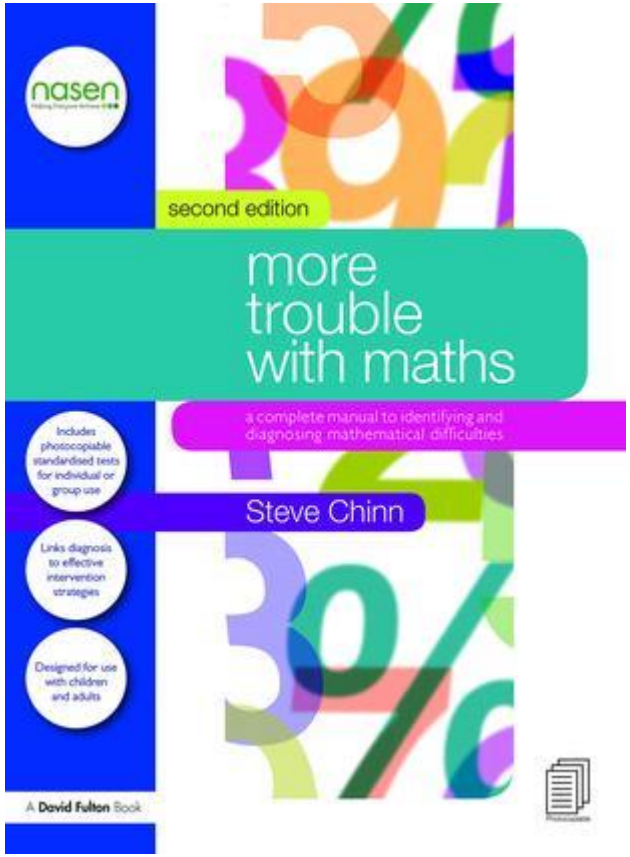
Diagnosis and Assessment of Maths LD and Dyscalculia.

Steve Chinn

February, 2017

maths explained



Second edition. Published July 2016

A complete manual to identifying and diagnosing mathematical difficulties

Alan Kaufman

- ‘Be better than the test you use.’

Assessment or diagnosis?

- *Assessment is about the measuring the student's achievements, skills and deficits.*

- *Diagnosis is about understanding why a student is not learning or why he is underachieving and should also lead to advice on how to teach him*.

- Teaching and diagnosis should be inextricably linked.

Good/bad at some maths or at all maths?

- What are the pre-requisite skills for each topic?
- Will the diagnosis give me guidance on what to do? Interventions?
- **Success and failure: identify areas**

The main issues for students with maths LD/dyscalculia

- Working Memory and stm
- Basic facts, procedures and rote learning
- The first learning experience (inhibition)
- Consistency
- Language, symbols and communication
- *Generalising/patterns*
- The inter-dependence of these

- And …. 'it's little more complicated than that' Ben Goldacre

Diagnosis and Intervention

Mabbott and Bisanz. (2008) JLD 41 (1) 15-28

- 'Children who experience difficulties in mathematics are a heterogeneous group…'
- 'Diagnosis and intervention requires tools that are useful for identifying the many reasons why children may perform poorly on standardised tests…'
- Evaluation of a broad range of skills and knowledge….'

A diagnostic test protocol (Chinn, 1993)

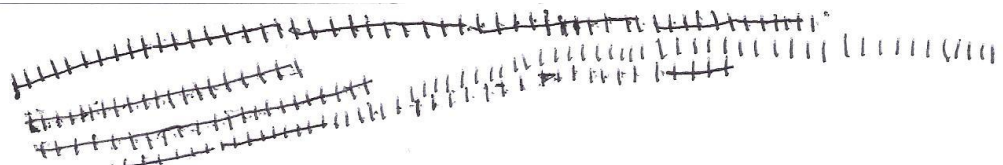
- A norm-referenced test
- Counting, number bonds
- Multiplication facts (strategies)
- Place value
- The four operations + - x ÷
- Language and symbols
- Word problems
- Cognitive (thinking) style (estimation)
- Anxiety/affective domain **What else?**

NRC: Key finding 2

- To develop confidence in an area of inquiry, students must:

- have a deep foundation of factual knowledge
- understand facts and ideas in the context of a conceptual framework
- organise knowledge in ways that facilitate retrieval and application.

