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Cover Page Footnote

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What If?: Mathematics, Creative Writing, and Play

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Synopsis

Mathematics can inform creative writing by suggesting structures for it to follow, as well as by providing the imaginative impetus for common rules to be broken. In a workshop co-taught by the author, a class of sixth-grade students explored this interplay as they produced fractal-inspired poetry and geometry-inspired fiction. This article describes the form and results of the workshop in the context of a broader discussion of the influence of mathematics upon literature.

Keywords: *mathematical fiction; mathematics education*

> *"I almost wish I hadn't gone down that rabbit-hole — and yet — and yet — it's rather curious, you know, this sort of life!"*
>
> – Lewis Carroll, *Alice in Wonderland*

Mathematics, in the public consciousness, has an unfortunate reputation for being both unknowable and undesirable. It is widely believed to consist of a collection of cold rules, and the student of mathematics to have a Kafkaesque imperative to follow these directives without question. There is no room for creativity or for beauty, and certainly no tolerance of play.

Nowhere is this sad perspective more apparent than among middle school students. Rather than exploring the meaning behind procedures, or, more unthinkable still, seeing what happens when rules are broken, the obedient young student tends to ask only what he or she is "allowed" to do. "Can I cancel the twos?" she asks, as though the only thing preventing her equation from behaving the way she wants it to is a mean conspiracy among teachers bent on detracting points.

It is no surprise, then, that Ms. Charles's sixth-grade students reacted with some suspicion when a couple of adults barged into their language arts classroom, a place they probably associated more with feelings than formulas, and began to talk to them about math. What does this have to do with writing? And is this even math, anyway?

It was math — real, deep math — and if the workshop I co-taught them was a success, then by the end of its two sessions the connection between mathematics and creative writing would be much clearer. Mathematics, after all, is a language, a set of structures through which ideas can be given both order and aesthetics. Like any language, it is capable of describing the world as one sees it, revealing patterns and properties that are often difficult to articulate without the right vocabulary. Yet also, like a language, mathematics can be used to explore the fantastic, the fictional, the conceivable but unreal. In providing an appropriate lexicon, mathematics gives form to our imagination of other worlds.

1. Session One: Making rules

The theme of the workshop's first installment was structure, and specifically, the structure of recursion. The take-home message of this forty-five minute class was that mathematics can inform writing by suggesting new frameworks for it to follow. A bit of constraint, as many artists have observed before, can be just the right thing to let loose one's creative flow.

After spending some time with a few of the most striking visual manifestations of recursion — things like fractals, mirrors facing mirrors, and the artwork of M.C. Escher — the students had built up enough curiosity and intuition about the concept to try applying it in their writing. Their goal was to write a "fractal poem," one whose last line loops back into its first so that, like "The Song That Never Ends" (the most infamous work of recursion among a certain generation of pesky younger siblings), it can be repeated *ad infinitum*. Furthermore, by arranging the words inside a simple shape and appending copies of the shape to one another, the poems themselves could be made to form fractals.

These young authors were not the first to shape a piece of writing recursively. Poet and artist Tatiana Bonch-Osmolovskaya takes fractals as her inspiration in "Old Chair" [6, 13], in which the conceit of a picture within a picture is used to capture a persistent longing for other places. In her case, layers of the poem are nested not successively but one within the other:

Above an old chair in our house—
I often had a dream that I climbed onto it,
And having spread my wings
Floated up and outside—
There was a wooden-framed picture, cracks on the frame:
A house on a street, one among many others,
Its walls freshly whitewashed, a wall
With an open window, through it I saw a room,
A table, a wardrobe, a piano, a chair,
Above the chair — sometimes I dreamt
That I climbed onto it and spread my wings and
Floated up and outside — in a flaking frame,
There's a picture...

Douglas Hofstadter's "Little Harmonic Labyrinth," one of the quirky interludes in his monumental work *Gödel, Escher, Bach* [7], is another perfect example; it practically bursts with allusions to and instances of recursion. The story follows two characters, Achilles and the Tortoise, who discover a book about themselves and begin to read it aloud. The Achilles and Tortoise of the book, in turn, happen upon a book about themselves, and their reading of that book commences with a cute imperative to "go down one story." The characters fall down a recursive rabbit hole step by step, peppering the action with other self-referential tidbits like a "pushing-potion" one can use to enter the world of a painting; the antidote to that move is a dose of "popping-tonic."

