AUSTRALIAN NATIONAL SCHOOLS NETWORK

Snapshot

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Numeracy across the curriculum

Written by:
Will Morony, Mathematics Educator
John Hogan, Director, Redgum Consulting Pty Ltd
Steve Thornton, Lecturer in Mathematics Education, University of Canberra

12-5x30=

2+7+5+9

Numeracy

4x5+9=

Snapshots are occasional papers about areas of interest for Network members. The ANSN is committed to making available quality resources to help teachers and schools improve their work.

ANSN Snapshot: Numeracy across the curriculum

Number 1 **July 2004**

Purpose of this paper

This Snapshot on Numeracy across the curriculum is designed to present the latest research-based information, advice and strategies[1]. It is relevant to all those engaged in school education — just like literacy, numeracy is everybody's business. The Snapshot draws heavily on recent Australian research to provide insights into the *what*, *why* and *how* of numeracy across the curriculum. It will assist those practitioners willing to engage with the issues, to interrogate their own beliefs and current practices and to develop a numeracy-informed culture in their classrooms. It will also challenge and inform those with formal leadership roles in education to acknowledge the importance of addressing numeracy across the curriculum through their inspiration and practical support of their teachers.

Introduction

Consider the following numeracy rich extract from page 77 of *armadillo* by William Boyd (Hamish Hamilton, 1998). Torquil and Lorimer are workmates who have met in the El Hombre Guapo for a drink after work. Lorimer has just refused the offer of a cigarette from Torquil…

'That's right, you don't smoke,' Torquil said incredulously. 'Why not? Everybody smokes.'

'Well, not everybody. Two-thirds of us don't.'

'Rubbish. All smoking statistics are lies, I tell you, Lorimer. Every government in the world lies about them, they have to. Smoking's on the increase worldwide and it suits them just fine, though they daren't admit it. So they routinely churn out these figures. But take a look around you.'

'You're probably right', Lorimer conceded. True enough, of the fifty or so people in El Hombre Guapo, ninety-eight per cent were smoking and the other two percent looked like they were about to smoke any minute, rummaging in pockets and handbags for their cigarettes."

Lorimer's comments about smoking statistics reflect the comment by Mark Twain that "there are three kinds of lies: lies, damned lies and statistics", and the capacity to take a critical viewpoint in relation to quantitative data is an important component of being numerate. However, his simple assertion and then reliance on a small and undoubtedly unrepresentative sample (the 50 or so twenty-somethings in a bar) leave something to be desired in terms of an effective argument that uses and explores statistics.

The more interesting insight into numeracy (or rather in-numeracy) is contained in the last paragraph of the extract. Did you notice it? Many people would have read this passage

[1] The ANSN, in collaboration with Redgum Consulting Pty Ltd and the University of Canberra, conducted a 2-year project called the Middle Years Numeracy Research Project. It was commissioned by the Australian Capital Territory Department of Education, Youth and Family Services (ACTDEYFS). The principal researchers, John Hogan of Redgum Consulting and Steve Thornton of the University of Canberra, worked with officers from the ACTDEYFS and teachers from several ACT schools to identify and document numeracy opportunities, and to design, develop and implement an effective and transferable model that would support ongoing, school-based engagement with numeracy across the curriculum.

before it was printed and, on the evidence, they have serious misconceptions about percentages.

It is very likely that there are no unintended spelling or grammatical mistakes in the whole book. Yet a serious piece of quantitative nonsense has apparently gone unnoticed — it is hard to imagine or justify it as some sort of literary device.

The letters pages of newspapers periodically fill with contributions lamenting poor spelling or grammar. Seldom are 'clangers' like this highlighted, yet the innumeracy that this passage illustrates is far more likely to place a person 'at risk' than any number of misplaced apostrophes or split infinitives. How can one make informed decisions about Superannuation? Medical insurance? Home mortgages? How does one negotiate working conditions trading off income with various conditions of work? What does it mean for me when the media reports that studies have shown that taking hormone replacement treatment drugs increases the risk of breast cancer by nearly 40%[2]? How should you respond to political decisions that are justified using quantitative data?