Dyscalculic?



Maths Test. **15 minutes** (© 2009 S Chinn)

M/F Date 19/05/11 Age 30+ y

1. 2 + 5 = 7
2. 7 + 8 = 21
3. 19 – 4 = 17
4. 5 + 4 + 3 = 12
5. 34 = 4 + 30
6. 400 + 600 = 100000
7. 100 – 58 = 19

Pre-assessment information

- School records
- Previous tests/examination results
- Teacher questionnaire

Dyscalculia checklist

- Could send out ahead of time.
- Less need to ‘see’ the pupil.
- Can still discuss items and points later
- Who filled it in?

The dyscalculia checklist

- This is about the interaction between the demands of maths and the learner.
- It can be used as a straight Yes/No list or given with gradings, using a Likert Scale.
- It is based on commonly found behaviours.
- There is no ‘score’.

Checklist for Dyscalculia and Maths Learning Difficulties **© Steve Chinn, 2012**

Does the learner ..... 1 .. not often 2 .. sometimes 3 .. always

Have difficulty counting objects accurately. For example,
lacks the ability to make 'one to one correspondence' when counting objects (match the number to the object) or does not organise objects to help monitor counting ☐

Find it impossible to 'see' that four randomly arranged objects are 4 without counting (or 3, if a young child) ☐

3) Have little sense of estimation for bigger quantities ☐

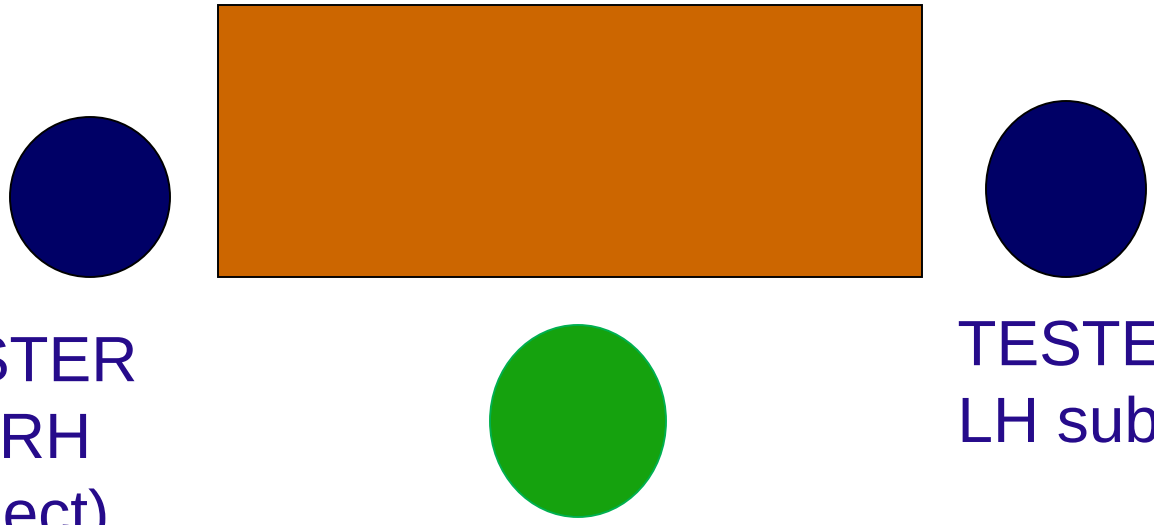
4) Reverse the digits in numbers, for example, writes 51 for fifteen or 45 for fifty-four ☐

5) Have difficulty remembering addition facts, which may be revealed by:
counting on for addition facts, for example, for 7 + 3, counting on 8, 9, 10 to get an answer, ☐
and/or
counting all the numbers when adding, as for 7 + 3 again, counts
'1, 2, 3, 4, 5, 6, 7, 8, 9, 10' ☐

How long will an assessment last?

- **IF** the right ambience/ethos can be set from the start, then about 60-90 minutes, depending on the age of the subject.
- They have to be as relaxed as possible.
- The structure of each test and the design of the protocol has to ensure this can happen.

Sit where you can see.



