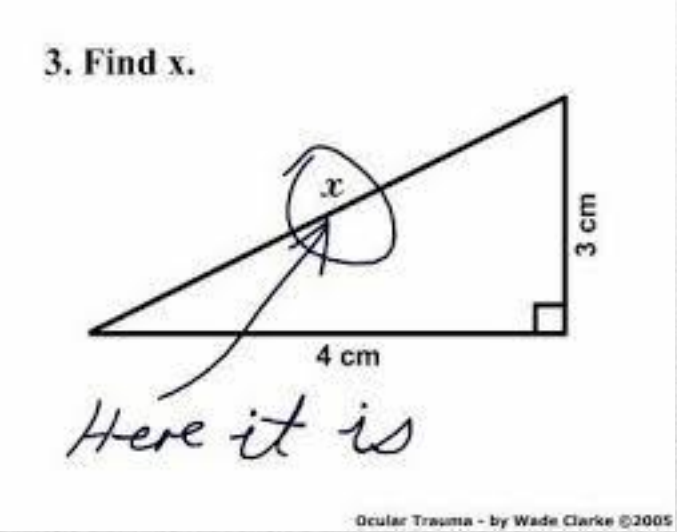
Literacy, Language and Mathematics Learning

The power of the preposition: a little on literacy, a lot on language and sum numeracy two/to/too?

We all know the old joke…



Why is it amusing?
Why should it make us concerned?

A little on literacy

A Little on Literacy…

- We have children in our schools who fail to meet literacy and numeracy benchmarks
- Many of these children are our English as Additional Language/Dialect learners (EAL/D) and children form low socio-economic backgrounds
- These learners have the same potential as any other learner in an Australian classroom

- Literacy is '*what students do with language*'.
- Language underpins literacy; they are not the same.
- *To improve literacy, do we need to pay more attention to language?*

- 'Making good use of school time is the single most egalitarian function the schools perform, because for disadvantaged children, school time is the only academic learning time, whereas advantaged students can learn a lot [about school] outside of school.' E J Hirsch Jr

Teacher Knowledge

- **Content Knowledge** – knowing our learning area content: knowing the mathematics, but also *knowing how the English language works to make meaning in mathematics*

- **Pedagogical Knowledge** – knowing how students learn

- **Pedagogical Content Knowledge** – knowing how to teach the specific content of our discipline (Shulman,1986)

Shared Content Understanding – The Australian Curriculum Mathematics

The Australian Curriculum

- It is written from the assumption that Standard Australian English is the first language of the learner, and as such they will have an intuitive knowledge of many aspects of the English language.
- It also assumes that students will have done all of their schooling in Australian schools, and so works on the assumption that literacy knowledge will be built cumulatively throughout the curriculum

Language aware teaching

- Operates with the understanding that our students won't have Standard Australian English as their first language. It focuses on the features of English language that are often intuitive to white, anglo learners of a particular SES.
- Does not work on the assumption that these students will have accumulated prior knowledge and understandings through a continuous experience of of Australian schools and the Australian Curriculum.

Disciplinary knowledge is constructed by the language of the discipline.

Language and Literacy in the Australian Curriculum

- We use language to make meaning.
- Literacy is about being able to make effective language choices and use language knowledge to make meaning in different contexts and for different purposes.
- Context and purposes change across the discipline areas; therefore the language changes also.
- The language and literacy specific to discipline areas (ie mathematics) is best taught **within** the discipline areas by **teachers who understand the content.**

The last word on literacy; what does the Australian Curriculum say?

Literacy
Students become literate as they develop the knowledge, skills and dispositions to interpret and use language confidently for learning and communicating in and out of school and for participating effectively in society. Literacy involves students in listening to, reading, viewing, speaking, writing and creating oral, print, visual and digital texts, and using and modifying language for different purposes in a range of contexts.

L*iteracy is an important aspect of mathematics*. Students develop literacy in mathematics as they learn the vocabulary associated with number, space, measurement and mathematical concepts and processes. This vocabulary includes synonyms, technical terminology, passive voice and common words with specific meanings in a mathematical context. They develop the ability to create and interpret a range of texts typical of Mathematics ranging from calendars and maps to complex data displays.

