METACOGNITION

QUESTIONING AND DISCUSSION

Mr Metacognition

Contracting Session

- Ask questions at any time!
- Time built in for thinking, discussion and planning

Session Aims

- Consider what makes an effective question
- Establish a metacognitive questioning approach
- **Explore three questioning strategies**
- Evaluate the importance of discussion
- Consider metacognitive components of discussion
- **Explore three discussion strategies**

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Who Am I?

- Nathan Burns
- Former Head of Maths/Pastoral Lead/MAT Lead
- Metacognitive researcher and author
- Full time training provider and consultant

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Why Metacognition? The Headlines...

- Greatest positive attainment impact of any intervention (EEF, 2019)
- OFSTED (2018) suggested area of focus for high-quality CPD
- Benefits ALL students (regardless of: socio-economic status; prior attainment; sex; behaviour; SEN status; age) (many, many papers...)
- Free for schools to implement

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Write Time...

What is metacognition?

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What Metacognition Is?

- Flavell (1972): 'I am being metacognitive if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before accepting it as fact'
- Burns (2023): '[Metacognition is] the little voice inside your head that constantly evaluates and informs your decisions.

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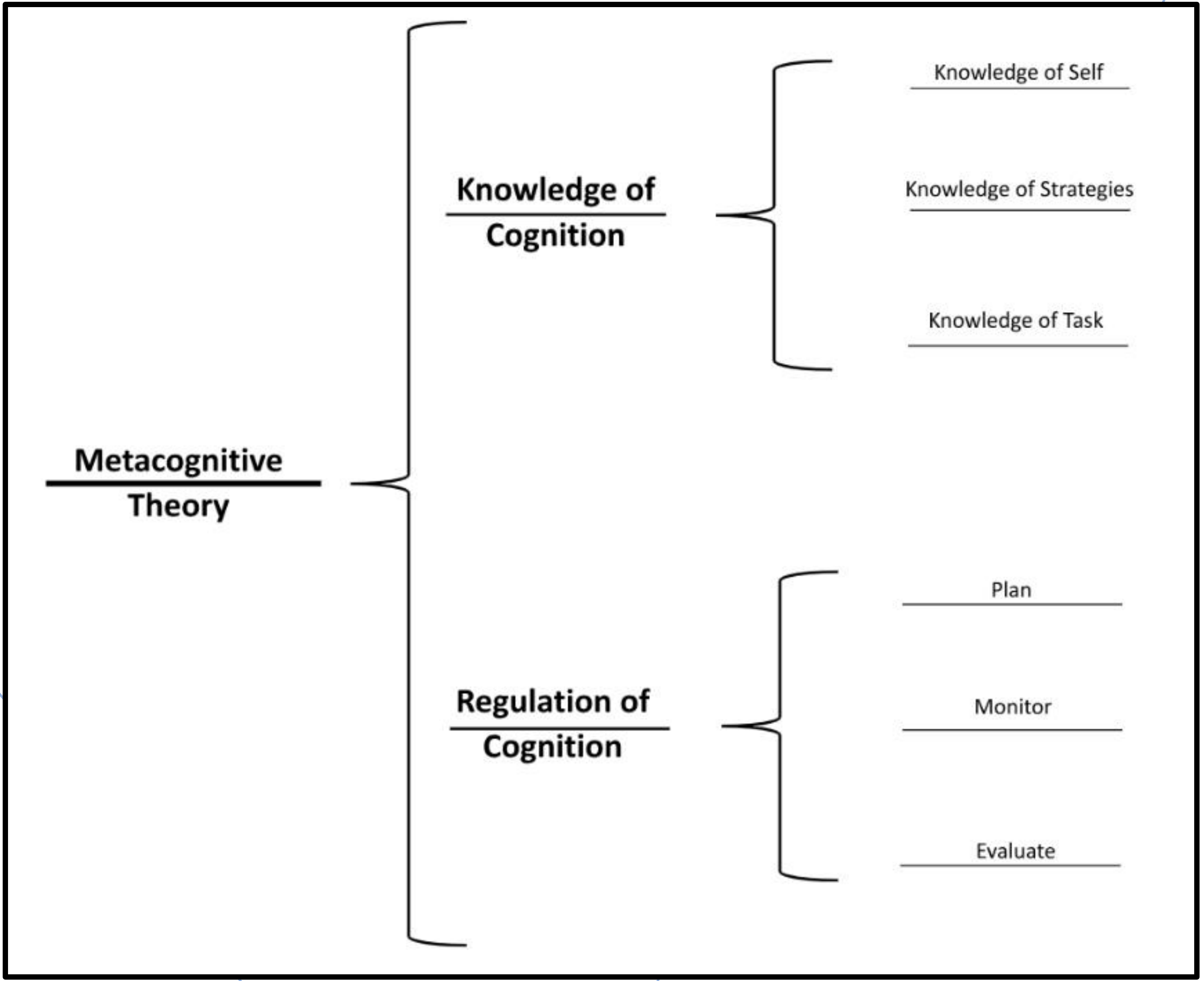