Visual/Vision/Aural/Oral

- Check the obvious
- Can they see? Can they hear?
- Does print/paper contrast/colour make a difference? (scotopic sensitivity)

Informal items

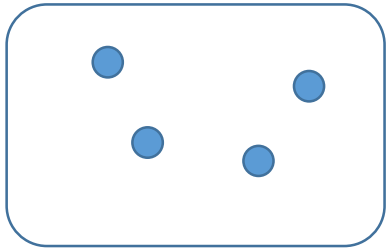
- ‘Warm up’
- A chance for initiating dialogue.
- Gathering evidence and clues for later exercises.

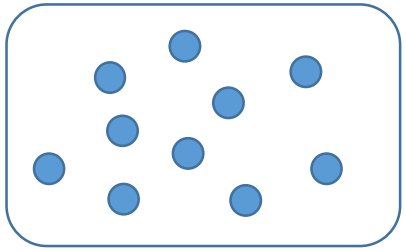
Questions that might give interesting and informative answers

- Where would you rank yourself for maths in your class?
- Which bits of maths are you comfortable with?
- Which topics do you like?
- Any parts of maths that you don't like? Why?

Informal items. Starting off...

- **Getting a sense of number sense**
- How many coins? Count them.
- How many dots?

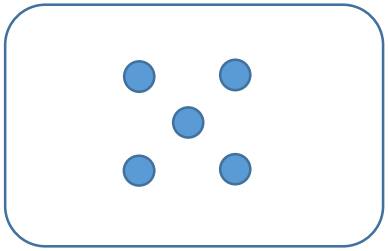


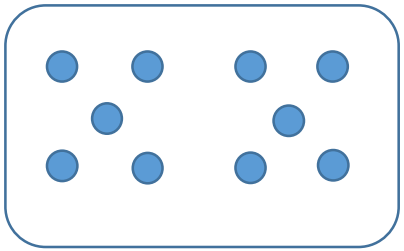


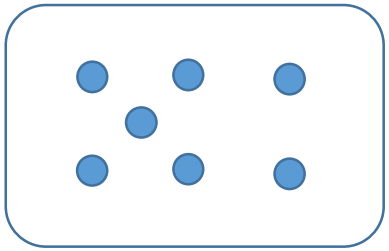
Informal items. Starting off...

- **Getting a sense of number sense**

- How many dots?







Number bonds/combinations

- Add these numbers

2 6

- 6 + 7 =
- 5 + 5 =

5 + 6 =

More links

- 10 + 7 =

- 9 + 7 =

- 5 + □ = 9

Number bonds/combinations for 10

- ‘Write for me two numbers that add up to make ten.’
- Can you write two more... Different
- And two more, and .....

Organisation in space

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

Place value and sequences

- 57 384 5012

- **2 4 6 __ 10 12 14 __ > and <**
- **1 3 5 __ 9 11 13 __ > and <**

- **14 24 34 44 ____ ____ > and <**

Symbols and word cards

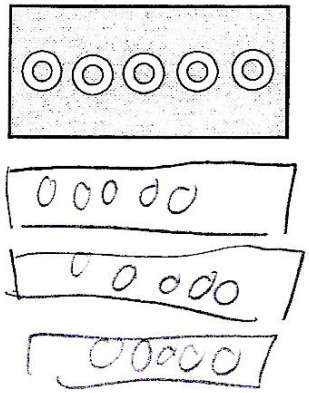
- + - x ÷ =

- Put the word under the correct symbol

add

subtract

4. Draw 3 more similar rectangles:



Complete the number sentence:

5 + 5 + 5 + 5 = 20

In 1 rectangle, there are 5 ◎.

In 4 rectangles, there are 20 ◎.

4 fives = 45

Altogether: 20 ◎.

Therefore, 4 x 5 = 20

Short term memory. Working memory

- Why test these skills?
- How to test?
- Cautions about dual tasking
- Vital information for teachers/tutors. Why?