Students use literacy to understand and interpret word problems and instructions that contain the particular language features of mathematics. They use literacy to pose and answer questions, engage in mathematical problem solving, and to discuss, produce and explain solutions.

Rather a lot more on language…

Problems with mathematics can stem from problems with language.

How many different ways can we say:

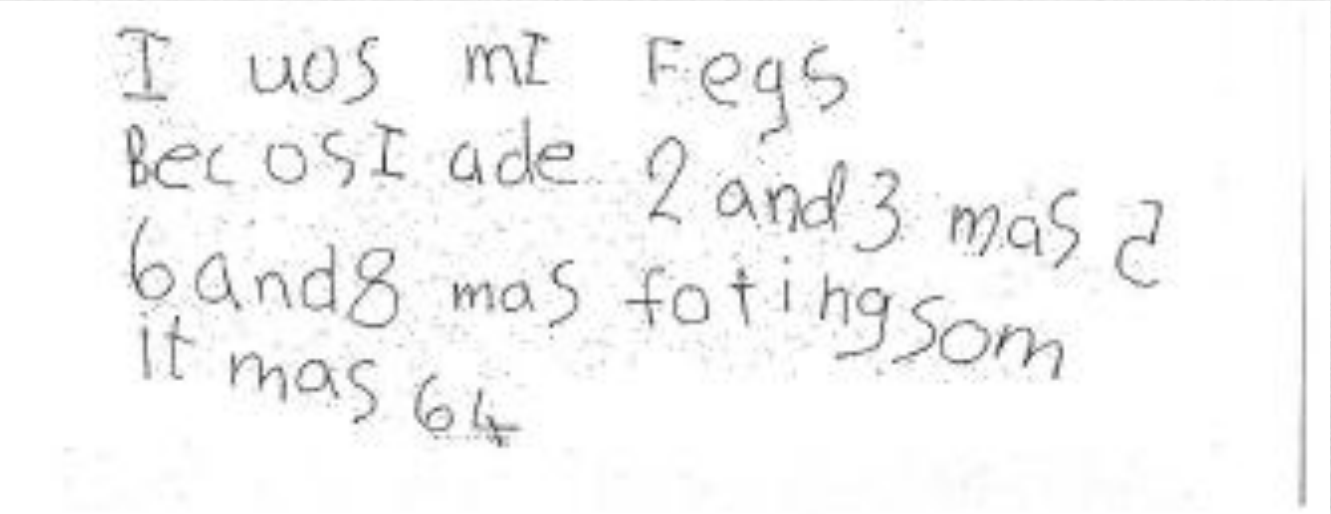
$$6 + 5 = 11$$

$$\frac{1}{2} \times 6 = 3$$

- Bilingual students or students from EALD backgrounds may have difficulty with certain language constructions.
- Literacy problems do not always mean numeracy problems

Mathematics difficulties and/or language difficulties?

