ESSAY; When Even Mathematicians Don't Understand the Math
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To most of us, smudgy white mathematical scrawls covering a blackboard epitomize incomprehensibility. The odd symbols and scattered numerals look like a strange language, and yet to read them, neurologists tell us, we would have to use parts of our brains that have nothing to do with what we normally think of as reading and writing.

Math and physics writers are the interpreters of this unconventional language. Their books, when written for a popular audience, may reach thousands of intrepid readers who barely made it past Algebra II. The abstract concepts they translate seep into the mainstream through books like "The Golden Ratio" (its ideas are featured in "The DaVinci Code") or "The Millennium Problems." Sometimes they even make the best-seller lists.

And yet much of this subject matter confounds even mathematicians and physicists, as they use math to calculate the inconceivable, undetectable, nonexistent and impossible.

So what does it mean when mainstream explanations of our physical reality are based on stuff that even scientists cannot comprehend? When nonscientists read about the strings and branes of the latest physics theories, or the Riemann surfaces and Galois fields of higher mathematics, how close are we to a real understanding? Despite the writer's best metaphors and analogies, what is lost in translation?

"It is a bit like trying to explain football to people who not only have no understanding of the word 'ball,' but are also rather hazy about the concept of the game, let alone the prestige attached to winning the Super Bowl," wrote Dr. Ian Stewart, professor of mathematics at the University of Warwick in England, in an email message.

Asked if there exist mathematical concepts that defy explanation to a popular audience, Dr. Stewart, author of "Flatterland: Like Flatland, Only More So" replied: "Oh, yes -- possibly most of them. I have never even dared to try to explain noncommutative geometry or the cohomology of sheaves, even though both are at least as important as, say, chaos theory or fractals."

Dr. Keith Devlin, a mathematician at Stanford University and author of "The Millennium Problems," which tries to describe the most challenging problems in mathematics today, admits defeat in his last and most impenetrable chapter, where he is forced to interpret something called the Hodge conjecture. He suggests to readers, "If you find the going too hard, then the wise strategy might be to give up."

The Hodge conjecture deals not only with cohomology classes, a complicated group construct, but involves algebraic varieties, which Dr. Devlin describes as generalizations of geometric figures that really do not have any shape at all. "Those equations represent things that not only can we not visualize, we can't even imagine being able to visualize them," he said. "They are beyond visualization." This difficulty points to a math truism that ultimately framed his entire project.

"What the book was really saying was, 'You're not going to understand what this problem is about as a layperson, but neither will the experts,'" he said, adding, "The story is that mathematics has reached a stage of such abstraction that many of its frontier problems cannot be understood even by the experts."

At the same time, higher math is used to decipher the existence and composition of the world. But how can it make sense that a nearly unintelligible language can explain the physical world?

In his densely packed, and best-selling, tome on physics, "Fabric of the Cosmos," Dr. Brian Greene, a Columbia University physicist, distills the dizzying calculations of quantum physics and string theory, invoking images of flowing time and textured space that should not necessarily be taken literally. "These translations by design suppress a huge amount of technical machinery that underlies the everyday English description," he said. "I would say that there's absolutely always something lost in the translation."
Dr. Devlin noted that the familiar model of the atom -- a nucleus of protons and neutrons orbited by electrons -- was long obsolete. "Yet physicists can successfully use that image of the solar system model with its rotating billiard balls," he said. "It's the same with string theory. I mean, give me a break -- they're not little loops of string! For one thing, they're in 11 dimensions."

Like Dr. Devlin, Dr. Greene is straightforward about the impossibility of explaining certain abstractions. But he thinks there is enough graspable material in the mathematics of physics to depict just about anything. About string theory, for example, he said: "The equations that govern a violin string are pretty close to the equations that govern the strings we talk about in string theory. So although the notion of strings is metaphorical, it's pretty close."

He added, "I suspect that the overarching aim of most every mathematical study can be described, even if you can't get to the guts."

But if science writers described breakthroughs in genetics or zoology in terms of overarching aims and not concrete facts, readers would question the foundations of that field. That lay readers and scientists alike accept that they will never wrap their heads around much of higher math is evidence that it is a world unto itself.

In fact, it is difficult to explain what math is, let alone what it says. Math may be seen as the vigorous structure supporting the physical world or as a human idea in development. Some mathematicians say it is not in the same category as biology, astronomy or geology. While those fields have empirical systems of experimentation and discovery, some might say mathematicians rely on something more intuitive.

"It isn't science," said Dr. John L. Casti, the author of "Five Golden Rules: Great Theories of 20th-Century Mathematics and Why They Matter." "Mathematics is an intellectual activity -- at a linguistic level, you might say -- whose output is very useful in the natural sciences. I think the criteria that mathematicians use for what constitutes good versus bad mathematics is much more close to that of a poet or a sculptor or a musician than it is to a chemist."

And just as one cannot define what it is that makes a moving phrase played on a violin moving, the essence of the superb equation may also be ineffable.

This makes for a frustrating human dilemma. Our brains have the ability to compute the abstract mathematics they created to construct theories about reality, and yet they may never be smart enough to comprehend those theories, let alone explain them.

Despite his and his colleagues' tireless efforts, Dr. Greene concedes that this paradox ultimately makes sense. "Our brains evolved so that we could survive out there in the jungle," he said. "Why in the world should a brain develop for the purpose of being at all good at grasping the true underlying nature of reality?"

Drawing (Drawing by David Klein)