WHY DO U.P.S. DRIVERS NEED TO KNOW PYTHAGOREAN TRIPLES?

A Personal Response to a Provocative Question

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On the evening of May 10th, 2016, Dr. Andrew Hacker (author of *The MATH MYTH And Other STEM Delusions,* The New Press, 2016) and I met at the National Museum of Mathematics to debate the current state of high-school mathematics education and its profound effects on our nation's next generations.

In his book, Dr. Hacker argues that forcing each and every student to take "advanced algebra," which he believes to be the dictate of the Common Core State Standards of Mathematics, will only continue to demoralize hundreds of thousands of students and deny them opportunity to pursue study for careers that do not themselves require a lick of algebra.* (This happens because completion of algebra II is often deemed a program admission requirement.)

To stress his point during the debate, Dr. Hacker asked the audience a rhetorical version of this essay's title question. He then later asked me directly the exact question in a discussion over dinner.

The question, when thrown specifically my way, took me aback even having just heard it an hour or so earlier. I wasn't able to respond readily on the spot.

Why?

Well, it's a loaded question. It's loaded with presumption and premise and it evokes, for me, some perturbing emotional reactions. It required thought to cut through its tangled shroud.

[* See the APPENDIX document for my reactions to the claims made in *The Math Myth* about the Common Core State Standards and the nature of "advanced algebra."]

THE CONTEXT OF THE QUESTION

The question is asking about the necessity of having required a successful and professional adult, in this case one following a career as a UPS driver, to have taken and passed algebra during her schooling.

Dr. Hacker points out that algebra (be it algebra I or algebra II, it is hard to pin down what exactly he means by "advanced algebra") is acting as a barrier for school graduation for so many of our young citizens. I am very perturbed by this too.

Dr. Hacker points to two key problems about it in particular: high-stakes, time-based standardized testing and mathematics content that is too hard and

irrelevant to what the majority of young folk will ever be doing in their lives.

I agree that the first issue cited is a problem – a serious one – and I talked about this too during the debate. But I disagree with the second issue. His question was clearly one about this second point.

WHAT IS THE ANSWER TO THE QUESTION?

Let's get some immediate responses out of the way.

Firstly – annoyingly -- since this question comes from the context of discussing the Common Core, I must point out that the study of Pythagorean Triples is not a Common Core State Standard. Yes, these triples are mentioned once in the Common Core document (in standard A.APR.4), but only as a possible example of an application of the mathematics a teacher might choose to pursue with his students.

Secondly, I have an emotional reaction to this question because, when stated in isolation, it sounds terribly condescending: An individual's richness in life comes solely through one's work? Once on a particular career track, always on that one track? One is entitled only to knowledge deemed (by others?) relevant to particular careers? Are these the messages being implied?

The question thus also raises deep questions about tracking: When must a young lass decide that a career of driving is the likely choice for her and so follow a particular math sequence that avoids the work of "advanced algebra"? Is the choice made based on clear-thinking and insight or on an emotional reaction or on social pressure to follow a cultural norm of disliking math? Will this lass ever later be given the opportunity to try more mathematics to see if algebra is to her taste after all?

And now to the actual answer to the question: When will a UPS driver ever need to know about Pythagorean triples, as in, really need to know about them while performing the role and duties of an exceptional UPS driver? Answer: Never!

WHY BE A HIGH SCHOOL MATH TEACHER?

So this then begs the question: What am I doing as a mathematician turned high-school teacher (and now to general mathematics promoter)? Why did I move into the system that teaches and demands quadratic equations and cosines of all? What damage was I doing to generations of young students for all those years of my life?

Let me share some of my opening remarks to the debate.

I completely agree with Dr. Hacker when he proposes in Chapter 1 that we should be focusing on a PATH mindset when teaching school mathematics: philosophy, arts, theology, and history, all while teaching math.

That is, we should teach the philosophy and art and the human story of mathematics, as well as the content.

But actually the content, at the HS level, can be argued as somewhat secondary. I've never used the quadratic formula in my everyday life (and I don't think in my research math life either), but learning the formula wasn't the point. It was about the story of quadratics. And from the story I know I can likely nut my way through most any problem that comes up about them.

Plus, I love the human historical story here, of how mankind battled with this topic over the centuries and used, what seems like to us, a surprising link to geometry, that of literally completing the square.

And when teaching the topic I love the mathematical connected stories one can portray for the algebra and for the graphing of quadratics, each a story of symmetry. I am teaching high school students the beauty and power of using symmetry to one's advantage in problem solving. There's so much beauty and richness and problem-solving learning and doing right there. The quadratic formula, itself, is somewhat irrelevant and incidental.

To me, the ultimate goal of high-school education is to help people see, consider, and practice taking the road to higher good, how to develop informed views about content, how to consider and probe alternative views, how to analyze how you know what you think you know, how to be curious. And also to be aware of some of the great human achievements of mankind - the works of Shakespeare, Greek drama, and the revelation of completing the square. It's about learning how to appreciate art, beauty, and intellectual accomplishment.

High school math is not primarily about content. Every piece of high school math, in fact every piece of most subject topics, can be whittled completely away if you are looking only for the utilitarian use of it. (When was the last time you had to compose a Haiku? When was the last time being aware of Picasso helped you with a problem in daily life?) So content is really not so much the point. After basic knowledge is built, it is all really about teaching a state of being and accomplished thinking.

