Coherence for responsive teaching

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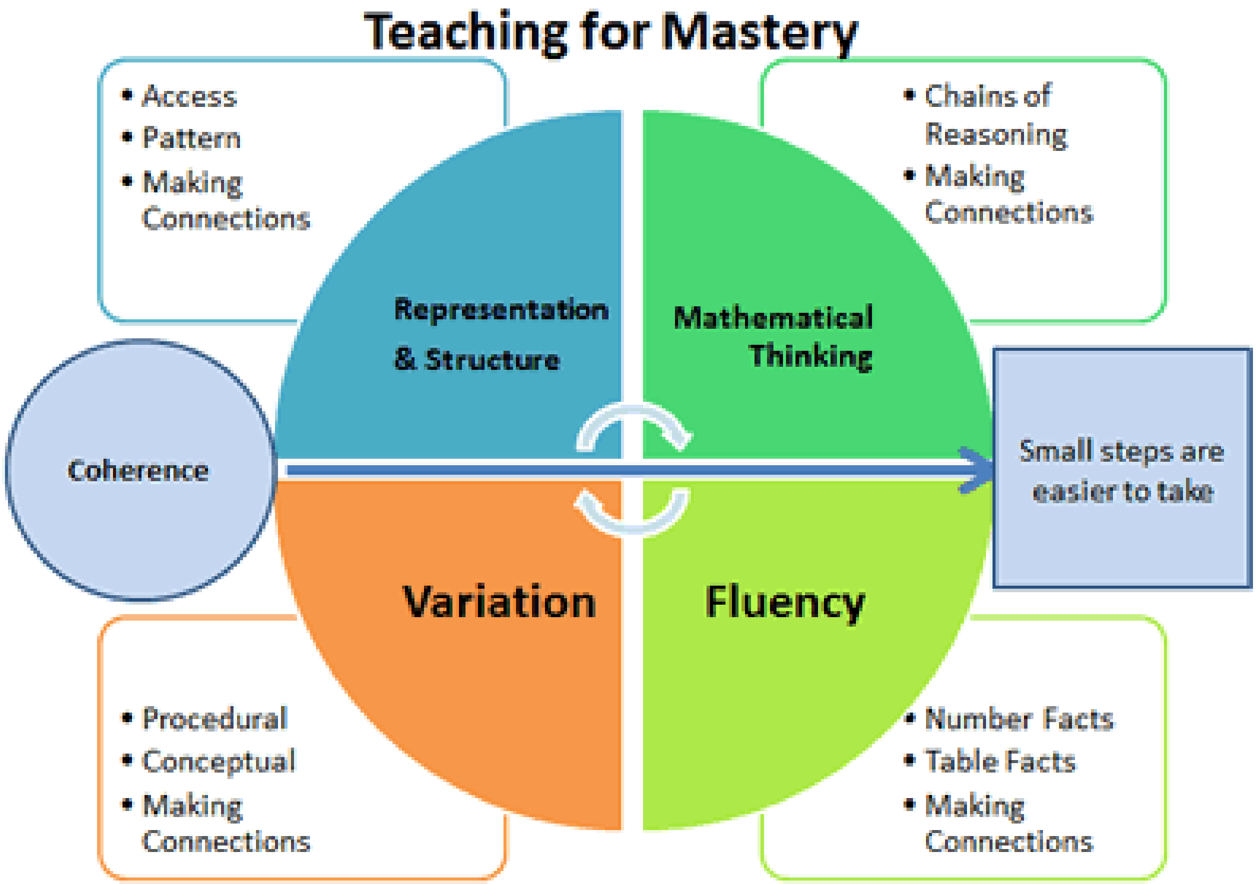
Aims of the session

1) Coherence and the 5 big ideas of teaching for Mastery
2) Planning for responsive teaching
3) Macro and micro coherence
4) Planning for responsive teaching through micro coherence

The 5 Big Ideas



Coherence

Lessons are broken down into small connected steps that gradually unfold the concept, providing access for all children and leading to a generalisation of the concept and the ability to apply the concept to a range of contexts.

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Big Idea: Coherence

Key Messages

1. Small steps are easier to take.
2. **Focusing on one key point each lesson** allows for deep and sustainable learning.
3. Certain images, techniques and concepts are **important pre-cursors** to later ideas. Getting the sequencing of these right is an important skill in planning and teaching for mastery.
4. When introducing new ideas, it is important to make connections with earlier ones that have already been understood.
5. When something has been deeply understood and mastered, it can and should be **used in the next steps of learning.**

Conceptual coherence

- In mathematics, new ideas, skills and concepts build on earlier ones.
- If you want build higher, you need strong foundations.
- Every stage of learning has key conceptual pre-cursors which need to be understood deeply in order to progress successfully.
- When something has been deeply understood and mastered, it can and should be used in the next steps of learning.

