Engaging Math-Circle Topics that have Attracted Girls

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Math Renaissance

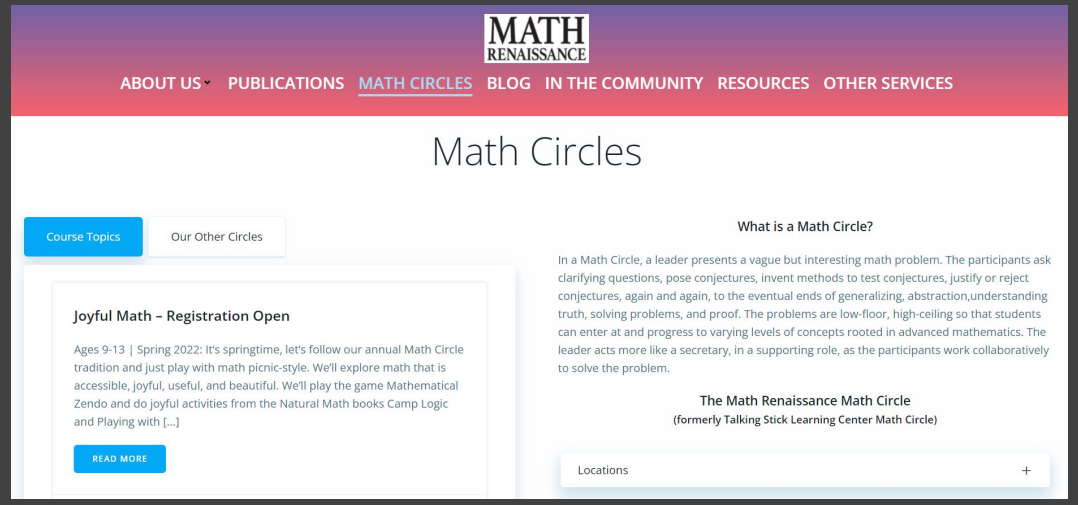
mathrenaissance.com

QUESTION:

•The Math Renaissance Math Circle has run 48 different courses. Total enrollment averaged 52% girls since 2011. Which topics attracted the most girls?

CONJECTURES

- Courses led or guest-taught by person who identifies as female
- Topics mentioning art, dance, history
- Topics not mentioning computer-science



RESULTS

2/3 or more girls: **10** topics

1/3 or fewer girls: **12** topics

Between 1/3 and 2/3 girls: **26** topics

Courses that Attracted 2/3+ Girls

RATIONAL TANGLES

- 100% girls, ages 12-14

Led by Rachel Steinig, students will make ropes dance via specified moves. Rational Tangles was invented by one of Rodi's favorite mathematicians, John Horton Conway, a living mathematician whose life we'll discuss in the course. Rational Tangles is rich in mathematical content, including algebraic thinking, transformations, symmetry, classification, geometric equivalence, the order of operations, and some of the more interesting arithmetic of fractions.

