# The Graphing Calculator Boondoggle

**By Michael Cohen**

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**Abstract**
An engineering professional argues that the graphing calculator is simply a pedagogical tool no more useful than the answer key in the mathematics text.

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As an adjunct math professor and licensed professional engineer working for a major defense contractor, I have seen a lot of technology evolve over the years.

As we all know, some technological innovations are indispensable to progress, some are more in the nature of fads, games, or gimmicks – and many of them sell, whether people need them or not.

But in my three decades of adult life, I have never seen so superb a job of marketing as has been achieved by the manufacturers of graphing calculators. And during a recent convention of an organization of math professors, I attended a session which reaffirmed my viewpoint.

Algebra books from elementary algebra on up now contain sections concerning graphing calculators. In any precalculus math course, a graphing calculator is certain to be required equipment. Virginia's Standards of Learning (SOLs) now require that math students be capable of using these devices, and I am certain that this reflects the requirements of other states.

Indeed, this device is rather securely embedded in our math curricula.

However, in view of the fact that a graphing calculator has no practical application in the real world, or even in advanced technical curricula, we should be asking ourselves why we require their use.

Based on years of experience as a college math and engineering instructor, in parallel with a career that started in nuclear engineering, I wonder whether the inextricable intertwining of graphing calculators into math books and courses is because they are such marvelous devices or, rather, because of the marketing proficiency of their manufacturers.

To put this issue into perspective, perhaps it would be useful to look objectively at a few issues: first, the graphing calculator's two predecessors in the realm of classroom computational devices – the slide rule and the pocket calculator; second, its relevancy in view of the ubiquity of computers; and third, what we expect the student to learn in those fundamental mathematical disciplines.

Finally, we need to borrow from the English Department and heed the words of Shakespeare, "To thine own self be true." We need to step back and be honest as to how much this device really helps our students.

Until approximately three decades ago, the college math or engineering student was required to possess no more than a slide rule. That same cleverly constructed arrangement of movable numerical scales often served an engineer well into his career. While its accuracy was limited to only a few decimal places, it provided numerical solutions for almost any mathematical or scientific discipline. Its chief limitation, other than precision, was its inability to add or subtract. This was considered a good thing because it required the student to maintain his or her proficiency in these operations.

In the early 1970s, the pocket calculator – a by-product of space program computer miniaturization technology –

surpassed the slide rule as the tool of choice. This truly miraculous device combined the capabilities of the slide rule with the rapid addition and subtraction capabilities of previously unwieldy and noisy adding machines – and it performed all operations with precision up to nine decimal places. For obvious reasons, the scientific calculator ultimately replaced the slide rule – as a matter of fact, early versions were known as "slide rule" calculators.

Enter the graphing calculator, whose primary distinguishing feature (for tenfold the price of a scientific) is the ability to plot and interpolate one or more graphs of functions.

This device may have been regarded as revolutionary, but it is actually little more than a single purpose pocket computer. Simultaneous to its development, desktop computers had already begun to populate every home, school, and office. A student needing really precise information on a graph could not only plot that graph on a computer but also could analyze the data in a variety of ways.

After having observed my daughter work through several advanced math classes, for which I was required to buy her a TI-83, I concluded that the only purpose it served was to verify the answers arrived at through the algebraic operations she was still required to learn. Again, I questioned the necessity of inflating my bill for school supplies by $100 after having spent twenty times that amount on a computer.

From a technological standpoint, the graphing calculator finds itself in a sort of no-man's land. Unlike the scientific calculator or desktop computer, it has virtually no application in the workplace, nor in applied disciplines such as engineering and physics. It has been rendered virtually obsolete by the advancing technology and dwindling size of fully capable computers.

In fact, a senior engineering faculty member recently expressed his opinion to me even more bluntly by commenting that math instructors are virtually the only proponents of these devices.

Why, then, do we continue to require that our students become proficient in their use?

At a recent convention of the Virginia Mathematical Association of Two-Year Colleges (VMATYC), I attended a session on "The Graphing Calculator as a Teaching Tool" to find the answer to that question and determine if my viewpoint was current. After all, my daughter graduated from high school almost a decade ago. And since my math classes have recently been devoted to courses below the precalculus level, perhaps these devices had evolved into something new and different that would make that hundred-dollar investment worthwhile.

What I found was that students are still required to sketch graphs using algebraic operations and recognition of a function's characteristics (at which I breathed a sigh of relief) and to use the graphing calculator only to confirm that their work is correct. But, according to one of the high school teachers presenting the session, they can also get the answer from the calculator and work backward.

I found certain fallacies in that logic. For one thing, the calculator provides no more information than the answer key to the book, and certainly does nothing that a desktop computer cannot do; second, there is no real-life applied discipline where we have the luxury of knowing the answer ahead of time. I came away from that session reassured that nothing has changed in the years since I bought my daughter's TI-83 (which is now gathering dust) and unconvinced that the expenditure on that device was any kind of investment in knowledge.

Quite to the contrary, the presence of graphing calculator sections in an elementary or intermediate algebra text is counterproductive, since it distracts students from the fundamentals on which they should be concentrating.

Along that same line of reasoning, it is worth noting that for decades before the pocket calculator arrived on the scene, adding machines were state of the art, but we did not force them into every classroom where students were learning to add and subtract. Indeed, anyone suggesting such an idea would have been encouraged to find a new line of work.

Incidentally, does anyone remember when cash registers rang up only the amount of sale, and cashiers were required to "make change"? I wonder how many could do it today.

But I digress. Back to the convention…

The presence of a Texas Instruments display in the vendor exhibit room led me to wonder whether or not it is coincidence that every textbook I have used refers to a TI graphing calculator, and that the requirement for such a tool is virtually universal in our school systems, essentially locked in by legislated Standards of Learning.

The presence of a half dozen textbook publishers in the same room reminded me of what an enviable position TI truly occupies. After all, even the textbook publishers have competition.

Using just one high school as an example, consider what this does for TI's financial situation. In a middle class suburban high school with 2,000 students, assume conservatively that 10 percent of the students take a math class requiring a graphing calculator. At a hundred bucks a copy, that translates into (and I did this without a calculator) $20,000 per school. Assuming two dozen schools in a moderately sized city, that fattens the TI wallet by a nearly a quarter million dollars – for one community! And let me again emphasize that I am using conservative figures. Multiply this by the number of communities out there and the figures are staggering.

One cannot fault TI; it has truly achieved the corporate dream. It produces a product that it can manufacture in huge quantities for a fraction of its selling price, has essentially no competition, and gets advertised in virtually every math textbook.

Best of all, its customer base is legally mandated to buy the product and, given the inertia of state educational agencies, will be for the foreseeable future. And since textbooks are now tied to the graphing calculator, they are also tied to its changing technology – which means that they will have to be periodically revised not because of any changes in the way algebraic operations are performed but simply because of changes in graphing calculator technology.

Indeed, we can learn a lot about business from the graphing calculator. But perhaps it is time to reflect on whose interest is best served by making it a requirement of our math curricula.

Are we talking about an indispensable tool, or the sale of the century?

"To thine own self be true."

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**Michael Cohen** is senior contract administrator at Northrop Grumman in Newport News, adjunct math faculty at Tidewater Community College, and adjunct assistant professor in Engineering Technology at Old Dominion University.

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