



# Midlothian Mathematics Questioning ASG

*....changing the way that secondary Mathematics teachers ask pupils questions, in order to improve the thinking done by pupils in reaction to these questions.*

August 2006 to June 2007

The Midlothian Mathematics  
Questioning ASG was made up of two  
teachers from each of the six secondary  
Mathematics Departments in the Midlothian  
High Schools:

**Beeslack Community High School**

**Dalkeith High School**

**Lasswade High School Centre**

**Newbattle Community High School**

**Penicuik High School**

**St David's RC High School**

We felt that improvements in questioning would lead to improvements in learning.

We wanted to change the way that secondary Mathematics teachers ask pupils questions, in order to improve the thinking done by pupils in reaction to these questions.

We hoped that staff would gain a greater understanding of how questioning in class can be used to promote pupil thinking so that pupils would be :

- thinking independently
- speculating, hypothesising, reasoning and justifying
- asking questions
- responding to each other
- happier and more confident about answering questions.

We said that we would have met our aims if staff felt comfortable with a variety of approaches to questioning, to make it an important tool for pupil learning

# We started by doing a lot of reading:

Mathematics Inside the Black Box

Questions and Prompts for Mathematical Thinking (ATM)

Deep Progress in Mathematics,  
The Improving Attainment in Mathematics Project

Formative Assessment in Maths: Rich Questioning

How do they walk on hot sand ?

Using effective questioning techniques,  
Using Assessment to Raise Attainment in Mathematics:

LT Scotland AifL Case Studies

The Socratic Method

After we discussed the reading we decided to try out 7 questioning strategies:

**Key Questions**

**Gathering Answers**

**Chains of Questions**

**True and False Answers**

**Pupils Making Up Questions**

**Wait Time**

**Socratic Method**

But over the project we focussed on:

**Key Questions**

**Gathering Answers**

**Chains of Questions**

**True and False Answers**

**Pupils Making Up Questions**

# Key Questions

Teachers identify questions which may:

- be “higher order”
- highlight misconceptions
- generate discussion
- allow pupils to show their understanding.

# Gathering Answers

Teachers, having asked a question, gather different answers on the board.

Thereafter the correct answer is identified. This can be done by the teacher “teaching”, by inviting pupils to “justify” or “contradict” an answer, giving reasons why or why not, or by a mixture of the two.

**S2 - aiming for level D (15 pupils)**

**Write 12 hundredths as a decimal.**

0.12

0.012

**What is  $2.3 \times 100$ ?**

20.3

0.023

230

23.00

$\frac{3}{4}$

of 200

15

$$4 \overline{) 200} \begin{array}{r} 5 \\ \underline{20} \\ 00 \end{array}$$

50

$$4 \overline{) 200} \begin{array}{r} 50 \\ \underline{200} \\ 00 \end{array}$$

$$5 \times 3 = 15$$

$$50 \times 3 = 150$$

Guess

66

150

$$\frac{1}{4} \text{ is } \frac{1}{2} \text{ of } \frac{1}{2}$$

$$\rightarrow 100 \rightarrow 50$$

$$\frac{3}{4} \text{ so } 3 \times 50 = 150$$

2 of 300

5

~~140~~ wrong!

