Connecting Art and Science: Teaching with Sublime

Mark Girod

Western Oregon University

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Contact Information:

Mark Girod, Ph.D.
Division of Teacher Education
Western Oregon University
345 N. Monmouth Ave.
Monmouth, OR 97361
Phone: (503) 838-0368
Email: girodm@wou.edu

The challenge of integrating art and science

I believe one of the shortcomings in most efforts to integrate art and science is that many of us have a shallow understanding of art – which inevitably leads to shallow connections between art and science. Coloring drawings of planets, building sculptures of volcanoes, and decorating scientific diagrams are nice activities but do not link science and art in powerful ways.

One way to more deeply connect art and science is to consider art in its more broad form – aesthetics. According to Wikipedia, aesthetics is the study of beauty, taste, transcendence, and sublime. Sublime, as an aesthetic category, was described at length by philosophers such as Kant, Burke, and Santayana and then adopted in literature by authors like Wordsworth, Emerson, and Thoreau. Fundamental to sublime is astonishment – astonishment such that all processes of the mind are suspended so it cannot entertain anything other than the object or event (Burke, 1990). Science education has attended to the notion of astonishment in the form of discrepant events (Liem, 1981) and their utility in helping students to discard their naïve understandings for more scientifically correct understandings. I do not believe, however, that we have tapped astonishment for all its worth. Who can deny the incredibly engaging qualities of a raging river, a fiercely howling wind, a night sky filled with stars, or a frenzied pack of feeding lions? Each are astonishing, engaging, aesthetic, and sublime. Table 1 describes in more detail several categories of sublime and where they might be used effectively in science.[i]

Table 1: Elements of sublime and related science content[ii]

Element	Synonyms	Possible science topics or concepts
Immense	Vast, powerful, ancient, magnificent, smallness, and suddenness	Impressive landscapes, incredible waterfalls, spectacular waves, infinite space, incredible distance, unbelievable temperatures, and tiny masses, distances, and volumes
Terrible	Hostile, violent, damaging, threatening, and scary	Raging floods, powerful earthquakes, damaging tsunamis, blazing infernos, burning lava, exploding volcanoes, and predators
Divine	Symmetry, elegance, and connectedness	Crystalline structures, food webs, balance in systems, and other elegant features

Science and sublime

Interestingly, scientists and mathematicians have, for quite some time, written about sublime. The mathematician Poincaré describes his sense of motivation in the fields of math and science exploring "simplicity and vastness" as we explore the "giant courses of the stars" and with a microscope "prodigious smallness which is also a vastness" (Chandrasekhar, 1987, p. 60). Similarly, Heisenberg in a discussion with Einstein wrote, "You must have felt this too: the almost frightening simplicity and wholeness of the relationships which nature suddenly spreads out before us" (Chandrasekhar, 1987, p. 53). And most poetically, Whewell, in commenting on Newton's *Principia,* suggests an awesome admiration at the mathematics within.

> As we read the *Principia*, we feel as when we are in an ancient armoury where the weapons are of gigantic size; and as we look at them, we marvel what manner of men they were who could use as weapons what we can scarcely lift as a burden (Chandrasekhar, 1987, p. 45).

For whatever reason, we often shield children from these characterizations of science. The trick is, in my opinion, to help children think more richly about what constitutes art and how we can explore aesthetics to learn more about science and world around us. What follows is one example using sublime to help children understand magnitude and build number sense.

Teaching big numbers with sublime

Science uses big numbers. We use big numbers to describe distances, time, volume, masses… it seems you can't go very far in understanding science without comprehending big numbers. My concern is that few people (adults included) really understand just how big. For example, a million miles (or dollars or people etc.) is a fairly common thing to talk about yet few truly understand the enormity of a million. In an effort to help a group of fourth graders understand this – prior to the study of rocks and geologic time – I designed the following activity that uses the aspect of sublime called immensity to facilitate aesthetic experiences, help students understand big numbers, and connect aesthetics and science in ways that are deeply engaging and educational.

The night before the science unit began, I used my computer to make a single page full of 10,000 dots (periods). I didn't sit at my computer all night and type periods (as many of my students accused me of doing). I typed one line of periods then used the "copy and paste" function to re-create that line of periods. I fussed with the margin settings and font size ultimately settling on a 1-inch margin on all sides and 4 point, Times New Roman font. Adding a border around the edge gave me a framed image of 10,000 dots. Quite impressive in and of itself!

As the science period began, I distributed one sheet of dots to each student and asked them to estimate how many dots were on each sheet of paper. Estimates included one billion, 42 million, and one bazillion – suggested by one verbally playful student. Consistently, they overestimated the number. Next, I asked each student to circle the number of dots that equaled their age. After a bit of squinting and complaining that it was difficult to circle only nine or ten, each student was able to complete the task. I then asked them to circle the number of dots equaling the age of the oldest person they knew. These two tasks were designed to connect them personally to their sense of number and its representation in "dot form." Finally, I asked them to work in small groups to identify 1,000 dots. After a bit of problem solving, all groups were able to figure out a method that allowed them to do this without actually counting all the dots. At this point, I asked students who would like to re-consider their original estimate of the number of dots on the whole page. Every child raised his or her hand. They were beginning to understand.

