MArTH Madness: Building a Culture
of Mathematical Art at Saint Ann's School

Anna Weltman, Paul Salomon, and Justin Lanier
Math Department • Saint Ann's School
129 Pierrepont Street • Brooklyn, NY 11201
Emails: weltman.anna@gmail.com • paulsalomon27@gmail.com • justin.lanier@gmail.com

Abstract

At Saint Ann's School in Brooklyn, NY, we've developed a successful mathematical art program including courses for grades 6-12 and an annual all-school event called MArTH Madness. We present our beliefs, progress, and successes in connecting students with mathematics and its beauty through the creation of art. We hope to inspire other educators and schools to create math art programs of their own.

Introduction

When Julia wore her MArTH Madness shirt to Algebra 1 this year, the quote on the back drew some attention from the other eighth graders: "Beauty is the first test: there is no permanent place in this world for ugly mathematics," by G. H. Hardy. Another girl, puzzled by the quotation, asked, "What is ugly mathematics? What does that mean?" As an experienced mathematical artist enrolled in our middle school elective, Julia was especially qualified to answer. What followed was a fascinating conversation that showed the success of our school's new math art program.
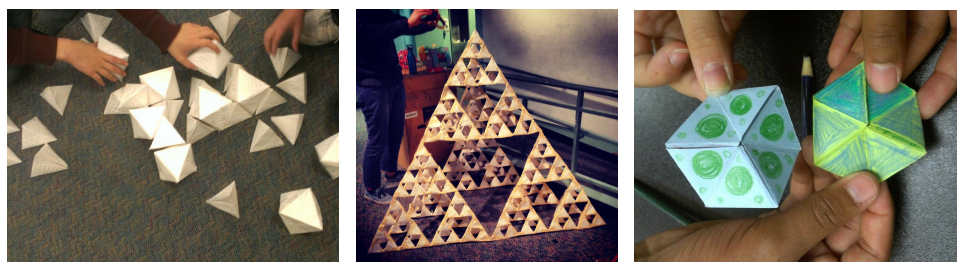

Figure 1 : *Left, paper plate polyhedra, made into a Sierpinski pyramid (center). Right, hexaflexagons.*

The Saint Ann's mathematical art (or, more affectionately, MArTH) program formally began in the winter of 2011 with the launch of the high school MArTH seminar. Since then, it has grown to include two elective classes for middle school students, an annual, school-wide mathematical art festival called MArTH Madness, and formal and informal making of mathematical art in classrooms, offices, hallways, and lunchrooms all over the school, for students in third through twelfth grades. Our blog, Math Munch, which we began writing in the fall of 2011, supplemented the program by providing students with ways to interact with mathematical art in the world beyond school. Through their works, students have shown for themselves a notion - widespread among mathematicians - that math is beautiful. We have seen students begin to see themselves as mathematicians in ways that go beyond the usual habits and practices of a math classroom. We hope our math art program can serve as an example for teachers and students as a way to build mathematical community and encourage engagement with mathematics and its aesthetic qualities.

Philosophy and Background

Mathematicians generally agree that math is beautiful. Many mathematicians will say that what motivates them is the search for and drive to create mathematics that they experience as beautiful. Given that aesthetics drive most mathematicians, an important question for math educators is whether math students are privy to this sort of aesthetic experience in math class. In a paper published in a recent edition of *Mathematics Education*, Nathalie Sinclair argues that the answer to this question is decidedly in the negative. Choice-making, emotion, imagination, and appreciating mathematics viscerally - all of which are part and parcel of understanding mathematics as beautiful - find little room in the conventional mathematics curriculum.
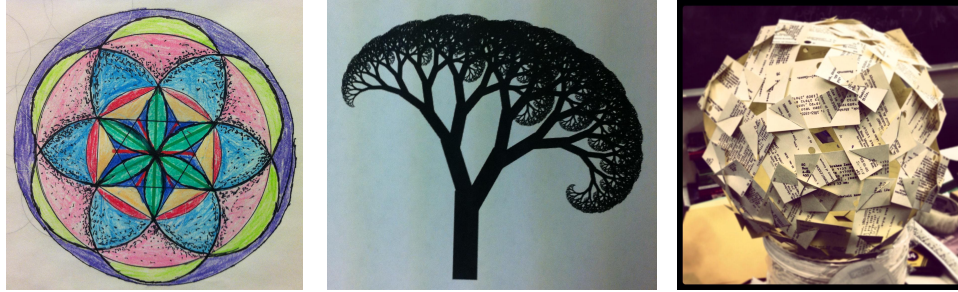

