Cracking the NAPLAN Code: Numeracy and Literacy Demands

THELMA PERSO examines the literacy demands of NAPLAN test items and provides advice about the explicit teaching of code-breaking and comprehension skills that are essential to numeracy.

Background

In May 2008, the first National Assessment Program for Literacy and Numeracy (NAPLAN) test was administered across Australia to determine the standard of literacy and numeracy achievement of Australia's students in Years 3, 5, 7 and 9.

Some students did very well on the tests and some did not. For a number of reasons, I am not necessarily a supporter of this type of test, although they do have their value and cannot be ignored. In fact, they can tell us a great deal about students' learning. They also reveal a lot about what is likely to be happening (or not happening) in classrooms and across schools in terms of what students are being taught and exposed to. One particular concern that has been raised in relation to the items on the tests relates to the literacy demands inherent in understanding the requirements of the tasks. This article looks at the literacy demands of the numeracy tests and draws attention to the importance of explicit teaching of the literacy skills that allow students to access what is being assessed in the questions.

The literacy of mathematics: What is it?

At a recent presentation that I gave to some school leaders, I drew attention to a question from the Year 3 numeracy test (see Figure 1).

The question shows a picture of four tricycles. Underneath the picture is a sentence asking children to "Complete this number sentence to show the total number of wheels in the picture." Under the sentence is space for the symbolic representation of what the picture shows.

reading, comprehension, and transformation stages. Being numerate requires a certain degree of literacy skill as well as being able to perform the mathematics. Indeed, the literacy is part of the mathematics since it does not make sense to separate the two.

Children need to be taught that part of being able to do mathematics successfully requires an ability to:

- read and comprehend a problem;
- identify that "maths can help here";
- work out what needs to be done;
- make some choices about how they might do it;
- do it; and
- decide whether the solution they have arrived at makes sense in the context.

All these skills are part of working mathematically which has been a major focus of the national curriculum for nearly 20 years. I believe that in a large proportion of classrooms where mathematics is being taught, lessons are still focussing on the "do it" step in the above process. Children are being taught all the mathematical skills that include times tables, multiplication (and other) algorithms, and a variety of processes in order to get "sums right." For the children in these classrooms, however, neglecting to teach the other skills listed above is likely to make it difficult for them to have success

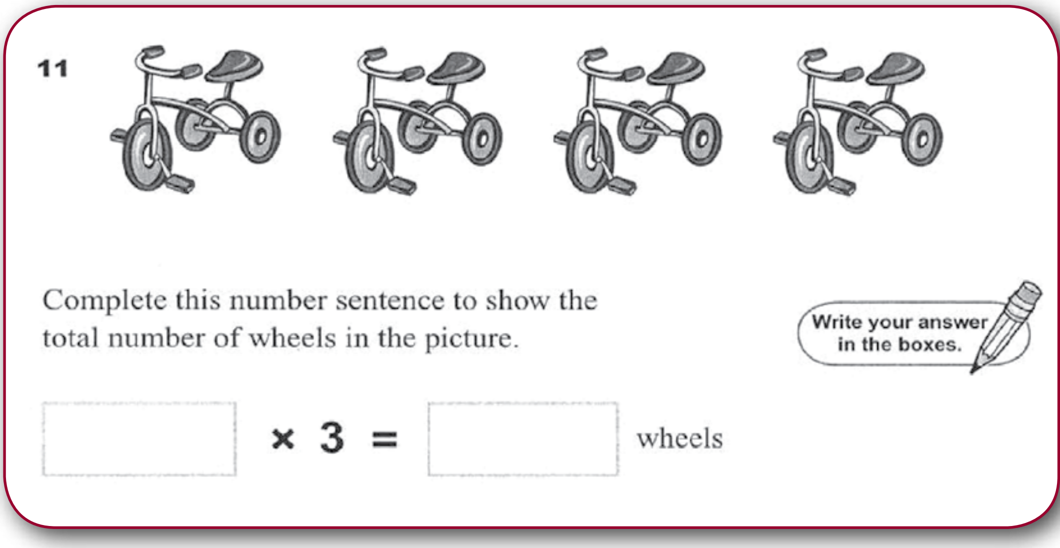

Figure 1. Question from the 2008 Year 3 NAPLAN numeracy test.

