Workshop in CATS-Math: Count and Add in Time and Space

Allan.Tarp@gmail.com, MATHeCADEMY.net, Bologna August 2024

Looking at four fingers held together two by two, we see four fingers, the essence. But, before school, children see what exists, bundles of twos in space, and two of them when counted in time. So, we may ask how mathematics may be taught to children if using their own two-dimensional bundle-numbers with units instead of the school's one-dimensional line-numbers without units. In other words, we may ask how children may learn mathematics by working with existence instead of listening to essence.

Here we use the two core concepts of philosophical Existentialism holding that existence precedes essence. This will mean that counting precedes adding since outside totals must first be counted to be added later inside. In this 'Many-math' approach, mathematical concepts are re-rooted in outside existing examples instead of being defined as examples itself inside. Now tens, hundreds and thousands become bundles, bundle-bundles, and bundle-bundle-bundles, as does 2, 4 and 8 when counting in twos instead.

Here one-dimensional lines on a ruler are replaced by two-dimensional rectangles on a ten-by-ten Bundle-Bundle Board, a BBBoard, containing the outside existing subjects that is linked to inside essence predicates in a number-language sentence as in a word-language sentence. Here units are always included in counting sequences as 0Bundle1, 0B2, …, 1B0. Here digits become icons with as many sticks as they represent. Here also operations become icons created in the counting process. Division is a broom to push-away bundles to be stacked by a multiplication lift before pulled-away by a subtraction rope to find the unbundled that are included on-top as decimals, fractions, or negative numbers. Here recounting in another unit creates the recount formula, $T = (T/B) \times B$, saying that T contains T/B Bundles.

Here recounting tens in icons creates equations solved when recounting moves a number to 'opposite side with opposite sign'. Here recounting icons in tens leads to early algebra when 6*7 becomes (B-4) * (B-3) placed on a BBBoard and found by pulling-away the top 4B and side 3B, and adding the 4*3 pulled away twice. Here bundle-bundles allow rectangular stacks to be recounted in squares with the square root as the side.

Here recounting in a different physical unit creates per-numbers as 4$/5kg bridging the units by recounting, and with like units becoming fractions. Here mutual recounting the sides in a stack halved by its diagonal leads to trigonometry before geometry.

And now, after being counted and recounted, stacks may finally add on-top after recounted has made the units like, or next-to as areas, i.e., as integral calculus becoming differential calculus when reversed, also used to add per-numbers and fractions that must be multiplied to unit-numbers to add. Squares add as the square formed by their mutual Bottom-Top line.

All in all, there are four ways to unite the world's four number-types. Addition and multiplication add unlike and like unit-numbers, where integration and power add unlike and like per-numbers. Together with their opposite operations, subtraction, division, differentiation, and the factor-finding root or the factor-counting logarithm they form an 'Algebra square' that is named after the Arabic word 'Algebra', meaning to reunite.

And that now is the number-language allowing us to tell inside number-tales about outside totals using the same three genres, fact, and fiction and fake, as does the word-language.

Can mathematics be decolonized? Well of course, since mathematics is a socially constructed essence that will always be a colonization of the natural existence it came from and reduces.

Operations **unite**/ *split Totals in*	Unlike	Like
Unit-numbers m, s, kg, $	**T = a + n** *T – n = a*	**T = a x n** *T/n = a*
Per-numbers m/s, $/100$ = %	**T = ∫ f dx** *dT/dx = f*	**T = a^b** *b√T = a loga(T) = b*

*The '**Algebra Square**' reunites unlike and like unit- & per-numbers with +, x, ∫, ^, and -, /, d/dx, √ & log)*	A ten-by-ten **B**undle-**B**undle **B**oard
*Details: http://mathecademy.net/bundlebundlemath-on-a-bbboard/ MrAlTarp: **Many before Math**, https://youtu.be/uV_SW5JPWGs*	a **BBB**oard

A01. We all Bundle-count with units before and after school

"That is not 4, that is 2 2s". Bundle-counting with units, using snap-cubes or a BBBoard. 2 3s is 2 bundles with 3 1s per bundle. Per-numbers in space and counting-numbers in time. The Algebra square reunites unlike and like counting- & per-numbers. Polynomials are also bundle counting with units. 43 = 4B3 tens. 2D Bundle-numbers with units are not line-numbers without units where 1+1 =2, when a V-sign says 1+1 =1.

A02. Counting fingers in space

Space-count five and ten fingers in 2s, 3s, 4s and 5s. ten = 1BBB 0BB 1B 0 2s. Flexible Bundle-numbers, 5 = 1B3 = 2B1 = 3B-1. And T = 38 = 3B8 = 2B18 = 4B-2. Carry not needed. 35+46 =3B5+4B6 = 7B11 = 8B1. 6*28 = 6*2B8 = 12B48 = 16B8 = 168. And T =n 4567 = 4BBB 5BB 6B 7, T = 4*B^3 + 5*B^2 + 6*B + 7*1.