Education must be about enabling people to understand and interact with the world. The skills, habits of mind and dispositions developed through effective attention to numeracy across the curriculum are clearly key components of understanding and interacting with the world.

What is numeracy?

Many people have put forward definitions for the term numeracy since it was coined in 1959, by the writers of the *Crowther Report*

> …numeracy is defined as a word to represent the mirror image of literacy [...] On the one hand [...] an understanding of the scientific approach to the study of phenomena–observation, hypothesis, experimentation, verification. On the other hand ... the need in the modern world to think quantitatively, to realise how far our problems are problems of degree even when they appear to be problems of kind. Statistical ignorance and statistical fallacies are quite as widespread and quite as dangerous as the logical fallacies that come under the heading of illiteracy. (Quoted in Cockcroft, 1982, p.11).

In recent times Willis' (1992, 1996, 1998a, 1998b) description of numeracy has become widely used[3]:

> (B)eing numerate, at the very least, is about having the competence and disposition to use mathematics to meet the general demands of life at home, in paid work, and for participation in community and civic life.

This is a fairly general statement and, as a consequence, there is considerable effort being invested in elaborating it and working through the implications for schools and schooling.

Perspectives on numeracy in schooling

Willis (1998a, p. 33) has categorised the different perspectives on what school students must be able to do to be called (and to be) numerate in three ways: numeracy in terms of the mathematics itself, numeracy in terms of the context in which people find themselves in and numeracy in terms of strategic processes needed to choose and use mathematics.

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[2] These 2003 reports were based on data from two groups of 10,000 patients — there was an increase from 21 breast cancers in the control group, to 29 in the HRT group (New England Journal of Medicine). Interestingly the finding that taking these drugs resulted in a similar *reduction* of incidence of bowel cancer was not widely reported.

[3] This statement has been incorporated into recent national reports and statements about numeracy in Australia (e.g. DEST, 2000; Curriculum Corporation, 1998; AAMT, 1998; DEETYA, 1997); its sense has been picked up by the jurisdictions in comments on numeracy in curriculum frameworks and syllabi.

Perspective one: Numeracy is the mathematical concepts, procedures and skills students should know and be able to do.

These mathematical concepts, procedures and skills are mostly seen as the mathematics of the school classroom. Whatever the view of the details of what should be included in this 'tool-kit', the intention from within this perspective is to teach students the mathematics 'they need to know'.

Perspective two: Numeracy is the capacity to complete practical tasks and meet social goals that make mathematical demands.

People are seen as numerate or not according to their capacity to cope with the mathematical side of the work and social settings in which they function. The educational intention from this perspective is therefore to help students understand and deal with such settings and work towards expanding the number of situations they can deal with mathematically.

Perspective three: Numeracy is the generic and strategic processes students need for applying mathematics in different contexts.

This approach focuses on developing students' capacity to 'bridge the gap' between mathematics and the 'real world' contexts they deal with. The educational intention is to help students develop an orientation and capacity to think of and use mathematics in practical (or real world) situations, without any explicit intention to expand the mathematics the students may know.

A blended perspective

Each of these perspectives has strengths, but there is an emerging view in this country that a blend of all three is a good way of thinking about numeracy. When faced with situations requiring the use of mathematics, a numerate person would use a blend of mathematical, contextual and strategic knowledge. This view is reflected in the Framework developed by Willis and Hogan that is discussed later in this paper.

Is it the same as mathematics?

This is a question often asked when educators and others begin to think and talk about numeracy. To begin to answer it, we need first to consider what we mean by *mathematics*. Of course there are many versions of this, but a popular one is that mathematics is the 'science of patterns' (Steen, L.A., 1988). This implies a sense of generality and, to some extent, working in the realm of ideas.

