The Barriers to Learning Maths

DansMa

04/10/2014

www.stevechinn.co.uk

Concerns?

Some of the factors #1

- Visual and aural aspects
- Directional issues
- Sequencing demands
- Short term memory/working memory
- Long term mathematical memory
- The vocabulary of mathematics
- The language of mathematics
- Organisation in space

Some of the factors #2

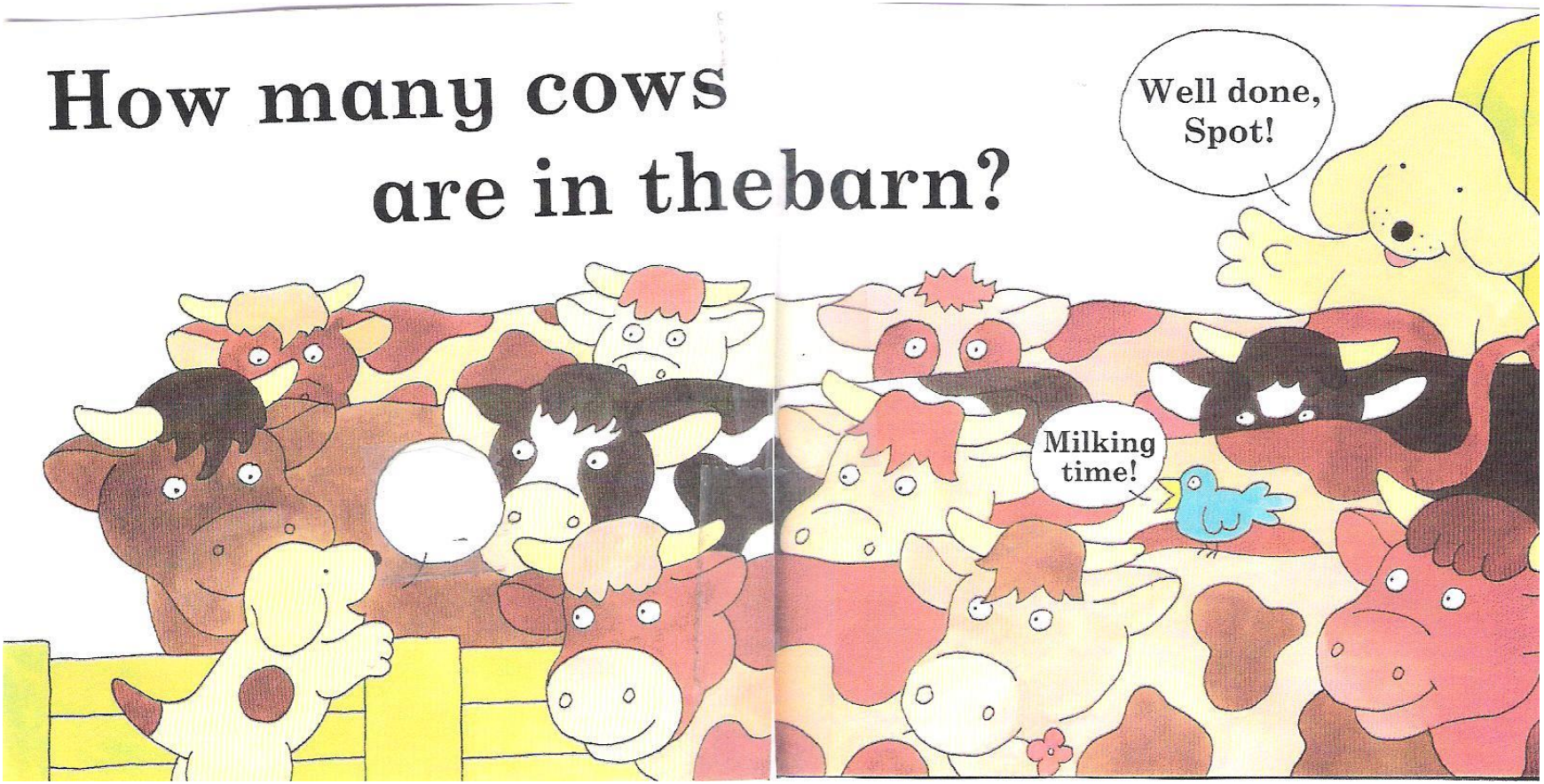
- Speed of working
- Thinking style
- The structure of the curriculum
- The style of the curriculum
- Anxiety, expectations, self esteem, risk taking
- Motivation, attributional style
- A heterogeneous population

Visual/Vision

- Can they see?
- Does print/paper contrast/colour make a difference? (scotopic sensitivity)
- Is the work cluttered?
- Does the page look intimidating?
- Is the font clear? + X ÷
- Are they visual learners?
- Do they confuse symbols?

