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Assessing numeracy *and* NAPLAN

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What is numeracy?

Mathematics and numeracy are often used interchangeably in schooling and in general usage, some believing numeracy to be a subset of mathematics, or the basic mathematics skills that are needed for participation in society or for further mathematics learning. The Interim National Curriculum Board now the Australian Curriculum Assessment and Reporting Authority) used the following definition of numeracy in its 2009 document *Shape of the Australian Curriculum: Mathematics*: "Numeracy is the capacity, confidence and disposition to use mathematics to meet the demands of learning, school, home, work, community and civic life" (Interim National Curriculum Board, 2009, p. 5).

The Australian Association of Mathematics Teachers describes numeracy as involving "the disposition to use, in context, a combination of: underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical and algebraic); mathematical thinking and strategies; general thinking skills; and grounded appreciation of context" (AAMT, 1997).

It is clear that numeracy is a capability; one is either numerate or not, meaning that a numerate person has the ability and disposition to use and apply mathematics in a range of contexts outside the mathematics classroom.

This means that mathematics is learned as a body of knowledge. Being able to apply it independently by first assessing a context and determining that 'some mathematics will help here,' then making some choices about what mathematics will help, the degree of accuracy needed for the context, and then applying that mathematics confidently, is what makes someone numerate.

Assessing numeracy

To assess a student's numeracy capability would require that we observe the student and determine their independent ability to:

- clarify and make sense of a situation and recognition that 'maths will help here';
- make appropriate choices, based on context, of:
  - mathematics methods,
  - tools and strategies,

  - degree of accuracy needed,
  - representations of interpretation,
  - reasonableness of solution, based on ability to estimate,
- apply/use selected methods, tools, strategies, accuracy level;
- interpret solution and appropriateness of choices made and efficiency of use; and
- communicate their results and methodology in appropriate format for audience and purpose.

Clearly it is impossible to do this on a large scale for every student across Australia, and some might even argue this for their own class. Indeed, very rarely do teachers assess numeracy, focussing instead on aspects of numerate behaviour and, in particular, on their students' abilities to use and apply selected methods. This type of assessment frequently results in only the assessment of mathematics and, even then, a narrow form of mathematics since the methods, tools, strategies and accuracy levels are often pre-determined by the questions used.

For example, consider the following assessment item:

> Use the Pythagorean Theorem to find the height of a tree which casts a shadow 2.35 metres long and has an angle of elevation with the ground of 53° (give your answer to two decimal places).

What is being assessed is a mathematical skill, as opposed to an application of mathematics since most decisions are made for the student; indeed, if a student had experienced many questions like this in the classroom and for homework, then it is likely that only the student's recall is being assessed. This same comment might apply to the following questions if found on an assessment task:

$23 \times 4 =$
$56 + 27 =$
$243 \div 7 =$

National Assessment Program Literacy and Numeracy (NAPLAN) numeracy tests

The NAPLAN numeracy tests, while not perfect, do attempt to assess numeracy *to some extent*. Clearly it is impossible to authentically assess student numeracy on a national scale. A downside of the NAPLAN numeracy test—from a definitional perspective—is that students do not have to make the decision about 'whether some maths will help' when answering questions because they already know it will due to the labelling of the test paper. Removing this part of the decision-making required for numeracy reduces the power of the test to measure numeracy capability, as defined here.

What the writers of the test attempt to do, at least, is to ensure that questions are not 'typical' of what students in Australian schools generally experience. They avoid using clues, including words such as "add," "subtract," "multiply" or even strategies and methodologies with which students might be familiar. Also, wherever possible, they embed the mathematics in contexts and situations that require students to read in order to clarify what mathematics is required. This ensures that students have to choose which strategies, operations and methods to use.

Whilst some might argue that requiring students to read in order to access the mathematics in a question disadvantages some students,

literacy is an essential part of the mathematical problem-solving process (Doyle, 2005) and problem solving is an essential part of a quality mathematics program. As such it needs to be attended to by teachers as part of teaching and assessing both mathematics and numeracy.