Consider some of the patterns that are inherent when we add whole numbers. If we add two even numbers we get an even result; two odd numbers also give an even result; an odd and an even, however, gives an odd result. These rules are mathematical. It is hard to imagine the joy felt by a teacher of mathematics in primary school when young children work with these ideas — do mathematics — to come up with a 'new' rule that "if you add an even number of odd numbers you get an even result". Or that of a secondary mathematics teacher when as older children they are able to use visual or algebraic reasoning to prove that results like this are mathematically true.

The rules when adding whole numbers are also very useful in everyday life — there is something amiss if you are charged $29.90 for three pizzas that cost $9.95 each. This kind of mathematics in use, for a purpose other than mathematics, is what numeracy is about. Of course, you might say that each pizza is about $10, so three will be close to $30. That is numeracy. Or you might think that it is only 5 cents so it is not worth worrying about. That is numeracy too.

This example illustrates, of course, that there is a strong relationship between mathematics and numeracy. It is appropriate and important that the teaching of mathematics in schools

does support the development of students' numeracy, both by helping them learn the mathematics (the rules in the above example) and that they can be useful. Current developments and emphases in mathematics curriculum and pedagogy are designed to improve the quality of mathematics learning in schools. Effective teaching and learning of mathematics is important to numeracy development, but it is not enough to ensure they become numerate citizens, however, just as teaching children to read and write is not enough for them to be literate in anything like the contemporary sense of the term. Schooling offers rich contexts across the curriculum with a wide range of numeracy demands and opportunities. Conscious and effective use of these opportunities for the students' numeracy development complements what school mathematics provides.

New demands, new numeracies

The shift from an 'industrial' society to a 'knowledge' society in countries like Australia is widely acknowledged and well documented. The implications of this shift are being worked through in a multitude of contexts of human endeavour, including considerations of numeracy. Zevenbergen (2001) argues that "(n)ew forms of numeracies are needed in these new times". Whether these are 'new numeracies' or new contexts in which numeracy (as 'using some mathematics for some purpose') is played out is perhaps questionable. What is clear is that contemporary attention to numeracy in education needs to pay attention to what Zevenbergen calls 'technological numeracy', 'statistical numeracy' and 'business numeracy'. Personal 'financial literacy' should also be added to this list of 'new numeracies'.

Numeracy across the curriculum

Much of the work on numeracy in Australia has and is being led by people with mathematics backgrounds. Some deep implications are emerging for the teaching and learning of mathematics. These include issues around transfer of knowledge from one context to another, teaching for understanding, the impacts of information and communication technologies and the 'positioning' of applications of mathematics. These are not the focus of this paper.

The implications and challenges for curriculum, teaching and learning in Key Learning Areas other than mathematics, whether in traditional or new and emerging curriculum and organisational structures, are equally profound. By definition these are areas in which the workers do not have mathematics as a focus. Numeracy across the curriculum initiatives have been characterised by the formation of teams of these people working, at least initially, with others with mathematical interests and expertise to understand the issues and develop approaches and strategies. Ultimately, however, success with numeracy across the curriculum can only come when numeracy truly becomes *everybody's business*.

There are obvious parallels with the literacy across the curriculum movement that started in the 1970s and has been prominent ever since. In fact, the success of this emphasis could be measured by the extent to which effective literacy across the curriculum practices are embedded and now naturally a part of teaching and learning. There is a long way to go before this is achieved in numeracy across the curriculum.

One of the fundamental principles of literacy education is that to be able to *do science* (or geography or dance or whatever), students need to *learn the literacy of science* (or geography or dance or whatever). A non-negotiable part of being 'good at science' is being good at the literacy of science. The logic is compelling: A non-negotiable part of being 'good at science' is being good at the numeracy of science[4].

[4] Using the graphs, calculations, diagrams etc. to make meaning in science. For geography it will be the maps, scales, graphs; in dance the angles, patterns of beats, symbol systems for choreography etc.

