. • Identify and access resources to provide relevant and appropriate learning experiences. It is essential that teachers relate the science that is done in the classroom to real life issues/circumstances/examples (Science as a human endeavour organiser). • Identify and explicitly teach the literacy and numeracy competencies which underpin/ support the development of science understandings. o Literacy - Science literacy text types or representations include: annotated diagrams, circuit diagrams, cross sections, cutaway diagrams, flow charts, graphs, concept maps, force arrow diagrams, maps, 3 D models, tables, Venn diagrams, science reports and science journals - Science texts aim to convince readers that explanations are authoritative, reliable and based on evidence. As new evidence develops, understandings can change. - Many science texts are multi modal - combine verbal, visual and, mathematical language to represent themes, concepts, relationships and explanations. - There are scientific conventions which are internationally recognised and must be followed – e.g. when naming species (*Homo sapiens*). o Numeracy - Science numeracy competencies largely relate to making sense of and manipulating data. This includes: - Appreciating the size of numbers (to rank or compare)

Definition of test content: Science

PCK construct	Required knowledge and understanding
Teaching Science continued	- Measuring, including converting between units of measurement, reading scales, approximating, estimating - Manipulating data – e.g. calculating averages - Using scientific notation – e.g. 300 = 3.0×10^2 - Modelling numerical information/data; creating formulae; understanding interactions between different variables - Making sense of number problems, including non-routine problems, and recognising the operations needed to solve them - Explaining and making predictions from numbers in graphs, diagrams, charts and tables - Explaining methods and reasoning using correct mathematical terms; judging whether answers are reasonable, and possessing strategies for checking them where necessary. • Work cooperatively and effectively with the school community. Use teacher aid/ support staff efficiently (e.g. preparing equipment and materials for investigations), communicate effectively with teaching colleagues, administration, parents and community members and know when to ask for help. • Use information and communication technologies (ICTs) by using and modelling the use of: learning objects, excel (spreadsheet and graphing), digital interfaced equipment (microscopes, environmental probes e.g. temperature), computer modelling and simulations, Web 2.0 technologies (wikis, blogs, YouTube).
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 science **assessment strategies** for gathering information and making judgements about students' development in science: o observation of experimental investigations o reviewing students' experimental reports and science journals o listening to and analysing group discussions and student presentations o discussions with students about their progress. • Use **assessment data** to evaluate student learning and review teaching and assessment practices e.g. assessment of using the scientific method should provide information about students' abilities and inform future teaching. It is collected through: o observing students performance in designing and carrying out science investigations o examining experimental reports and associated tasks to identify their correct application and understanding of the scientific method. o using student self-assessment and conferring with students about their scientific results and conclusions. • Determine students' **prior learning and assess their current levels of proficiency:** o assessing prior knowledge e.g. where in the broad scope of science students' current conceptual knowledge and understanding' of science contexts lies. o developing activities to recognise and address alternative conceptions and/or misconceptions e.g. complete concept cartoons or maps.

References

General

Hawley, W. & Valli, L. (1999). '*The essentials of effective professional development: A new consensus'* in Darling-Hammond, Linda and Sykes, Gary, Editors (1999) 'Teaching as the Learning Profession. Handbook of Policy and Practice', Jossey-Bass Publishers, San Francisco

Luke, A & McArdle, F. (2008). *An Evidence-based Approach to Professional Development Planning In Large State Educational Systems*, Unpublished research paper for the Queensland Department of Education, Training and the Arts, Brisbane: 11/12/08

Masters, G. N. (2009). 'A Shared Challenge: Improving Literacy, Numeracy and Science Learning in Queensland Primary Schools', Australian Council for Educational research, Camberwell, Victoria

Rahman, A. F. & Scaife. J. A. (2005/6). *Assessing Pre service Teachers' Pedagogical Content Knowledge Using a 'Bricolage' Approach,* International Journal of Learning, Common Ground Publishing

Shulman, L.S. (1986). *Those Who Understand: Knowledge Growth in Teaching*, Educational Researcher, Vol. 15, No. 2. (Feb., 1986), pp. 4-14

Shulman, L. (1987) *Knowledge and Teaching: Foundations of the Reform.* Harvard Educational Review, 57 (1), 1-22

Timperley, H. Wilson, A. Barrar, H. & Fung, I. (2007). *Teacher Professional Learning and Development: Best Evidence Synthesis Iteration*. Wellington: New Zealand Ministry of Education

Literacy and Numeracy

Department of Education, Employment & Workplace Relations (2008). *National Numeracy Review Report.* Commonwealth of Australia. Canberra

Department of Education, Science & Training, (2005). *National Inquiry into the Teaching of Literacy. Teaching reading: Report and recommendations*. Commonwealth of Australia, Canberra

Fairclough, N. (1995). 'Discourse and Social Change'. Cambridge, Polity Press

Guthrie, J.T. & Wigfield, A., (eds) (1997). 'Reading Engagement: Motivating Readers Through Integrated Instruction', International Reading Association, Newark

Johns, J. L. Van Leirsburg, P. & Davis, S. J. (1994). 'Improving reading: Handbook of Strategies', Kendall Hunt, Dubuque

Keene, E. & Zimmerman, S. (1997). 'Mosaic of thought'. Portsmouth, NH: Heinemann

Kress, G. (1998*).*'Language as Social Practice', in Language and Education: Discourses Analysis, Deakin University, Geelong, (1995)

Routman, R. (2005). 'Writing Essentials: Raising Expectations and Results While Simplifying Teaching'. Portsmouth, NH: Heinemann

The New London Group (1996). *A Pedagogy of Multiliteracies: Designing Social Futures*, Harvard Educational Review, 66(1), 60-92.

Science

Goodrum, D. Hackling, M. & Rennie, L. (2000). *The status and quality of teaching and learning of science in Australian schools: A research report prepared for the Department of Education, Training and Youth Affairs* http://www.dest.gov.au/NR/rdonlyres/5DF3591E-DA7C-4CBD-A96C-CE404B552EB4/1546/sciencereport.pdf

Goodrum, D. Hackling, M. & Rennie, L. (2001). *The state of science in Australian secondary schools*. Australian Science Teachers Journal, 47(4), 6-17

Hackling, M. & Prain, V. (2008) *Impact of Primary Connections on students' science processes, literacies of science and attitudes towards science; A research report for the Australian Academy of Science,* Department of Education, Employment and Workplace Relations

MCEETYA, *Primary Science Assessment Project* (2003) http://www.mceecdya.edu.au/verve/_resources/PSAP_SRM_Complete.pdf

National Assessment Program Science Literacy Year 6, (2009). *Assessment Domain and Progress Map* http://www.curriculum.edu.au/verve/_resources/NAP_ScienceLit_2009_Assessment_Domain_Dec_08.pdf.

OECD Programme for International Student Assessment (1999). http://www.pisa.oecd.org

Tariq, V. *Numeracy, Mathematical Literacy and the Life Science Mathematics, Statistics and Operational Research* (MSOR) Connections, May 2004, Vol 4, No 2 http://ltsn.mathstore.ac.uk/newsletter/may2004/pdf/numeracy.pdf

The Department of Education, Science and Training, *The Science Education Assessment Resources* (SEAR) (DEST) http://cms.curriculum.edu.au/sear/

The National (USA) Science Digital Library Science Literacy Maps http://strandmaps.nsdl.org/

Tytler, R. (2007). *Re-imagining Science Education: Engaging students in science for Australia's future* ACER Press, Australian Council for Educational Research, Camberwell, Victoria.