CURRICULUM INSPIRATIONS: www.maa.org/ci

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### *TANTON'S TAKE ON …*

# "WHY DO WE NEED TO KNOW THIS?"

**FEBRUARY 2015**

"Why do we need to know this?"

I remember my colleagues and I making this cry too in our grade ten algebra class. We never got a satisfactory answer to the question and, in the end, my colleagues and I decided that the question was actually moot: we had signed up for this track of mathematics, this was the content of the track, and that was that. Don't complain!

I was terribly bored in high-school mathematics. I personally found it a sterile, context-less, and drearily rote enterprise, and certainly not a subject worth pursuing. (It really was an unenlightened curriculum back in the early 80s and my poor teachers—I realise now—were working under terribly stifling constraints.) I ran from mathematics when I started university, signing up for physics instead. Luckily, along the way, I took advanced mathematics courses (I had to run from hands-on lab work) and it was Abstract Algebra that hooked me. It was paradise! Why didn't anyone show me these questions before or discuss these ideas? Why didn't school mathematics show me what mathematics actually is? I knew then I was a mathematician and actually had been all along.

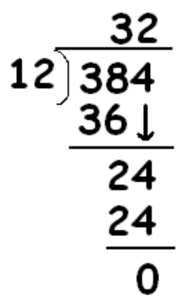
Not everyone revels in the abstract and the theoretical, I know, but every student deserves an answer to the question: Why do we need to know this?

At face value, one can argue that the premise of the question is false. Must everything we study have an evident and immediate purpose? Why play the violin? Why read great works of literature? Why study extinct lichen?

That students tend not to ask “Why do we need to know this?” in an English class is telling. It is understood that the pursuit of knowledge is fulfilling in its own right, it deepens ones humanness and connection to the world, it uplifts, enlightens, and empowers.

I would argue that that a rote mathematics curriculum usually does little to uplift, enlighten, and empower.

Consider the long division algorithm, for example. Why are we teaching this?




Students know the truth: Anyone who really needs to know the answer to $3332904 \div 57$, for example, would get out a calculator or smart phone. This is the smart and efficient thing to do! Who ever does division by hand? Teaching it in the classroom can’t be for getting answers to division problems.

Why memorize the quadratic formula? (Worse, why do we teach students a song to help memorise it?) No engineer would use the formula to solve a quadratic equation if one happens to arise in her work. One would just type

$$1.34206t^2 - 7.98762t = 20.75421$$

into *Wolfram Alpha* to get the answers.

Why do we have students divide polynomials by hand? Why do students comply?

The traditional curriculum is riddled with pencil-and-paper and hand-held graphing calculator algorithms. Their purpose is mostly unknown to students and their practice is often seen as tortuous and irrelevant busy work.

I am being harshly provocative, I know. I am fully aware that we persist with these algorithms in our 21$^{st}$-century classrooms to develop number sense and number fluency. Both are important and relevant for sure.

So then, let’s make sure we are teaching these algorithms for number sense, thinking, numerical fluency, and the problem-solving skills they can induce. Let’s make it absolutely evident to students that we are not practicing these algorithms to get answers – the computation itself is not the point. (Calculation by hand is so 1800s!)

So to make this point, let’s give students quizzes with all the answers supplied! (Still leave plenty of blank space after each question for students to write in the work that leads to each answer.)

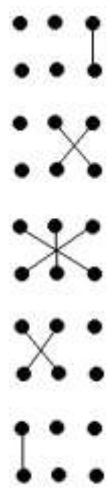
Perhaps ask meta-questions about the standard algorithms?

> *Is it obvious from the long division algorithm that every four-digit palindrome is divisible by* $11$*?*
>
> *If* $(-11, 25)$ *and* $(5, 25)$ *are two points on the graph of a quadratic equation* $y = x^2 + bx + b$ *can we logically deduce the value of* $b$ *?*
>
> *Jeanine said that because* $276 \div 12 = 23$ *we must have*

$\frac{2x^2+7x+6}{x+2} = 2x+3$. *(Is this right?) Why don't we just convert every polynomial division problem into a grade* $5$ *long division problem and make our work much easier?*

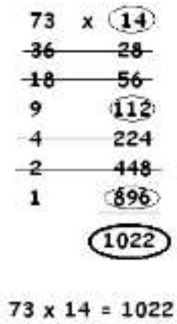
Let's present algorithms from other cultures students have never seen before and let them work to decipher and make sense of them.

*Vedic mathematics taught in India (established in 1911 by Jagadguru Swami Bharati Krishna Tirthaji Maharaj) suggests students compute the multiplication of two three-digit numbers as follows:*



*What do you think this sequence of diagrams means?*

*Here's an unusual method of multiplication believed to have originated in Russia. To compute the product of two numbers, say,* $73 \times 14$, *repeatedly halve the first number, ignoring remainders, while doubling the second. Delete pairs that begin with an even number and sum the doubled numbers that survive. This sum is the desired product.*




*Can you figure out why this method works?*

Let's let students develop their own notational system for shortcuts to computations and hence create their own algorithms.

*One gets tired of drawing dots after a while when doing Exploding Dots ( http://gdaymath.com/courses/). One even gets tired of drawing the boxes!*

Let's take a standard algorithm and ask "what if" questions about it.

*Instead of "completing the square" to solve quadratics, might there be cubic equations we could solve by "completing the cube"?*

*Can we "OLIF" instead of "FOIL"? (Better yet: Can we just never mention FOIL just have students conduct algebraic expansions via common sense?)*

*Can we give false algorithms too and teach students to mistrust ideas and procedures they personally cannot unpack and understand?*

*Did you know you can just "cancel" common sixes from fractions?*

$$\frac{1\cancel{6}}{\cancel{6}4} = \frac{1}{4} \qquad \frac{2\cancel{6}}{\cancel{6}5} = \frac{2}{5}$$

$$\frac{2\cancel{6}6}{6\cancel{6}5} = \frac{2}{5}$$

This brief essay is really is an invitation to watch my video on the Common Core State Standards: what they are and what I personally believe is their ultimate goal.

You can find the video on the front page of www.jamestanton.com or link directly to it at https://www.youtube.com/watch?v=j4I-jkUt49I&feature=youtu.be . (For swiftness, adjust the settings to watch the video at double speed!)

"Why do we need to know this?"

If we are thinking only in terms of the formulas and the details on the page, as is the case with a rote-repeat-and-do curriculum, the answer truly is: "We will very likely never need to know this!"

But, as I compel in my video, let's turn this around! Let's make the true spirit and intent of the curriculum loudly and clearly teaching for thinking, problem-solving, fluency, agility, and mathematical confidence and adaptability. We can, and should, still play with and develop the familiar algorithms, but with the message and intent of thinking. Then the answer to question "Why do we need to know this?" becomes self-evident to all:

> "We are learning this for intellectual empowerment and confidence. We need to do this because we are doing everything we can to learn how to solve problems."

I vote for a curriculum with that consistent message and intent!


tanton.math@gmail.com