Child 204 **26 + 38**



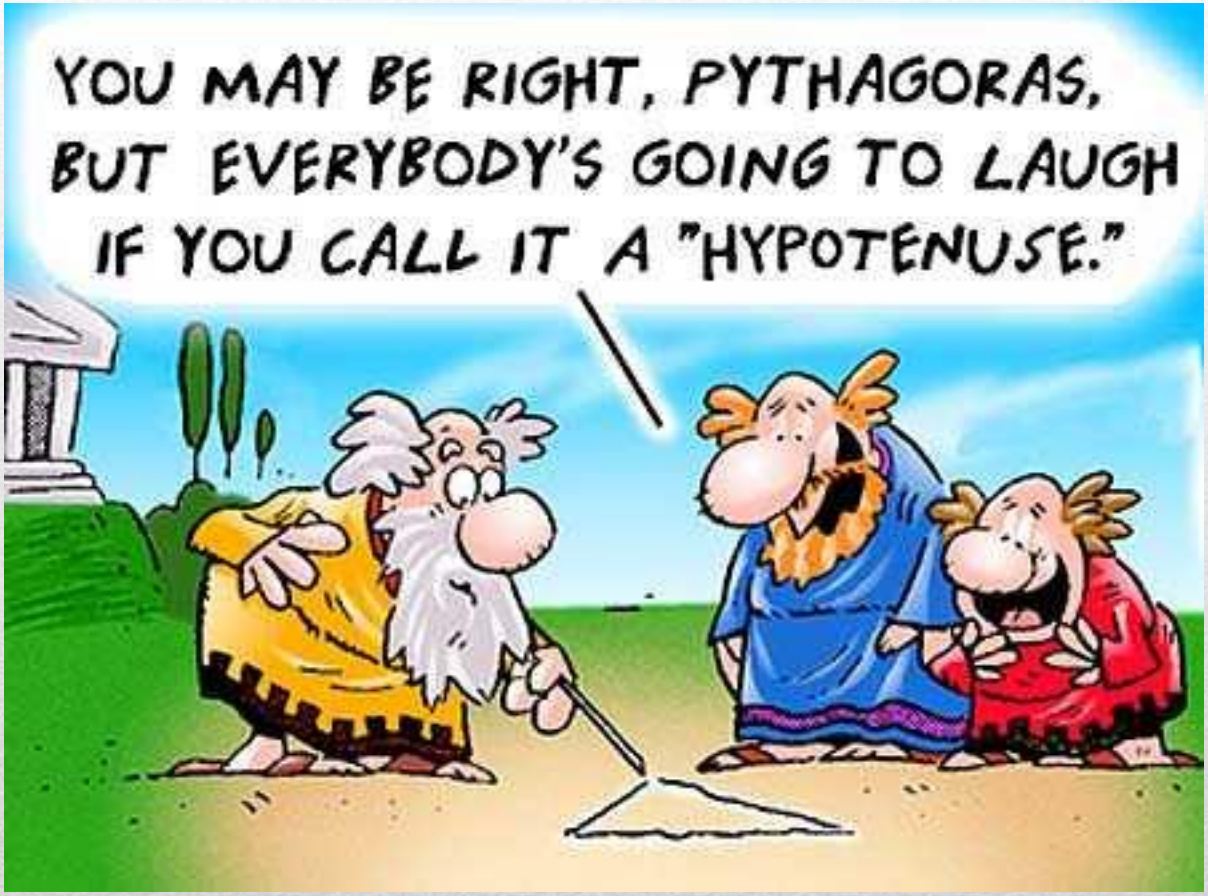
Features of mathematical English

- **Synonyms:** subtract, minus, take away, decrease, less than, difference…
- **Imperatives:** Circle correct answers…
  … evaluate…, simplify…, justify…, explain…, calculate…
- **Ellipsis:** convert your age to days, then hours, then minutes, then seconds.
- **The passive voice:** If 7 *is taken from* 25…
- **Compound phrases to represent new concepts:** lowest common denominator, square root, inverse proportion
- **Technical terminology:** lowest/least common multiple, hypotenuse, trapezium/trapezoid
- **Common words with a technical meaning in mathematics:** mean, plane, root
- **Terms with multiple meanings within mathematics:** median, base, range, square
- **The use of metaphorical language to express concepts and processes:**
  How many fours are there in 44?
- **Homonyms:** two/too/to, pi/pie, whole/hole, four/four, complement/compliment, sum/some

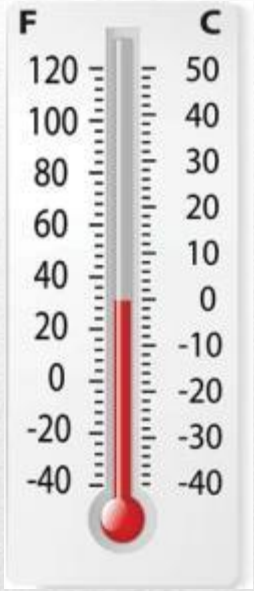
Those common words…

common	*face*	*line*
edge	*mean*	*plane*
power	*point*	*place*
positive	*negative*	*odd*
even	*proper*	*improper*
construct	*normal*	*base*
set	*translate*	*derive*
round	*table*	*rational*
radical	*limit*	*supplement*
index	*product*	*union*
order	*volume*	*prime*

… and many more!


YOU MAY BE RIGHT, PYTHAGORAS,
BUT EVERYBODY'S GOING TO LAUGH
IF YOU CALL IT A "HYPOTENUSE."