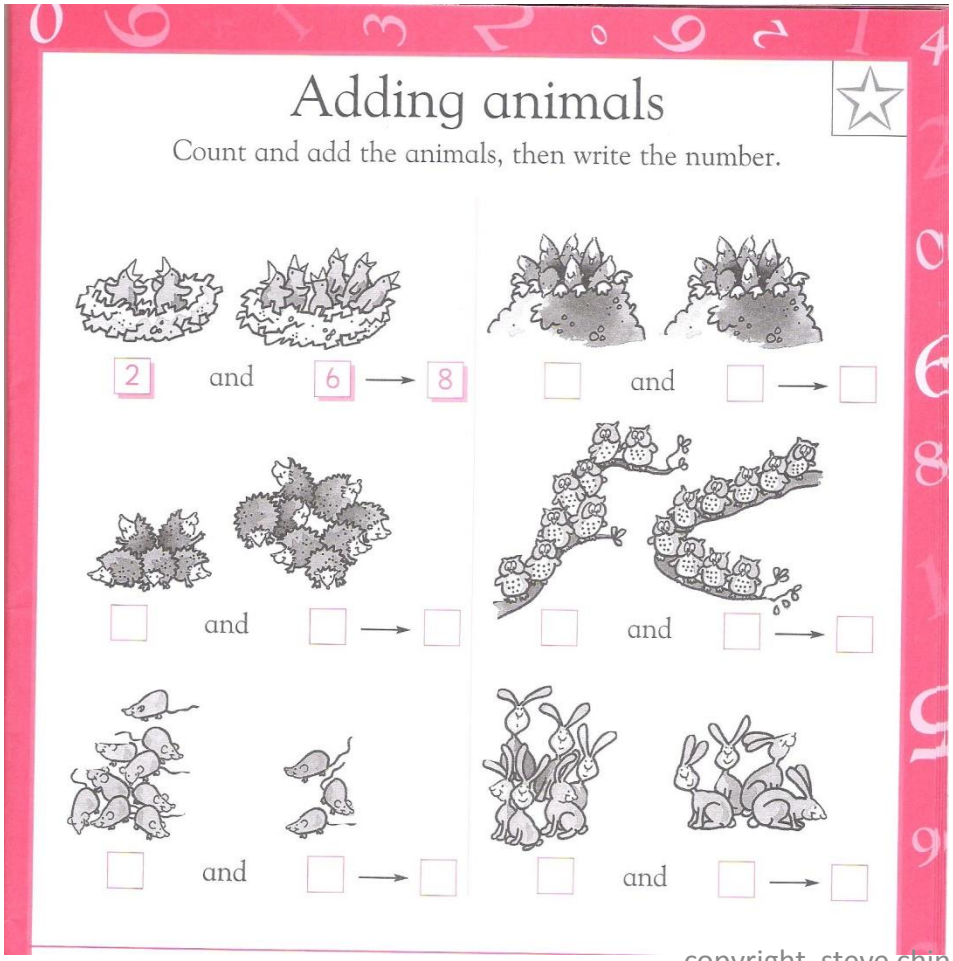
Early/first learning and its impact

Subitising? Number sense.



Every Child Counts? (5-6y)

‘Maths Made Easy’



‘Everything can be made as simple as possible, but not simpler than that.’ Einstein.

Siegler et al 2012

Psychological Science. 23 (7) 691-697

- Knowledge of division and fractions at age 10 years was consistently related to later maths proficiency.

- WHY?

Carry out short multiplication and division of a three-digit by a single digit integer (age 9 years)

2)38

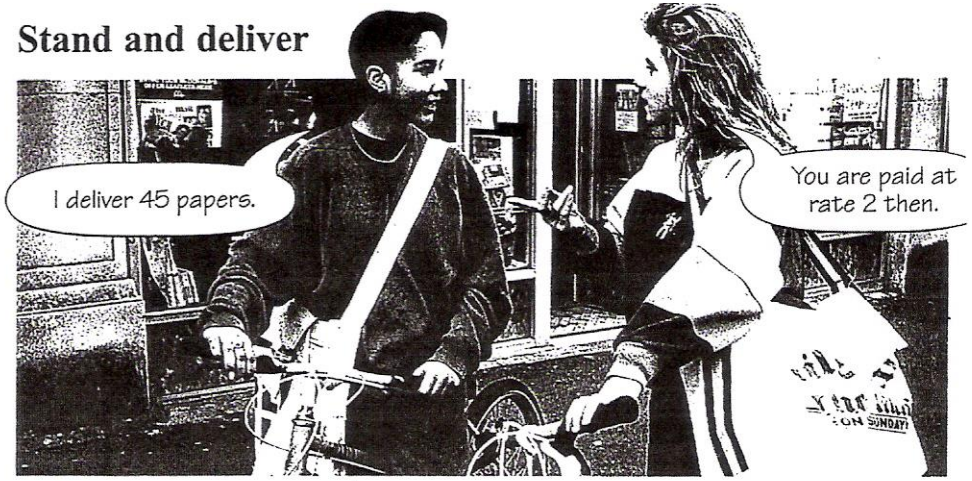
10 yrs	59.1%
13 yrs	60.7%
15 yrs	75.0%
16-19 yrs	74.7%

9)927

10 yrs	23.2%
13 yrs	41.9%
15 yrs	44.5%
16-19 yrs	35.2%

Back to visual

Stand and deliver



The manager of Central Newsagents has to decide what people are paid.
This depends on how many papers each person delivers.
Mathematical symbols are used to help when this is done.

We can use the signs > and < to help us group numbers.

> means **is greater than . . .**
< means **is smaller than . . .**

Central Newsagents

This year's pay rates

< 40 papers	rate 1
< 60 papers	rate 2
> 73 papers	rate 4
> 84 papers	rate 5
> 90 papers	rate 6

Central Newsagents

Ken	98	Ravinda	83
Pete	72	Royston	37
Sarah	82	Shana	45
Dave	32	Mike	55
Julie	72	Becky	62
Lana	48	Amrit	46
Chris	65	Andy	90

1 List all the people paid on rate 1.

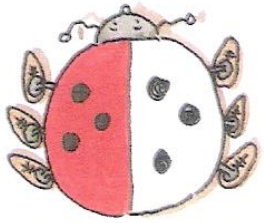
2 Which people are paid on rate 2 ?

3 What rate of pay does Sarah earn ?

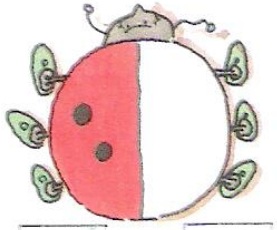
4 What rate of pay does Andy earn ?

5 Describe what you think rate 3 is.

doubling



3 + 3 = ☐



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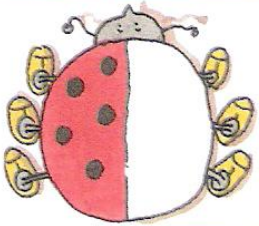

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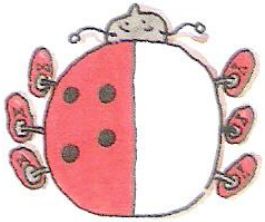

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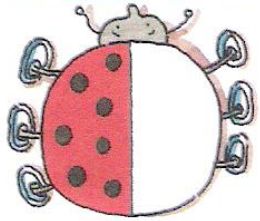

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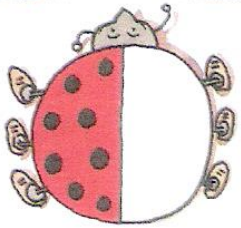


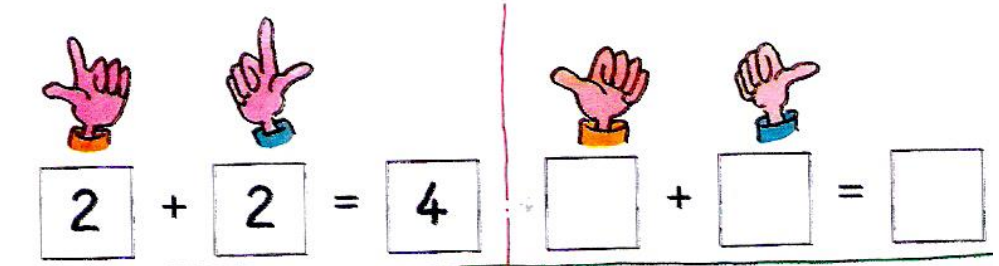
☐ + ☐ = ☐

Teacher's instructions

Draw double the number of spots on the ladybird. How many altogether?