Building a tapestry

Next, I distributed three additional sheets of 10,000 dots to each of my students – so each child had four sheets. I asked them to carefully tape the sheets of paper together side-by-side (they agreed on a 10 x 10 grid). We pushed our desks back from the middle of the room and began to assemble the tapestry on the floor in the center of our classroom. It just happened that 25 students were present on this day so their 100 sheets of 10,000 dots would equal one million dots total – though one could adjust for different numbers of students.

After the tapestry was assembled I asked the children to gather around the edges to talk about our creation. I asked them once again to estimate how many dots were present. This time estimates were a bit more conservative. We discussed different ways to figure our how many dots were there and finally I disclosed that we had made a tapestry that included one million dots. Several students gasped at the representation. Antwan spoke in amazement, "Wow! I've never seen a million of something!" Rachel agreed, "I never thought I'd see a million of anything!" Again, they were beginning to understand that a million is a very big number.

Connecting to our upcoming unit

As students marveled at their creation and the enormity of one million, we had this conversation. "Anybody ever heard of the ice age? What kinds of creatures were roaming around during the ice age, right here in the United States?" I asked. We discussed wooly mammoths, giant sloths, and saber-toothed tigers. My students were shocked to understand these things were roaming the area only 10,000 years ago. As many students had studied dinosaurs in previous grades, they wanted to know how long ago dinosaurs walked the earth. Again, they were shocked to learn that dinosaurs last lived about 65 million years ago – or a tapestry of dots 65 times as big as the one we had just made. An animated discussed followed as students tried to figure out if we'd need to carpet the entire floor, walls, and ceiling of our classroom to reach 65 million dots. At that point, I produced several fossils from varying time periods – clams from 150 million years ago, a fish from 220 million years ago, and a few fossilized leaves from 350 million years ago. Students were enthralled – almost disturbed and uncomfortable with the enormity of these numbers – that these things were living on the earth so many, many dots ago. We ended the conversation with a series of comparisons about the age of the earth, the number of people on earth, in the United States, the distance to the moon, to the sun, to Pluto. In each instance my students were stunned by the vastness – or in some cases, the relative smallness – of these numbers. My students were positioned for our study of geology with a deeper understanding of time and big numbers. In discussions about fossils, ice ages, and periods of mountain building in the Pacific Northwest, my students referred back to this activity and marveled at the vastness of geologic time.

Table 2: Interesting distances, quantities, and ages in millions of years[iii]

Millions	Distance, quantity, or time
64	Years ago that dinosaurs last walked the earth
225	Years ago of first mammals
430	Years ago of first air breathing animals
800	Years ago that mostly just simple organisms rule the sea
4,600	Years ago that the earth formed
.025	Distance around the earth in kilometers
.384	Distance to moon in kilometers
78	Distance to Mars in kilometers
150	Distance to sun in kilometers
628	Distance to Jupiter in kilometers
5,740	Distance to Pluto in kilometers
15,000,000	Distance to Oort cloud
100,000	Estimate of the number of major galaxies in the universe
300	Population of United States
6,600	Population of Earth
15,000	Temperature of sun's core in degrees Celsius

In conclusion

It isn't enough to simply teach the science ideas represented in table 1. For effective integration of science and aesthetics, one must craft lessons, and use language, that helps students see the sublime elements of these features. In teaching these same fourth graders about water and the water cycle, I described the experience of standing at Niagara Falls. I described carefully the thundering sounds of the crashing waters below the falls, the clouds of mist, the curve of the falls, and the color and silence of the water as it poured over the edge in a powerful blue-green ribbon. After painting the sublime picture – and effectively generating astonishment – my students were hooked and listened carefully as I described the individual water molecules and the circuitous journey they might have taken to reach this point. Perhaps each long ago evaporated from an ancient lake, carried aloft for a thousand miles before being deposited in a winter blizzard, melting and flowing slowly in a mountain stream, perhaps consumed and expelled by numerous plants and animals, before finally reaching this point cascading in immeasurable glory over Niagara Falls. Having taught the water cycle many different ways over the years, this introduction with its aesthetic, sublime connections through a form of vastness, was by far, the most effective introduction I had ever designed. Once captured by sublime, my students were motivated to learn about the water cycle as they had not been previously.

Thoughtful arts-science integration should be applauded as these two fields share many underlying skills such as observation, analysis, and inference (Rommel-Esham, 2005) but deep, powerful integration is often elusive. One useful strategy is to broaden our definitions of art to include aesthetics and the having of aesthetic experiences through concepts like sublime. Other aesthetic categories could be equally powerful like pattern, rhythm, symmetry, movement, perspective, form, contrast, juxtaposition, and a variety of others. The challenge is to employ these devices to hook children, to gather their emotional support, to position them for learning, and to enrich their perceptions and experiences in the world. This is, in my opinion, the goal of arts-science integration.

References

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Rommel-Esham, K. (2005). Do you see what I see? Science and Children, 43(1), 40-43.

Endnotes

[i] Interestingly, philosophers have recognized several other categories of sublime such as privation (darkness and silence), obscurity (rarity and exceptionality), the cries of animals and wild beasts, and pain, including bitters and stenches. These seem to have less utility in connecting to science.

[ii] Taken from Santayana, G. (1955). The sense of beauty: Being the outline of aesthetic theory. New York: Dover. (original work published in 1896)

[iii] Taken from Maton, A., Hopkins, J., Johnson, S., LaHart, D., Warner, M., & Wright, J. (1995). Exploring earth science. Englewood Cliffs, New Jersey: Prentice Hall.