- **What are the effects of poor stm and WM? For students? For teachers?**

Basic facts test(s)

- Decisions and implications. Formal/informal

- Why test these facts? How?
- What age range?
- What format?
- How long for a test?
- Standardise/norm reference? 1700

The 120 second Test for Division

Name _____ date_____ age_____y _____m

2 ÷ 1 =	4 ÷ 1 =	4 ÷ 2 =
6 ÷ 2 =	6 ÷ 3 =	9 ÷ 3 =
10 ÷ 2 =	12 ÷ 4 =	10 ÷ 5 =
16 ÷ 4 =	15 ÷ 3 =	20 ÷ 5 =

Basic facts

- There were few errors in addition and subtraction. Learners who scored low in these tasks tend to be slow, answering few questions.

- The more frequently occurring errors in multiplication are around 0x and 1x and 6x

- Low scorers in division often multiply some facts. ÷ 1 is a problem, **so is ÷ 10.**

What do they know?
‘Which tables do you know really well?’

- 0 1 2 5 10
- Can they build patterns?
- 10 20 50 100
- Can they inter-relate the operations?

Do they have strategies?

- ‘Number combinations’
- Gray and Tall research
- Key finding 2 (NRC)
- ‘..... organise knowledge in ways that facilitate retrieval and application.’

First experience (Buswell and Judd, 1925)

- There is the problem that the first time you learn a new idea or procedure it often creates a dominant learning experience.
- This means that the consequences of that experience being incorrect are highly detrimental.
- A reason to use materials/visual?

www.mathsexplained.co.uk

- Inhibition

Thinking (cognitive) style test

- Decisions and implications

- What will this test tell us about the learner?
- Can the items be constructed to encourage different thinking styles?
- It has to be about dialogue, but avoid leading questions. ‘How did you do that?’
- How long? Is every item needed in every diagnosis?

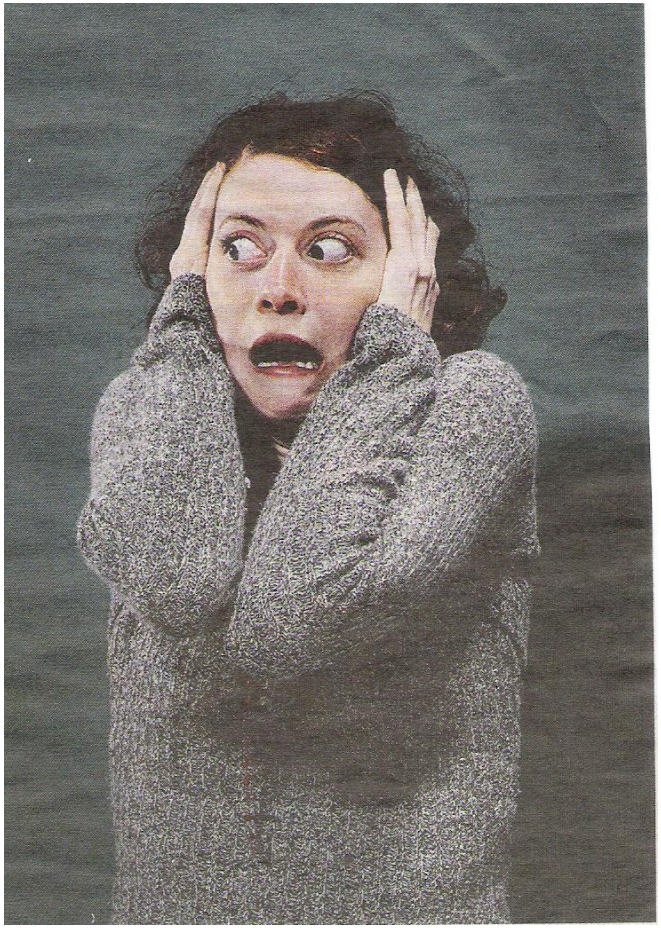
NRC. Key Finding 3

- A ‘metacognitive’ approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

Why do we need to know thinking style?

- Learners at either extreme of the spectrum are at risk (different risks)
- Working memory and maths long term memory are significant interacting factors
- Knowledge of thinking style should influence intervention
- It is linked to the consistency/flexibility factor

Anxiety



Anxiety ‘test’

- **Decisions and implications:**

- How many and what items?
- Does every component test in this protocol have to be used every time?
- Can this test be used to encourage dialogue?
- Is the test objective? No!!

