Mastery or inquiry approaches? Might there be a feasible middle way?

Wee Tiong SEAH

Setting the scene

Australian Association of Mathematics Teachers

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Teaching by Mastery

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Improving mathematics outcomes in schools: Teaching by Mastery

August 24, 2020

Teaching by mastery is a general term used to describe the pedagogical approach to teaching maths that is commonly used in Singapore and Shanghai. In this approach, the teaching of mathematical concepts is broken down into steps. The teacher focuses on each step in turn and ensures, often through explicit teaching, that all students gain a thorough understanding, or mastery of it, before moving to the next step in the sequence. Relationships between concepts and their application in problem-solving are introduced to the students as part of the acquisition of mastery skills. The intention is for each student to acquire a deep, long-term, secure and adaptable understanding of the mathematics concepts that they learn (https://www.ncetm.org.uk/teaching-for-mastery/mastery-explained/).

In recent years, mastery techniques have been adopted by maths educators in the UK. The transition to mastery in the UK is of particular interest to Australian teachers. The two countries share a similar cultural and educational context and prior to its recent changes in teaching practice, the UK, like Australia, emphasised inquiry-based learning.

In the coming weeks AAMT will be organising a series of webinars about Teaching for Mastery. These will be given by maths education colleagues in the UK and Singapore.
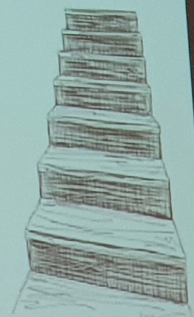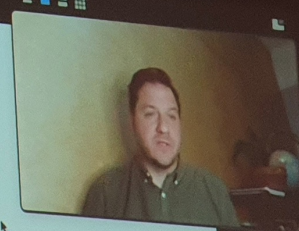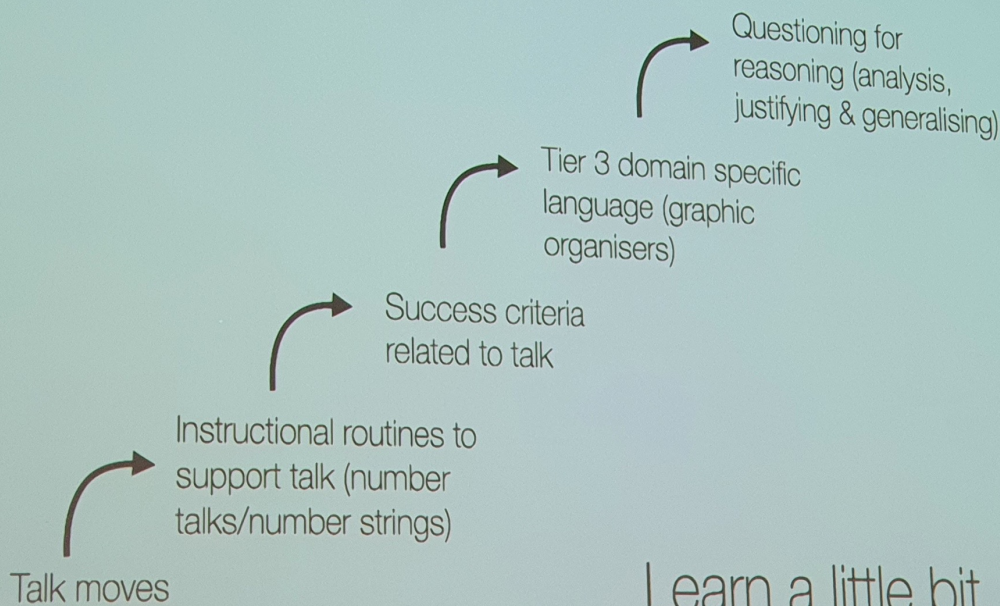
Teaching for Mastery webinars (12 & 19 Nov)

More details

Reasoning

'construct viable answers & critique the reasoning of others'

Questioning for reasoning (analysis, justifying & generalising)

Tier 3 domain specific language (graphic organisers)

Success criteria related to talk

Instructional routines to support talk (number talks/number strings)