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Ofsted Research Review Series: Mathematics

The recent Ofsted Research Review (May 2021), focusses on the importance of sequencing.

“Close examination of lesson planning and teachers’ thoughts about lesson planning in education systems where pupils do well reveal an intense focus on underlying knowledge structures and connections rather than the surface coherence of activities and teaching. This means that teachers are planning for what pupils will be thinking about or with, not what they will be ‘doing’.”

Small steps

"The coach has to design a series of activities that will move athletes from their current state to the goal state. Often coaches will take a complex activity, such as the double play in baseball, and break it down into a series of components, each of which needs to be practised until fluency is reached, and then the components are assembled together."

(Dylan William 2011, 'Embedding Formative Assessment')

Responsive teaching and planning

Within a unit of learning, there is a lot of learning which is meaningless (Graham Nuthall, 2007)

*"Student learning **primarily depends on the information they are exposed to.** This means that **activities need careful designing** so that students cannot avoid interacting with this relevant information."*

Planning should **focus on carefully planned units** rather than lessons.

Responsive teaching and planning

Harry Fletcher-Wood identifies four stages to planning a unit:

1) Focus on powerful knowledge

- What are the *most important things* for the students to learn? - we don't want to overload the students

- **Acquisition**- basic knowledge which can be accumulated - what previous learning underpins this new learning?

- **Participation** - being able to communicate in the community

e.g. speak like a mathematician (Sfard's, 1998)

Responsive teaching and planning

2) Specify what students should learn

- Vague objectives are common in education (Millar, 2016)
- "Compare two fractions to identify which fraction is larger" (Hart, 1981)

This is difficult for us to respond

$\frac{3}{7}$ and $\frac{5}{7}$	90% of students were correct
$\frac{3}{4}$ and $\frac{4}{5}$	75% of students were correct
$\frac{5}{7}$ and $\frac{5}{9}$	15% of students were correct

Responsive teaching and planning

3) Identify connections and threshold concepts

- **Make connections:** helping them to *apply what they have learnt* and have an *understanding of the curriculum overall*
- **Develop knowledge of substantive concepts:** vocabulary can have different meanings in *different contexts* within your subject
- **Pass through threshold concepts:** lightbulb moments - *individual realisations*
  - **Troublesome:** difficult to understand
  - **Transformative:** of a students perspective
  - **Irreversible:** once learned, they are hard to unlearn
  - **Integrative:** they show how different ideas are related
  - **Bounded:** there are limits to the insight they off (Meyer and Land, 2003)

Responsive teaching and planning

4) Plan units, not lessons

- **Ease:** if you understand the learning over the unit then you can plan the lessons and **build on the students learning.**

This can help with the pace and differentiation within a lesson for a particular class

Responsive teaching and planning

"Rather than presenting skills in large complex chunks, which can lead to cognitive overload, we break them down into smaller components, crafted in a carefully chosen order, that accumulate to achieve greater success with a larger, well-defined goal."

(Emma McCrea 2019, 'Making every maths lesson count")

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What this means for coherence

There are implications for curriculum design (macro) and lesson design (micro).

Orton (2004) indicated that it is the teacher’s role to plan and structure learning experiences and to help the student in conceptual organisation and reorganisation.

It is the student who must do the conceptualising!

Examples of macro coherence:

Edexcel Specification

A19 solve two simultaneous equations in two variables (linear/linear **or linear/quadratic**) algebraically; find approximate solutions using a graph

A21 translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution

28	Simultaneous Equations

Key Learning Points

In this topic students are able to…	Done	RAG	Notes
Solve simultaneous equations when the coefficients are the same			
Solve simultaneous equations when the coefficients are different			
Understand that the solutions to simultaneous equations is where 2 lines intersect			
Set up and solve simultaneous equations			

10	16	Linear Graphs
	17	Trigonometry
	18	Averages
	19	Representing Data
	20	Proportion
	21	Inequalities
	22	Factorising and Solving Quadratic Equations
	23	Non-linear Graphs
	24	Volume and Surface Area
	25	Probability
	26	Real-Life Graphs
	27	Plans and Elevations
11	28	Simultaneous Equations
	29	Further Algebra Skills
	30	Vectors

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1. Solve one-step equations
2. Substitute into x and y
3. Show that (x, y) is a solution to an equation
4. Identify when equations are unsolvable e.g. $3y + 2x = 10$
5. Add/subtract two or more equations
6. Identify when equations have an infinity of solutions e.g. $3y + 2x = 10$
7. Find some solutions to an equation that has infinite solutions
8. Decide whether to add or subtract a pair of equations
9. Identify when equations have an infinity of solutions, from their graph
10. Determine whether a given value for (x, y) is a solution, based on the graph
11. Multiply two equations to get a common coefficient
12. Put everything together to solve a pair of simultaneous equation
13. Find the unique solution to a pair of simultaneous equations based on their graphs

