

MET Legacy Series: Theoni Pappas

Richard Seitz

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Overview

This set of notes comes from e-mails, conversations and an interview with Theoni Pappas in Orlando, California. Early in 2016, we had the opportunity to visit about what it is like to write about mathematics. Pappas has written many books about mathematics, and she is known for her ability to take topics, present them with visual appeal and make the mathematics truly come alive.

The Mathematician and Mathematics Teacher as a Writer

As a young graduate in mathematics, Theoni Pappas made a decision that resulted in the start of her writing journey as an author who specializes in bringing alive the fun side of mathematics. She remarked, "When I graduated from UC Berkeley in 1966, I decided to become a teacher, so I entered the STEP education program at Stanford rather than pursue postgraduate work in numerical analysis. I know if I had not become a teacher, I would never have written math books. Instead, I would have become immersed in a specialized field of math." Since that time in 1966, we have seen a prolific collection of books that

aspiring authors in the realm of mathematics writing would do well to read. Below are questions from the author of this article, followed by Theoni Pappas's responses in her own words.

Richard Seitz: It seems unusual for a calculus teacher to take the career path of becoming an author of mathematics books (including ones for younger readers). What prompted you to take on this challenge?

Theoni Pappas: I am not a calculus teacher, but rather a teacher who loves teaching and has a passion for mathematics. I like teaching any math subject, from arithmetic to calculus, and enjoy working with students in all levels of math. While in college, I learned how much I liked teaching while helping friends cope with their required math courses. From my first day of teaching mathematics, I realized I was teaching a subject that was probably the least popular in the school's curriculum and knew barriers had to be brought down if I was to be successful. I found that students usually entered the class with apprehension and fears about math. In my quest to break down math phobia, I sought out math concepts that would spark curiosity. I wanted students to ask, "How's that possible?" "How can that be?" "That can't be math." Over the years, the inevitable question all math teachers hear: "When and where am I going to use this math?" or "What does that have to do with my life?" became less and less frequent. Breaking down barriers and working with students to make them feel confident in math class is one of the hardest and most important things for a teacher to accomplish without compromising the subject matter. This was my challenge, even as it is the challenge of all teachers.

I knew what I was doing was exciting, and I wanted to share it not only with my classes but with a wider

audience. One of the first books I wrote and designed was far from the typical math book of that time. Its title alone was unique: *The Joy of Mathematics*. Few lay people ever linked joy with mathematics. Rarely had a math author ever dared to “lower” the status of mathematics to the layperson’s level.

Seitz: How would you say your writing differed from the traditional writing in math books at the time?

Pappas: There was an elitist attitude among math people that math books had to be written in a prescribed way, or they were not math. I purposely designed *The Joy of Mathematics* to be opened at random, copying how one discovers articles in a newspaper. The reader did not have to know what went on in the previous pages. Each topic was short and self-contained, with lots of visuals including photos and graphics. I wanted to make it as user friendly and eye opening as possible. I wanted to introduce the world of mathematics in a familiar yet different way. I knew I was entering uncharted areas, and the project might have just been criticized and/or ignored. But, I knew it was important if inroads were to be made in overcoming math phobia and the threatening feelings mathematics can conjure up. This explains why so few people could or wanted to wrap their minds around what they perceived as its abstract, cold and alienating ideas.

Seitz: Where did your writing and energy take you next?

Pappas: Next, I introduced *The Mathematical Calendars*, an active approach to mathematics in small doses. It featured short math articles each month and a problem a day for each date that ranged from arithmetic to calculus. I tried to build success into the problems, and even though the hitch that the solution was staring you in the face, the challenge remained before you. Could you figure out how to solve it? How soon would you realize the problems’ answers were the dates? The calendar was extraordinarily popular, not only as a math calendar but in general; it was a tremendous success. In fact, the Smithsonian has said it was their bestselling calendar through the years. Its success made me realize that Yes! people were thirsty for more math. It all depended on how it was presented. Hence, I also introduced *The Children’s Mathematics Calendars* and *The Mathematical Engagement Calendars*. From here, I and one of my colleagues formed a company called Math Products Plus, deciding to present mathematics on things people were used to using in their everyday lives. Hence, the math T-shirts were born, along with math mugs, math post-its, bumper stickers, buttons, posters

etc. In essence, we helped math enter the mainstream! It was all cutting edge! It was exciting.

Seitz: I also understand that your writing took a turn into poetry and stories. Can you tell us about that?

Pappas: I feel there is no area in which math cannot be presented. For example, when I first heard a poem from the book *Joyful Noise: Poems for Two Voices*, I felt that this could be a new venue for mathematical ideas. I immediately sat down and began writing *Math Talk: Mathematical Ideas for Poems in Two Voices*. It found its audience, and it has become a mainstay in classrooms at all grade levels. Whenever and wherever I get an exciting idea on how to introduce math, I waste no time moving on it.

