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Ontario's math curriculum is failing our students. This week, we announced education consultations, which will include moving away from Discovery Math to traditional formulas and memorization techniques. Let's get our kids back to basics with proven methods of teaching that work.

Memorisation is less useful as problems become more difficult (OECD average)



Defining Math Fluency

"...knowing how a number can be composed and decomposed and using that information to be flexible and efficient with solving problems."

(Parish 2014, p 159)



2-Digit Multiplication (A)

Multiply to determine each product.

70 ×11 70 700 770	2* 35 ×52 170 1750 1820	41 × 41 41 1640 1681	80 <u>× 83</u> 24 0 64 0 0 66 4 6	36 <u>×23</u> 108 720 828	84 <u>×51</u> 84 <u>4200</u> 4284
74 <u>× 26</u> 44 4 14 80 (9 2 4	42 × 93 126 3780 3906	54 × 42 108 1080 1188	38 ×23 114 760 874	67 × 73 201 4690 4891	43 ×99 . 387 3870 4257
$ \begin{array}{r} 51 \\ \times 60 \\ \hline 00 \\ 3060 \\ \hline 3060 \\ \hline 3060 \end{array} $	97 .×49 .¥73 3880 4753	50 × 16 36 O 500 80 O	2 34 × 62 68 264 0 21 68	70 × 67 490 4200 4890	3780 3780
62 <u>× 93</u> 186 55 8 0 57 6 6	\$5 ×92 .110 4950 5060	24 ×70 1680 1680	18 ×52 36 900 736	× 69 - 71 1 474 0 545 1	×45 145 1260 1405

What are your experiences with math worksheets as a learner?

Note- I am not claiming that repetitive worksheets are to be avoided at all costs. However, if it is the only approach to build fluency in a math program, then issues with motivation, engagement and active thinking will emerge.

2-Digit Multiplication (A)

Multiply to determine each product.

70	2*35	41	80	36	84
× 11	× 52	× 41	<u>× 83</u>	×23	<u>×51</u>
70	• 70	4	24 0	108	84
700	1750	1640	64 00	720	<u>4000</u>
770	1820	168	664 6	828	4084
74	42	54	38	67	43
<u>× 26</u>	× 93	× 42	×23	× 73	<u>×99</u>
44 4	126	108	114	201	. 387
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62 <u>×93</u> 186 5580 5766	\$5 ×92 .110 4950 5060	24 ×70 1680 1680	18 ×52 36 900 936	× 69 - 71 1 474 0 545 1	* 45 145 1260 1405

Limited opportunities for:

- creativity
- collaboration
- communication
- reasoning
- critical thinking
- Concepts of place value & partial products must be in place
- Motivation based on final mark
- Repetition is monotonous
- Learning is contrived
- Procedurally focused

Math practice is required! -automaticity, fluency -reduces cognitive load -means to an end

But what kind of math practice?

 Must promote reasoning, flexibility with numbers, active engagement, strategizing, communication







How close to 100?

- Partners share a blank 100 grid.
- Take turns rolling the two dice
- Record and multiply the two factors
- Fill in the array, e.g., 2x6=12
- Goal to fill up the grid

Variations:

- Each child can play on their own and compare arrays after completion
- Grids of 400 and use dodecahedron dice (12sided)



Global Competencies

- critical thinking/problem solving
- creativity
- collaboration
- communication
- citizenship

High Achieving and Low Achieving Students

7 to 11 year old students

- teachers assessed students as low, middle or high achieving in math
- important difference between the low and high achieving students

High Achieving Students:

-solved arithmetic problems with number sense

e.g., "21-16" changed the question to 20-15

Low Achieving Students:

-solved through inefficient strategies, inflexible with numbers

e.g., "21-16" counted backwards starting at 21

(Gray & Tall, 1994)

Math practice should involve:

- active thinking
- strategizing
- decision making / choice
- social interaction
- purposeful learning
- use of previous knowledge

FOUR 4s!

Using only the digits 4, 4, 4, and 4, find an expression equal to all of the numbers from 1 – 100. Each expression must use each 4, making a total of four 4s for each expression. You may use any operation you can think of within your expression.

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$44 \div 44 - 4 \div 4 + \frac{4}{4}$	1	4-54+4-4 4+4	2
4-54+4 (4+4+4)	3	54+54+4-4 4+4	4
J4+4-4 J4+4+4	5	14-4-4+4	6
4+4-4 4+4-(4+4)	7	J4+J4+J4+J4	8
4+4+# 54+4+4	9	14+54+54+4	10
$\frac{44}{\sqrt{4+54}}$	11	444-54-54 -54 14+3+	12
44 + 14	13	4+4+4+54	14
(14)4-4	15	$4x4 - \frac{4}{4}$ $4+4+4+4$	16
4 4 4 + 4 (4)4+4	17	4x4 + 4 - 54	18
$\left(\frac{44}{4}\right) + 4 + 4$	19	4- × 4 + 54 + 54	20
$4! - 4 + \frac{4}{4}$	21	4! - 4 + 4 - 54	22
4! - 54 + 4	23	(4+4) (14+14)	24
4! + 4 (4-4)	25	4! - 54 + 54 + 54	26
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Do...

- emphasize facts as a means to an end
- ensure students are active in their practice, e.g., use strategies, make decisions, use reasoning
- practice operations in different mathematical situations
- support interacting with numbers flexibly and work with numbers in different ways
- reach automaticity through understanding of number relationships
- motivate students' practice through engaging math games, puzzles, and activities

Do NOT...

- emphasize facts for the sake of facts
- force memorization without meaning
- force following procedures without understanding how and why they work
- value speed as a math strength
- bore students
- take the joy out of math
- make worksheets the focus of math practice



Traditional rote learning offers:

- low motivation
- weak engagement
- limited conceptual aids to understanding

Practice through games and puzzles has shown to:

- decrease anxiety
- increase motivation
- improve student math performance
- deepen understanding

Offenholley (2012)













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