$$\begin{array}{r} 6 \\ \times 0 \\ \hline 5 \overline{) 300} \end{array}$$

$$\begin{array}{r} 70 \\ \times 2 \\ \hline 140 \end{array}$$

120

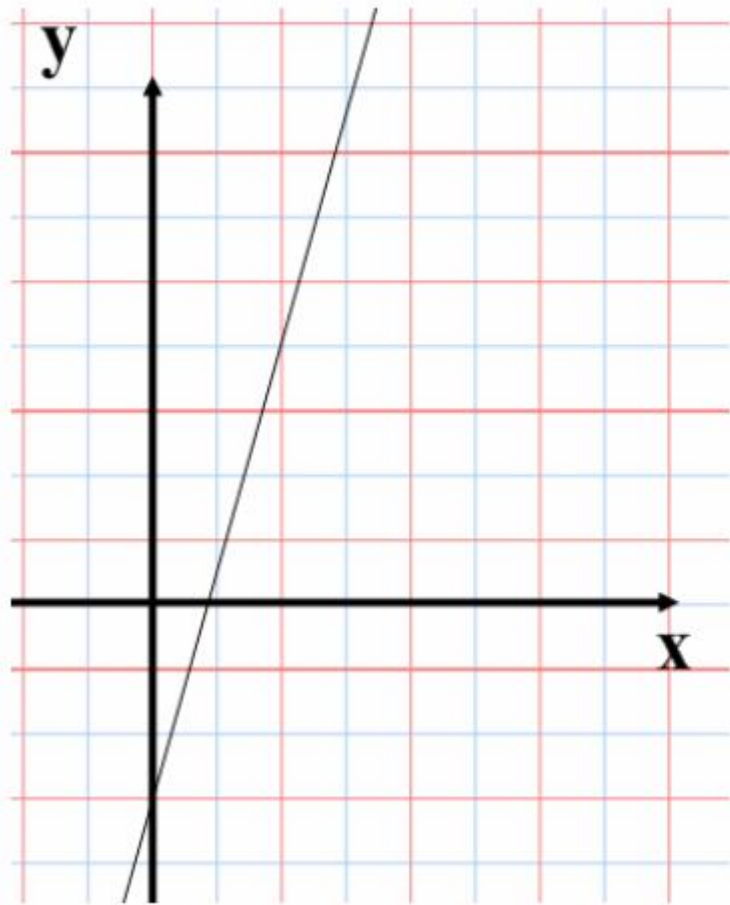
$$\begin{array}{r} 60 \\ \times 2 \\ \hline 5 \overline{) 300} \\ 120 \end{array}$$

$$\begin{array}{r} 60 \\ \times 2 \\ \hline 120 \end{array}$$

60

Mentally  
 $300 \div 5 = 60$

$\frac{1}{5}$  of 300



What is the equation of this line?

$$8) \quad m = \frac{v}{h} = \frac{4}{1} = 4.$$

$$y = x + 4$$

---

$$y = mx + c$$

$$m = \frac{v}{h} = \frac{4}{1}$$

$$y = \frac{1}{4}x - 3$$

---

$$y = mx + c$$

$$m = \frac{7}{2}$$

$$y = \frac{7}{2}x - 3$$

---

$$y = 3.5x - 3$$

---

$$y = mx + c$$

$$y = mx - 3$$

$$y = \frac{7}{2}x - 3$$

$$y = 3\frac{1}{2}x - 3$$

$$y = mx + c$$

$$m = \frac{3}{1}$$

$$y = \underline{3}x - 3$$

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# Chains of Questions

Teacher asks a series of questions, one question leads to another.

Session starts with questions that pupils are confident about, and moves to questions which extend understanding.

## Factorising a Quadratic Expression - Chain of Questions

Factorise these fully using common factors:

$$5x + 20$$

=

$$16 + 20y$$

=

$$56h - 79t$$

=

**Factorise these fully:**

$$2x^2 + 3x$$

=

$$mn - mno$$

=

$$6xy^2 + 9xy - 3y$$

=

## New work - Factorising a Quadratic

Factorise this expression,

$$x^2 + 3x + 2$$

Hint: Use a pair of brackets.

(                    ) (                    )

Factorise,

$$x^2 + 6x + 5$$

Factorise,

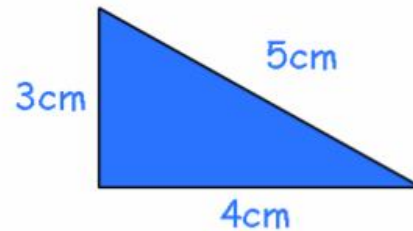
$$x^2 + 8x + 15$$

# **True and False Answers**

Teacher puts a question on the board, along with some wrong answers.

Pupils are asked to identify what is wrong with each answer.

## True or False?



- 1) The area of the rectangle is 36cm.
- 2) The perimeter of the triangle is 12cm.
- 3) The area of the triangle is  $15\text{cm}^2$ .
- 4) The perimeter of the rectangle is 15cm.
- 5) The area of the triangle is  $12\text{cm}^2$ .

**SURDS - True or false?**

$$\sqrt{9} + \sqrt{4} = \sqrt{13}$$

$$\sqrt{3} + \sqrt{5} = \sqrt{8}$$

$$\sqrt{3} \times \sqrt{3} = 3$$

$$\sqrt{2} = 1.414213562$$

$$\sqrt{9} \times \sqrt{4} = \sqrt{36}$$

$$\sqrt{3} \times \sqrt{5} = \sqrt{15}$$

$$\sqrt{2} \times \sqrt{2} \times \sqrt{2} = 2\sqrt{2}$$

$$\sqrt{9} - \sqrt{4} = \sqrt{5}$$

$$\sqrt{200} = 10\sqrt{2}$$

$$\frac{\sqrt{36}}{\sqrt{4}} = \sqrt{9}$$

$$\sqrt{200} = 2\sqrt{100}$$

$$\sqrt{200} = 5\sqrt{8}$$

$$\sqrt{200} = 2\sqrt{50}$$

$$\sqrt{200} = \sqrt{20} \times \sqrt{10}$$

Now fill in = or  $\neq$ : (you may want to try a few more numerical examples of your own first)

