

Citizen Science

at Natural Math

Dr. Maria Droujkova



Hi, I am Maria Droujkova, director of [Natural Math](#). I am a mathematics education consultant, doing development, online courses, and math circles, like adventures in calculus for 5-year-olds. Natural Math organizes events, runs online courses for parents and teachers, and does curriculum development projects. Everything we do is an experiment and an exploration.

In this story, I will talk about math circles. I will show how we study and crowdsource what people want from them, and then use the results for development. Then I will introduce another type of citizen science we just started at Natural Math.

“A math circle is a social structure where participants engage in the depths and intricacies of mathematical thinking, propagate the culture of doing mathematics, and create knowledge. To reach these goals, participants partake in problem-solving, mathematical modeling, the practice of art, and philosophical discourse. Some circles involve competition, others do not; all promote camaraderie.” (Yes, the definition is from Wikipedia, because I actively curate the [Math Circle](#) article there.)

Taxonomies



	useful good	neutral good	chaotic good
	useful neutral	neutral	chaotic neutral
	useful evil	neutral evil	chaotic evil

I will use math circles as an example of what crowdsourcing and citizen science does really well: sorting things! I find good taxonomies both empowering and liberating. Once you define and name parts of a field, you have the power over its patterns and relations. You have the freedom to build new and exciting entities, to be consciously creative. A good taxonomy is also a tool for sharing and collaboration - it can give people in a community power and freedom to discuss their problems.



Types of Circles: Diversity and Complexity



Many people run math circles, each one unique. But sometimes other people repeat a format pretty closely. When enough people do it, we get a sort of a franchise going - a new category, like teacher circles. I am sure every math circle leader tweaks some variables. What are the variables? I've been collecting some. Location, governance, content, age... The combinatorial complexity grows very quickly.

Tweaking just one variable can bring very dramatic changes. The book "Circle in the Box" has a chapter called "Location, Location, Location." Imagine that you keep the same participants and the same topic, for example, fractals. But imagine how much your circle will change if you meet at university, at someone's living room, at a forest on a hike, in the virtual world of Minecraft.



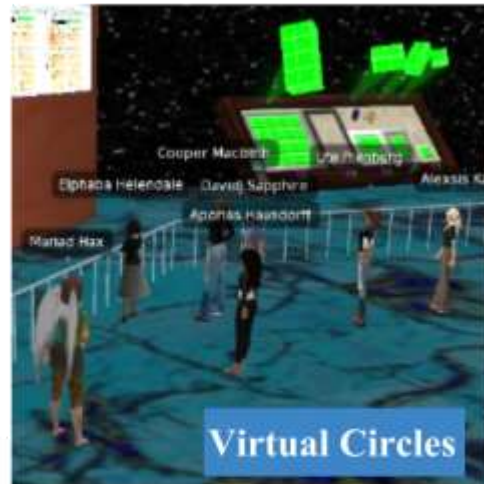
Missing Categories



So one thing you can do with a taxonomy is to see what combinations of variables, or what categories, are promising but missing. For example, let's look at target audience categories. We have student circles, and we have teacher circles - what about parent circles? Turns out there is a big demand for whole-family circles and for parent math workshops. We've been providing those at Natural Math. Within this group of family circles, one sub-group are toddlers and their parents. Toddlers are a demographic category too - but it boggles the mind to think of math circles for them!



Outdoor & Embodied Math

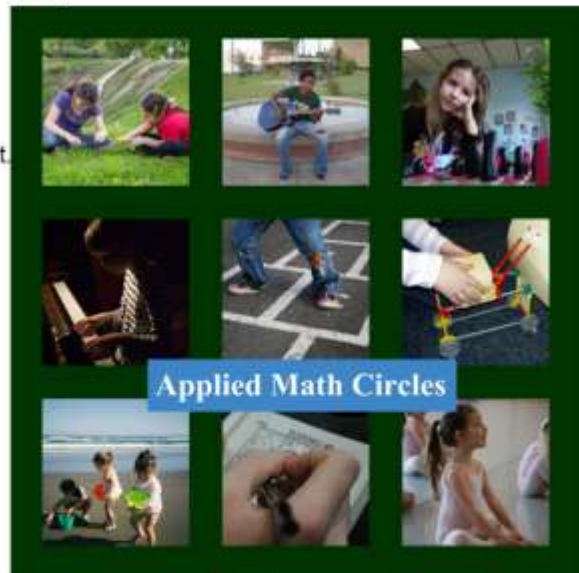


Virtual Circles

Types of activities*

What do you want to do at your circle?

- Projects, explorations
- Unit studies
- Problem-solving
- Maker activities and modeling (paper, Zome, LEGO, crochet...)
- Computer modeling
- Puzzles
- Board games
- Outdoors activities
- Visual arts
- Storytelling
- Dance
- Sports and active games
- Debates, discussions, Socratic learning
- Math manipulatives (algebra tiles, abacus, Cuisenaire...)
- Large (body-scale) math models, structures, art



Applied Math Circles

Math Circle Builder: Types of Activities



We had a forum in the Math Circles 1001 course, and conducted other open-ended interviews with parents and potential leaders about their dreams. Then, I compared the dreams to existing types of circles and existing materials. Here are some dreams and needs that are in demand, but not yet addressed well. There are a lot of requests for outdoor activities, and whole body activities. There is a lot of backlash against sitting at a desk and writing. People want to be outdoors, move around, and connect with nature. We at Natural Math develop outdoor circle formats like Math Trek, then there are resources like Vi Hart building activities, and Malke Rosenfeld's mathematical dance, but there is more demand than supply.

And on the opposite end, people are very interested in purely virtual math circles. One general effect of the internet is the creation of gazillions of niche interests. If you are one in a million, there are still about

two thousands of you online - enough to form a little Special Interest Group. We had people from four continents in that Circles 1001 course. So many people want to run math circles with their distant friends and relatives. Or to find very, very, very like-minded people, which inevitably means worldwide search. Virtual circles have their own issues, for example, keeping people's voice and face, because text-heavy communication loses most of our personalities, and is not accessible to young kids.

Another big demand is for applied math circles - which is different from science circles, robotics, or maker spaces. These circles are more like unit studies, for example, mathematics of architecture, or mathematics of medicine. Again, when people have the power to customize their learning more, they want to adapt it to their particular passions.

When we have that wild variety, that much combinatorial complexity, 1001 or maybe 1000001 circles - how can people even find one another? That's the biggest problem the math circle community needs to solve. It's relatively easy to find or adapt resources and activities that fit any type of circle reasonably well. But it is very difficult to find opportunities for live, meaningful interactions with people who share your journey. Power and freedom should not make us lonely. So we need tools for sharing and collaboration among very unique, very different circles, and their very free leaders. In the end, our community, our 1001 circles is really all about the same as one mathematical circle: connecting with other people, and loving one another in the context of mathematics.

Guesses When Jar Has 100 Jelly Beans

Guess	Number of guesses
98	1
99	2
100	10
101	12
102	10
103	5
104	3
105	2
106	1
107	1
108	1

Guesses When Jar Has 10 Jelly Beans

Guess	Number of guesses
8	1
9	2
10	25
11	10
12	5
13	2
14	1

IS WHAT YOU MAKE OF IT!

Citizen Science at Natural Math

I would like to briefly introduce a project we just started – it is now in alpha testing. The goal is to help researchers and developers find citizen scientist parents and teachers who can help them in their endeavors. You can learn more about it at the [Citizen Science Station](#) landing page we made.

Write maria@naturalmath.com to join our network, to collaborate, and to talk!