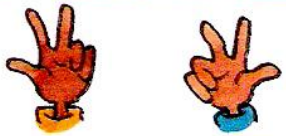
Find double 20 using cubes.

doubling

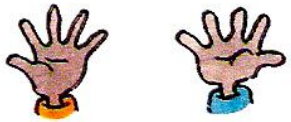


2 + 2 = 4

__ + __ = __



__ + __ = __



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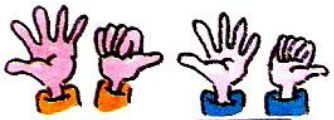
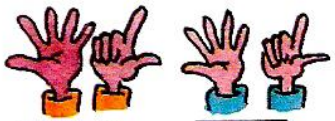
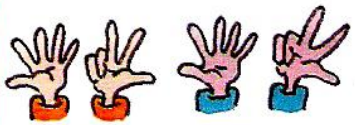


__ + __ = __

__ + __ = __



__ + __ = __



__ + __ = __

Write the number of fingers standing up on the hands.
You are doubling. Write how many altogether.

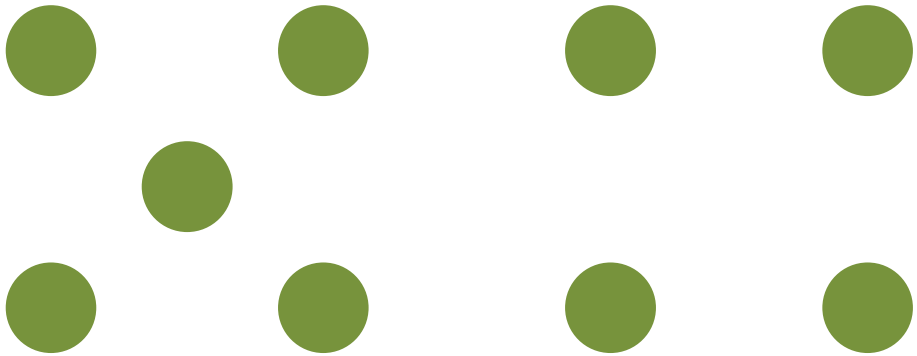
● Make each double using two towers of cubes. Use two colours.


add
plus
forwards
more than
after
answer
less than
equals
before
smaller
—
total
minus
sum
between
subtract
backwards
bigger
0 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 38 39
40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59
60 61 62 63 64 65 66 67 68 69
70 71 72 73 74 75 76 77 78 79
80 81 82 83 84 85 86 87 88 89
90 91 92 93 94 95 96 97 98 99
copyright: steve chinn. 2014

Direction

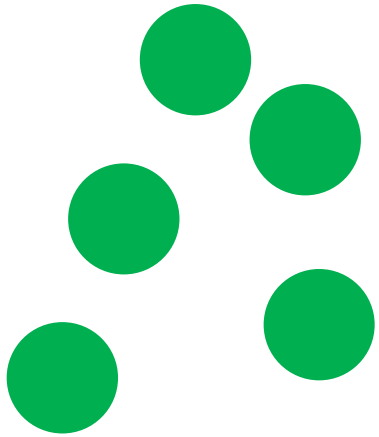
- Counting backwards
- Two digit numbers and place value 13
- (1 2 3 4 5 6 7 8 9)
- Decimal numbers… focus on the ‘ones’ 5348.435
- Add, subtract, multiply….. then division

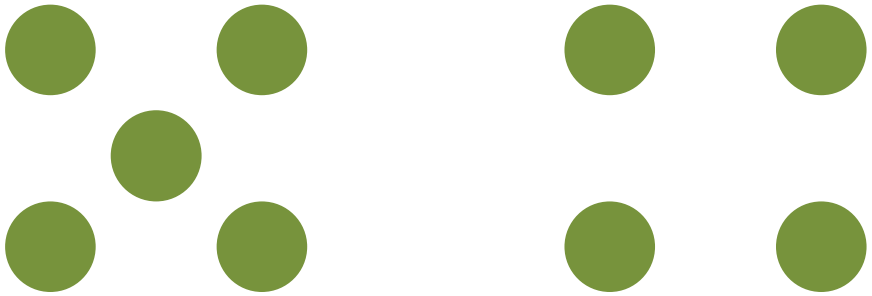
Counting



0 1 2 3 4 5 6 7 8 9

Subitising





9 8 7 6 5 4 3 2 1 **0**

It is important to learn how to count back

What happens after 9?

How do we write numbers that are bigger than 9?

Sequencing Skills and patterns

- Recall/retrieval of sequential information
- Numerical sequences
- 10, 20, 30……. 14, 24, 34……
- Reversing the sequence
- Interaction with stm
- abcdeabcdeabcdea….. abc dea bcd eab
- Fraction sequence. ‘Long’ division
- Language sequence

Too much choice #1

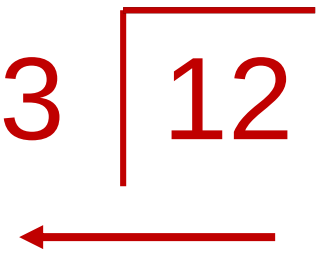
- We can now write the **division** operation in *three* ways……..