Prepositions



- Consider:

  the temperature fell ***to*** 10°C

  the temperature fell ***by*** 10°C

  the temperature fell ***from*** 10°C

  the temperature fell 10°C

- Or this:

  … the bearing ***of*** ship A ***from*** the lighthouse
  and the bearing ***of*** the lighthouse ***from*** Ship B…

- And what about:

  dividing **into** and dividing **by ?**

- **A few little words**

  and *or* *all* *any* *of*

- **Some logical connectors**

  …if and only if…

  if …then

  because

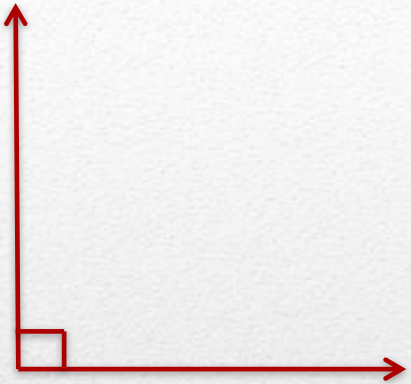
- **Some complex structures**

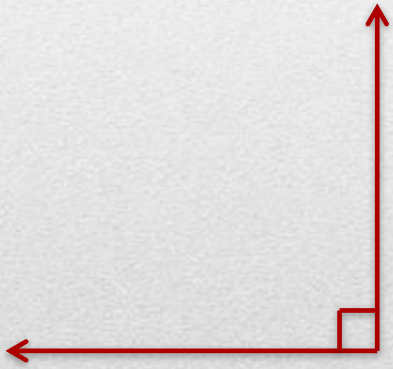
  greater than *less than*

  n times as much as *as…as*

The things they say!

1. If this is a right angle…

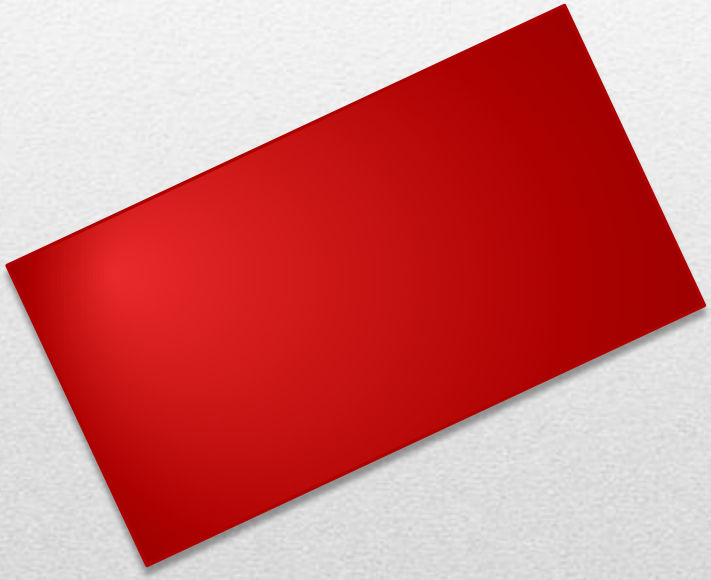




… then that must be a left angle

2. **Diagonals**

0 diagonals



4 diagonals

What is a diagonal? What is the problem?

Cues that may be conveyed by numbers in a word problem

- If there are more than two numbers, add them.
- If two numbers are similar in magnitude, subtract the smaller from the larger.
- If one number is relatively large compared to a second number, divide.
- If the division answer has a remainder, cross out your work and multiply!

Some word problems to think about.

1. What is the difference between 14.3 and 3.8?
2. There is a certain number. If this number were 4 more than twice as large, it would be equal to 18. What is the number?
3. There are 10 birds in a tree. 2 get shot. How many birds are left?
4. John can eat a Big Mac in 5 minutes. How many could he eat in 2 hours?
5. Given that Wendy is 1.60 m tall, a bus is 5.50 m tall, and an elephant is 2.80 m tall, find the ratio of Wendy's height to the elephant's height, and the ratio of the elephant's height to the height of the bus.
6. A pharmaceutical company manufactures a drug called Fizmatum. Each 1.2 g pill contains active ingredients 5mg of Potassium Hypophosphate and 6.5 mg of Calcium Silicate. What proportion of the pill is made up of active ingredients?
7. As viewed from the batsman, the angle between the cover and extra cover fieldsmen is 28°. If each fielder is equidistant, 25m, from the batsman, how far are the fielders apart?