Talk moves

Learn a little bit, do a little bit

Dr Ryan Dunn
@DunnEducation

'Teaching for Mastery' in England (2014 -)

Shanghai-style maths lessons to help British pupils match Chinese

Countries' performance over time

PISA results 2000-2018

Reading, maths and science skills of 15 year olds – top five nations, Australia and OECD
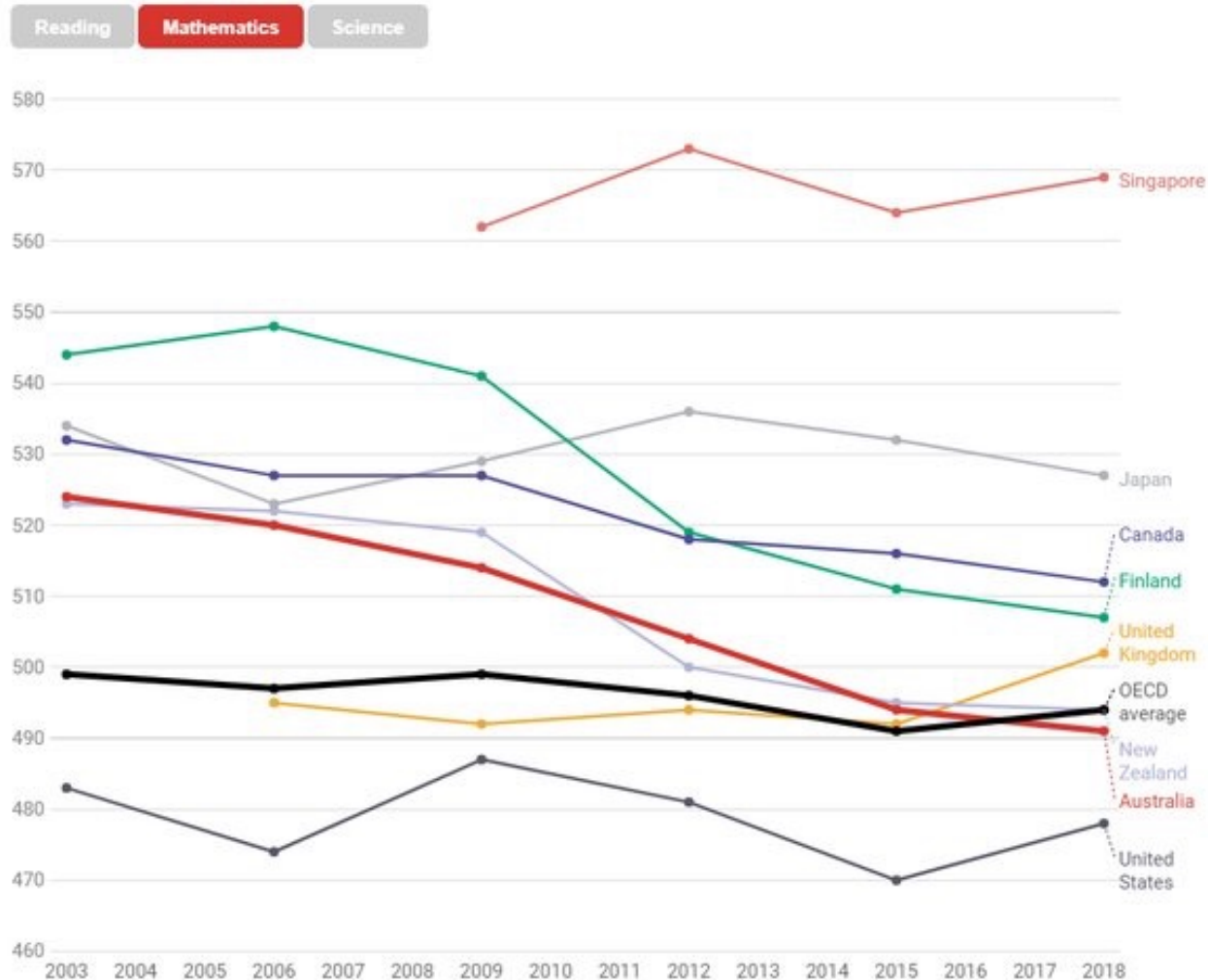
Back at home …

Higher and intermediate mathematics students in Australia

Higher and intermediate mathematics students in Australia, percentage of Year 12 students, 2008–2020.