- Read from left to right, ’12 divided by 3’

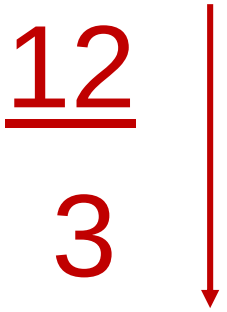
- $12 \div 3$

Too much choice

#2

- Read from right to left ‘12 divided by 3’
- 

Too much choice

- Read from top to bottom
- ‘12 divided by 3’
- 

Writing numbers

- Write ‘forty thousand and seventy’ as a number.
- 16 – 19 year olds
- 67.2%

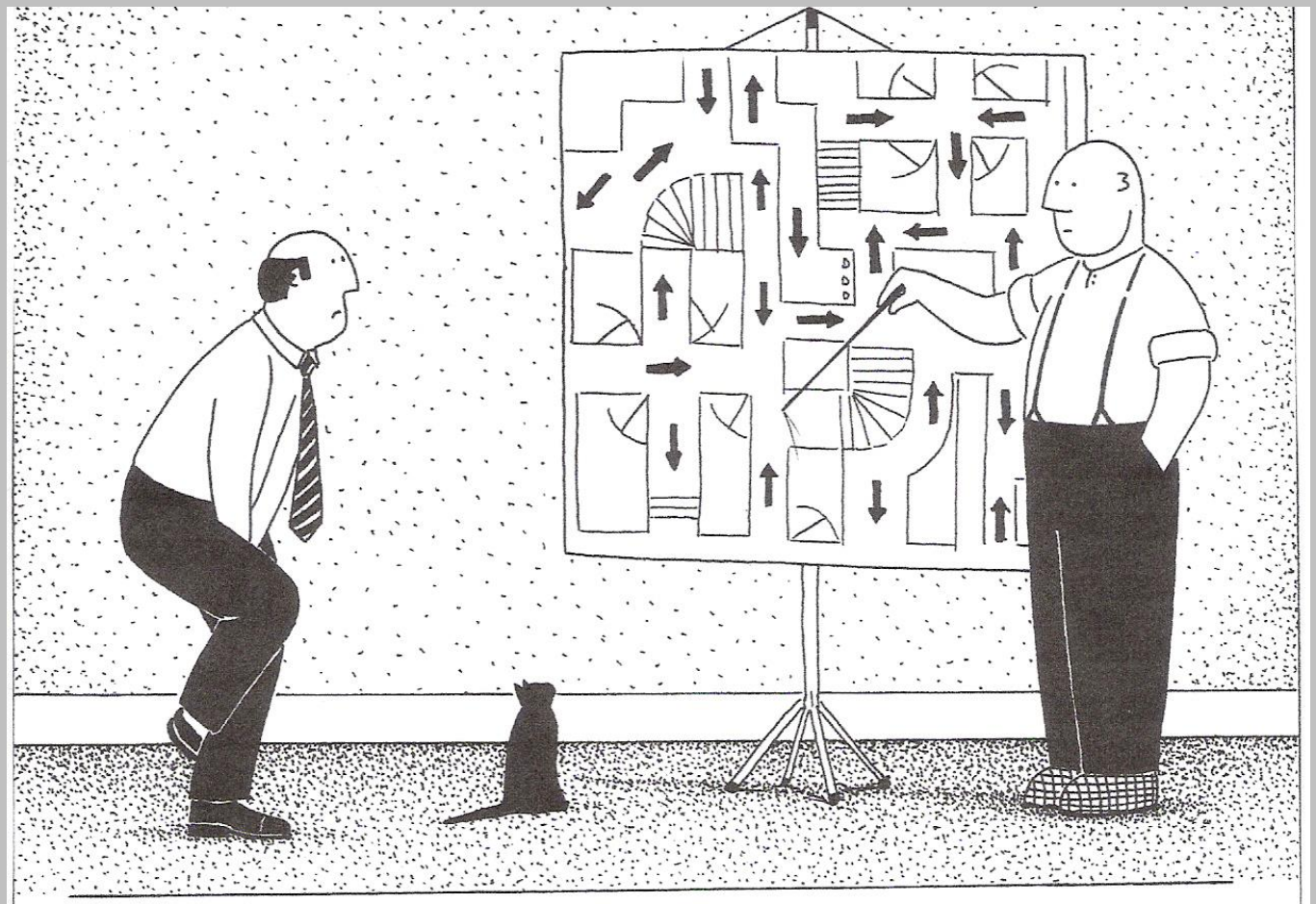

Memory


Short term/working memory

- Chunks of information

(instructions, copying, methods)

- Repeating information
- Mental arithmetic
- Written work
- Overload
- Link to thinking style and anxiety



FRED GAVE PIP DIRECTIONS
TO THE BATHROOM

Backward Digit Span

- ‘ … the single most powerful task of all… working memory tasks used in discriminating learning disabled students from non-learning disabled.’

- Gathercole and Pickering (2001)

Mathematical long term memory

- Recall of procedures
- Language, for example instruction words ‘decompose’
- Multi-sensory input
- Secure knowledge
- Patterns and generalisations
- ‘Basic facts’

Mathematical (long term)memory

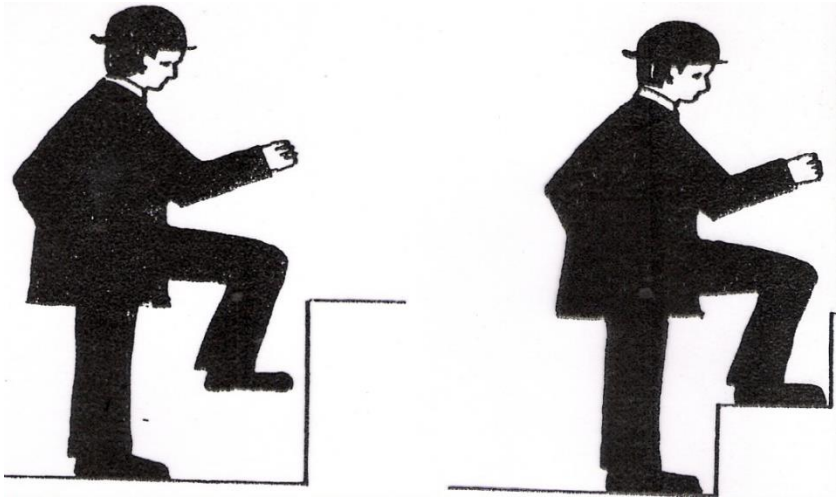
- *Quick* retrieval of basic facts

- D. Tel 18/02/14
- ‘Children may be falling behind their Chinese counterparts in maths because of a failure to learn times tables by heart.’
- This includes the times tables up to 12 by the age of nine.’
- a ‘strong resistance to traditional teaching methods’
- **‘Fluency’**