And I think math is particularly good at teaching problem-solving and even basic life skills: thinking through challenges. I make no claim that the skills of math are necessarily transferable. How can you possibly prove that for math, or for any subject? But math certainly offers one of many ranges of human thinking and is a worthy piece to have in one's general thinking repertoire. I think math is good at teaching patience, and problem-solving, and developing certain confidence for relying on your wits and nutting your way through challenges, dealing with false leads and false turns, and the like.

Dr. Hacker and I each believe in the Common Core. [Read on for the context of this remark.] *But I think we are each deeply concerned about its possible implementation, in particular, with the deleterious effects of this persistent culture of testing that doesn't seem to ever go away in mathematics education. Let's teach algebra II and the Common Core as it should be, a human experience, a human story with context and joy. It really can be a grand service for our next generations.*

It is because of this last last line I decided to leave the college world and become a high school teacher in 2003. (This was well before the Common Core.) As a "mandarin" of mathematics, I was worried about a sense of joylessness in high school mathematics at the time – the intense focus on computation and single numerical answers, all to be done with speed and the subsequent priority of mechanics, memorization, and rote procedure over thinking and joyful mulling. I worked to bring the humanness of mathematics to my classroom (and still have my students pass those tests!) and to encourage the play of ideas. We worked beyond just the "what" questions and headed to the "what else", "why," and, best of all, "what if" questions too. I pointed out in my discussions with colleagues that English departments teach both the grammar and the poetry. Mathematics departments should too.

And here's where I differ with Dr. Hacker. I truly believe that the content of a typical algebra II course is accessible, and if done as a story of human thinking and intellectual play, is human and delightful, relevant, and joyful. Chapter 3 of his book is titled "Will Plumbers need Polynomials?" Answer: Of course they won't for their

direct job activity. But look at my work on Exploding Dots, www.gdaymath.com/courses/exploding-dots, and see why I routinely have large crowds of folks – parents, teachers, students, general public – excited to be dividing polynomials. It truly is wild! No one in the room "needs" any of this work. But we are humans and we are uplifted by connection, poetry, beauty, play, resonance, and intellectual delight.

Let's teach all of algebra this way.

Let's eradicate this damaging focus on testing, testing with speed in particular.

Let's trust teachers to be their wonderful human selves, each with their own love for the subject, to have joyous mathematics conversations with their students.

Why does a UPS driver need to know about Pythagorean triples? Because they are joyous. They are "up there" with Bach, the history of the Ottoman Empire, and the chemistry of cooking.

[Here's a question: Why were the Babylonians of some 3000 years ago recording examples of triples on clay tablets? For example, the tablet Plimpton 322 presents, among a number of examples, 65 squared plus 72 squared equals 97 squared, and 119 squared plus 120 squared equals 169 squared, all expressed in, believe it or not, base 60. What did they find so compelling about Pythagorean triples? Why did they do their arithmetic in base 60? For that matter, why do we do ours in base 10?]

FINAL THOUGHTS

Dr. Hacker, in publishing *The Math Myth*, has accomplished an important service to the nation: bringing our attention to the state of mathematics education. It is absolutely appropriate, and I would say vital, to continually reflect on and re-assess the context, meaning, and relevance of mathematics education for our future generations. A great deal of good mathematics work is afoot. We must work to continue expanding that good.

But Dr. Hacker has also raised a number of alarming concerns about matters. He portrays (and I worry perpetuates) damaging impressions, perceptions, and public misconceptions about the state of mathematics teaching today. Without examination, they rightly cause serious worry.

But here's something wonderful. We live in the 21st century and we adults, we parents, are personally empowered to check facts. They are at our fingertips. We can download original documents, hit "control F," and check truths for ourselves and personally assess the validity of claims that come our way in the media, on the internet, and in general conversation. We can check on the year quotes were made about the "current" state of mathematics, and even learn about the very beginnings of the Common Core State Standards. (So watch out for quotes made before 2008 or so! http://www.usnews.com/news/special-reports/articles/2014/02/27/the-history-of-common-core-state-standards .) We can ask: *How do I know what I "know"?* and not succumb to impression and general commentary alone.

I did enjoy reading Dr. Hacker's book. And I came away from it with an interpretation that many might find surprising: I think Dr. Hacker is actually arguing strongly, very strongly, for the Common Core State Standards in Mathematics. He has beautifully captured sets of deep concerns that date back before the conception of the Common Core and all serve as mighty strong warnings about how not to implement the Common Core State Standards. (It is sadly too easy to confuse States' choices and approaches for

implementing the Common Core as the Common Core. Again. Watch out!)

Like me, Dr. Hacker doesn't want its implementation to fall into old traps – resorting to rote formulaic teaching, resorting to heavy-handed speed testing, putting mechanistic doing above number facility and quantitative literacy, and, above all, letting the human discussion and experience of mathematics be pushed to the side. I couldn't agree more that these are real concerns. Many proponents of the Common Core I know feel the same way.

Oh! And I did eventually manage to give Dr. Hacker an answer to his question over dinner. It came as he was describing to me an exercise he does with his students about flipping coins and looking at the patterns of heads and tails random actions tend to make. I asked: *Why does a UPS driver need to know about patterns of random events?* He looked at me and then said: *Good point!*