My work for young readers evolved as I was asked to help the children of friends and relatives with their math. I really like creating stories in which math ideas are the main characters. In addition, my cat and his mischievous behaviour were influential in introducing Penrose the math cat as the hero of many stories for children. Penrose made it a point of intruding on my math work, so eventually Penrose became a math protagonist in youth books. His books, *The Adventures of Penrose the Mathematical Cat*, *The Further Adventures of Penrose* and *Puzzles from Penrose*, have been extremely popular. Penrose even has his own fan club! I then began writing a number of math stories geared for an adult audience. Readers have told me that they forget they are reading about math as they get caught up in the stories in *Numbers and Other Math Ideas Come Alive*.

Today my math books have been translated into many languages and are attacking math phobia on a global level. My mathematical journey was not easy, but it has been fascinating, fun and exciting. Trying to introduce the beauty of math to more and more people is a never-ending journey. I am happy to see that my approach and book designs are no longer the exception but are being imitated by many writers. I am both flattered and encouraged that the beauty that mathematics holds is shared by more and more people. I am happy to have made a contribution.

Seitz: I understand you enjoy the outdoors, along with a wide range of other pursuits—painting, music (especially the flamenco guitar) and gardening. Has your love of mathematics been influential in your other activities?

Pappas: I can’t say math has directly influenced activities I pursue, but I have an insatiable curiosity and love of learning. The best part of learning is the

joy of discovery, of experiencing that aha! moment. I am always on the lookout for things related to mathematics, whether I find it in one of my interests or simply walking down the street. Nowadays it's wonderful to see math in our lives in so many places. It's in TV ads, on billboards, on public transportation and, especially, in the movies. It's almost a cliché, but I firmly believe math is everywhere. One doesn't have to look too deeply to find its connection to the foods we eat, the music we hear, the art we see. I never made a conscious decision to go for a hike and see what math ideas I might run into. But I know they're there, and I always keep an open mind. The same is true about my other areas of interests/activities. Everywhere I look, I see a math connection. Sometimes something is right in front of our noses, yet we don't see it. I like to write about the math I see, whether it's in mundane and familiar territory or in the complex and abstract. It's all exciting, but people are more likely to explore and read about mathematics in familiar realms.

I have always loved music and have enjoyed trying to play various instruments, from the violin as a child to trying any instrument I could lay my hands on. What better nonthreatening area to introduce mathematics than in the music and sounds that touch our lives? I loved researching the math of music and introducing my students and readers to what I had the joy of discovering. I found the music in math and math in music. For me, one of the most intriguing math/music links I learned was about music and string theory: how the vibrations of multidimensional infinitesimally small strings are believed to describe elements.

The same motivation was true for the many art/math topics I wrote about. Art, like music, is an area in which most people are comfortable and willing to explore. Which of us did not delve into art as children with finger painting and crayons? We never suspected to find math there, but it is, and that's what makes it a tantalizing area to write about. Granted, many artists may not create their works using math, but somehow it can be found in their works. Regardless, whether an artist intentionally uses mathematics in their art, such as Leonardo di Vinci or Sol de Witt, or does not give it a thought, I strongly feel it inherently exists in art. I personally chose the media of watercolour because of how water wreaks chaos with paint and art emerges.

I love to garden. Gardening is kind of a Zen experience. My mind often wanders as I'm digging or weeding, and it was during one of these times that I wrote the adult story about a gardener who is oblivious of the mathematical ideas growing in her yard.

[The mathematically annotated garden appears in the book *The Magic of Mathematics*.]

For me, mathematics is more than a set of tools—it's a world unto itself, and I love to introduce people to its many areas. My main goal in my math books is that I want people to realize you don't have to be a math enthusiast to be excited by math ideas. All my activities have opened up areas in which to examine math and to communicate how I feel about it. I hope my work invites people to join me on mathematical journeys.

Seitz: Your writings include a wide variety of topics and problems across a spectrum of mathematics. What advice would you give a young teacher on how to acquire and develop a rich repertoire of mathematical ideas?

Pappas: I would encourage every teacher to follow his or her instincts and passions. If they follow what they enjoy learning, their enthusiasm will shine through to their students.

I am convinced you can find mathematical connections to any topic that interests you.

- Read or listen to a newspaper story, an article, a book, and find how it leads in numerous mathematical directions.
- Take notes and compile articles you might like to pursue when you have time.
- Randomly name 10 things you see or do during a typical day and see how many of these have something mathematically linked to them.
- Keep records and notes of things you think will work for you and your classes.
- Don't be afraid or intimidated to follow in a non-traditional approach or direction.

I would have never written the books and produced math products if I was concerned about what would be considered acceptable or conforming. Keep current on evolving math ideas. It was not long ago that most people had no idea what a fractal was or what the butterfly effect was all about. Work in conjunction with students. Let students be your scouts. They will love it and discover the art of exploring and researching. Challenge yourself and your students to look beyond your comfort zones. Delve into areas you may have never heard of or lack background in.