Key facts

0x 1x 2x 5x 10x

The two-steps strategies

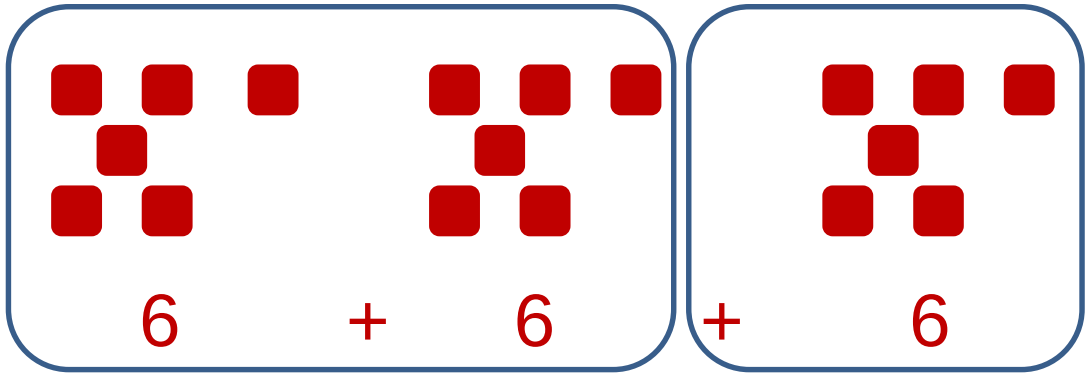


For 3x 6x 7x

Strategy (1)

Example 1 3 x 6

3 x 6 = 18



2 x 6 + 1 x 6

12 + 6 = 18

Strategy (2)

$6 \times 6 = \boxed{6 + 6 + 6 + 6 + 6} \boxed{+ 6}$

$5 \times 6 \quad + 1 \times 6$

$30 \quad + \quad 6$

Multiplication is repeated additions of the same number

$6 \times 6 = 36$

$6 \times 8 = 5 \times 8 \; + \; 1 \times 8 \; = 40 + 8 \; = 48$

$6 \times 8 = 48$

Strategy (3)

$7 \times 6 = \boxed{6 + 6 + 6 + 6 + 6} \boxed{+ 6 + 6}$

$5 \times 6 \quad + 2 \times 6$

$30 \quad + \quad 12$

Multiplication is repeated additions of the same number

$7 \times 6 = 42$

$7 \times 8 = 5 \times 8 \; + \; 2 \times 8 \; = 40 + 16 = 56$

$7 \times 8 = 56$

What else are you teaching?

Developmental maths….. linking

Organisation in space

- $2x$ x_2 x^2

- $\begin{array}{r} {\scriptstyle 1\ \ 1\ \ } \\ 368 \\ 257+ \\ \hline 625 \end{array}$

- ‘Write today’s date in the middle of the page’

Teacher-identified math weaknesses. Bryant, Bryant and Hammill, JLD, 2000

12th …. (out of 33)

- Orders and spaces numbers inaccurately in multiplication and division

13th ….

- Misaligns vertical numbers in columns

- Maths is an international problem.

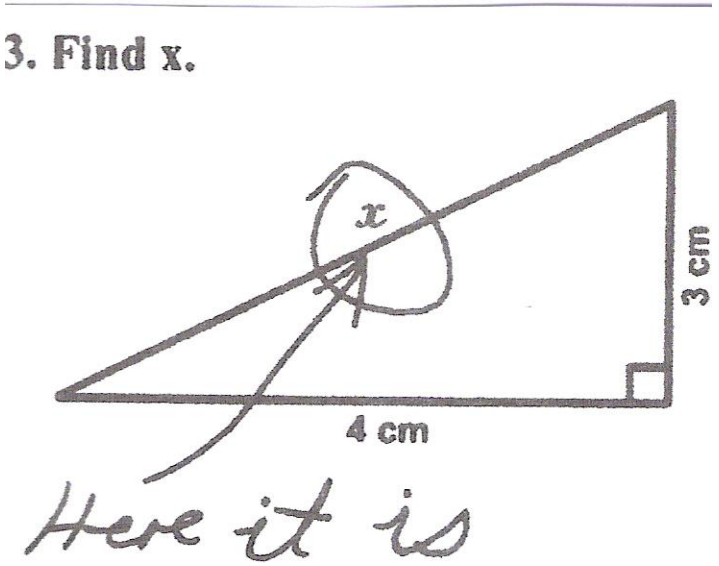
Vocabulary and language

Vocabulary and language

- The power of first learning experiences.
- The language of mathematics, especially word problems, is not English as we know it. ‘Is it better in Denmark?’
- Communication.

Command/Instruction Words

- It's not just the 'reading'……



Consistency and Choice

- Add more plus and
- Subtract take away minus less than
- Multiply times of lots of
- Divide share

Pupils have to translate English into ‘Maths’

A car can seat 5 people.

Yes

How many cars do you need to take a group of 32 people to a concert?

32

The Elephant in the Classroom

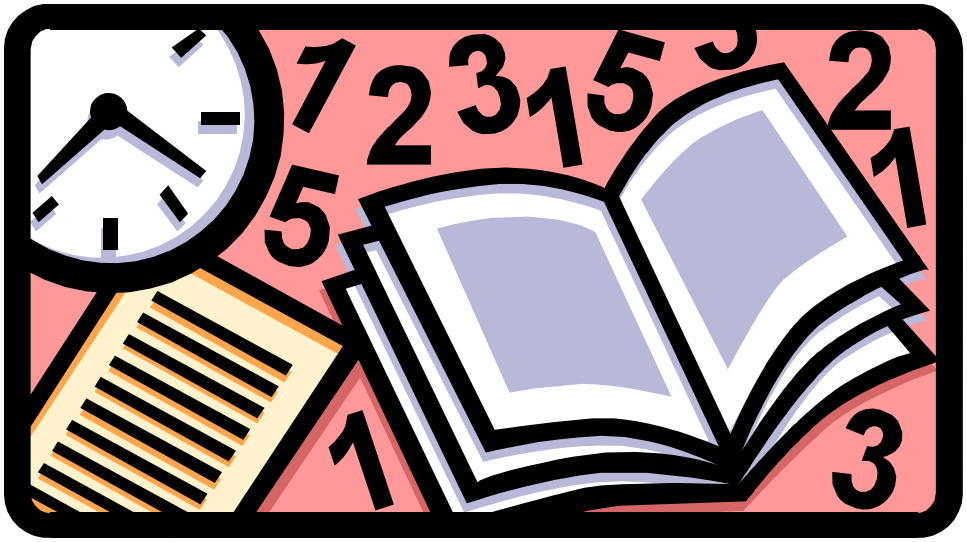
Jo Boaler. Souvenir Press. 2009

- ‘Students come to know that they are entering a realm in which common-sense and real world knowledge are not needed.’
- ‘Students learn to ignore contexts and work only with the numbers.’

