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It's the geometry, stupid

Ontario's debate over high-school calculus misses the point

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KENNETH KIDD

FEATURE WRITER

We've got Bill Casselman on the line from Vancouver. He teaches mathematics at the University of British Columbia, whose renowned website on calculus lists him as the "voice of experience," like a patron saint.

So you'd expect Casselman to wax evangelical about the sublime beauty of calculus, not least the importance of spreading that message among the unenlightened souls known as high school students.

You'd also be wrong.

The word that most often springs to Casselman's mind in association with calculus is "painful" — as in, "teaching calculus is painful and taking calculus is painful."

Not that calculus can't have a kind of beauty to mathematicians. It's just that teaching it and learning it has become a species of torture.

Punch the word "calculus" into Google and you'll come up with 56 million hits (more or less), a lot of them websites aimed at helping students endure the pain. They're the ones with titles like "Calculus Made Easier," as in easier than, say, cutting off your arm with a paper clip.

To the likes of Casselman, though, one of the biggest issues facing math education today isn't calculus, much less whether it should be taught in high school, as Ontario is debating.

No, the real shame and tragedy is the steady decline of another branch of mathematics, one that might actually help kids handle calculus a lot better: geometry.

You remember (if you're old enough): all those triangles, parallelograms, angles and deductive proofs, the stuff Euclid consolidated into a standard set of theorems back in 300 BC.

"Geometry has all but disappeared from Canadian education," says





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Casselman. "What's happened all over North America, except at the very best private schools, is that the reasoning in geometry is gone."

He isn't the only mathematician to get wistful about things Euclidean. Peter Taylor, head of mathematics and statistics at Queen's University, still has vivid memories of his first encounter with geometry in high school. "We were blown away by its elegance and power."

That same word, "elegance," dances on the lips of Steve Brown, associate dean in charge of undergraduate admissions at the University of Waterloo's mathematics department. "I think geometry would be a wonderful topic to have more of in high school."

Why is it so important?

It's all about puzzles, for one, and people like solving puzzles, even mathematical ones. But geometry puzzles also have a visual component. You can see all those triangles and parallelograms, move them about, really see the relationships, how the angles relate. In other words, an additional sense — sight — plays a reinforcing role.

It's akin to the way Montessori kids learn the alphabet: not just by seeing letters and copying them, but by tracing their fingers over letters rendered in sandpaper on little cards. There's a tactile component, bringing in another sense to help them learn the attributes of an "s" or a "k."

But here's the other thing about geometry, the kind Euclid brought so vividly to life: It demands deductive proofs. In other words, you're expected to mount a logical, mathematical argument in which statement "A" leads to statement "B, then to "C" and so on.

You lay it all out like that and you can see, not just why the answer is right, but the exact point where logic may have escaped you, producing a wrong answer.

"I think developing a knowledge of proofs is very important in all mathematics," says Brown. "Geometry has been an area where that was taught."

But as the teaching of mathematics has progressed in the last 40 or so years, the central role that old-fashioned geometry once played has been shunted toward the wings. Or, as Taylor puts it, whole chunks of geometry have been relentlessly "sliced out" of the curriculum to make way for other branches of the discipline deemed more important.

Where it was once practically a full-year course in early high school, what's left of geometry has since been spread out over several years, and in Ontario only pops up in earnest in the final year. Geometry, says Brown, ends up being taught in "two-week segments and then they leave it for another year."

Getting rid of grade 13 has scarcely helped. "One of the reasons (for geometry's decline) in Ontario in the last few years is just the compression of five years into four," he says Brown. "Geometry has lost out in that deal."

Or, less charitably, it has been smothered by the sheer variety and tonnage of other mathematical tools and disciplines that have been crammed into high school curricula across North America.

That smorgasbord approach doesn't always delight university professors, the ones who inherit the result.

"It's a so-called improvement in high school education, which is really a disaster," says Casselman. "I think what they do is sort of squeeze the kids until they squeak, and then they let them go, and then they squeeze them someplace else."

The same worry haunts Taylor. "The curriculum is too packed and the textbooks are too concerned with giving exercises that are drilled," he says. "Students get lost in a maze of details. They get glutted and they just can't pay attention anymore."

This has had dreadful implications when it comes to something as advanced as calculus.

"If you understand geometry well, then you can enjoy even calculus more, because you can picture what's going on easily," says Casselman. "Without the reasoning, it's no fun."

In the absence of that ability to "see" a calculus problem in the same way you'd look on a geometry puzzle, calculus becomes just a series of messy formulas to be memorized and applied. In other words, a necessary but unpleasant tool you need to pursue other academic disciplines, such as engineering.

Given all this, should high schools bother with calculus?

As part of the current round of revisions, Taylor thinks a fifth math course should be added to the basic curriculum and, yes, calculus should be part of that package. But only up to a point: Teach them some basics of calculus, like rates of change, and a bit of modelling. Beyond that, he says, "They run into grief."

Casselmann wouldn't even bother going that far, especially if the calculus comes at the expense of geometry and other basics. Across the continent, he says, high schools are mostly dispensing "a quick coast over calculus, and it gives the kids the illusion they know calculus and it doesn't teach them the algebra and trigonometry they would actually need to do well in college."

So where would he go for the best high school education in math?

South, says Casselman. As in Australia. "New South Wales, in my experience, has the best math teaching on the planet, and it's very much more traditional than the rest of the English-speaking world. A great deal of time is spent on geometry.

"They're sort of isolated down there," he says. "They don't know how to improve high school education so they haven't tried, which is a big plus."

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