$$\sqrt{a} + \sqrt{b} \quad \sqrt{a+b} \quad \sqrt{x^2} + \sqrt{y^2} \quad x+y$$

$$\sqrt{a} - \sqrt{b} \quad \sqrt{a-b} \quad \sqrt{x^2} + \sqrt{y^2} \quad x-y$$

$$\sqrt{a} \times \sqrt{b} \quad \sqrt{ab} \quad \sqrt{x^2} \times \sqrt{y^2} \quad xy$$

$$\frac{\sqrt{a}}{\sqrt{b}} \quad \frac{\sqrt{a}}{\sqrt{b}} \quad \frac{\sqrt{x^2}}{\sqrt{y^2}} \quad \frac{x}{y}$$

True or false?

Work through to justify your answers (and make corrections)

1.  $(x + 3)(x - 7) = x^2 - 10x - 21$

2.  $(2x - 1)(3x + 5) = 6x^2 + 7x - 5$

3.  $(4x + 3)(2x + 3) = 6x^2 + 18x + 6$

4.  $(2 + 3x)(4 - 3x) = 8 - 2x - 3x^2$

5.  $(9 - 2x)(4 - 3x) = 36 - 35x - 5x^2$

6.  $(x + 4)(x - 2x + 5) = x^3 + 2x^2 - 3x + 20$

## Mean, Range, Mode and Median

Decide if each statement is True or False.

If you think it is false, what do you think the correct answer is?

1. The mean of 2, 3, 4 is 3
2. The median of 2, 3, 5, 4, 4 is 5
3. The range of 2, 3, 4, 5, 9, is 9
4. The mean of 4, 0, 2, 9, 0 is 5
5. The mode of 1, 6, 2, 4, 1 is 6
6. The median of 0, 0, 1, 1, 2, 2, 4 is 2

## Some Large and Small Numbers!!

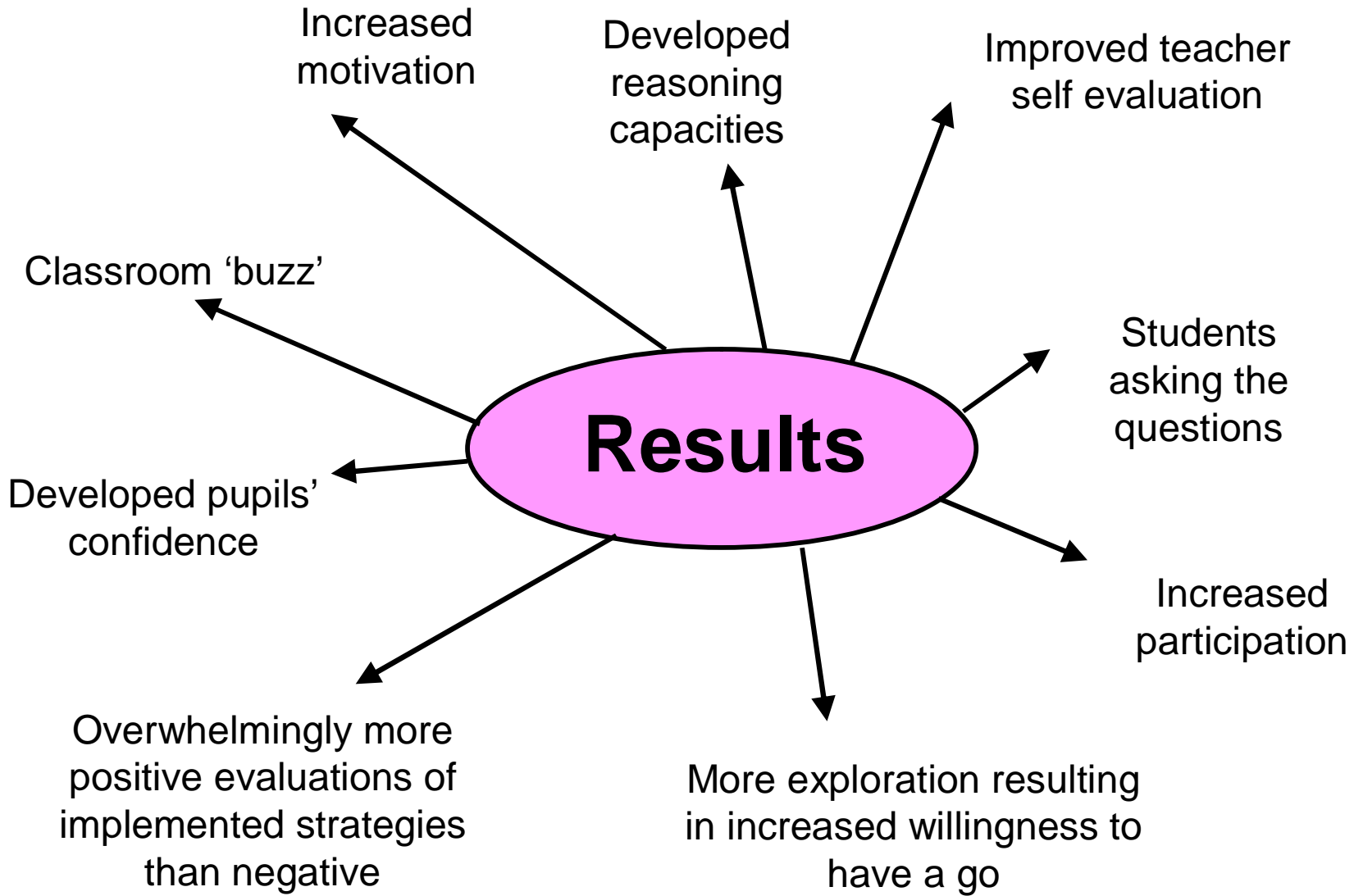
The correct standard form is given for the normal form number??	True Or False
1. $400 = 4 \times 10^4$	
2. $230 = 2.3 \times 10^2$	
3. $1230 = 12.3 \times 10^2$	
4. $110\ 000 = 1.1 \times 10^3$	
5. $0.04 = 0.4 \times 10^{-1}$	
6. $0.65 = 6.5 \times 10^1$	
7. $0.0005 = 5 \times 10^{-4}$	
8. $0.103 = 10.3 \times 10^{-2}$	