- **Singapore Model Method**

Why start?

What is the time now if it were two hours later it would be half as long until midnight as it would be if it were an hour later?



Speed of working

- Mental arithmetic
- Slow to start work
- Slow written work
- Less experience
- Impulsivity
- **Anxiety survey: Ranked 4th – 7th**
- Is this a necessary expectation?

Teacher-identified math weaknesses. Bryant, Bryant and Hammill, JLD, 2000

- Ranked 6th ….
- Takes a long time to complete calculations

School Reports #1

- I am constantly having to prompt her to look at Mrs Smith and listen to her. She seems to spend a lot of time rubbing out and sharpening her pencil!

- Mrs Smith paces the lessons very well and Ellie should be able to follow what she is teaching.

School Report #1 cont.

- I also feel that Ellie has become rather lazy from the point of view of always saying she doesn't remember how to do any maths processes. She will seem to have grasped a concept yet the following lesson she will have forgotten it.

- I am beginning to insist that she tries to remember how to do the work.

- Wipe clean boards (Cialdini)

‘The nasties’ (Chinn 2012)

Division, fractions, decimals and percentages

Fractions

- Seigler, Fuchs, Jordan, Gersten, and Ochsendorf (2010 – 2015)

- ‘Despite these advances in our understanding of cognitive processes underlying mathematics difficulties, relatively little work has been done to capitalise on this research and develop innovative strategies for improving instruction for students who struggle to learn mathematics’

The Center for Improving Learning of Fractions.

Fractions are so difficult for so many children. For example, despite children in the U.S. receiving substantial fractions instruction *beginning in 3rd or 4th grade* (NCTM, 2006), the 2004 National Assessment of Educational Progress revealed that 50% of 8th graders could not correctly order three fractions (2/7, 1/12, and 5/9) from least to greatest.

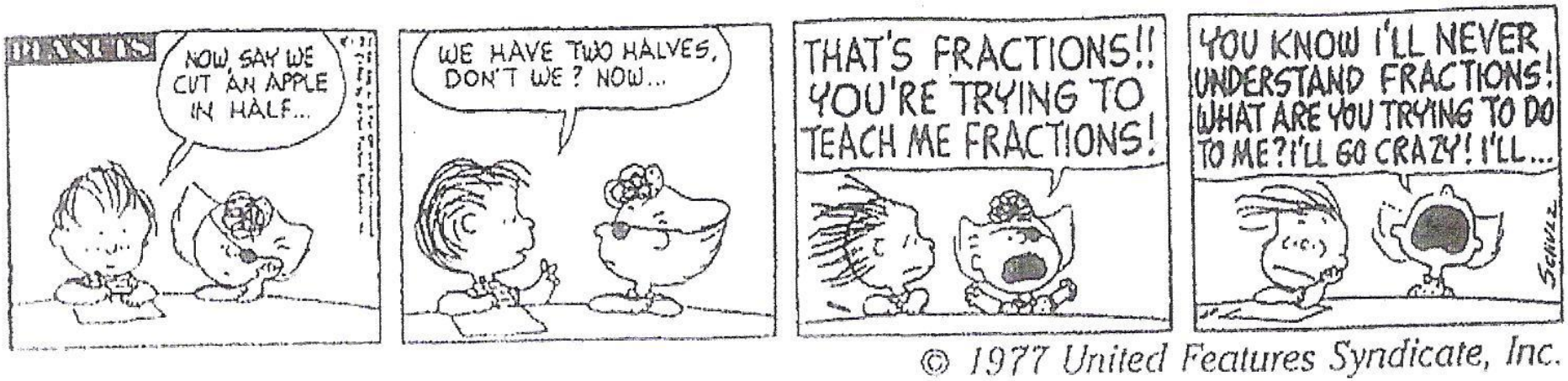
The difficulty continues in high school and college; for example, fewer than 30% of 11th graders translated 0.029 into the correct fraction.

UK data (Chinn, 2012)

Write 0.125 as a fraction in its simplest form (age 10 years)

13 yrs	17.3%
15 yrs	31.4%
16-19 yrs	33.6%

Not everyone buys into visuals!

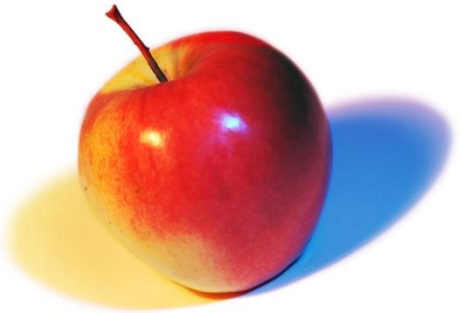


Materials don’t teach. Teachers teach.

Estimations: Approximate halves

When something is divided into two halves mathematically, the halves have to be **equal** …. exactly equal.

Some ‘everyday halves’ are not exactly equal… they are approximately equal, but are **not** mathematically correct halves.