Figure 2 : *Left, overlapping circles, hand-drawn. Center, a fractal tree made with Recursive Drawing, an online math art tool. Right, a polyhedron made from discarded card catalog cards.*

Sinclair points to a number of reasons that most schools neglect the aesthetics of math, including the tendency for the mathematics community to be exclusive and to approach mathematics as a hierarchical discipline in which one must master the basics before moving on to more creative endeavors. This approach effectively denies the most interesting and beautiful mathematics to most students. At Saint Ann's, we contest this view. We have seen novice mathematicians drawn to mathematics through its beauty and through the opportunity to create beauty. Rather than saving the aesthetics of mathematics for advanced students, our experience has been that math art can have its greatest effect in the earlier stages of math education.

Our goal at Saint Ann's has been to help our math students answer the question that our eighth grade student posed of her classmate: "What is ugly mathematics?" or, put more positively, "What is beautiful mathematics?" How can we enable our students to create their own beautiful mathematics that will take its place in the world of mathematical ideas? How can we help them to feel the power they have as makers of beauty in the community of mathematicians? Mathematical aesthetic is central to mathematical habits of mind, and with that in mind, we began the MArTH Program at Saint Ann's School.

The Program

The cornerstones of our MArTH program are the classes. We offer twice-weekly elective classes for sixth through eighth graders. In the high school, a seminar meets weekly for an hour and a half. These classes mainly serve as workshop and sharing time for the students. After examining some examples of mathematical art and learning about techniques and mediums, the students spend class time creating math art. We also hold peer critiques, during which the students share their works-in-progress and field ideas from their classmates. An ongoing discussion of what constitutes math art and what makes mathematics beautiful permeates our classes and the dialogues that take place among students and teachers.

To help students to communicate about math art outside of class, we started a math art Facebook group for high school students. Members post links to sites with math art and images of projects they'd like to make or are working on. The group includes current students, teachers, and alumni not enrolled in the class.

Figure 3: *Left, overlapping grids printed on overhead projector paper. Center, hyperbolic paraboloid icosahedron, cardstock. Right, generative drawing on graph paper.*

Student enthusiasm and the desire to share math art more widely at Saint Ann's prompted us to begin an annual MArTH festival called MArTH Madness. For one day, classrooms on two floors of the school are devoted to math art workshops run by teachers and students in the MArTH classes. Math teachers of students from fourth through twelfth grades bring their classes to the festival during math periods. The workshops have included giant collaborative ZOME builds, modular origami, mathematical doodles, and stop motion animation. Hundreds of students participated in MArTH Madness during the two years it has been held. The festival gives students enrolled in the MArTH classes the opportunity to share their math art passions with their peers, and gives teachers and students not enrolled in the classes a chance to participate in the exciting program that they have heard much about. The event has also given the mathematics department at our school a forum to engage with students, parents, teachers, and administrators about creative mathematics education. In the current era of heightened anxiety about skill-building and testing in mathematics, and a tendency among educators to feel that they must fall back on the basics, this has been very helpful.

Figure 4: *Students working on the collaborative ZOME build from 2013 MArTH Madness.*

We want math art to reach beyond specific classes and events and become part of how mathematics is routinely taught. As such, we have incorporated math art into our standard teaching and to encourage our colleagues to do the same. From presenting visual proofs of the Pythagorean Theorem in trigonometry classes, to using color patterns to learn about numbers in third grade classrooms, to MArTH days interspersed with standard work, we have tried to make math art permeate the math classroom. It is now common for other teachers to use the activities we use in the math art classes and at MArTH Madness in their own classes.

