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Come and be counted

TSG 3.4: Mathematical applications and modelling in mathematics education

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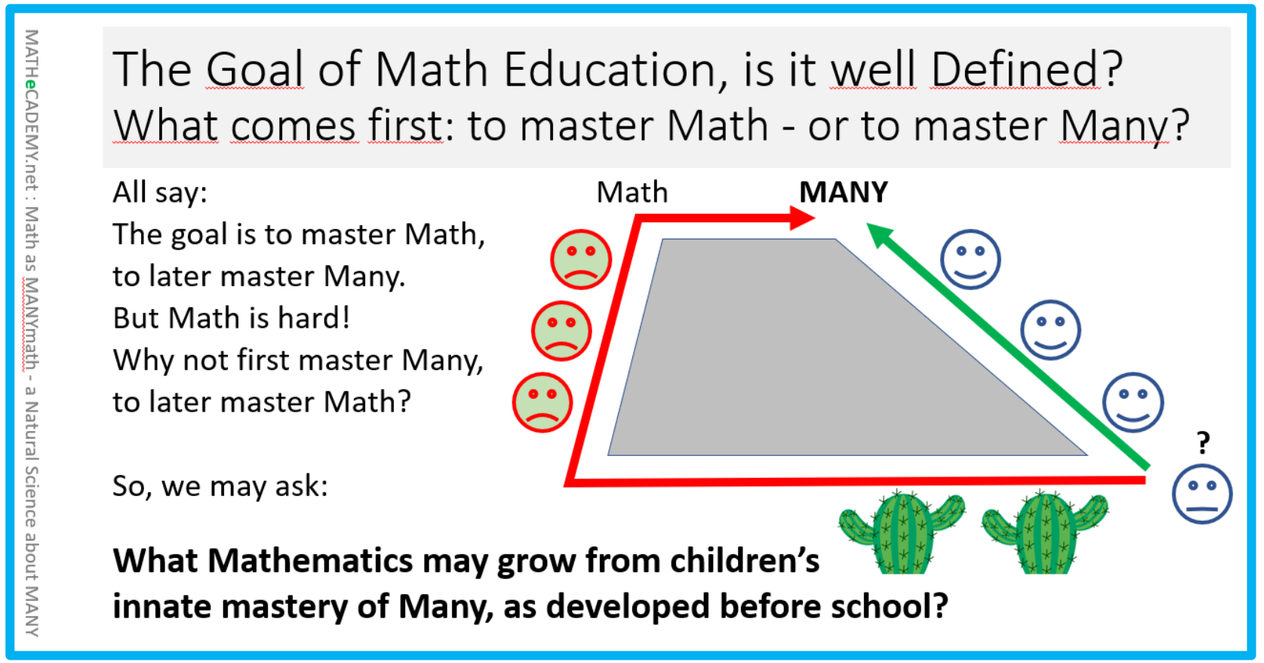
De-colonizing mathematics by de-modeling & re-rooting

De-modeled & re-rooted, **de-rooted math** may finally change from '**mathematism**' and its no-unit regime to **Many-math**, a natural science about Many in time and space, where **counting precedes adding**, to let **existence precede essence** as philosophical **existentialism** holds.

So, let **mastery of Many** precede mastery of math



Findings:

"That is not four, that is two twos". Said a 3year old child when asked "How many years next time?" And seeing 4 fingers held together 2 by 2.

So, un-colonized by the 1D number **no-unit essence-regime**, children describes existence by 2D **bundle-numbers with units**.
A **curriculum** built on **existence before essence** and **counting before adding**, will lead directly to the core of mathematics:
• digits & operations as **icons** • **re-counting** to shift units and to solve equations • fractions and **trigonometry** as **per-numbers**
• **add on-top** after recounting gives like units • **add next-to** by **calculus**, also adding **piecewise & locally constant per-numbers.**

There are two numbers-types in the world: UNIT-numbers & PER-numbers

which may be unlike or like, & which may be united or split

The aim of math education therefore is not to 'learn to math', because math is not an action verb, but to actively act to:	**Re-unite unlike & like UNIT-numbers & PER-numbers**

- 3$ and 2$ are unlike unit-numbers where the calculation 3+2 = 5 predicts the result of uniting them.
- 3 times 2$ are like unit-numbers where the calculation 3*2 = 6 predicts the result of uniting them.
- 3 times 2% are like per-number where the calculation 102%^3 = 106.12% predicts the result of uniting to 6% and 0.12% extra.
- Unlike per-numbers as mixture: 2kg at 3$/kg and 4kg at 5$/kg. Here, the unit-numbers 2 and 4 add directly while the per-numbers 3 and 5 must first be multiplied to unit-numbers before adding as areas, called integration, where multiplication precedes plus: T = (2+4)kg to (2*3+4*5)$, i.e., 6kg á 26/6$/kg. In Aarabic, 'algebra' means to re-unite.

Unite / *split into*	Unlike	Like
UNIT-numbers (meter, second)	**T = a + b** $T - b = a$	**T = a*b** $T/b = a$
PER-numbers (m/sec, m/100m = %)	**T = ∫ f dx** $dT/dx = f$	**T = a^b** $b\sqrt{T} = a$ $\quad log_a(T) = b$

- Tarp, A. (2018). *Mastering Many by counting, re-counting and double-counting before adding on-top and next-to*. Journal of Math. Education, 11(1), 103-117.
- Tarp, A. (2019). *A decolonized curriculum.* Mathecademy.net/a-decolonized-curriculum/
- Tarp, A. (2020). *De-modeling numbers & operations: From inside-inside to outside-inside understanding*. Ho Chi Minh City Univ. of Educ. Journal of Science 17(3), 453-466.
- Tarp, A. (2021). *Flexible Bundle Numbers Develop the Childs Innate Mastery of Many*, youtu.be/z_FM3Mm5RmE.