Other formal structures besides recursion can also be culled from mathematics to inspire creative writing, as Hofstadter proves repeatedly in *Gödel, Escher, Bach*. The work of Italo Calvino provides a number of other examples, infused as it is with a certain mathematical sense of form. His *Invisible Cities* [4], for instance, is shaped around the idea of describing every conceivable city. While, of course, he does not literally follow this guideline, the book is nevertheless poetically reminiscent of the mathematician's penchant for exhaustive classification. Author Barry Cipra provides another beautiful example in his "Loopy Love", a short story composed on a Möbius band [5]. The geometry he uses allows Cipra to tell the story of the relationship between two characters, presenting each character's perspective while quite literally revealing them as intertwined.

And the feedback between mathematical structure and literary form is not necessarily one-sided. The sestina, for example, is a particularly mathematical type of poetry based on the notion of a permutation. Each of its six-line stanzas uses the same set of words to end the lines, but the order of these final words changes in a tightly-prescribed way from one stanza to the next. Naturally, one might wonder whether the appropriate pattern can be applied to stanzas of five lines, or seven, or some other number. In fact, only certain stanza lengths are possible, but the proof of this statement is a truly mathematical artifact [11, 14].

2. Session Two: Breaking rules

Not only can mathematics suggest new structures for creative works to follow, but it can also serve an apparently opposite role, supplying ways to break the rules of everyday experience. The second session of our workshop was devoted to this theme, focusing specifically on the ways in which a change in geometry would affect our lives.

The consequences of strange geometries have been explored in many works of fiction. In the two-dimensional world of Edwin A. Abbott's *Flatland* [1], for example, characters are simply polygons. When a polygon is viewed at a distance in two dimensions, it always looks like a line segment, regardless of its particular shape, so it is impossible for Flatlanders to determine the identity of another person visually without the aid of a "Fog" that permits perception of relative distance. This is just one of the many difficulties faced by flat characters. Although sixth-grade students are unlikely to be familiar with *Flatland*, most of them have some experience with flat worlds from video games, so they are capable (with a bit of mind-stretching) of a good discussion of the challenges of two-dimensional life. Classic arcade games make for ideal examples. Even better, as many mathematicians have jokingly noted, certain games — such as *Pac Man* and *Asteroids* — encode a further geometric surprise. Since an exit from the right-hand side of the screen leads to an entrance on the left-hand side, and the top and bottom of the screen are similarly connected, both of these games can be understood as occurring on a torus.

For a greater challenge, four-dimensionality can also be explored. Science fiction writers Henry Kuttner and C.L. Moore, writing under the combined pseudonym Lewis Padgett, consider how children could expand their perception by playing with a four-dimensional toy in the bizarre, unsettling story "Mimsy Were the Borogoves" [10]. As these children haltingly learn, pieces of a three-dimensional object seem to pop into and out of existence when it is merely a slice of something with a higher-dimensional extension.

Even more straightforward geometric properties are rewarding to play with. Size, for example, is an important issue in *The Little Prince* [12], where a small planet risks being completely overrun by a species of pernicious trees. Unimaginably large size — perhaps even infinitude — propels Jorge Luis Borges's short story "The Library of Babel" [3], in which the entire universe is an enormous library containing every possible way of organizing the letters of the alphabet into a "book" of four hundred and ten pages. (In fact, the closing paragraph of the story suggests that the Library may have an even more striking geometry. The speaker postulates that it is unlimited but periodic; perhaps it is a three-dimensional torus!)

The students themselves came up with some wonderfully weird geometric fiction, from life on a cube to shape-shifting worlds to planets on which everyone has eight clones — an interesting take on periodicity. Some of these worlds were created by mad scientists experimenting with the shape of the Earth; others are completely extraterrestrial. One student, inspired by the example of *Pac Man*, conceived of a world made by gluing the sides of an octagon, thus brilliantly and independently re-discovering the two-holed torus.

3. The spirit of play

The two sessions of the workshop with Ms. Charles's sixth-grade class set up something of a dichotomy: mathematics as a maker of rules (albeit fun and interesting rules, like those that govern fractals) and as a breaker of rules (like the rules about how the world around us looks and behaves). While this format is useful for conceptualizing the power of math, in truth the distinction between the two sides of the coin is quite blurry, especially as far as fiction is concerned.