A03. Add and subtract 1digit numbers counted in half-bundles.

T = 6+7 = ½B1 + ½B2 = 1B3 = 13. T = 4+7 = ½B-1 + ½B2 = 1B1 = 11. T = 3 + 4 = ½B-2 + ½B-1 = 1B-3 = 7
T = 8-6 = ½B3 - ½B1 = 3-1 = 2. T = 6-4 = ½B1 - ½B-1 = 1 - -1 = 2 (- - = +). T = 6-8 = ½B1 - ½B3 = 1-3 = -2

A04. Time-counting fingers

Time-count fingers in ½B, "1,2,3,4,5,6" no, "0B1, 0B2, 0B3, 0B4, 0B5, or 1½B0, 1½B1". Time-count from 88 to 102: "8B8, 8B9, 8Bten or 9B0, …, 9B9, 9Bten or tenB0 or ten-ten 0, or 1BB0B0". 9h9ty9, 9h,9ty, ten, 9h,tenty,0, 10h, 0ten0, tententen, 0 teneten, oten,0, 1BBB0BB0

A05. Digits are icons

4 stokes in the 4-icon: I I I I -> IIII -> 4. 5 stokes in the 5-icon: I I I I I -> IIIII -> 5, etc.

A06. Operations are icons, the recount formula

Push-away and push-back to stack, (division & multiplication), 6 = 3x2 = (6/2)x2, **T = (T/B)xB** (recount formula) Pull-away and pull-back (minus and plus) to get decimals, fractions and negatives. 7 = 3B1 = 3½B = 4B-1 2s.

A07. Recounting between from icon and tens

? 5s gives 40 , *u**5 = 40 = (40/5)*5, so *u* = 40/5, "To Opposite Side with Opposite Sign".
6 7s = ? tens. 6 7s = 6*7 = (B-4)*(B-3) = From BB, pull-away 4B & 3B and pull-back the 4*3 pulled-away twice = 3B12 = 4B2 = 42. So (B-4)*(B-3) = BB - 4B - 3B + 4*3, and minus * minus is +.

A08. The recount-formula gives per-numbers as 2$/5kg.

20kg = (20/5)*5kg = (20/5)*2$ = 8$. Meter = (meter/second)*second = speed*seconds. Fractions with like units: 2$/5$ = 2/5. Trigonometry in a stack: height = (height/base)*base = tan(Angle)*base.

A09. Bundle-bundles are squares

2 2s = 1BB 0B 0 2s. 3 3s = 1BB 0B 0 3s, etc. T = 1BB2B1 = next BB, T = 1BB-2B1 = before BB.

A10. Squaring stacks

T = 6 4s = 1BB what? (where B=√(6*4)). Guess 1: '(6-1) (4+1)s' or '5 5s', since ½(6-4) = 1. The empty 1-corner needs two 't 4s' stacks, and t*4 = ½ gives t = 1/8. Guess 2: '4.9 4.9s'. Bingo, so √(6*4) = √24 = 4.9.

A11. Solving quadratics

A (*u*+3) square has two squares and two stacks: (*u*+3)^2 = *u*^2 + 3^2 + 2*3**u* = *u*^2 + 6**u* + 9.
If *u*^2 + 6**u* + 8 = 0, all disappears but 1, so, (*u*+3)^2 = 1, so *u* = -4 or u = -2.

A12. Adding next-to and on-top, and reversed

2 3s + 4 5s = ? 8s. (Integral calculus add areas, recounting change units). 2 3s + ? 5s = 3 8s, ? = (T2-T1)/5 = ΔT/5.

A13. Adding per-numbers and fractions, and reversed

2kg at 3$/kg + 4kg at 5$/kg = (2+4)kg at (3*2 + 5*4)/(2+4) $/kg. Integral calculus adds (locally constant) per-numbers.

A14. The Algebra square

The 'Algebra Square' reunites unlike and like unit- & per-numbers with (+, x, ∫, ^, and -, /, d/dx, √ & log)

A15. Fact, fiction & fake models

Fact model are 'since-then' stories that quantify and predict predictable quantities by using factual numbers and formulas. Typically, they model the past and the present. They need to be checked for correctness and units. Fiction stories are 'if-then' stories that quantify and predict unpredictable quantities by using assumed numbers and formulas. Typically, they model the future. They need to be supplied with scenarios building on alternative assumptions. Fake stories are 'what-then' stories that quantify and predict unpredictable qualities by using fake numbers and formulas. Typically, they add without units or hide alternatives. Here, number stories need to be replaced by word stories.