Higher mathematics: 2008: 11.6, 2009: 11.2, 2010: 10.9, 2011: 10.3, 2012: 10.2, 2013: 10.3, 2014: 10.6, 2015: 10.1, 2016: 10.0, 2017: 10.0, 2018: 10.1, 2019: 10.1, 2020: 9.2

Intermediate mathematics: 2008: 23.3, 2009: 22.5, 2010: 21.5, 2011: 21.3, 2012: 21.0, 2013: 20.4, 2014: 20.6, 2015: 20.2, 2016: 20.5, 2017: 20.6, 2018: 21.1, 2019: 20.5, 2020: 17.6

Wienk AMSI (2022)

Australian Curriculum vers 9 (wef 2023)

- a stronger focus on students mastering the essential mathematical facts, skills, concepts and processes, and being introduced to these at the right time
- making clear what mathematical computations need to be done without a calculator, reinforcing the importance of achieving proficiency in foundational skills
- a revision of the sequencing of content in Mathematics, in particular, telling time, introduction of fractions, recall of multiplication facts and the solution of linear equations
- lifting standards for Mathematics in Year 1 in relation to addition and subtraction, and with additional content setting expectations about recall and proficiency with multiplication facts ("times tables") beginning in Year 2.

Mastery vs Inquiry approaches

What do these approaches look like?

	Practices $_0$	Values	P_1	Integrating
Mastery				
Inquiry				

Same practice, different values

Country S

Variation Theory (Marton & Booth, 1997)

Country A

repetition

(Source: Smith et al, 2011, p. 64)

NUMBER AND ALGEBRA • NUMBER AND PLACE VALUE

4 a MC What does $(p^7)^2 + p^2$ equal?
A p^7 B p^{12} C p^{16} D $p^{4.5}$ E p^{11}

b What does $\dfrac{(w^5)^2 \times (p^7)^3}{(w^2)^2 \times (p^3)^5}$ equal?
A $w^2 p^6$ B $(wp)^6$ C $w^{14}p^{36}$ D $w^2 p^2$ E $w^6 p^{19}$

c What does $(r^6)^3 \div (r^4)^2$ equal?
A r^3 B r^4 C r^8 D r^{10} E r^{12}

5 Simplify each of the following.
a $(a^3)^4 + (a^2)^3$ b $(m^8)^2 \div (m^3)^4$ c $(n^5)^3 \div (n^6)^2$
d $(b^4)^5 \div (b^6)^2$ e $(f^7)^3 \div (f^2)^2$ f $(g^8)^2 \div (g^5)^2$
g $(p^9)^3 \div (p^6)^3$ h $(y^4)^4 \div (y^7)^2$ i $\dfrac{(c^6)^5}{(c^5)^2}$
j $\dfrac{(f^5)^3}{(f^2)^4}$ k $\dfrac{(k^3)^{10}}{(k^2)^8}$ l $\dfrac{(p^{12})^3}{(p^{10})^2}$

6 WE19 Simplify each of the following.
a $\left(\dfrac{3b^4}{d^3}\right)^2$ b $\left(\dfrac{5h^{10}}{2j^2}\right)^2$ c $\left(\dfrac{2k^5}{3t^8}\right)^3$
d $\left(\dfrac{7p^9}{8q^{22}}\right)^2$ e $\left(\dfrac{5y^7}{3z^{13}}\right)^3$ f $\left(\dfrac{4a^3}{7c^5}\right)^4$

UNDERSTANDING

7 Simplify each of the following using the index laws.
a $g^3 \times 2g^5$ b $2p^6 \times 4p^2$ c $(w^3)^6$
d $12x^6 \div 2x$ e $(2d^8)^2$ f $5a^6 \times 3a^2 \times a^2$
g $15s^8 \div 5s^2$ h $4bc^6 \times 3b^3 \times 5c^2$ i $\dfrac{14x^8}{7x^4}$
j $(f^4 g^3)^2$ k $\dfrac{16u^6 v^5}{6u^3 v}$ l $x^2 y^4 \times xy^3$
m $5a^6 b^2 \times a^2 \times 3ab^3$ n $x^2 y^4 \div xy^3$ o $(4p^2 q^5)^3$