When I started teaching math, I had no idea that my passion for math would lead me to where I am today. I have been fortunate to be able to pursue the dream of helping to change the image of mathematics from one that was all too often considered cold, sterile and elitist to one that is exciting, fascinating and connected to so many things in our world. Now

more than ever, math is achieving a new status. The digital age and so many other mathematical and scientific discoveries have helped elevate the importance of the role of mathematics in our lives. I have tried to write books that point to where mathematics is, has been and where it's going to lead us. Math is in the mundane, the complex, and the real and abstract worlds. I encourage you to seek it everywhere.

Seitz: What are some of your favourite mathematical topics?

Pappas: I'm just passionate about mathematics and discovering its many facets and quirks.

At the top of my list are non-Euclidean geometries. I especially like to explore the histories of their evolutions. For example, how Riemann introduced the ideas of elliptical/spherical geometry in his 1854 lecture. The story of how trying to see whether Euclid's parallel (fifth) postulate is actually a postulate and how this quest led to uncovering non-Euclidean geometries. Among the many stories studied, I found the one about how Saccheri's doubt in his own work delayed the discovery of hyperbolic geometry by nearly a century poignant.

Another area I like to explore is the role problems played in the development of new math ideas—how unsolved problems of mathematics challenge and lead mathematicians on many journeys and to new math ideas. I like learning about their successes and failures and periodically looking into the progress of various problem lists, such as the Millennium Prize problems or David Hilbert's list of 23 problems.

I am intrigued by types of numbers that have evolved and continue to evolve over the ages. For example, the Feigenbaum constant and its connection to chaos theory. How imaginary numbers and quaternions emerged and now influence digital graphics. The Cantor and the transfinite numbers is another great story in the history of mathematics. The topics seem endless. Many of these topics offered fertile ground for my book *Mathematical Scandals*.

My first book was *The Joy of Mathematics*. Most subsequent ones [*More Joy of Mathematics*; *Math Stuff*; *Math Snippets*; *Mathematical Footprints*] are designed in the same way I discover mathematics. They feature short topics to introduce the reader to ideas in the world of mathematics. There is no order to how they are presented. I just want people to be able to open the book at random and be introduced to a topic independent of what preceded

it and discover something that might spark their curiosity further so they may explore it in depth. I think not needing to read these books linearly added to their popularity and made them more approachable.

Seitz: Can you recommend some topics that middle school teachers or high school teachers should introduce to their students?

Pappas: I really feel that most topics in my books and calendars can be used by middle or high school teachers. I like to choose "exotic"-sounding topics in order to catch the students' attention. I like to select topics in which all students in the class can be successful. Their past math background is not important, and most topics will probably be new to all the students in the class. Here's a short list of what I have enjoyed teaching for grade levels from Grade 4 through Grade 12:

- Fractals explored through paper folding
- Spherical non-Euclidean geometry
- Multiple dimensions and the hypercube
- Tessellations and art and design
- Time-travelling through the evolution of number systems
- Discovering the cycloid
- Discovering what the Möbius strip is all about
- Discovering mathematical ideas through paper folding, from geometric properties to the golden rectangle
- Exploring paradoxes
- Topology
- Magic squares
- What do you see? An introduction to optical illusions
- What makes some problems' solutions impossible?
- What is mathematics?
- How are the Fibonacci numbers, the golden rectangle and the equiangular spiral connected?

I am delighted that many of these topics have begun to enter today's classroom curriculum.

Seitz: What advice would you give to someone who wanted to follow your lead in becoming a mathematics author?

Pappas: Enjoy and care about what you do. Find out what ideas, areas, fields really excite you, and pursue them. Whatever you choose to write about, immerse yourself in the topic. Try to find a new way to present your ideas. It's important to find your own niche.

Theoni Pappas Biography



Theoni Pappas is committed to giving mathematics greater exposure and making it more approachable. Pappas encourages mathematics teachers to share and develop new teaching ideas, methods and approaches. Her gift to the Mathematics Education Trust (MET) helps teachers in Grades 9–12 develop mathematics enrichment

materials and lessons complementing a teaching unit implemented in the classroom.

Currently, Pappas is a mathematics educator and consultant. She received her BA from the University

of California at Berkeley and her MA from Stanford University. She became a member of the National Council of Teachers of Mathematics (NCTM) in 1967, when she began teaching high school mathematics. Over the years, she has taught basic math, prealgebra, algebra, trigonometry, geometry, precalculus and calculus.

Through her studies and research, Pappas has developed products that address mathematical ideas and she has written numerous books, for both the general public and educational audiences. Her books include *More Joy of Mathematics*; *The Joy of Mathematics*; *Mathematics Appreciation*; *Math Talk*; *Greek Cooking for Everyone*; *Fractals, Googols, and Other Mathematical Tales*; *Mathematical Footprints*; *The Magic of Mathematics*; *Math-A-Day*; *The Music of Reason*; *Mathematical Scandals*; *The Adventures of Penrose, the Mathematical Cat*; and *Math for Kids and Other People Too!*