# **Pupils Making Up Questions**

Teachers ask pupils to make up questions and assessments, in order to let pupils demonstrate understanding.

In our lessons we observed that pupils are:

- more enthusiastic and confident to answer questions
- answering more questions, enjoying answering questions
- more enthusiastic and actively involved in their learning.
- thinking about and talking about Mathematics,
- sharing answers to questions with rest of class,
- sometimes out at board., and helping other pupils.
- more confident in solving problems.
- thinking more about why a method is used and how it is applied,
- giving answers which explain not just how but why !
- more comfortable in exploring answers: justifying or contradicting.
- **asking questions.**



# Evidence

How do we know its made a difference???

## Class Observation Comments

“ Pupils confident to explain ”

“ Excellent discussion between students and with teacher ”

“ Loads and loads and loads of ideas to try ”

“ Fantastic pace of lesson ”

“ True or False worked very well ”

“ Lots of participation ”

## Following the trial of techniques after observing:

“ For the first time ever, I had EVERY member of the class participating ”

# Evidence

How do we know its made a difference???

## Log Extracts

### True or False Answers

“ pupils were engaged and liked the ‘prove the teacher wrong’ element ”

“ even the most reluctant learners got involved ”

“ Highlighted common misconceptions ”

“ generated lots of valuable discussion ”

# Evidence

How do we know its made a difference???

## Log Extracts

### Gathering Answers

“ (pupils) started to realise what they had done wrong following peer discussion ”

“ worked well to motivate ”

“ extended discussion ”

“ We had a big debate! ”

“ pupils took charge of explanations at the board ”

# Evidence

How do we know its made a difference???

## Log Extracts

### Pupil-generated Questions

“ Surprisingly (for this class) everyone had done their homework [creating questions]. They were really enthusiastic, some unsure about what they had done, but still attempted. ”

“ An excellent tool which I'd use again on the right topic ”

“ engaged, enthusiastic and most left with a better understanding because of it ”

“ great for gauging understanding ”

# Recommendations

- *Particularly recommend:*

True/False

Pupils creating questions

Gathering answers

- *Start small* – focus on one strategy with one class and build it from there. Avoid being overwhelmed by trying too much at once.
- *Keep a log* – even just a few comments to remind you of what went well / to improve. It can help motivate you later on!
- *Give it a go!* – it can re-energise your teaching, for both your pupils and you!

As teachers :

we have given more thought to how we teach, and have changed teaching approaches to make greater use of questioning,

feel re-energised and the project has increased our enjoyment in teaching.

Use of the small individual whiteboards has increased whole class participation and enjoyment.

Good experience observing/being observed by teachers in same/other schools.