8 Simplify each of the following, giving your answer in index form.
a $(w^3)^4 \div w^2$ b $\dfrac{4x^5 \times 3x}{2x^4}$ c $(2a^3)^2 \times 3a^5$
d $12x^6 \times 2x \div 3x^5$ e $2d^3 + d^2 + 5d^3$ f $\dfrac{(2k^3)^2}{4k^4}$
g $\dfrac{4p^5}{p^4 \times 6p}$ h $15s^8 t^3 \div 5s^2 t^2 \times 2st^4$ i $12b^4 c^6 \div 3b^3 + 4c^2$
j $(f^4 g^3)^2 - fg^3 \times f^7 g^3$ k $\dfrac{(3p^3)^2 \times 4p^7}{2(p^4)^3}$ l $2(x^2 y)^4 \times 8xy^3$
m $5a^6 b^2 + a^2 \times 3a^4 b^2$ n $24x^2 y^4 \div 12xy^3 - xy$
o $\dfrac{4p^2 q^7 \times (3p^3 q)^2}{6(pq)^3 \times p^5 q^4}$

REFLECTION
How will you remember to raise all coefficients to the power outside the brackets?

64 Maths Quest 8 for the Australian Curriculum

eBook plus
Digital doc
Spreadsheet
Raising a power to another power
doc-2162

eBook plus
Interactivity
Indices
int-2360

eBook plus
Digital doc
WorkSHEET 3.2
doc-6852
Weblink
Multiplying numbers in index form

Same practice, different values

"Helping my maths teacher with classroom chores"

Country C
source of pride, indicator of teacher acknowledgement

Country A
manual work, teacher monitoring of behaviour

	P_0	Values	P_1	Integrating
Mastery				
Inquiry	Starts with a prompt	~~Authenticity~~ Interest		

Maths curriculum's most pressing conundrum: 'Inquiry-based learning'

By **Adam Carey**

Disputes over history and phonics have taken much of the attention during the debate over Australia's proposed new national curriculum, but the teaching of maths has also split the profession and divided some states from the Commonwealth.

At the heart of the argument are two meth...

Colin Chapman, one of Victoria's new master teachers and a member of the Australian Curriculum, Assessment and Reporting Authority's teacher reference group for mathematics, summed up the difference, saying: "If you're looking at multiplication, let's say, is it more useful to know your eight times tables by heart, or to recognise that to multiply any number by eight you just have to double it three times?" he asked.

Rote memorisation can only take a student's knowledge so far, Mr Chapman said, after which point a student must apply their knowledge to a broader set of real-life examples. A good system of teaching maths draws on both methods.

Achieving a balance

The director of the Australian Mathematical Sciences Institute (AMSI) at the University of Melbourne, Prof Timothy Marchant, says both approaches are useful – explicit teaching to build up mastery and fluency of basic concepts, as well as student-centred complex problem solving.
"Having a balance there between those two different approaches is important in the classroom," he says. "I think well-trained teachers can find that right balance."

<div align="right">(Lu, 2022)</div>

	P_0	Values	P_1	Integrating
Mastery	Conveyer-belt curriculum	Fluency	Ability grouping	
Inquiry				

	P_0	Values	P_1	Integrating
Mastery	Organise concepts into steps	Structure	Organise concepts into steps	**Teacher-led, student-centred** Planning – co-planning - Concepts introduced in steps Room setting - Ability grouping - Student group work
	Conveyer-belt curriculum	Fluency	Ability grouping	
	Teacher asks qns in class	Formative assessment	(A variety of ways)	
	Hi quality initial and corrective instructions	DI	Teacher instructions supported by co-planning	
Inquiry	Starts with a prompt	~~Authenticity~~ Interest		Teaching - Explicit, accurate and confident instruction - Active FA, emphasizing process (over product
	Student group work	Collab	Student group work	
	Investigations	Explorations		
	Students explain working out	Process	(To combine with FA above)	

Values alignment

Thank you

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