Knowledge

Vs

Regulation

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Knowledge Of Cognition

- Knowledge of task – knowledge of requirements to meet to fulfill task criteria
- Knowledge of self – knowledge of… knowledge
- Knowledge of strategies – knowledge of methods available to attempt a cognitive task

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Regulation Of Cognition

- Planning – an approach for the task
- Monitoring – staying on track for successful task completion
- Evaluation – review of the efficiency and effectiveness of approach and outcomes

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Write Time...

What makes a good question?

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A 'Good' Question

Provides us with information that we didn't otherwise have around student understanding...

OR

Provides a student with new information to help them more forward...

Getting Questioning Spot On!

- Questioning is just like playing darts…
- So…
  - We need to plan out our questions
  - We need them to build (appropriately) in difficulty (GOLDILOCKS!)
  - They need to illuminate new information (for us, or student)

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Metacognition, Not Cognition

- Typically, we ask 'cognitive' questions
  - What do I do next?
  - What is the answer?
  - How much do you need to write?
- Instead, we need to direct *some* attention to metacognitive questions

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Connections

What?

- Utilise questioning to draw connections with previous tasks
  - Conceptual variation... 'What is the same'; 'what is different?'
- Can become embedded in every lesson

Why?

- Learn from previous experiences
  - (Both positive and negative)
- Develop student schema; draw links between ideas and learning episodes

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Example

$3 + 4 - 5$

$3 - 4 + 5$

$3 \times 4 + 5$

$3 + 4 \times 5$

What varies between each question?

How does this impact the resulting answer?

What mistakes may be made?

What could we do to make sure our answers are correct?

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Example

Miss Konstantine @giftedHKO

Write each of the following in standard form

$\frac{1}{4}$	$7 \times 2^4 \times 5^4$	$(0.2)^3$
$5 \div 1000$	$9\ million$	$4 \times 10^5 + 3 \times 10^4$
$(8 \times 10^7) \times 5$	$\frac{735}{4}$	$10^3 \times (6 \times 10^{-7})$

How is the aim of each question the same?

What stages are going to be the same in each question?

What other topics does this question draw upon?

Why are these all reasonable questions?

Example

Dr Austin Maths

Adding and Subtracting Decimals

Increasingly Difficult Exercises

a) 0.3 + 0.4	b) 0.8 - 0.2	c) 0.8 + 1.9
d) 2.3 – 0.5	e) 0.35 + 0.4	f) 0.89 – 0.3
g) 0.351 + 0.12	h) 0.5 – 0.22	i) 0.4 – 0.159
j) -1.4 + 3.1	k) -3.5 – 2.7	l) -6.1052 – 3.48

What connection questions could we ask here?

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Strategy Comparison

What?

- Questioning around the relative strengths, weaknesses, appropriateness of alternative strategies.
- Potentially better once students have a better awareness of content and strategies available to them (cognitive load).
- Not appropriate where there is no reasonable alternative approach.

Why?