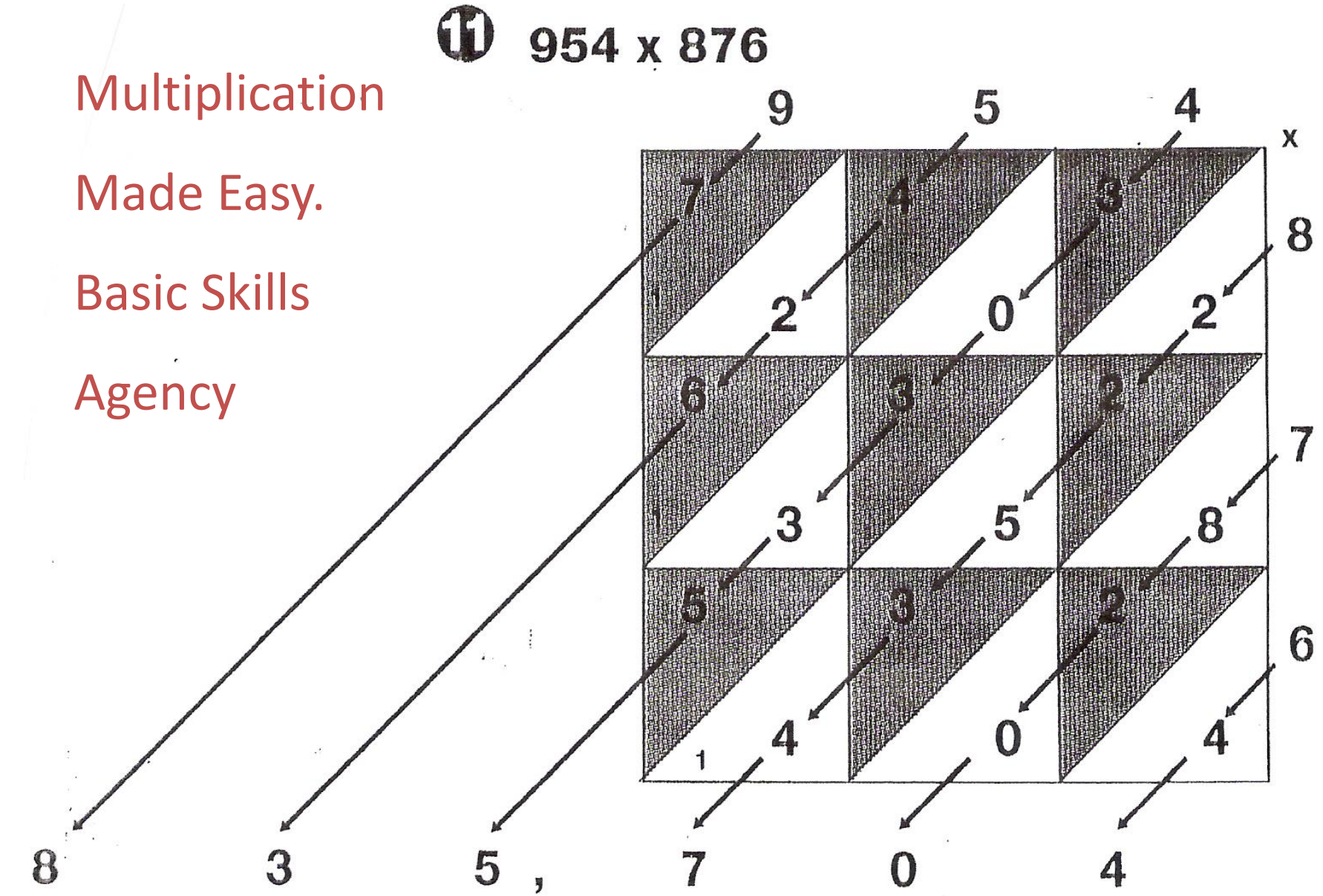


Multiplication

Made Easy.

Basic Skills

Agency



Anxiety and the affective domain

Building confidence

Emotions and Maths

TES April 3rd 2009

- Research by Cambridge Assessment found that the better pupils were at expressing their emotions, influencing other peoples' feelings, networking, using social skills and general social awareness, the worse their maths results were at GCSE

Anxiety and Expectations

- Anxiety impacts on working memory
- Avoiding risk.. ‘Never mind, you did your best.’
- Where do expectations come from?
- Are ‘targets’ expectations? And is it possible to set the perfect target?
- Worries

Data and Scarfpin (1983)

- Mental block anxiety can be triggered by a symbol or a concept that creates a barrier for the person learning maths.
- Socio-cultural maths anxiety is a consequence of common beliefs about maths, such as, if you cannot learn facts you will never be any good at maths

High Anxiety Items

- Taking an end of term maths exam
- Doing long division questions without a calculator
- Having to take a written maths test
- Having to work out answers to maths questions quickly
- Waiting to hear your score on a maths test

- Fear of negative evaluation

High anxiety

Around 4%

Barriers to learning and attributional style

- Maths is judgmental. Right or wrong for a computation is down to the maths not to the teacher's judgment…. But the marks and how they are awarded are within the teacher's control.

- How many barriers will a learner experience before he says, 'I just don't get maths and I guess I never will.'

- Wipe clean boards

Attributional Style. Martin Seligman

- Permanent. ‘I’ll never be able to do fractions.’
- Pervasive. ‘I can’t do this division stuff. I can’t do any maths.’
- Personal. ‘I’m too stupid to do maths.’

Professor Tim Miles

- ‘To put the matter another way, if there is bad practice it seems likely that intelligent non-dyslexics may in many cases survive it without any major disaster, whereas its effect, even on the most intelligent dyslexics is likely to be catastrophic.’