Consider each of these in terms of language, syntax, vocabulary and context. How might they be rewritten to make the language more accessible?

And the things we say and write!

- *Can you describe the distribution of the data?*
- $6 \text{ x } 5$ 6×5 $6\text{x} \times 5$
- ¾ $\frac{3}{4}$
- X x x $3x$ $3x$ 3x 3x $3\text{x} \times 3$ Does it matter?
- Less and fewer…
- Straight lines…
- $a^2 + b^2 = c^2$
- Does 4 divide evenly into 12?

How do we read mathematics?

- Left to right?
- Inside out?
- BODMAS, BOMDAS, BEDMAS?
- More reading examples:

$$\text{Solve } \frac{m}{4} - \frac{2-m}{3} = \frac{1}{4} \text{ for } m.$$

$$(\frac{3}{4}+5)^2$$

$$\int_1^6 \frac{1}{x^2} dx$$

$$(A \cap B) \cup C$$

$$\sin^2 2x$$

$$-15 \pounds x \pounds 12$$

Some work for us to do

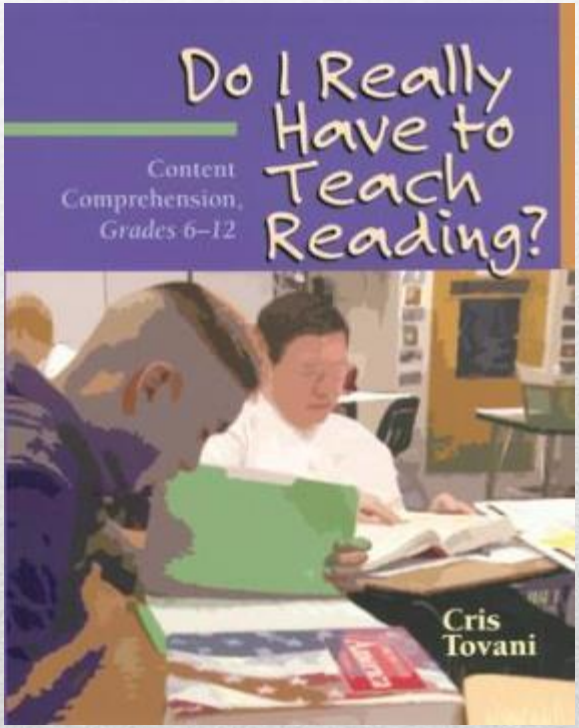
1. La chèvre de M.Séguin.

Il était une fois un fermier qui s'appelait M. Séguin. M. Séguin avait une chèvre, une bien belle chèvre. Chaque jour, M. Séguin se levait tôt le matin et amenait la chèvre au pré, pur qu'elle puisse brouter l'herbe. Elle avait faim, ce chèvre! Dans le pré M. Séguin avait construit un abri protégait la chèvre contre les intempéries. It attachait la chèvre au coin de l'abri avec une corde. It la laissait brouter toute le journée. L'abri était sur roues afin que M. Séguin puisse le bouger lorsque la chèvre avait fini de manger l'herbe à sa portée. Votre problème est celui-ci: quelle superficie de pré la chèvre peut-elle manger?

2.

Z mista A vygel do mista B cyclista prumernou rychlosti 20 km/h. Za 45 munut vygel z A do B motocyclista prumernou rychlosti 44km/h.
Oba do mista B dojeli soucasne. Urcete vzdalenost AB.

Do I Really Have to Teach Reading?



Cris Tovani has so much practical advice to offer us.

'Teachers outside of English classrooms are being called upon to assist struggling readers throughout the day.' (p. 7)

Fix-up strategies

A ‘fix-up’ strategy is any strategy used by a reader to help get unstuck when the text becomes confusing.

- Make a connection between the text and the following:
  - your life
  - your knowledge of the world
  - another text
- Make a prediction.
- Stop and think about what you have already read.
- Ask yourself a question and try to answer it.
- Reflect in writing about what you have read.
- Visualise.
- Use print conventions.
- Retell what you’ve read.
- Reread.
- Notice patterns in text structure.
- Adjust your reading rate: slow down or speed up.

