

TEACHING STATEMENT: BEAUTY IN MATHEMATICS

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“The lecturer should lay [her or his] hands on the plough, the loom, the forge, the workshop, the mine, the sea, the stars, all things on earth or under heaven, which may help to arouse the attention or interest the imagination.” – J. J. Sylvester

My personal goal in teaching is to convey to students the beauty in mathematics, as well as its immense utility. Mathematics is an art form that is supremely elegant; but its “unreasonable effectiveness” in practical matters (in the words of physicist Eugene Wigner) all but overshadows the creative leaps and internal aesthetic compass that guide the mathematician. Just like painters, poets and composers, mathematicians engage in our art because we are mesmerized by its beauty, and because we have a need to express ourselves, and to share. We pursue problems because we are curious. Without question, this “art for art’s sake” approach has produced a number of the more useful ideas in the history of thought; that is why children study arithmetic at school. Yet as G. H. Hardy wrote, “Beauty is the first test: there is no permanent place in the world for ugly mathematics.”

The story of mathematics is a tale of discovery that reads like a mix of philosophy, mysticism and futurism. The plot begins in Africa over 20,000 years ago in mysterious notched bone fragments, and connects scribes and geometers of Babylon, Egypt, India, China, Greece, to the theoretical megaliths of the twenty-first century. In the mathematics classroom we are active participants in this living tradition, and the instructor is the face of the subject. One lectures with the collective voice of one’s discipline. Then I have a responsibility on behalf of my discipline, to welcome students into the world of ideas that made me feel at home.

As a Ph.D. student, it was my privilege to teach six semesters of Calculus I at Emory University; it is the first mathematics course to grapple with higher-order concepts like change, limits and infinity, prompting very philosophical questions from students. I have frequent opportunity to remind my class that these ideas *seem* difficult because they *are* difficult, that we are reaching now into subtle realms beyond algorithm and computation — ideas that were highly controversial when they were introduced. Yet these ideas rapidly gave birth to the futuristic landscape of our digital age, and are still developing. I love the intellectual challenge of trying to give each student a presentation that speaks to her or him, and the looks of surprise and relief when students suddenly reach “math enlightenment.” My hope is to teach undergraduate (and graduate) courses like abstract and linear algebra, complex analysis, combinatorics, number theory, history of mathematics, introduction to proof, as well as higher calculus classes.

For my current, sixth year at Emory, I was awarded the Dean’s Teaching Fellowship at Arrendale State Prison, which allows me to design a course to be taught through a certificate program at a women’s prison. In the Spring 2018 semester I will lead a research-based course called “Ancient arithmetic: the birth of mathematics,” a blend of a math class in which arithmetic, geometry and also art skills will be reinforced, a math history course, and a world religions class, for mathematics throughout the world often emerged in the context of religious practices. Students will present research projects on cultures or mathematical practices of their choice; I plan to compile these, along with examples of their art, in a booklet for them to keep and share. It is moving, to have the chance to use mathematics to help others in society, beyond traditional academia. Moreover, as an author as well as an instructor, I am actively into the history of

math, which brims with romantic characters and anecdotes to appeal to in order to “arouse the attention or interest the imagination” of students.

I came to mathematics from a lifelong background in the arts — having had a career as a musician and composer for twenty years prior to entering graduate school, plus being involved in poetry, visual art, theater and film — which informs my teaching style. There is an element of performance to lecturing, aiming for an emotional as well as intellectual connection with one’s audience, and gauging attention in real-time. I emphasize rigor in the notes I write on the blackboard (students reproduce these, so they must be clear and self-contained), but as a speaker I approach each lesson as if it were a public talk, with catchy title, unifying story-line or “moral,” and punchy ending. I believe a mathematics course can offer something of interest for every student; I lean on storytelling, humor, artistic drawings and occasionally dramatic costumes and music to drape the equations in human interest.

Sometimes I appeal to other sensory stimuli to reach out; for example, I pass out a bell to a volunteer each class session (the old-fashioned metal kind like on hotel reception desks), who is responsible to tap the ringer when any student raises his or her hand with a question. This serves a dual purpose: it helps me be more responsive, even if I am writing on the board and miss the visual cue, and the room is filled with laughter periodically when the metallic “ding” sounds, keeping a happy mood in class. For another example of a sensory-based stimulus: my wife read of a study suggesting students feel less anxious during exams, and perform better, if they smell the scent of citrus; so I give my students each an orange as I pass out exams. Beyond possibly inducing a real (or placebo) test-taking effect, giving out oranges is a gesture of my respect for the students, during what may be a stressful episode.

My hope is to create an atmosphere of mutual trust by framing the class as a community. I begin each semester by insisting the students meet one another. I introduce myself as a tour guide on a somewhat rugged hike: my role is to teach the class how to navigate the topography, help them around obstacles, and point out interesting sights along the way. I implore students not to let a single day go by without reaching out to me, if they are falling behind. The hike is a group effort, and I’m here to assist. Personal appeals like this seem to resonate. Students are subject to complex academic, societal and existential pressures, and thrive in a network of support. If they are part of a community, they will look forward to class, want to progress alongside their colleagues, and feel open to ask questions.

Their questions are a source of inspiration. When my teenage son was a child, I served at his elementary school as a weekly math tutor from kindergarten through fifth grade (now I serve as coach to his high school math team). I had just begun studying mathematics seriously, and I became aware of certain patterns in arithmetic by addressing the observations of small children, which re-wired my brain to some degree: in my late-30s, having spent my adult life as a musician and artist, I resolved to obtain a B.S. in Mathematics. I have grown as a thinker through continual contact with the blossoming math skills of students. Each one approaches mathematics from a uniquely personal angle, and goes through wild creative maneuvers to solve a problem. There is a delightful freedom with symbols and algebraic rules as students synthesize new techniques, that startles the reader who is so familiar with these rules, hinting at new perspectives like a *Zen koan*, or free jazz.

Evidently, behind this symbolic “free jazz” lies a fertile mental process. History bears witness to countless innovations in science (and subsequent benefits to humanity) propelled by the curiosity of young mathematicians. Then my job as instructor is not only to impart to students all the requisite skills, that they can easily handle applications in the sciences, engineering, business, and other real-world applications; but to teach them to ask questions, and to value aesthetics, so they may develop their own internal compasses and discover their own examples of beauty in mathematics.