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What should name a mathematical concept, *what exemplifies it OUTSIDE - or from what it exemplifies INSIDE?*

The goal of math education, is that to learn to master math to later master Many, or the other way around?

● Traditionally, the goal of math education is seen as learning to master math to later master Many. So, a difference could be to see the goal of math education as learning to master Many directly to indirectly learning math on the way, at least the math core as displayed on a calculator: digits, operations, and equations.

●Traditionally, these all occur as **products** in space, so a difference could be to see them as **processes** in time by letting **outside-Many precede inside-math**. And the math core is different as **tales about Many** existing as rectangular totals of bundle-stacks on a plastic ten-by-ten bundle-bundle board, a **BBBoard**.

● To see if a 'process-based' 'Many-first' education will make a difference to the traditional 'product-based' 'Math-first' education, **micro-curricula** are designed using **flexible bundle-counting** to bring outside totals inside as **flexible bundle-numbers with units**, that are rectangular where the bundle-bundles are squares.

● Here both **digits and operations are icons**. Digits when uniting sticks. And operations with division to **push-away** bundles that multiplication **lifts** into a stack. Subtraction **pulls-away** stacks so unbundled are included as decimals, fractions, or negatives. The addition-cross shows the **two ways to add**, next-to & on-top.

● Once counted, **changing unit** may be predicted on a calculator by **the recount formula T = (T/B) x B**, saying that the total T contains T/B Bundles. Here recounting from tens to icons and vice versa leads to **equations**, and to **multiplication tables** existing as the stack left when removing the 2 surplus stacks from the full bundle-bundle on a BBBoard. And here recounting a rectangle as a square introduces its side as the **square root**, and a way to solve quadratics.

● Here recounting in two physical units leads to **per-numbers** as 4$/5kg bridging the two units; and becoming fractions with like units, 4$/5$ = 4/5, 4$/100$ = 4%.

● Here mutual recounting the sides and the diagonal in a stack leads to **trigonometry before geometry**.

● Once counted, totals may **add on-top** after recounting makes the units like or **add next-to** as areas as integral calculus becoming differential calculus if reversed.

● **Per-numbers and fractions are operators** needing numbers to become numbers, so also adding by their areas after being multiplied to unit-numbers to add.

● So, outside totals inside appear in an '**Algebra Square**' where unlike and like unit-numbers and per-numbers are united by addition and multiplication, and by integration and power. And later again split by the reverse operations: subtraction and division, and by differentiation and factor-finding root or -counting logarithm.

● Once process-based Many-first Many-math micro curricula have been designed, they are **tested** in online education, as well as **in special education** to see if **BBBoards 'Bring Back Brains'** excluded from the 'Math-first' education.

Details: A. Tarp. "*ManyMath 2030: Decolonizing 1D Mathematism into 2D Many-math*", http://mathecademy.net/manymath-2030/

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2 Colonizations: Bundle-numbers by Line-numbers, then by abstract SETS

De-colonization by de-modeling & re-rooting & de-construction will change

	ESSENCE-math, Mathematism **into**	**EXISTENCE-math, ManyMath**
Digits	Symbols	Icons
345	Place value system	T = 3**BB** 4**B** 5, **BB** = **B**^2, **BBB** = **B**^3
Operations	Functions, order: **+ - x / ^**	Icons, opposite order: **^ / x - +**
3 + 4	3 + 4 = 7	Meaningless with no units
3 * 4	3 * 4 = 12	3 * 4 = 3 **4s** *that may be recounted to 1.2 tens*
9 = ? 2s	Meaningless, only ten-counting	9 = 3**B**3 = 5**B**-2 = 4**B**1 = 4½ **2s**
8 = ? 2s	Meaningless, only ten-counting	8 = (8/2)*2, **T = (T/B)*B**, proportionality
2*u = 8	(2*u)*½ = 8*½, (u*2)*½ = 4, u*(2*½) = 4, u*1 = 4, u = 4	2*u = 8 = (8/2)*2, så u = 8/2
6*7 = ?	eh, 44? eh, 52? eh, 42? OK	(**B**-4)*(**B**-3) = (10-4-3)**B**+12 = 3**B**12 = 4**B**2
4kg=5$, 6kg=?	1kg = 5/4$, 6kg = 5/4*6$	6kg = (6/4)*4kg = (6/4)*5$
1/2 + 2/3 = ?	1/2 + 2/3 = 3/6 + 4/6 = 7/6	1/2*2 + 2/3*3 = 3/5*5
2 3s + 4 5s	2*3+4*5 is 10*5 = 50, or 6+20= 26, decided by definition	2**B**0 **3s** + 4**B**0 **5s** = 3**B**2 **8s**, integration
6 + 9 = ?	6 + 9 = 15	1**B**0 **6s** + 1**B**3 **6s** = 1**B**-3 **9s** + 1**B**0 **9s** = 2**B**3 **6s** = 2**B**-3 **9s** = 1**B**5 **tens** = 15
Tangent = ?	Tangent = sine/cosine	raise = (raise/run)*run, tan = raise/run

2+3 = 5, seldom, since 2weeks + 3days = 17days.
2x3 = 6, always, since 2 3s = 6 1s.

Mathematism adds without units, true inside & maybe outside.
ManyMath adds with units, true inside & outside.

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