I showed the group the percentage of children in my state who had correctly answered the question, but before I could describe possible reasons for this, a member of the audience interrupted with, "But the question isn't fair. They all know how to multiply and they all know their tables: they just can't read it to find out what maths they need to do."

This interruption was quite fortuitous because I was about to launch into what I believed were the reasons for the poor results of the students — which was that teachers may not be teaching the children how to read and interpret questions; indeed, many teachers do not believe this is part of teaching for numeracy.

Newman (1977) examined the errors made by students as they solved worded mathematics problems and found that at least 35% of the errors made occurred before students even attempted to apply mathematics skills and knowledge. The language-based errors occurred during the

on the NAPLAN numeracy tests, let alone position them to be numerate as a result of schooling.

Reading and comprehension

In order to understand what the question is asking students to do, reading and comprehension skills need to be developed. Reading requires skills in code-breaking; i.e., knowing the words and how the words, symbols and pictures are used in the test genre. Comprehension — i.e., making meaning of the literal, visual and symbolic text forms presented — requires students to draw on their skills as a text user, a text participant and a text analyst (Luke & Freebody, 1997). The following sections describe the application to numeracy of two major aspects of literacy: code-breaking and comprehension.

Code-breaking

There are many different codes in mathematics that children need to crack if they are to have success with the NAPLAN test genre. These include:

- English language words and phrases (e.g., wheels in the picture);
- words and phrases particular to mathematics (e.g., number sentence, total);
- words and phrases from the English language that have a particular meaning in the mathematics context but that may have a different meaning in other learning areas (e.g., complete);
- symbolic representations which for many learners are a language other than English (LOTE): these include “3” representing “three,” “×” representing “times,” “multiply” and “lots of,” “=” representing “is equal to.”
- images, including pictures/drawings, graphs, tables, diagrams, maps and grids.

These codes need to be explicitly taught and not taken for granted. This means that children need experience in not only reading these but using them, writing them, drawing them and matching them to different codes. In teaching words and phrases such as, “total” or “number sentence,” for example, children need to be asked to use them in a sentence of their own, or place them in a sentence with gaps by matching them from a list or describing orally what they mean. An example of such a task is shown in Figure 2.

Use the word “total” and the phrase “number sentence” to fill in the blanks in this sentence:

John wrote a ____________ that would help him find the _________ number of books on the shelf.

Figure 2. Example of a sentence completion task.

For mathematical jargon words like “complete,” students need to write sentences using them in a mathematical way and in other ways, such as:

Jane took her homework home to complete it that night.

Sam has the complete set of portable media player tunes.

This vocabulary needs to be built by using dictionaries, thesauruses and by discussing and sharing meanings of words as found in phrases.

All of these strategies are familiar to teachers teaching English language; however, they are rarely used by teachers of mathematics. Similarly, when teaching symbolic representations, children should be taught explicitly to match the symbol with the word it represents, and a drawing or visual representation of the quantity or operation it represents. For example, Figure 3 shows multiple representations of a quantity and an expression.

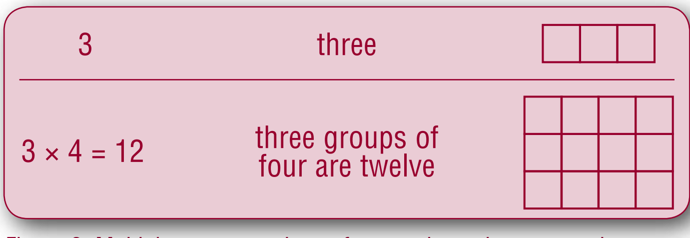

Figure 3. Multiple representations of a quantity and an expression

The spin-off from engaging children in these activities is that translating one representation to another also facilitates deep learning of mathematical concepts such as multiplication.

Comprehension

Children use their knowledge of the codes to make meaning of the questions. They use their previous experiences in the classroom to comprehend what is required. They use:

- drawings and images (such as the picture of the tricycles) to help them visualise and infer what the question might be asking;
- words like "complete" and "total number of" to infer what the question is asking; and they also
- translate from the drawing to the sentence and then to the symbolic representation to understand they need to "fill in the empty boxes."