- Strengthen student knowledge of strategy appropriateness
- Improves problem solving and learner flexibility
- Deepens topic understanding

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Example

$$3(x - 5) = 17$$

Expand?

Don't expand?

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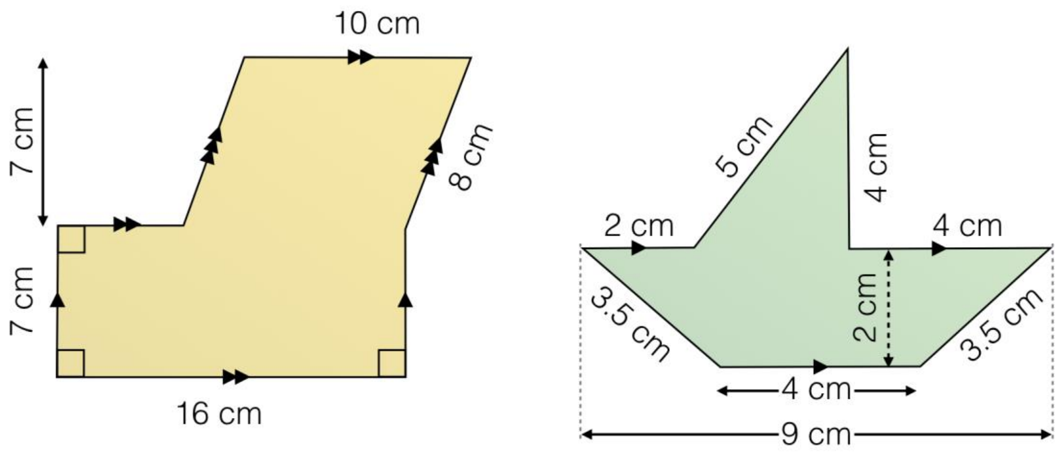
Example

Boss Maths

Examples

Find the **a)** the perimeter and **b)** the area of each of the following shapes:



Where can I divide the compound shapes to calculate the area?

What strategies do I need to avoid when calculating the perimeter?

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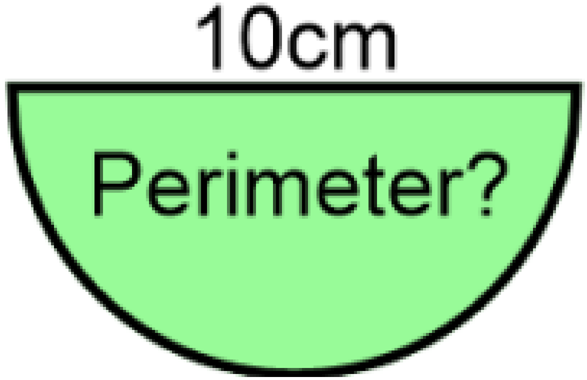
Example

Dr Austin Maths



What strategy questions could we ask here?

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Comprehension

What?

- Comprehension - what is the task requirement?
  - How long do you have? What do you need to do? How do you know that? Does it matter what method you use? (etc.)

Why?

- Improved comprehension = improved planning
- Improved planning = improved outcomes
- Comprehension often the biggest barrier to task success

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Example

Access Maths

Simplify (3): $\sqrt{20} : \sqrt{45}$

How long do I have?

How many stages am I likely to have to work through?

What does the command word 'simplify' mean?

What knowledge will I need to draw upon?

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Example

Find the equation of the line perpendicular to the line $y=2x+3$ and passes through the point $(4,11)$

Where does the line cross the x and y axis?

Access Maths

What are you being asked to find? In what form?

What are the key words? What do they mean?

What are you going to have to calculate?

Why is the information you have been given important/relevant?

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Example

Boss Maths

Ben saves £300 in an account paying 4% per annum **simple** interest. How much will he have after 7 years?

What comprehension questions could we ask here?

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Supporting Effective Answers

- Consider the wait time that we provide students with
- Ensure a climate where verbal answers can be messy, incoherent and colloquial

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Silence = Good?