Consider "The Library of Babel." At first glance, this fits well into the category of rule-breaking geometries, since its infinitude makes it completely unlike the world we are familiar with — not to mention the dizzying repetition in its three-dimensional matrix of identical hexagonal rooms. Yet what allows Borges to meaningfully describe such an alien universe is a description of the pattern that generates it:

> Each wall of each hexagon is furnished with five bookshelves; each bookshelf holds thirty-two books identical in format; each book contains four hundred ten pages; each page, forty lines; each line, approximately eighty black letters.

By instructing us to imagine all the ways in which the letters of the alphabet (along with the space, the comma, and the period) might be arranged in such books, Borges gives us a tool, a kind of crutch, for attempting to conceive of a world that is much too large and too unfamiliar for us to completely grasp.

Herein lies the true creative potential of mathematics. The precision of its language permits one to create a detailed imaginative picture of possible objects, possible structures, and possible worlds that do not, in practice, exist. Anything that can be conceived can be explored with as much rigor as the sensory world — indeed, even more so.

In many works of fiction, this ability of mathematics to produce ideas beyond the realm of experience is charged with a certain mysticism, an otherwordliness bordering on horror. Borges writes that "There is no combination of characters one can make ... that the divine Library has not foreseen and that in one or more of its secret tongues does not hide a terrible significance." Another of his stories, entitled "Blue Tigers" [2], concerns a collection of stones that refuses to obey the laws of arithmetic, leading their discoverer into a nightmarish obsession in an attempt to make sense of them. The quest is familiar to any researcher, but the tone of the story is downright disturbing. Similarly, the adult onlookers in Padgett's "Mimsy Were the Borogoves" are mystified, shocked by the seeming "madness" of their children as the youngsters manipulate their multidimensional toys in ways that an adult brain, conditioned to mundane geometry, cannot fathom. This story takes its title from the work of mathematician Charles Dodgson, best known for writing *Alice in Wonderland* and *Through the Looking Glass* under the penname Lewis Carroll [8]. These books, too, bear the distinct fingerprint of their mathematically-minded author, and though they are narrated in a more measured voice than Borges's or Padgett's stories, they are nevertheless sprinkled with ghoulish images like the Jabberwocky and the Cheshire Cat, whose "grin without a cat" has been compared by Martin Gardner to the project of pure mathematics.

Still, despite their unsettling tone, there is an interesting feature that many of these stories share: in them, children react to their bizarre surroundings not with horror, but with curiosity. The only character in "Blue Tigers" who appears to get any enjoyment out of the baffling stones is a young boy who plays with them, and the children in "Mimsy Were the Borogoves," too, adapt to four-dimensional objects with relative ease. In Lewis Carroll's writings, Alice shows a scientific unfazedness to new rules and circumstances; as she shrinks in size, she calmly observes that the process might end in her "going out altogether, like a candle," a shocking prospect to which her reaction is simply: "I wonder what I should be like then?" Her response to a sudden spurt of growth is the similarly unruffled and memorable line: "Curioser and curioser!"

The good-natured inquisitiveness of the children in these stories serves as an important reminder: mathematical adventures are, and should be, infused with a spirit of play. It is the habit of both the child and the scientist to ask "what if?", to bravely imagine other realities. Like any game of make-believe, a piece of mathematics begins with a premise and forages for all the fun that can be had in fleshing out that premise into the most robust reality possible. There is, indeed, something a bit mystical about this process, but it need not be frightening; ideally, it should be freeing, intriguing, and light-hearted.

Lewis Carroll was particularly attuned to the parallels between children and mathematicians. The *Alice* books are suffused with goofy literalism, such as the White Knight's remark that Alice must have excellent eyesight "to be able to see Nobody!" or the Mad Hatter's response to Alice's claim that she cannot take more cake if she hasn't taken any to begin with: "you mean you can't take *less*." These linguistic games are charming versions of mathematicians' pedantic tendencies, as are the many puns sprinkled throughout the text. "Lessons," the Tortoise claims, bear their name because the number of hours taught lessens by one each day. Of course, such wordplay often leads to practical nonsense; what happens when we get to negative numbers? But it is in the attempt to make sense of the zany that all the fun can be found.

Mathematics is a language. But it is also, importantly, a playground. It is a shame that so many children come to believe that mathematical rules are dictatorial, since the reality is quite the opposite: these rules were made to be questioned, to be broken in the most interesting ways one can find. There are worlds where $2 + 2$ equals 1, where the angles of a triangle do not add up to 180 degrees, where infinity is a number. Strange ideas, to be sure, but by putting them into words — whether the words of a mathematical proof or of a compelling story — they can be made tangibly, beautifully real.

Acknowledgments

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