A consequence of this is that, just as literacy is now considered across the whole curriculum, there needs to be purposeful and explicit attention to numeracy and achieving numeracy outcomes for students.

This is all very well at the broad level of good intentions — the rest of this paper provides some practical advice and support.

A Numeracy Framework

Willis and Hogan (2000) have developed a 'Numeracy Framework' (Hogan, 2000) as a way of thinking about numeracy. For educators it provides a means for analysing what students are being asked to do and the role they need to adopt. It helps focus intervention and action in the classroom by helping teachers identify more precisely what students are having trouble with — when students are 'stuck' it is not always because 'they can't do the maths'! The framework describes three types of 'know-how' that are part of being numerate in a context, and three roles that can be adopted in relation to the numeracy of the context.

Being (becoming) numerate involves a blend of three knowledges:

- *Mathematical* knowledge – having (learning) the skills, techniques and concepts necessary to solve quantitative problems encountered in a real context;
- *Contextual* knowledge – having (developing) an awareness and knowledge of how the context impacted on the mathematics being used; and
- *Strategic* knowledge – having (developing) the confidence, disposition and skills to find out what needs to be known in order to act numerately.

Being, or becoming, numerate involves being able to, or learning to, take on three roles:

- *The fluent operator* - being (becoming) a fluent user of mathematics in familiar settings;
- *The learner* - having (developing) a capacity for the deliberate use of mathematics to learn; and
- *The critical mathematician* - having (developing) a capacity to be critical of the mathematics chosen and used.

A NUMERACY FRAMEWORK

Being numerate within a context involves a blend of

three types of know-how

Mathematical

Contextual

Strategic

and three roles

The fluent operator

The learner

The critic

Willis, S & Hogan, J (2000)

Illustrating the Numeracy Framework with an example[5]

Julie is a Science teacher working with a class of 13 year olds. The students were watching a video on how the blood circulates around the body. The narrator talked about the number of red blood cells in the body, what their purpose is and how they travel around the body. After the video she asked the students if they had any questions and what they thought of the video. Straight away one of the students asked some questions related to red blood cells.

1. What does 250 million look like? That is a lot of blood cells! How is it possible for all of those cells to fit into our body?

2. If you were fatter, like myself, wouldn't you have more red blood cells?

Understanding this science requires students know some *mathematics*. They must be able to read, say, represent and understand 250 million and that the cells must be very small to have that many red blood cells in a human body. However in order to do this they require some understanding of the *context*. This means realising that red blood cells are very small. They need to be able to work *strategically* linking the mathematics (250 million) and the context (blood in the human body).

It was apparent to Julie, after an initial discussion with the class, that many of the students did not know how to represent 250 million using numbers. She had assumed they would all be *fluent operators* with respect to the number itself. However most of the students were not able to write the number, visualise 250 million as a quantity of cells indeed as a quantity of 'anything'.

The young man who asked the questions was acting numerately in the role of *the learner* – by asking the questions. He was using his limited knowledge of mathematics to try and make sense of something new and he was heroic enough to ask the questions on behalf of the class. We can guess that he was figuring that 250 million was a lot of cells – how do you fit that many 'things' in a body? He was using his common sense notion that a bigger body might contain more blood and therefore have more blood cells than a smaller body. The mathematics and the context (the science) were interacting to confuse him. Having the agency to ask the questions is something we might want for every young student.

After further research, prompted by the young man's questions, the class found that the figure 250 million may have been misinterpreted by him. In looking at information from two different sources, a conflict becomes apparent. The text that students were reading claimed that there are about 5 million red blood cells in a micro-litre of blood. This means that there are around 6 trillion cells in a human body. Perhaps the 250 million is in a drop of blood, around $\frac{1}{20}$ of a millilitre. Having the capacity to ask questions about whether the mathematics is appropriate, and to try to reconcile information from different sources, is a key aspect of being critically numerate.