- Poor proxy for learning: silence = effective learning
- Demand for oracy high – a key focus for most (all?) schools?
- Metacognitive development is reliant upon verbal communication

Discussion

- Discussion can be difficult – groups, behaviour, timings, evidencing learning…
- Metacognitive discussion requires two scaffolds:
  - Task understanding (e.g. time allotment; writing down or not?)
  - Cognitive understanding (*what* to discuss, with visible statements)

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Goal Free Problems

What?

- Provide students with a longer problem question, but remove the question/task element
- Allow students to recall as much information as they can.

Why?

- Superb retrieval task
- Removes the barrier of a 'question'
- Improves student confidence; show them what they can do

Example

The diagram shows the floor plan of Mary's conservatory.

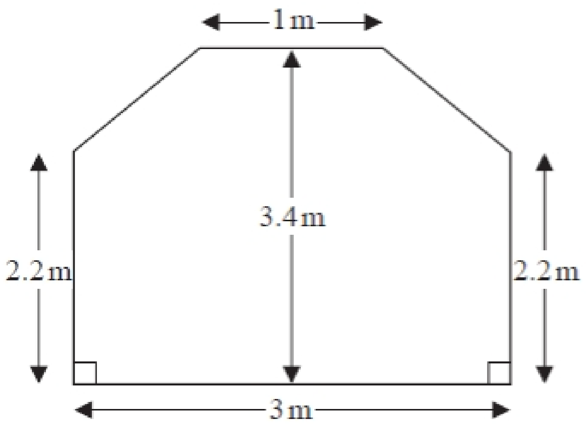

Diagram **NOT** accurately drawn

Mary is going to cover the floor with tiles.

The tiles are sold in packs.
One pack of tiles will cover $2m^2$.
A pack of tiles normally costs £24.80
Mary gets a discount of 25% off the cost of the tiles.

Mary has £100

Work out what you can from this information.

Peter Mattock; Goal Free Problems

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Example

potatoes
£1.50 per kg

carrots
£1.80 per kg

Jack buys $1\frac{1}{2}$ kg of potatoes and $\frac{1}{2}$ kg of carrots.

What can you calculate?

How many marks can you achieve?

List all potential questions

What units does the question link to?

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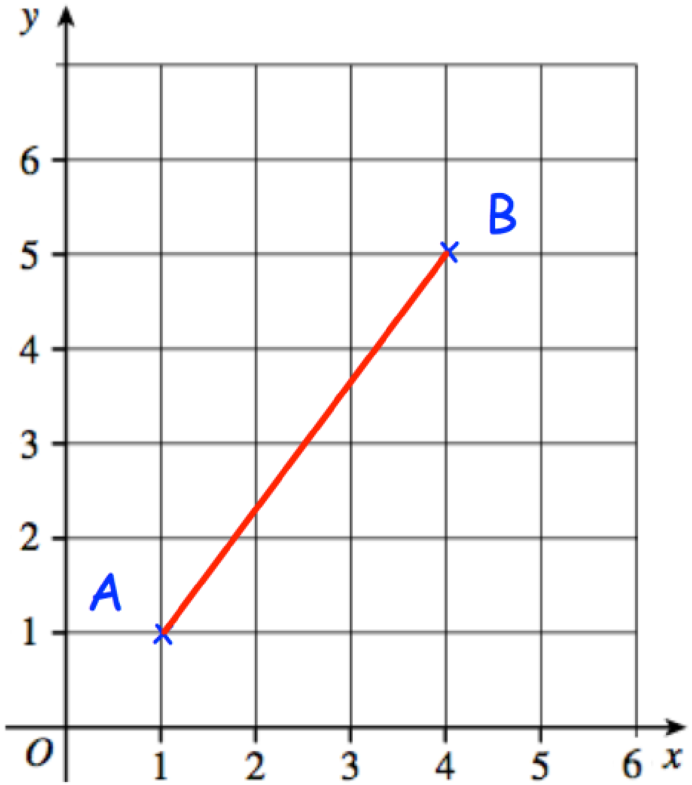
Example



Corbett Maths

What might we/students be able to calculate here?

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Talking Heads (Concept Cartoons)

What?