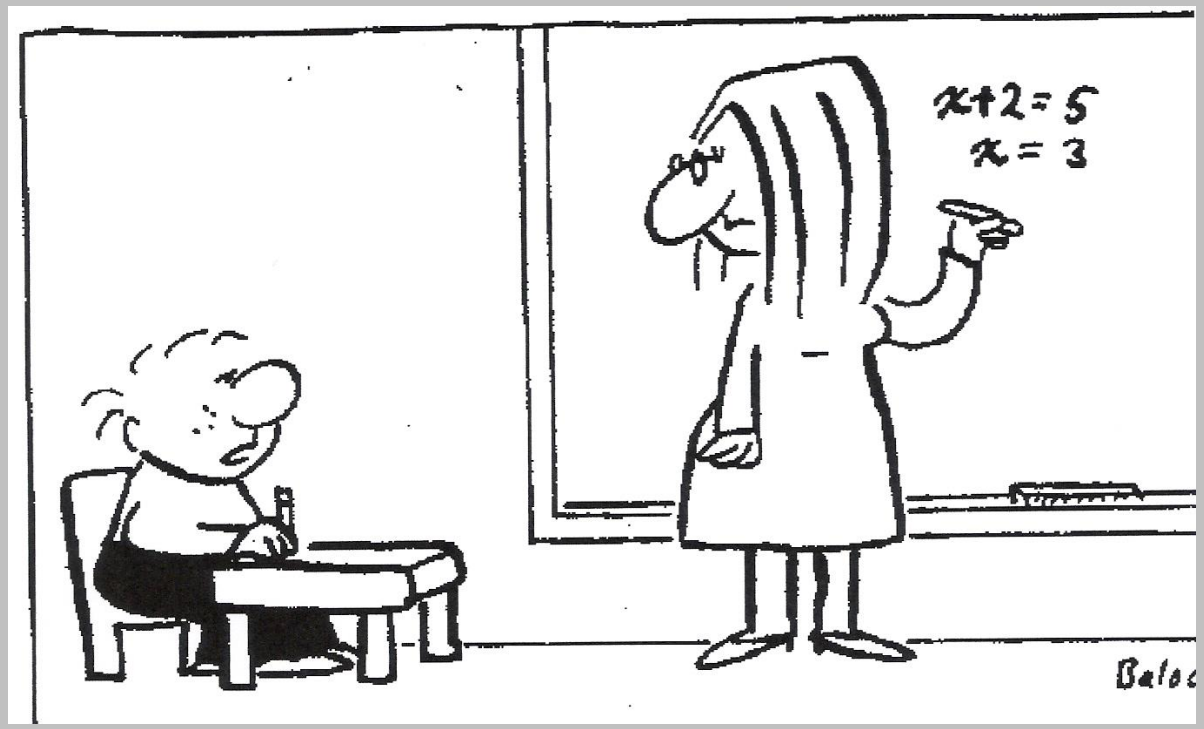
‘Dyslexia and Mathematics’ Miles T and Miles E (1992)

Effective learning

- Find the appropriate place to start … inevitably much further back than you think
- Know and use what the learner knows to take him to things he doesn't know.
- Make each learning experience part of his maths development.

- **What else are you teaching?**

Consistency brings security



"Just a darn minute! Yesterday you said that x equals two!"

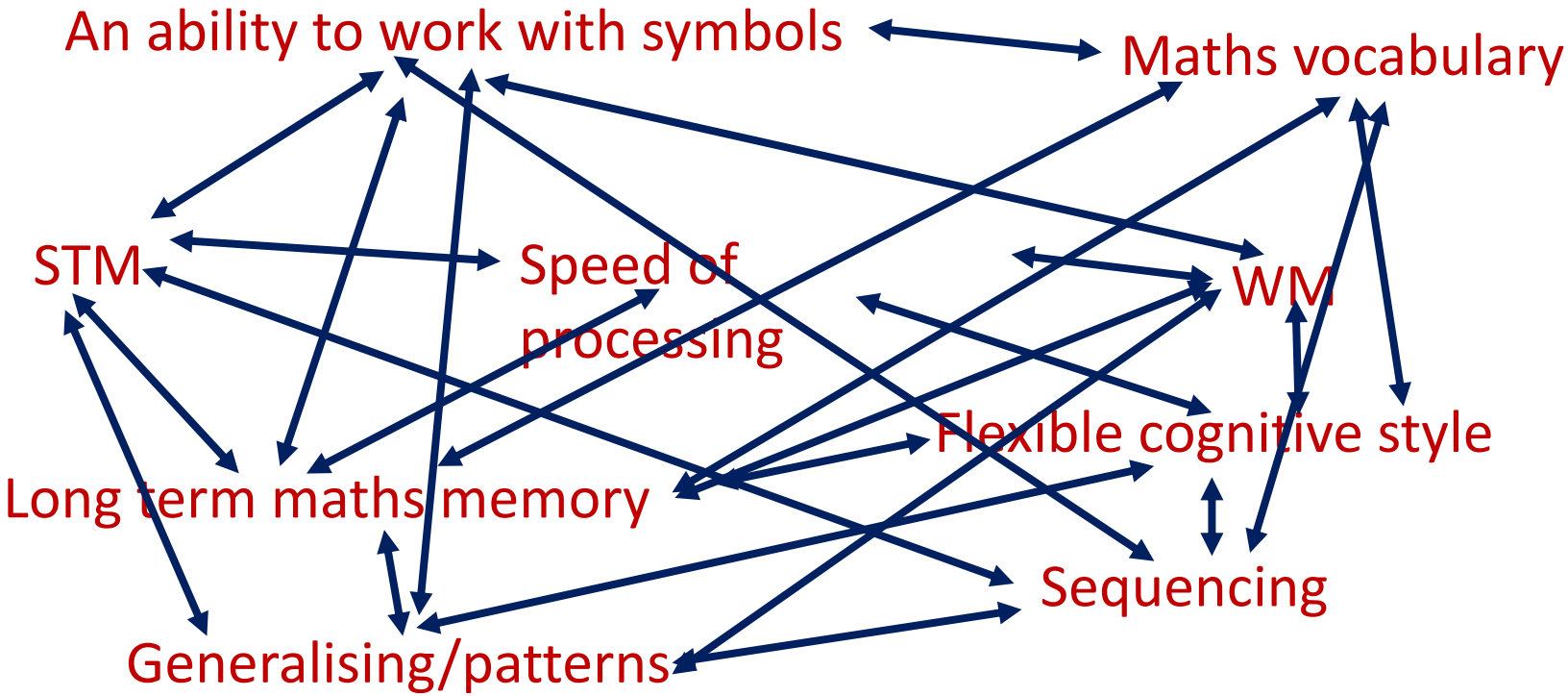
Effective Teaching

- Empathetic classroom management
- Responsive flexibility
- Methods that are mathematically developmental
- Effective communication

Listening to stuents.
10 year old Australian boy

- “I am good at x + and – divide is sometimes hard. I would love to be a bit better at ÷ and x. If you want me to be better at maths you should show me a pattern in it like a rhyme.
- I like maths when I get it right. I don’t like getting maths wrong. You should show me how to get my errors right by giving me a strategy.”

Learner skills



It's complicated!

Maths Explained

A series of teaching videos

www.stevechinn.co.uk

Learner skills