The Numeracy Framework has been tested in a number of projects[6] and other school settings. As the above example shows it can be used to describe numeracy and numerate behaviour. Many teachers and others have found it to be a useful tool to help identify the numeracy demands of situation, diagnose student numeracy problems in a situation and assist the teacher to plan sufficient, appropriate learning situations that require intelligent, practical mathematical action by the student. Their ideas are listed below.

[5] Example used with permission from ACTDEYFS Numeracy Research Project

[6] AISWA Numeracy Research Circle (Redgum Consulting Pty Ltd), 2004; ACTDEYFS Numeracy Research Project (ANSN, University of Canberra and Redgum Consulting) 2002-2003; DEST Cross-sectoral Numeracy Research Project (Murdoch University) 2001-2003; ACTDEYFS Numeracy Research Circle (ANSN and Redgum Consulting) 2000; NSWDET Numeracy Research Circle (ANSN and Redgum Consulting) 2000; SA Numeracy Action Learning Circle (SA Middle Years Network, Murdoch University and Redgum Consulting) 2001.

Strategies for the teacher

An awareness of numeracy across the curriculum generates opportunities for engaging students with the numeracy in tasks. The teachers in the projects listed in the footnote, who have begun to explore these opportunities, have been suggesting the following strategies. Teachers and educators not involved in this research have commented that this list just represents 'good teaching'. This may be true. The essential point to make about this list though is that they are to be applied to numeracy – across the curriculum.

Capturing the numeracy in the moment

Be alert to the numeracy demands that arise in class work. Take the time to notice the students learning needs in the experience. Decide to deal with it - then or later.

Being aware of possible numeracy demands when planning

Take the time to review your curriculum planning for possible numeracy demands. This does not mean ensuring that these demands are always pointed out to the students prior to the experience (indeed if the numeracy demands are always identified for the students they will not get the essential experience of dealing with them themselves) but you can be prepared for the possibility that the students might need extra time, extra support or explicit teaching. Planning also means that you can ensure that students are confronted with dealing with sufficient numeracy demands over the school year. You might also identify any areas where sensible links to mathematics could be made and therefore where there might be opportunities to enhance student numeracy.

Allowing students to work it out

Provide students with both individual and collaborative opportunities to work things out for themselves. Don't rush to do it for them. Be patient and flexible with time to allow students to engage with the numeracy themselves, ask questions, fully understand the lesson and gain confidence in themselves as learners.

Supporting student numeracy learning by questioning

Facilitate discussion and support students' deliberations by asking questions about their handling of the task. Questioning can help students identify the numeracy and then use their mathematics. Try to keep the questions 'open' to encourage a willingness to participate.

Diagnosing student numeracy by listening purposefully

Monitor students' numeracy knowledge and skills by asking questions and listening purposefully as students engage with numeracy in a moment.

Debriefing the numeracy

Ask open questions that encourage students to reflect on the use of mathematics in the situation and the role numeracy played in their learning, understanding and problem solving. Ask the students 'what is the key mathematical idea that we have used here?' Ask them 'where else might we use this idea?' as well.

Practising

Give the students a different context that makes similar numeracy demands to one they have completed to allow the students an opportunity to practise their capacity to be numerate.

Promoting critical use of mathematics

Discuss with students whether or not mathematics might be able to shed new light on a situation. Where mathematics is being used - 'Is this use appropriate?' When they have used some mathematics to learn something, do something, make something ask them whether it 'was the best method?'

Teaching the framework to the students

Explicitly teach the students about numeracy and the ideas in the Numeracy Framework. Discuss with students what it means to be numerate. Students can practise the roles in the framework and develop a numeracy 'habit of mind'.

Sharing information on student numeracy with others

Sometimes you won't be able to find the way to help a student with a particular numeracy problem. Other teachers have found that it helps to share problems like this and get advice from others.

