

IN MATHEMATICS, AS IN ART

Many of the essential components of modern-day society were created and designed by mathematicians and artists. The artist's vision helped decide what should be created. The mathematician's insight what can be created. Yet most people view art as merely decoration, or a reflection of existing reality, while mathematics is simply a tool for accurate scientific description. Can most people learn to value both art and mathematics? And spend a lifetime exploring them and appreciating them for their own sakes? Appreciating the beauty of mathematics is currently left to too few, and readily discounted by too many. It is evident that more people feel a connection with great art than with great mathematics, yet arguably their connection to both can be similar.

John Keats wrote that "Beauty is truth, truth beauty". Is this the beauty that mathematicians and artists seek? When the mathematician discovers that various, seemingly unrelated, phenomena organize themselves into the same basic patterns, she searches for the underlying truth that creates those patterns. The quest is to find a unifying, simple principle that ties together different ideas and concepts in a way that makes them part of one whole. The less complicated that description, the better it describes the truths, allowing us to understand them. This economy of description allows the ideas to flourish. Picasso's *Guernica* witnesses unspeakable horrors, yet mutes both the form and the colours. Inner turbulence is revealed by the steady gaze of Greta Garbo's *Queen Christina*. These presentations of truth lead us to ask ourselves the most penetrating questions. This quest for simplicity has led to much of the most profound and moving art and mathematics.

Henryk Iwaniec's 1977 seminal work, *The Sieve of Eratosthenes-Legendre*, seems to now contain more provocative ideas than it used to. The article hasn't been changed so I, the reader, must have. Each time I read it, it reveals something new to me, not only answering the questions that Iwaniec intended, but also questions that had not been dreamed of at the time that it was written. As with all great works, the mathematics in Iwaniec's paper appeals in different ways to different people, at different times, whether or not that was its creator's intention. That is the beauty of provocative ideas. They have a life of their own, transcending and augmenting the author's own vision.

To engage two teenage boys at Musée d'Orsay in Paris, I asked them to describe a Van Gogh painting of two men sitting opposite one another at a rustic table. To each, the men in the painting had different motivations and intent. And as the boys heard each other's description, they reconsidered their own initial perceptions, leading to several revisions of the meaning that they had initially found in Van Gogh's tableau. These boys came to understand that real art poses more questions than it answers, and one's view can change with time, thought and context. The process that widens our perspective when viewing a Van Gogh is not so different from the changes that we undergo when studying an Iwaniec

paper. At different times, in different contexts, the ideas lead us beyond the restrictions of our personal horizons.

How can one appreciate great art and great mathematics? What does one look for? Technique is vital but it is not what excites or moves us. Indeed, in great art and great mathematics “the more technique there is, the less you have to worry about it” (Picasso). How does one read a seminal math paper, or navigate a provocative exhibit? Immersing oneself is important, but one cannot appreciate more than a few new ideas in one go. Reading an inspiring paper, or familiarizing oneself with a complex painting, takes time, and requires choices. A guide is helpful: The gallery’s catalogue, or the introduction to the paper, helps prepare you to explore by yourself. However, a curator, an author, even an artist, do not share your interests, experience and imagination. Nor your personal needs at that particular moment. You have to learn to identify your interests, though be aware that they develop over time, influenced by other works, different ideas, and your own emotional balance.

With Iwaniec and van Gogh, we need to go carefully and methodically, so as not to miss any of the good bits. Sometimes one equation derived in passing, or one blurred image, can provide inspiration for weeks. With great papers one feels satiated one day, then keen for more the next. Ditto, with great art. It can be difficult to get to grips with unfamiliar themes. De Kooning’s abstract expressionism or Iwaniec’s subtle mastery of deeper themes, require careful contemplation, maybe even training. At first it is difficult to value art that does not conform to our pre-conceived notions of what art is. When Picasso reduces animal form to basic shapes and reconstitutes the body, for some he has lost connection to the physical world, while for others he has accentuated it and moved on to a more meaningful realm. Giving an abstract description of simple mathematical phenomena seems to lose touch with the reality, yet for the cognoscenti it gives a more meaningful, and ultimately more useful, understanding.

Indeed, the mathematician, Turing, conceived of an abstract device that could change its own purpose through internal switching (as opposed to on/off switches operated by external operators) — this abstract idea eventually led to the computer, only becoming reality some time later, when electrical engineers created a device that could make a “Turing machine” practical. Turing work was, and is, beautiful, and inspired so much, in so many different realms, that he could never have conceived of.

No formula can describe the elegance and insight of Iwaniec’s equations. No palette can describe the beauty, depth and resonance of colour in Van Gogh’s self portraits. The more often one experiences such profundity, the more one learns to appreciate what each has to offer, ever the same, yet always changing too. It is only by swimming ourselves that we can appreciate the broad strokes of the masters.