Sequencing

	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Solve 1 step equations	R	R	R	R	
Sub. into x and y	R	R	R	R	
Show (x, y) is soln to an equation	R	R	R	R	
Identify unsolvable equations	I	R		R	R
Add and Subtract Equations	I	R	R		
Decide whether to +/- to eliminate			I		
Identify equations with infinite solns.		I	R	R	R
Find some solns.		I			
Find some using a graph			I	R	R
Show whether (x, y) soln. using a graph				I	R
Multiply equations to find common coeff.				I	
Put it all together					I
Show (x,y) is soln. to both using a graph					I

R = Revisit

I = Initial instruction

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Micro coherence – why is it so important?

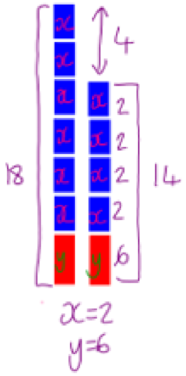
“The problem came whenever a student would announce that they were no good at simultaneous equations. It was quite tricky to know where to begin and help them.”

(Craig Barton 2018, ‘How I wish I‘d taught maths’)

Micro coherence:

- What is happening in the lesson?
- How are you breaking the learning point down even further to make sure the students are secure in their understanding?
- How will you bring these smaller learning points together to make sure the students can be flexible in their approaches to a range of questions?

Examples of micro coherence:

Lesson	Key Learning Point	Description	Linked Topics (Students have previously seen)	Resource
2	Solve simultaneous equations when the coefficients are the same Solve simultaneous equations when the coefficients are different	Introduce solving linear equations algebraically by focussing on visual images and finding the value of a shape – do not spend too long on this as it can cloud the picture for some (the nrich task is accessible). Start by solving simultaneous equations where the coefficients are the same and are both positive. Alongside the equations use a bar model to represent this.  $6x + y = 18$ $-\ 4x + y = 14$ $2x + 0 = 4$ $2x = 4$ $(\div 2)\ (\div 2)$ $x = 2$ $6(2) + y = 18$ $12 + y = 18$ $(-12)\ (-12)$ $y = 6$ Practise solving simultaneous equations where the coefficients are the same and positive (for either term e.g. x or ys's in both equations).	Algebra Skill (KS4 Topic 2) Forming and solving linear equations (KS4 Topic 5)	https://nrich.maths.org/1053 https://www.mathspad.co.uk/i2/teach.php?id=simultaneousPuzzles https://www.mathspad.co.uk/i2/teach.php?id=simEqElim1 – slide 1 only

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Micro coherence – why is it so important?

Practise solving simultaneous equations where the coefficients are the same and positive (for either term e.g. x or ys's in both equations).

Have a think why each of these examples will be used and what are the small steps involved?

1) $$\begin{aligned} 4x + 3y &= 10 \\ 2x + 3y &= 8 \end{aligned}$$

Positive values of x and y

2) $$\begin{aligned} 7x + 2y &= 14 \\ 5x + 2y &= 10 \end{aligned}$$

Positive value of x and y is equal to 0

3) $$\begin{aligned} 4x + 3y &= 14 \\ 2x + 3y &= 4 \end{aligned}$$

Positive value of x and negative value of y

4) $$\begin{aligned} 7x + 2y &= 25 \\ 7x + y &= 23 \end{aligned}$$

The coefficient of x is equal

5) $$\begin{aligned} 5x + 2y &= 26 \\ 7x + 2y &= 34 \end{aligned}$$

The larger coefficient of x is the bottom equation

6) $$\begin{aligned} 3x + 3y &= -21 \\ 2x + 3y &= -16 \end{aligned}$$

Negative value of both x and y

7) $$\begin{aligned} 4x + y &= 9 \\ 2x + y &= 7 \end{aligned}$$

Coefficient of y is 1

8) $$\begin{aligned} 4x + 6y &= 18 \\ 4x + 5y &= 16 \end{aligned}$$

The value of x is not an integer

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For micro coherence I use examples to break the learning down into the small steps – **linked heavily to variation**

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Micro Coherence – Over to you…

In your break out rooms I would like you to consider micro coherence for finding the nth term of a liner sequence.

What are the small steps you would take within a lesson or series of lessons to make sure that you are able to efficiently respond to the students learning?

Micro Coherence – Over to you…

Reflection on the task

Where do all of the small steps lead to?

Dr Helen Drury also emphasises that whilst we want to build upon the small steps, we also want the students to piece these together to make decisions and combine the steps to solve more complex problems.

“We mustn't ignore the final outcome altogether!”

(Dr Helen Drury 2018, ‘How to teach mathematics for Mastery’)

Thank you

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