Life

The maths drive is like the sex drive

What urges mathematicians to spend years in pursuit of solutions? Perhaps it's because we can't help seeking beauty

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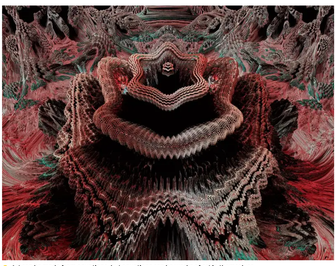
28 January 2015



Art can be made from equations, but equations can be works of art in themselves
(Image: Laguna Design/Getty)

MATHEMATICIANS are famous for the lengths they go to when solving problems. To crack Fermat's Last Theorem, Andrew Wiles worked in isolation for more than six years. And Thomas Hales produced a body of work consisting of 250 pages of notes and 3 gigabytes of computer programs to solve Kepler's Conjecture, a problem open since 1611 regarding the most efficient way to stack cannonballs.

What is it that motivates mathematicians to go to these extremes? It seems there is something compelling, almost seductive, about their subject. Could there be some sort of drive, similar to the sex drive? In other words, something that we could call a "maths drive"[1] that urges us to find new mathematical explanations and truths?

As strange as this idea sounds, it is not without precedent. In 2000, the psychologist Alison Gopnik suggested, in full seriousness, that finding an explanation is like having an orgasm. Similarly, the physicist Frank Oppenheimer claimed that "understanding is a lot like sex. It's got a practical purpose, but that's not why people do it normally."

Can intellectual pursuit be as compelling as bodily urges? It might be going too far to claim that the drive to do mathematics has evolutionary roots, but perhaps not too far to suggest that it could be as rooted as the desire to reproduce – and that the production of meaningful, significant mathematics might be just as satisfying as sex.

"Can intellectual pursuit be as compelling as bodily urges?"

At the core of this hypothesis is a claim that doing mathematics is, at least in part, aesthetic. It is a human trait to hunt for what is beautiful, and we do so because beauty is compelling. I contend that the same is true of mathematics. Beauty – or aesthetics more generally – is not just a by-product of the subject. It isn't that you look back at the end of day and notice that a proof or definition is beautiful. It seems to be that beauty is an essential part of the process. In her article "*The role of the aesthetic in mathematical inquiry*", Nathalie Sinclair of Simon Fraser University, in Canada, finds that aesthetic sensibilities help guide the mind and maintain interest in a problem, as well as influencing the choice of problems to work on and the quest to find solutions to them.

This is not to say that all mathematical work is beautiful. Some proofs are tedious and long. Some, like Hales's proof of Kepler's conjecture, require computer code and are difficult to check. And it is not clear that aesthetic experiences are uniform. What is beautiful to a geometrician might not be an algebraist. What was beautiful to you as a graduate student might not be after 20 years of research.

Although research on the nature of mathematical beauty is under way in several fields – such as philosophy, psychology and education – there are still many open questions. What does beauty mean by beauty? Is it objective or subjective? Can equations be beautiful in their own right, or must they be connected to some sort of visual or sensory representation? And how does the feeling of beauty manifest itself in the brain?

Answers are beginning to emerge. For example, a recent study led by Semir Zeki at University College London involved scanning the brains of mathematicians while they viewed different formulae, such as Euler's identity, $e^{i\pi} + 1 = 0$, an equation rated as beautiful by the participants. The scans showed that the experience of mathematical beauty excited the same area of the brain as music or art (*Frontiers in Human Neuroscience*, vol 8, p 68).

My research has shown that there is some consensus about what kinds of mathematical proofs are deemed beautiful (*Research in Mathematical Education*, vol 15, p 199). Those found to be beautiful seem to give a more immediate sense of why the claim is true. For instance, a geometric proof of the relationship between the sides of a right-angled triangle, that compared areas of small triangles inside it, was considered more aesthetically pleasing than an algebraic proof. This is probably because the algebraic proof gives no immediate sense of why the theorem is true.

Whatever we mean by the term "mathematical beauty" and how we judge it, there is no doubt that aesthetics plays a significant role in the working life of mathematicians. Last year, after she won the Fields Medal, the maths world's Nobel prize, Maryam Mirzakhani talked about "the beauty of math" that one can appreciate after a lot of hard work. But how many children work through their years of schooling without experiencing this kind of appreciation? If there really is a "maths drive", at least in some proportion of the population, do we do enough to tap it?

It is not obvious whether the beauty of mathematics can be conveyed at the school level, but this question is not one that has received a great deal of attention. School lessons tend to be centred on a standard set of mathematical topics and processes. There has been little discussion of aesthetics, despite its motivational capacity. A leading journal, *Educational Studies in Mathematics*, called mathematical aesthetics one of the most under-researched areas in the field.

The question for school mathematics is simply this: do we teach it without conveying the true nature of the subject? Teaching maths solely in terms of procedures such as practising sums is like teaching music through practising scales without ever exposing children to Beethoven.

When experiencing a moment of true mathematical understanding – grasping why something is so, or seeing how everything hangs together – you can feel a sense of meaningfulness, connection and purposefulness, just as you might with poetry or music. Perhaps this was what the prolific mathematician Paul Erdős meant when he claimed that certain proofs were so perfect they were divine.

Once you realise that mathematics is, in addition to its scientific merits, an essentially aesthetic subject, you realise that teaching it to students without conveying its beauty might be to miss the essence, the very life, of the subject.

This article appeared in print under the headline "Seduced by the beauty of mathematics"

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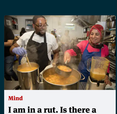
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