These comprehension strategies need to be explicitly taught and deliberately practiced. Strategies include:

- experiences with the test genre;
- relating the text types (drawings, grids, word sentences) to children's experiences;
- asking children to "retell," clarify or paraphrase the situation that is being represented and describe or explain to others what they are inferring and thinking about a situation.

An example from Year 7

The literacy demands of mathematics are similarly significant for older children, whether they be in a primary or secondary setting.

Question 31 from the numeracy non-calculator paper for Year 7 has strong literacy demands:

> Ben puts 7 flowers in each of 8 vases.
> He has 3 flowers left over.
> Ben wants to put 9 flowers in each vase.
> How many more flowers does he need?

Clearly, the comprehension demand is a major part of the question. Students also need a strategy for dealing with this question; they need to know how to 'hold' all pieces of information in their head and deal with the cognitive load this creates. An appropriate strategy would be to draw a visualisation of the given information to assist this process. Without such a strategy, many students are likely to simply read and re-read trying to make sense of the question; many would be overwhelmed and not know where to start.

Breaking the codes is critical: words and phrases of which they need to make sense include: "in each of," "left over," "in each," "how many more… does he need?"

The students should learn "in each of" explicitly in the context of sharing and this can be supported through strategies such as asking students to write a sentence explaining a picture of three vases with four flowers in each one and then explaining verbally how they understand the situation.

"Left over" is an interesting phrase which can be confusing because of the dual meaning of the word "left." Students need to be taught the two meanings and to write sentences showing each in context.

"How many more" is demanding for students as they frequently learn to associate "more" with addition. They consequently need to be taught the phrase "how many more" as implying the need for either an "add on" strategy or a "take away" strategy in order to find the difference. These can be learned through partitioning accompanied by drawings, sentence/phrase writing and use of an unmarked number line. For example, to answer the question: "How many more than 12 is 35?" the numbers 12 and 35 can be drawn on an unmarked number line as shown in Figure 4.

By jumping along the number line in two tens and then a three, they learn that 35 is 23 more than 12. They should also be taught

to go backwards and learn that 12 is 23 less than 35.

This type of strategy is useful in supporting students in Years 7 and 9 who obtain incorrect answers in questions such as these. They are particularly valuable for students who have failed to grasp concepts in their early years of schooling and lack deep understandings of numbers and operations and how they work. As part of the teaching and learning strategy, they should draw and write, and use images and text. They could be asked to write in words what they have done and/or describe a real life situation in which this calculation might occur or be needed. They should then be asked to represent what they have shown and describe it using symbols; e.g., 35 – 23 = 12 and 12 + 23 = 35. They might then be asked to write a variety of literal descriptions for this operation and process, including intermediary steps. Examples of possible descriptions of this calculation are:

- 35 is 23 more than 12.
- 12 is 23 less than 35.
- 22 is 10 more than 12 and 10 less than 32.

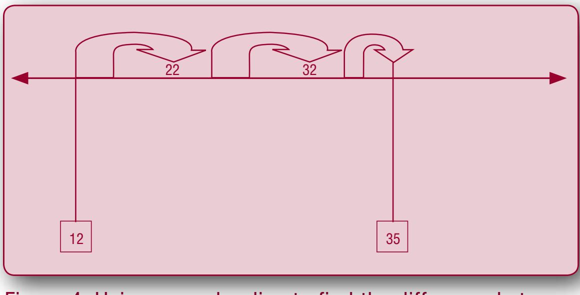

Figure 4. Using a number line to find the difference between 12 and 35.

Conclusions

Clearly, mathematics is more than symbols and hence requires literacy skills to be deeply understood. We do our students no favours if we fail to teach explicitly the literacy demands of mathematics. Indeed, all mathematics occurs in context and numeracy requires that we use the words to determine whether "maths will help here" and to choose and use the mathematics that will help, guided by the context and the level of accuracy required.

In the same way that students need to be taught explicitly how to deal with the literacy demands of a task, if students are to become numerate, teachers need explicitly to use a literacy frame when planning and teaching mathematics. A comprehensive view that "the words are part of the maths" is essential for every teacher of mathematics as well as the use of a lesson planner that includes a column/space for "literacy demands."

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