- Provide students with a question and several different responses
- These can be alternative answers, or often, answers with varied depth
- Students need to identify correct answer/most detailed answer

Why?

- Force consideration of depth of answers
- Develop understanding of effective answers
- Discuss subtlety in response
- Tease out misconceptions

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Example

Define a rectangle

A square is a rectangle

A rectangle has two pairs of opposite parallel sides

A rectangle has two pairs of equal sides

A rectangle has four sides

A rectangle is a quadrilateral with four right-angles

A rectangle has four sides, with two pairs of congruent parallel sides

A rectangle has parallel sides

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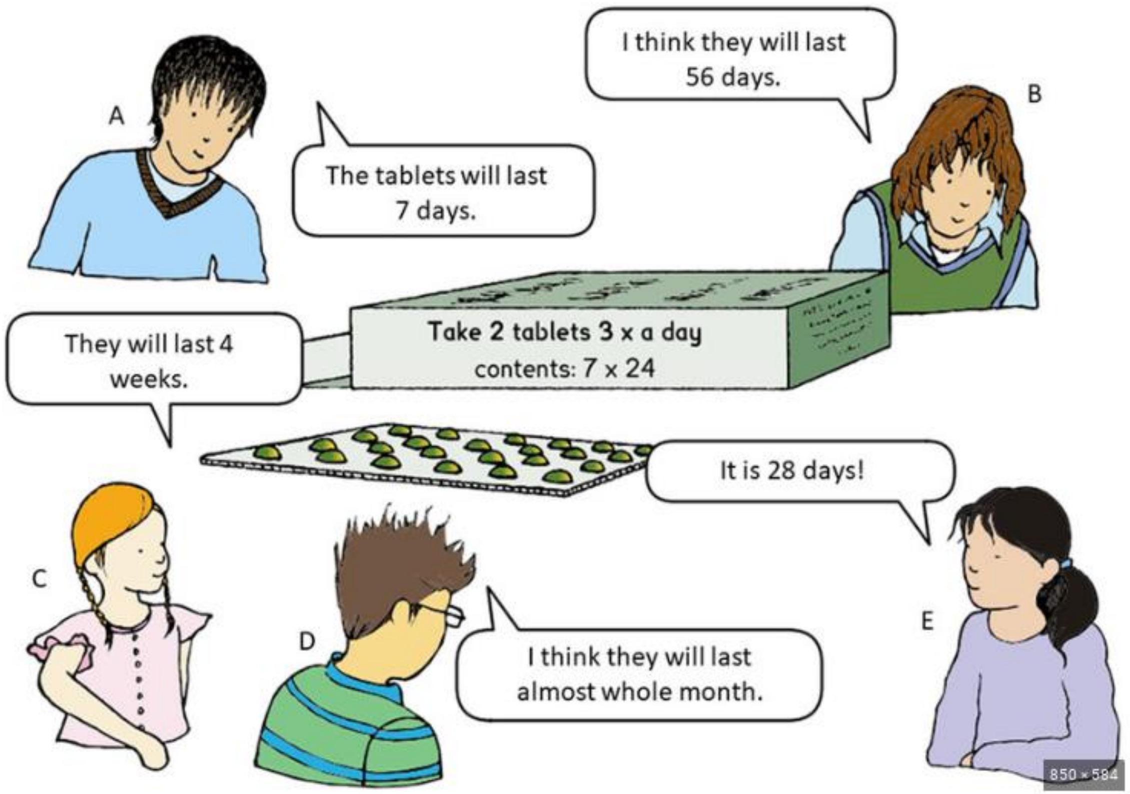
Example



