# The Emperor's Vanishing Clothes

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One of the occupational hazards of teaching at an independent secondary school for more than a few years is that you are eventually asked to serve on a curriculum committee. I have actually been around long enough to have served on three. These committees, consisting of about a dozen teachers from all academic departments, are usually charged with the daunting task of reviewing graduation requirements in light of the changing needs of society. Predictable turf battles ensue, wherein each department attempts to convince the others that the citizens of the future need increased exposure to that department's courses, a premise that is rarely challenged until somebody suggests that this might occur at the expense of some other department's slice of the academic pie. Many heated meetings later, the frazzled committee members finally reach a compromise between change and tradition by resolving to tinker with the school's class schedule until everything can be added without anything appearing to have been subtracted. This necessitates several more months of meetings.

The amazing thing about these turf wars is that, while the sciences, arts, and social studies slug it out, English and mathematics remain seemingly above the fray—despite the fact that these are the only subjects that most students take every year. Nobody, apparently, dares to suggest that the need for knowledge in either of these classic disciplines will decrease in the future. In fact, our own department has often had to apologize for not making four years of mathematics a graduation requirement, a position we can afford to take simply because ninety-nine percent of our

students are already electing a fourth year of mathematics at the urging of their parents and college counselors.

Contrast this unquestioning enthusiasm for mathematics in the curriculum with the widespread belief of so many people that they cannot "do" mathematics, or, indeed, with the bad memories that so many people seem to harbor about their own mathematics courses, and you are faced with a bit of a conundrum. Why are so many educated people so eager to visit upon their children what might reasonably be considered to be the mistakes of their past?

I submit that this irrational behavior derives from the fact that parents have not understood what we mathematics teachers have been teaching their children. The mere fact that the subject is called "mathematics" has enshrouded it in an intimidating cloak of mystery beneath which few people have cared to peer. They have seen that the world is increasingly reliant on technology and increasingly data driven, and they correctly perceive that some people understand these changes although they themselves do not. Blaming their own lack of understanding on their inability to do mathematics, and wishing their children to be among the future understanders, they conclude that their children had better learn as much mathematics as they possibly can, even if they themselves do not understand what it consists of. Thus it is that mathematics for so long has been given a free pass in curriculum committees.

People reading this response will probably recognize that what parents really want for their children is for them to become quantitatively literate. A parent reading "The Case for Quantitative Literacy" would, no doubt, nod enthusiastically at the lists of expressions and skills and say, "Yes! This is just what I want for my child!" That parent would have every right to assume that the mathematicians who created the need for this kind of literacy by now would have designed a curriculum enabling a child to learn it, especially since the expressions and skills involved in quantitative literacy can be so readily itemized.

## Hiding in Plain View

Alas, this is not the case. Even in the most "reformed" of U.S. classrooms, students are being prepared for a capstone experience of college calculus and for embarrassingly little else. This obvious disconnect

between supply and demand has endured only because we have been able to hide it behind the cloak of mystery that has enshrouded mathematics—the same cloak that has protected us in curriculum committees all these years. It is, for all its perversity, a cozy situation. But before we allow ourselves to become too comfortable, let me sound the warning to my colleagues in mathematics departments across the country that our cloak of mystery has started to unravel. If present trends continue, it is only a matter of time before our patrons see us standing at the chalkboard arrayed ignominiously in the emperor's new clothes.

As evidence, I offer several observations. First is the case statement, one of many recent documents calling attention to the contrast between the mathematics that ought to be learned and the mathematics that is actually being taught. These documents are not without precedent; indeed, the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) has been urging curriculum reform for three decades, citing essentially the same computer-driven societal needs.

What makes the current reform agenda so powerful is that it has managed for the first time to reach *teachers* at every level, prompting a groundswell for change that has never before been present. Some mathematicians, hoping that the groundswell will pass, are trying to foment a "math war" in the hope of preserving the traditional curriculum. Unfortunately for their cause, there can be no war—because there is no army. Thanks to the changes already wrought by the standards for school mathematics, the calculus reform movement, and numerous exhortative documents such as the case statement, secondary school teachers who historically have been obedient foot soldiers on the precalculus drill team have now developed an appetite for relevant mathematics. So have many college teachers, and so have the university departments of mathematics education. The only math war that will attract their support now is that of addressing the challenges that the case statement presents. Most of my colleagues are not only willing, but also eager, to join that fight.

Second is the phenomenon of Advanced Placement (AP) Statistics. When the College Board introduced this course in 1995, it debuted with the largest opening volume of any AP examination ever. In five years the volume grew from 5,000 to more than 34,000, exceeding even the wildest predictions of anyone associated with AP. Lost in the dazzle of this unexpected growth has been the curious fact that most AP Statistics students

are being taught by mathematics teachers who have never even taken a college statistics course. This apparent drawback has not prevented either the students or their teachers from loving the subject.

Statistics sessions now draw huge crowds at professional meetings of mathematics teachers, the Internet crackles with lively exchanges among statistics teachers from coast to coast, college departments are teaching more and more statistics courses, and editors of mathematics journals are suddenly hungry for articles about statistics. Many mathematics teachers (who are, after all, not engineers) are feeling for the first time in their careers the exhilaration of knowing firsthand what their upper-level courses are good for in the modern world. Understandably, they are dying to carry that enthusiasm into their algebra and geometry courses, but they are frustrated by the amount of traditional material that they still feel compelled to cover. In the parlance of the case statement, they really want to be teaching quantitative literacy to all their students.

Third is the catalyst that has brought us this far and that shows no sign of abating: technology. For better or worse, computer technology (for secondary school teachers, that means graphing calculators) is now inextricably entwined with mathematics education. The dramatic effect of this technology on the teaching and learning of mathematics since 1990 probably needs no recapitulation here. Let me simply note that the amazing capabilities of these machines have forced many of us to confront directly the questions of what algebra and geometry we ought to be teaching with the aid of technology and what should be taught without it. These questions have exposed the traditional mathematics curriculum to unprecedented scrutiny, raising along the way some embarrassing questions about its relevance. The case statement provides powerful evidence of why we can no longer avoid these questions.

Finally, the disturbing trend toward outright distrust of mathematics is perhaps the most apparent indication that the cloak of mystery is unraveling. The University of Rochester almost lost its graduate program in mathematics a few years ago because the administration had lost faith in its relevance. Many states, looking to hold secondary schools accountable for student performance in mathematics (and not content to let the teachers measure it), now require students to pass high-stakes tests administered by external organizations. Parents send letters to the editors of local newspapers protesting the adoption of particular mathematics textbooks in their

districts. Education ministers in some countries (notably France and, surprisingly, Japan) have recently presented proposals for *less* mathematics in the curriculum.

It is apparent that many people are beginning to look more closely at the mathematics being taught in our schools, and we mathematics teachers have only ourselves to blame if parents and taxpayers do not like what they are seeing. Moreover, the noisy disagreement among professional mathematicians about what mathematics we ought to be teaching, far from being helpful, has surely increased the public's suspicion that we have nothing on underneath our vanishing cloak of mystery. After all, the only reason they trusted us when they did not know what we were talking about is because they thought that we, at least, did know. We need to justify our courses to ourselves before we can justify them to our constituents.

One of the most common questions posed by students to their high school mathematics teachers is "What is this mathematics good for?" It is a question that we have been nervously answering for our 14-year-old algebra students throughout our careers. Fortunately for us, most of those youngsters can be taken in by a teacher's authoritative reply. The stakes are a lot higher now that we have to answer that question for impatient adults with clipboards.

We need better answers—and soon. We need to be teaching quantitative literacy.