- Research based on over 2400 students ages from 11 to 16 years. DYSLEXIA. **15** p61-68. 2012

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

A standardised (norm-referenced) test

- What are you testing and why?
- What information can you get from the test?

A standardised (norm-referenced) test

- Content?
- Length?
- Style?
- Age range?
- Parallel form?
- Standardising sample?
- Diagnostic? **Numbers chosen?**
- Existing tests

The standardised test

- 15 minutes
- 44 items. 4 pages
- Minimal use of words
- Numbers that allow focus on procedures
- Diagnostic
- 5 trial versions
- Simple lay-out
- Age 7 to 59 years old
- Sample: about 2000 across the UK

Formative and Summative Evaluations

- A formative evaluation is diagnostic in nature. Formative evaluations are normally criterion referenced.
- A summative evaluation is the measurement of achievement. Summative evaluations are usually normative.
- Can I get formative information from a summative test?

Maths Test. **15 minutes** (© 2012 S Chinn)

Name _____

M/F **Age** _____**y** _____**m** **Year/Group** _____ **Date** ___/___/2016

1. 2 + 5 = ___ *2*. 7 + 8 = _____

3. 19 – 4 = ____ *4*. 5 + 4 + 3 = _____

---

5. 34 = 4 + ___

6. 400 + 600 = ____ *7*. 100 – 58 = _____

24. 2 ¼ hours = _____ minutes

31. $\frac{4}{7} + \frac{2}{7} =$ _

32. 23 ÷ 1000 = _____

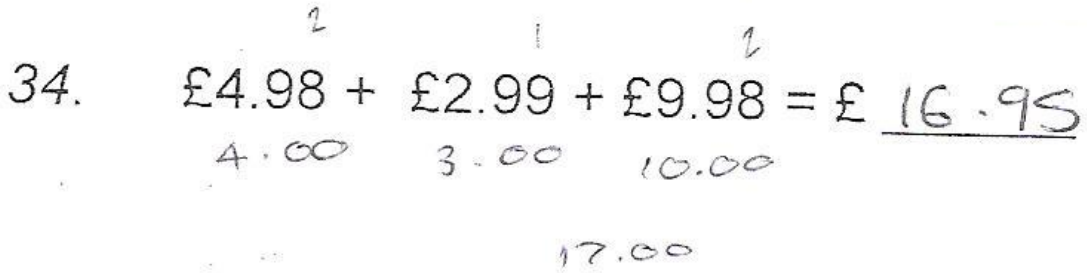
33.
$$\begin{array}{r} 541 \\ \times\ 203 \\ \hline \end{array}$$

37. 5.67 km = _____ metres

Strategies

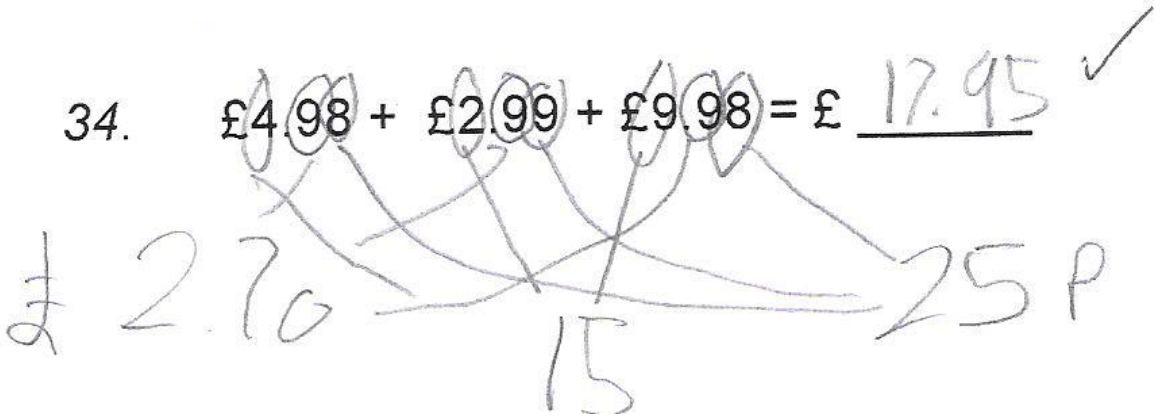
- 15y

38/44



- 11y

25/44



Errors and Error Patterns

Rationalising:

Age 58y 41/44

Job: researcher film maker

33. 541
x203

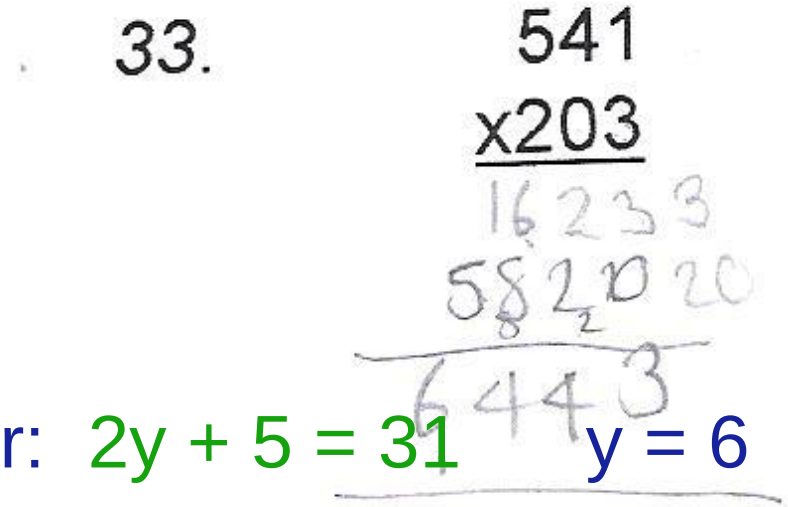
too hard!

Age 15y3m 25/44

541
x203
1003

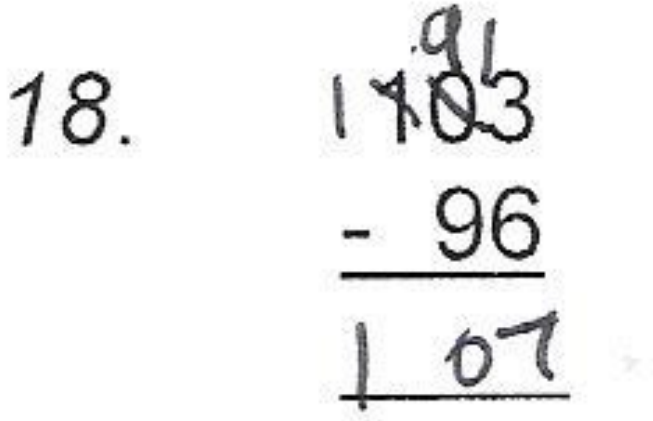
Not every error can be interpreted

- Age: 15y 10m 20/44



A (fairly) frequent error: 2y + 5 = 31 y = 6

17y 2m Male 28/44
The triumph of procedure over number sense



Addition Error

- 46
  38
  74
  + 62
  20
  20
  40

Errors. Engelhardt 1977

- In all quartiles of ability basic fact errors were the most common.
- **The error type which most dramatically distinguishes highly competent performance is the defective algorithm type error. Top performers rarely commit these errors.**
- Basic facts, grouping, inappropriate inversion and defective algorithm account for almost all the errors committed.

Basic fact errors

- 60 = 5a $\frac{60}{5} = a$ 15y 37/44

$a = 7$

19. $2\overline{)38} = 16$ 15y 36/44

Zero errors

(14y 43/44)

- 827
  -705
  102

Speed of working test

Abandoned!

But ……

Classroom study. Chinn. 1995

- 16 + 37 308 + 897

  12.3 + 5 19.09 + 10.91 63 + 2.1
- 67 – 32 72 – 48 813 – 668 601 – 346

  37.6 – 4 21.003 – 2.114
- 5 x 6 5 x 60 33 x 20 44 x 21 25 x 202
- 2)39 6040 ÷ 10 3)906 5)668 15)345

- (122 dyslexic pupils, 11-13, 8 schools)
- (122 from upper sets of 9 mainstream schools)

Speed

- Dyslexic pupils 13.00 mins, SD 5.41
- Mainstream pupils 8.50 mins, SD 3.41
- **Anxiety survey: Ranked 4th – 7th**

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

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

No attempt

• 12.3 + 5	2.5%	0%
• 37.6 – 4	14.0%	2.2%
• 33 x 20	15.7%	3.6%
• 6040 ÷ 10	39.7%	5.8%
• 2)39	21.5%	2.9%

The ‘no attempt’

- Generally speaking, we don’t like failure and we don’t like being wrong….. The fear of negative evaluation.