What works

1. Good readers use reading, writing, and talk to deepen their understanding.

2. Good readers have a variety of ways to think about text. They can make connections, ask questions, infer, and visualise, as well as sift and sort the value of different pieces of information.

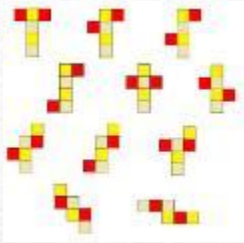
3. Good readers don't need end-of-the-chapter questions or isolated skill sheets. They ask their own questions, based upon their need for a deeper understanding of the specific aspects of the text.

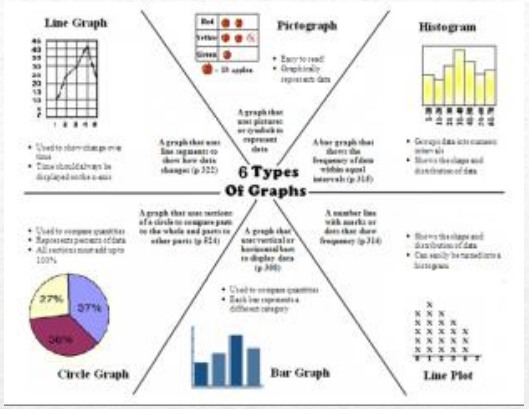
4. Good readers reread and return to the text to build and extend their knowledge of specific concepts, or to enhance their enjoyment of texts they have enjoyed previously.

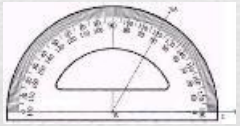
" *I am not a speed reader. I am a speed understander*." Isaac Asimov

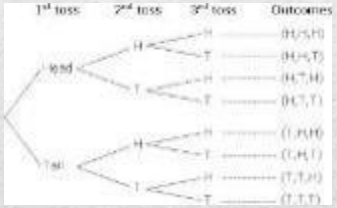
Text types

A brainstorm…

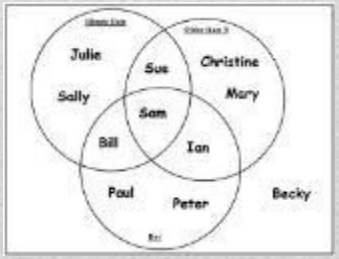








$$
\begin{aligned}
a &= b \\
a^2 &= ab \\
a^2 - b^2 &= ab - b^2 \\
(a+b)(a-b) &= b(a-b) \\
a+b &= b \\
2b &= b \\
2 &= 1
\end{aligned}
$$



And then there's the Maths text book: how do we read it?

What are the features?

- Structure
- Format
- Purpose
- Audience
- Pagination
- Contents page and index
- Examples and exercises
- ..and friend BOB

What about the e-book? How do we read it?

The EALD Learner

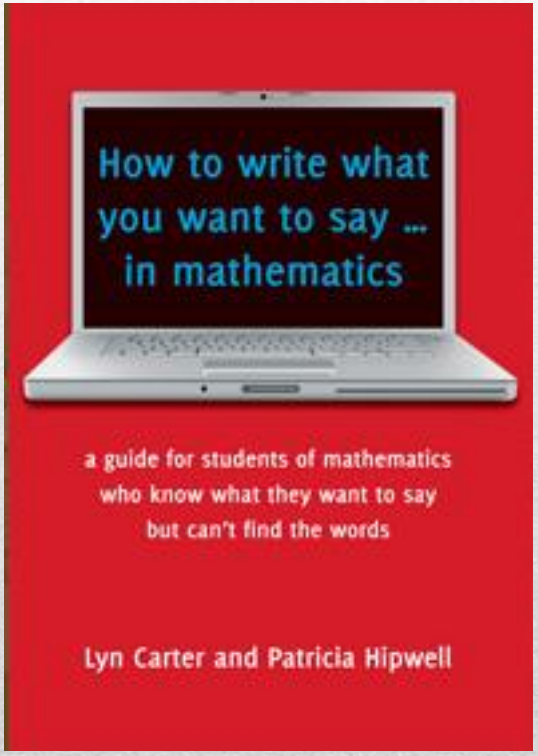
- EALD learners enter Australian schools at different ages and at different stages of English language learning.
- They have various educational backgrounds in their first languages. For some, school is the only place they speak English.
- The aims of the Australian Curriculum are ultimately the same for all students. However, EALD learners are simultaneously learning a new language and the knowledge, understandings and skills of the curriculum through that new language.
- They require additional time and support, along with informed teaching that explicitly addresses their language needs, and assessments that take into account their developing language proficiency.