Teacher professional learning

The numeracy research circle

The Research Circle methodology, as outlined by the ANSN has been found[7] to be an effective way to begin consideration of numeracy issues at the school level and to support sustainable change processes within a school community. It provides teachers with the opportunity to consider in-depth new ideas about numeracy, many of which they are likely to find problematic, and to debate these ideas with each other. The principles of the Research Circle methodology ensure that enquiry is done in ways that both respect and benefit from the knowledge and experience of the teachers involved.

The Research Circle approach is a cyclic one, with in-school investigation of issues occurring between face-to-face meetings. Research Circles tend to operate simultaneously on two levels.

At the **classroom level** there is an emphasis on actual student work and the issues that surround it. An often used investigative tool is the documentation of 'numeracy moments'. These are instances in which some numeracy demand or opportunity emerges in the classroom. Teachers have gained a great deal of insight through recording and analysing these moments, and discussing them with colleagues.

Numeracy moments can be an important part of the **school level** operation of Research Circles in numeracy as they often raise questions of consistency across the school. They also identify issues that relate to matters of operations and organisation, professional learning priorities and processes and so on. Another approach that has been useful in Research Circles in numeracy as they attempt to investigate and improve whole school approaches to numeracy has been the Numeracy Audit.

Numeracy Audit[8]

The *Numeracy Audit* is a process through which teachers can collect information about numeracy within the school in order to plan improvement strategies. The following outlines this process as applied to numeracy across the curriculum. Student performance in mathematics is only looked at as a reflective question once information about numeracy across the curriculum has been collected, collated and analysed.
It has the following goals for benefit of the whole school community:

- Teachers will become better informed about numeracy demands across the curriculum.
- Teachers will develop skills in recognising numeracy demands in their classroom and their curriculum; and therefore students' performance in relation to numeracy.
- The school will be able to make informed judgments about the extent to which numeracy requires action and where that action should be directed.
- Students will have greater opportunities to develop numeracy, as teachers will extend their knowledge of numeracy teaching strategies.

In order to achieve these goals the *Numeracy Audit* provides teachers with information, which enables them to respond to the following questions.

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[7] www.ansn.edu.au

[8] Further information on the Numeracy Audit is available on www.redgumconsulting.com.au and will be also available on www.act.gov.au

1. What is numeracy and numerate behaviour?

- Do teachers have a common view of numeracy?
- How confident do teachers feel in providing opportunities to develop numerate behaviour and in recognising student numerate behaviour?

2. What is the school doing with regard to numeracy?

- How do our curriculum documents refer to numeracy?
- How do our school documents refer to numeracy?
- How do our own teacher documents and planning refer to numeracy?
- Are students being provided with enough opportunities to develop numerate behaviour?

3. How well are our students developing numerate behaviour?

- What do our students think numeracy is?
- How well are students responding to classroom tasks that make numeracy demands on them?
- Are they responding fluently when and where we might expect?
- Are they using mathematics in their learning strategies and for understanding the context?
- Are they being constructively critical of the mathematics they use?
- Do our students know how to go about improving their own numeracy?

4. How effective are current practices for developing students' numeracy.

- What should we do more of?
- Are there aspects of classroom activities we should do less of?
- What could we start doing to improve student numeracy?

There are a number of key steps to take in conducting the numeracy audit. While they appear to be a generic list of steps applicable to any review what is different is the focus – numeracy.

1. Collect and organise background information on the school
It is important to take into account the various factors that identify your school — particularly any groupings of students that may require extra attention.

2. Identify staff perceptions of numeracy
It is likely that staff have different understandings about numeracy. By making these explicit staff can discuss how they are different, the extent to which they differ from school and system descriptions, how their view impacts on their teaching of numeracy, and to what extent they might want to change. Schools have done this by interview, workshop and survey.