- There are several consequences that might follow when attempting to diagnose maths difficulties, including:
- Untypical performance (usually lower)
- Refusal to get involved and take any risks
- Do we ask, ‘What’s the point of this?’ if we enjoy doing it?

Criterion referenced tests

- Follow up exploration
- Worksheet design
- Pre- and post- tests
- Build up a resource bank
- Build into work sheets, but....
- Beware the influence of the first experience
- **On-going tracking**

Setting up your own criterion referenced test

- What part of the curriculum do you want to test? Eg. Subtraction with whole numbers.
- How many items do you need?
- Which criteria are you going to test?
- Are you looking for particular errors?
- Do you need a pre-teaching and a post-teaching version?
- What other factors may influence performance?

Whole numbers – algorithms
(Wilson, 1976)

1. Basic facts with sums to 10
3. Column of 1-place addends with zero. 3 + 0 + 5
9. Basic facts with sums from 11 to 18
12. Adding hundreds to hundreds. 500 + 300
15. Bridging the tens. 15 + 9
18. Renaming tens, 2-digit sum. 45 + 38
23. Renaming hundreds. 275 + 142
24. Renaming a ten and a hundred. 399 + 276

Word problems

The language, and order, of 8 – 3

- 8 subtract 3
- 8 take away 3
- What is 3 less than 8?
- What is left if I take 3 from 8?
- What is the difference between 8 and 3?

What is 8 minus 3?

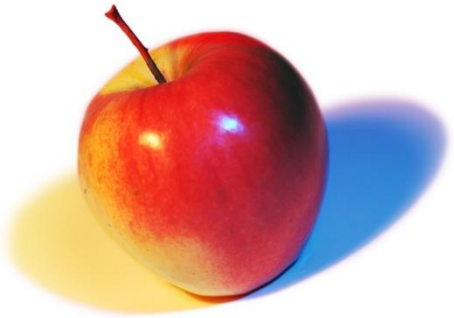
Developing Word Problems 8 – 3

- Dan has 8 toys. Bill takes 3 toys away. How many toys does Dan have now?
- Jill has 8 sweets. She eats 3. How many are left?
- Nathaniel has 8 chocolate digestive biscuits. He eats 3. How many are left?

Developing Word Problems: 8 – 3

- Kate has 8 coins. Sue has 6 coins. Kate loses 3 coins. How many coins does Kate have left?
- Tia has 8 cans of cola in her bag. She drinks 3 and gives away 2. How many cans in her bag now?
- Sam has eight cakes. He gives three to his friends. How many more cakes can he give to his friends?

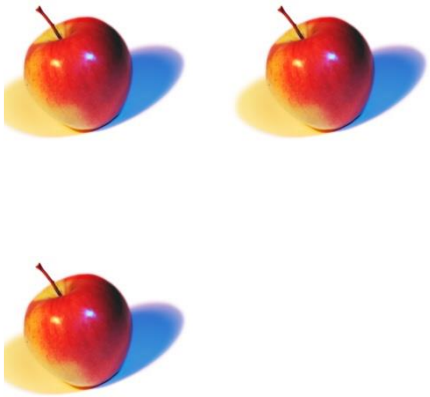
Developing Word Problems for Functional Skills *(Horticulture).*



It was a cold and stormy night as the tall dark stranger took the three shiny Washington red apples from Sinead leaving her with a scarcely viable five apples for her favourite teacher Mr Ramsbotham.

‘What will be will be,’ sighed Sinead philosophically as she reflected on what had been hers for such a tantalisingly short, but memorable time. She turned to Raghavpat, looking longingly into those two dark brown eyes and asked, ‘How many apples did I have back then, you know, before the stranger entered our lives?’

? – 3 = 5



8

maths explained

‘Maths Explained’

A series of video tutorials

maths explained

maths explained