Via Research Gate

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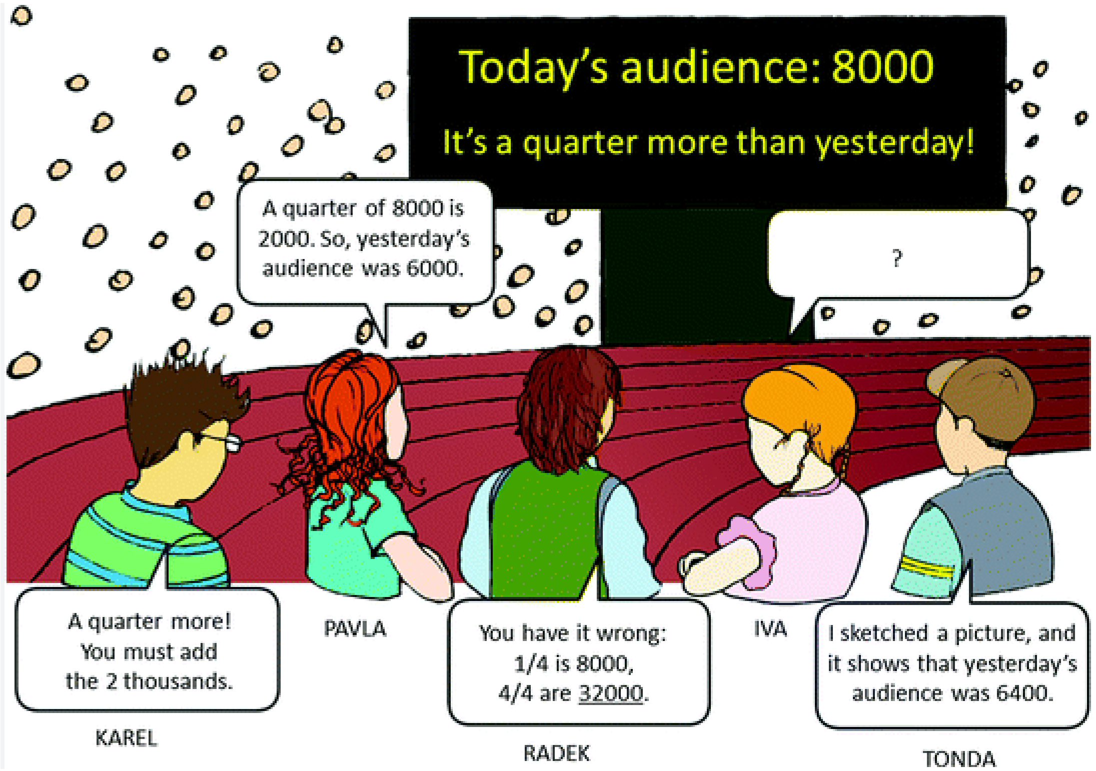
Example



Via Springer Link

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Misconception Discussion

What?

- Provide students with a misconception answer, or a range of answers containing at least one misconception
- Students need to identify the error, correct it, understand why it has come about

Why?

- Supports monitoring and evaluation abilities (i.e. identifying 'red flags')
- Significant subject knowledge benefits
- Develops students criticality

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Example

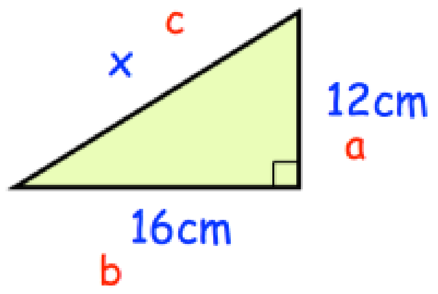
'Mr Woolaston's Mistakes'…

Four prompts:

1. What is the error?
2. What should I have done?
3. Why do you think I made the mistake?
4. Mistake or misconception?

Example

Benjamin has completed this question.
Can you spot any mistakes?



$$a^2 + b^2 = c^2$$
$$12^2 + 16^2 = x^2$$
$$144 + 256 = x^2$$
$$400 = x^2$$
$$x^2 = 400$$
$$x = 200\text{cm}$$

Corbett Maths

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Example

Question 7: Duncan has answered the questions below.
Can you spot any mistakes?

Write down the value of

(a) 3^2

$3 \times 2 = 6$

6

(1)

(b) seven squared

$7 \times 2 = 14$

14

(1)

(c) 8^2

$8 \times 2 = 16$

16

(1)

Corbett Maths

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Ponder...

Any final questions?

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