Using a problem-solving framework such as *Clarify, Choose, Use, Interpret and Communicate*—particularly the clarification stage—will assist students in meeting the literacy demand of numeracy (and of NAPLAN). Indeed, Recommendation 8 of the *National Numeracy Review* (Council of Australian Governments, 2008, p. xiii) states:

> That the language of mathematics be explicitly taught by all teachers of mathematics in recognition that language can provide a formidable barrier to both the understanding of mathematics concepts and to providing student access to assessment items aimed at eliciting mathematics understandings.

Research conducted by Newman (1977) found that, on examining the errors made by students as they solved worded mathematics problems, at least 35% of the errors made occurred before students were even able to attempt to apply mathematics skills and knowledge. The language-based errors occurred during the reading, comprehension, and transformation stages.

It is more than likely that Australian students struggle to read and interpret many questions on the NAPLAN numeracy tests and are unable to determine what they are required to do. Often this is because they are not taught literacy skills in their mathematics learning opportunities:

- there may be words and phrases with which they are unfamiliar (e.g., number sentence, total, difference between)
- there may be text forms such as data displays, tables and arrays which they may have never seen or engaged with;
- there may be connections between pictures and diagrams, photos, symbolic number sentences and literary statements that they are demanded to make that they may have never been required to make before.

All these text forms need to be explicitly taught as it is unfair that students be assessed in them if they have never been taught how. Note that it is *not* unfair that these things are assessed, since these text forms are part of numeracy, and that is what is being tested.

What many teachers have failed to recognise is that students can capitalise on the genre or text format of these tests, and should be taught to do so as part of learning the skills of numeracy. Many questions are multiple-choice which means that they can often be done by estimating the solution and looking among the answer choices for the answer closest to the estimation. Of course, students need to deeply understand mathematical concepts in order to estimate solutions, and since many students do not have this deep knowledge, this strategy is usually avoided; instead students will choose to attempt to calculate the exact answer, which usually takes a lot more time than estimation. Moreover, research has shown that, in real-life situations, more calculations require estimation than require exact answers, and more than 85% of these calculations are done mentally (Northcote & McIntosh, 1999).

What is also tested in NAPLAN numeracy tests is *fluency*—a skill that has been significantly elevated in the *Australian Curriculum: Mathematics* (Australian Curriculum Assessment and Reporting Authority, 2010)—since students are required to complete the test in a given timeframe. Choosing what are inefficient methods for many students (e.g., calculation instead of estimation) means that students usually have to work more quickly to

complete the test—and this means increased anxiety and hence greater risk of error. However, if they have neither been taught to estimate using mental calculation and visualisation skills, nor that estimation is sufficient and appropriate for many questions, then they are also not in the position to choose the best method as they only have one method in their repertoire!

Conclusions

I have attempted to clarify the distinction between numeracy and mathematics and the implications of this distinction for teachers of mathematics. In doing so I have, of necessity, focused on one—albeit significant—high stakes assessment genre used on Australian students that purports to measure numeracy.

It is essential that we, as teachers, understand the genre used in the NAPLAN numeracy test in order for our students to be prepared for it. There does, of course, need to be some balance in how we do this: spending inordinate amounts of time 'preparing for the test' creates another set of problems. However, if the preparation is embedded in the mathematics program of the school, where students are taught and required to clarify contexts and situations, make choices about the mathematical models, tools and strategies needed, and to critique their own mathematics choices as well as those of others, we will not only be improving their numeracy capability but also their mathematics skills and understandings.

The NAPLAN numeracy test is not perfect. However, I believe that the way in which the results are used is more problematic than the test itself. Teachers can learn a lot from the test results if they analyse the data generated to inform their teaching and learning programs; i.e., if they were to use the information provided by the test data as assessment *for* learning, rather than as assessment *of* learning.

Finally, we must ensure that we are teaching our students for numeracy attainment: mathematics skills and procedures alone are insufficient for students to have the capabilities needed to be numerate at school, home, at work, in the community and in civic life, let alone to be successful on an assessment genre designed to assess numeracy in a pen and paper test.

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