What strategies do we have to support the EALD learner?

1one	Brainstorming
2wo	Labelling
3hree	Word grouping
4our	True-False exercises
5ive	Cloze exercises
6ix	Process description (pair/group work, rearranging)
7even	Problem reconstruction
8ight	Mix and match activity
9ine	Picture dictation
10en	Cooperative problem-solving

How do we write what we want to say?
…how do we support our students in their writing?

- Creating glossaries
- Writing definitions
- Journal writing
- Investigations and reports
- Justifying results
- Reporting research
- Summaries and procedures
- Creative writing



- The nature of mathematical writing
- Key terms and ideas
- Common forms of mathematical writing
- Mathematical report writing
- Words to avoid
- Lots of substitutes for ‘showed that’
- Teacher reference (stuff for us too!)
- Lots and lots of useful and practical advice and examples

…and some numeracy?

What is numeracy?

Using mathematical skills across the curriculum both enriches the study of other learning areas and contributes to the development of a broader and deeper understanding of numeracy. Therefore, a commitment to numeracy development is an essential component of learning areas across the curriculum and a responsibility for all teachers. This requires that
teachers:

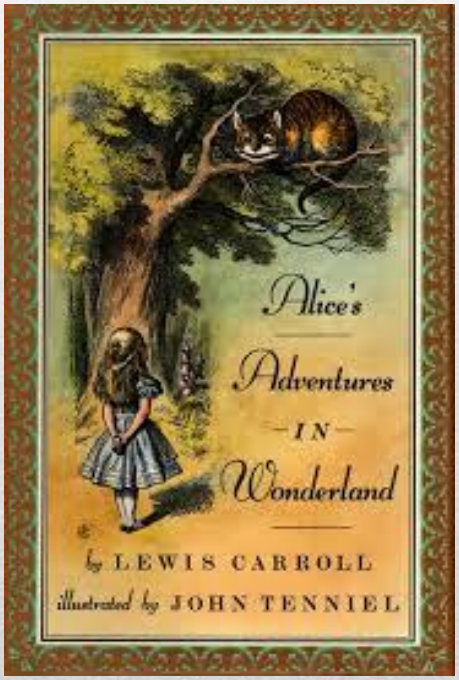
- identify the specific numeracy demands of their learning area
- provide learning experiences and opportunities that support the application of students' general mathematical knowledge and skills
- use the language of numeracy in their teaching as appropriate.

Teachers should be aware of the correct use of mathematical language in their own learning areas. Understanding mathematical terminology and the specific uses of language in mathematics is essential for numeracy.

Do we have to be literate to be numerate?

“Reeling and Writhing of course, to begin with,' the Mock Turtle replied, 'and the different branches of arithmetic - ambition, distraction, uglification, and derision.”

Lewis Carroll, *Alice In Wonderland: Including Alice's Adventures In Wonderland And Through The Looking Glass*



The problem written in the Czech language is given as:

> *Z mista A vygel do mista B cyclista prumernou rychlosti 20 km/h. Za 45 munut vygel z A do B motocyclista prumernou rychlosti 44km/h. Oba do mista B dojeli soucasne. Urcete vzdalenost AB.*

There are two places A and B. One person travels by bike at 20 km/h, and another, setting off 45 minutes later on a motorbike, travels at 44 km/h. They both arrive at B together. Calculate the distance AR.

If the distance from A to B is denoted by x km, then the time taken by the cyclist is $\frac{x}{20}$ hours, and the time taken by the motorcyclist is $\frac{x}{44}$ hours. The difference between these times is 45 minutes, or three quarters of an hour. So we obtain the equation:

$$\frac{x}{20} - \frac{x}{44} = \frac{3}{4}$$

which can be solved to give $x = 27.5$