Finally, through our blog, Math Munch, we help students to continue their math art work outside of the classroom. We curate and feature articles, videos, images, interviews, and projects found on the internet in weekly posts that are accessible to students, many about math art and artists. We also provide links to free, web-based mathematical art tools. Math Munch is a launching pad for our students to explore the world of mathematicians and math art outside of the classroom.

Evaluation and Conclusion

The Saint Ann's MArTH program has touched hundreds of students in our school. The math art classes have high enrollment, and students throughout the school eagerly look forward to MArTH Madness. The announcement, "We're going to do some MArTH today!" in a math class is met with cheers. Math art lines the hallways and stairways, and math art fads - like sonobes and hexaflexagons - take the school by storm. Does the program meet our goals of enabling our students to become powerful makers in the world of mathematics, to have personal connections with the math they study, to like the idea of being mathematicians, and to see math as beautiful? We think so. We can provide mainly anecdotal evidence from within our school community of these claims, having few ways to objectively measure this type of success. We believe, however, that these anecdotes speak to the success of the program.

Take, for instance, one of our eleventh graders, Chloé, a student in one of the author's math classes for the past two years and in the MArTH seminar. Last year, Chloé felt anxious about math. She felt that math was a subject in which she had little creative power or freedom. Part-way through the year, we noticed that Chloé's doodles were remarkably mathematical. We showed her Vi Hart's math doodle videos, shared with her the world of tessellations, and encouraged her to keep drawing. When she saw that her doodles filled a niche in a world of math art, Chloé was ecstatic. Chloé has become a leader in the MArTH classes and has submitted some of her artwork to the Bridges conference. Additionally, her math work in her standard mathematics classes has blossomed. Finding a way to express herself mathematically has enabled Chloé to tackle math class with confidence and a sense of ownership over her work. Her sense of mathematical beauty permeates the work she does outside of the world of math art, guiding her to find problems she enjoys and helping her to set goals for and assess the quality of her work.
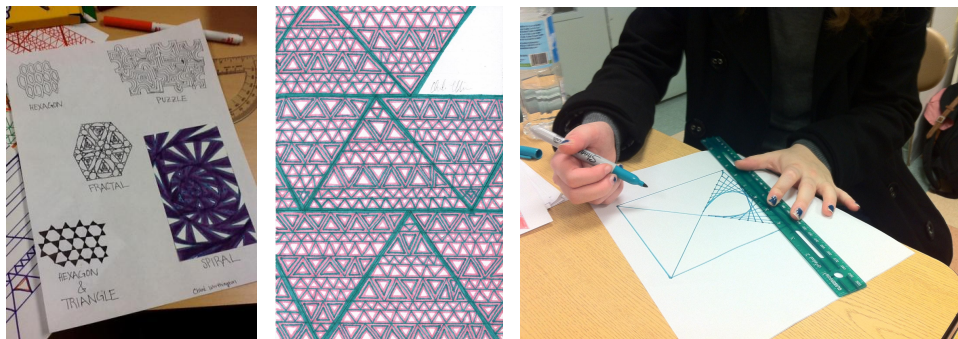

Figure 5 : *Math doodles. Left and center by Chloé.*

This is only one anecdote among many. Our program suggests ways for teachers to address the problems of limited engagement of their students with math and the divide between the community of mathematicians and the young people we are trying to bring into the community. Looking to the future, we hope to find ways to expand and deepen the reach of our program within our school and in the wider world of math education.

References

[1] Sinclair, Nathalie. "Aesthetics as a liberating force in mathematics education?" Mathematics Education, vol. 41, pp. 45-60, 2009.

[2] Sinclair, Nathalie. "The Many and the Few: Mathematics, Democracy and the Aesthetic." Educational Insights, vol. 13, 2010, http://www.ccfi.educ.ubc.ca/publication/insights/v13n01/articles/sinclairpimm/index.html.