3. Find out what students think about numeracy
In the ANSN Research Circles we have found it interesting and informative to ask the students about their understanding of numeracy. Teachers have asked students, working in groups, to describe situations in school, at home or elsewhere where they use mathematics to help them do things. Some teachers have then extended the exercise by asking the students to interview their parents to find out what they think about numeracy.

4. Examine school and curriculum documents for descriptions of numeracy.
An individual or team examines the school, system and commercial curriculum documents used by the school for reference to numeracy and strategies they suggest for teachers to use for developing students numeracy. The intention is to search for patterns of similarity and different between how numeracy is described and 'acted upon'. Teachers use the *Numeracy Framework* to decide the extent to which numeracy is being addressed.

5. Review teachers' own curriculum documents for references to numeracy.
Similarly teachers review their own documentation for reference to numeracy and to investigate how numeracy is being described and developed.

6. Collect examples of what actually happens in the classroom.
This is the key step in the numeracy audit. It is about noticing and wondering about the extent to which:

- numeracy demands are being made on students across the curriculum
- the nature of these numeracy demands
- students are coping with the numeracy demands being made on them
- students are developing a robust capacity to be numerate when required
- what you are doing as a teacher, and what you might start or stop doing.

There are numerous ways this work can be approached:

- collecting, documenting and sharing with other teachers one significant numeracy example
- observing and documenting numeracy moments over a period of time
- analysing a slice of student work across the curriculum
- shadowing a student across the curriculum over a period of time.

Doing the above activities, or ones like them, produces a rich array of information that requires thoughtful analysis and the subsequent action. The next steps of the audit are typical of any action research and evaluation activity. Data is collated, analysed and displayed. Participants identify and discuss issues arising from the information collected and plan future action, including working with parents. An ongoing cycle of research can then be established.

Issues for further research

Significant research needs to be conducted into numeracy and how to support the development of student numeracy. This would seem particularly significant for two current priority areas – the middle years of schooling and vocational education and training (VET).

1. Investigating the impact of a 'whole school' approach to numeracy across the curriculum

A project(s) that document(s) student numeracy, developing whole school approaches to conducting an audit of numeracy; developing student numeracy across the school; and whole school numeracy planning.

2. Longitudinal study of numeracy across the curriculum

It is important to begin to document and analyse the images of what coherent and consistent approach to numeracy across the curriculum looks like over time e.g. numeracy within different communities of practice (learning areas, home, school, community).

3. Numeracy assessment strategies

Recent projects have commenced the work of developing test items with the intention of testing numeracy in context. This work needs to be continued and further developed. Assessing numeracy using short timed tests will always be of limited value. Further work needs to be conducted to develop richer tasks that make numeracy demands on students; where student numeracy performance can be rigorously assessed in ways that both inform their learning and that can be reported to parents and others.

4. New numeracies

Research into what 'new numeracies' (from the use of technologies; pervasive quantitative information) might be, how they might begin to manifest themselves in the school curriculum and hence how teachers might deal with them is essential.

5. The role of the mathematics teacher in developing student numeracy

Restricting mathematical thinking to the domain of school mathematics lessons will not, on its own, develop students' capacity to be numerate in a range of contexts. However school mathematics does play a crucial role in developing the skills, understandings and dispositions that underpin the rich interpretation of numeracy outlined above. What should school mathematics look like if it is to give students the agency to be numerate? How do skills, understanding and habits of mind work together and how should they be developed? What implications are there for the way we conceptualise the school mathematics curriculum?

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Written by:

Will Morony, Mathematics Educator

John Hogan, Director, Redgum Consulting Pty Ltd

Steve Thornton, Lecturer in Mathematics Education, University of Canberra.

Refereed by:

Beth Powell, Senior Lecturer, Murdoch University

Rick Owens, Numeracy Officer, ACTDEYFS

Phil Daly, Executive Teacher, Ngunnawal Primary School

Peter Mobey, Executive Teacher Mathematics, Gold Creek Middle School

Series Editor:

Christine Owen