RATIONAL TANGLES – source material

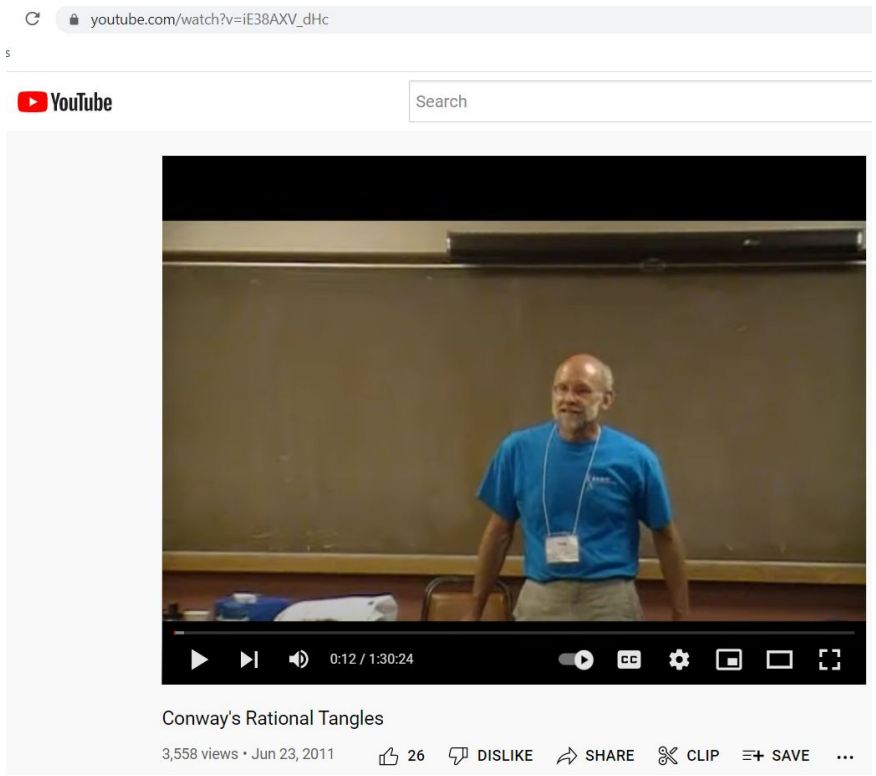
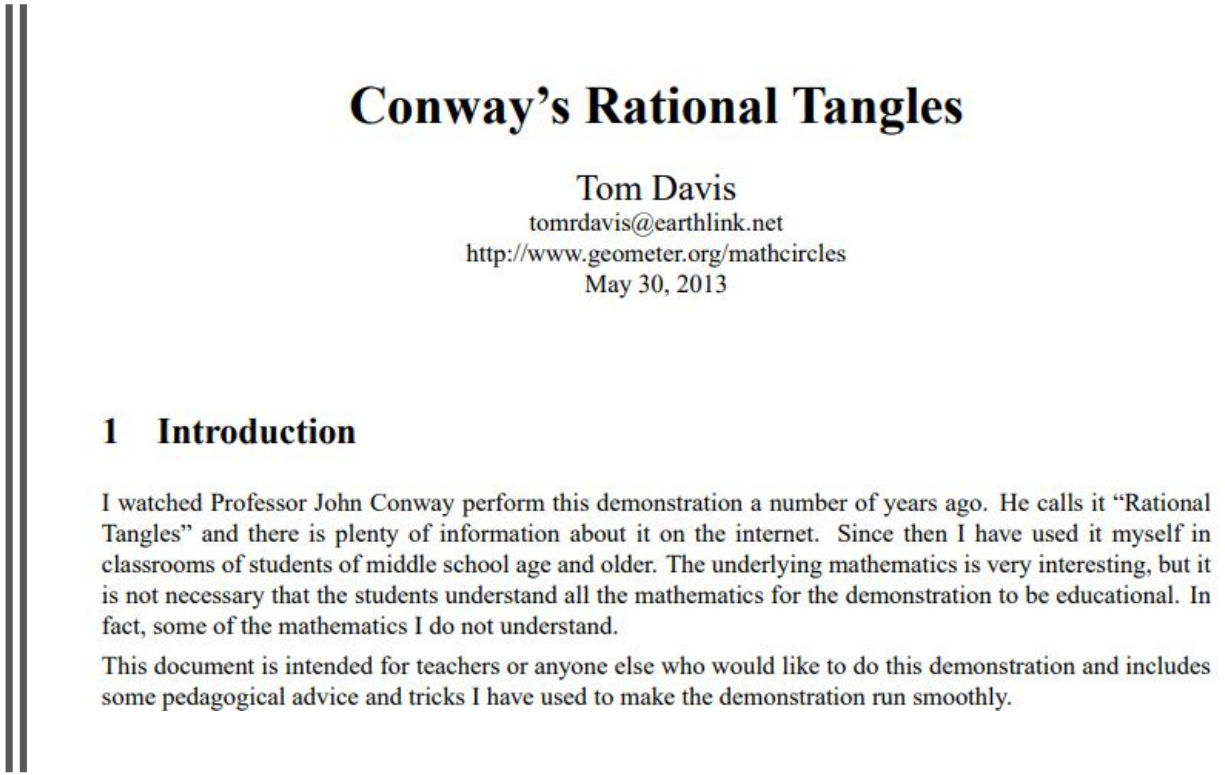


Photo Credit: YouTube



Conway's Rational Tangles

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http://www.geometer.org/mathcircles
May 30, 2013

1 Introduction

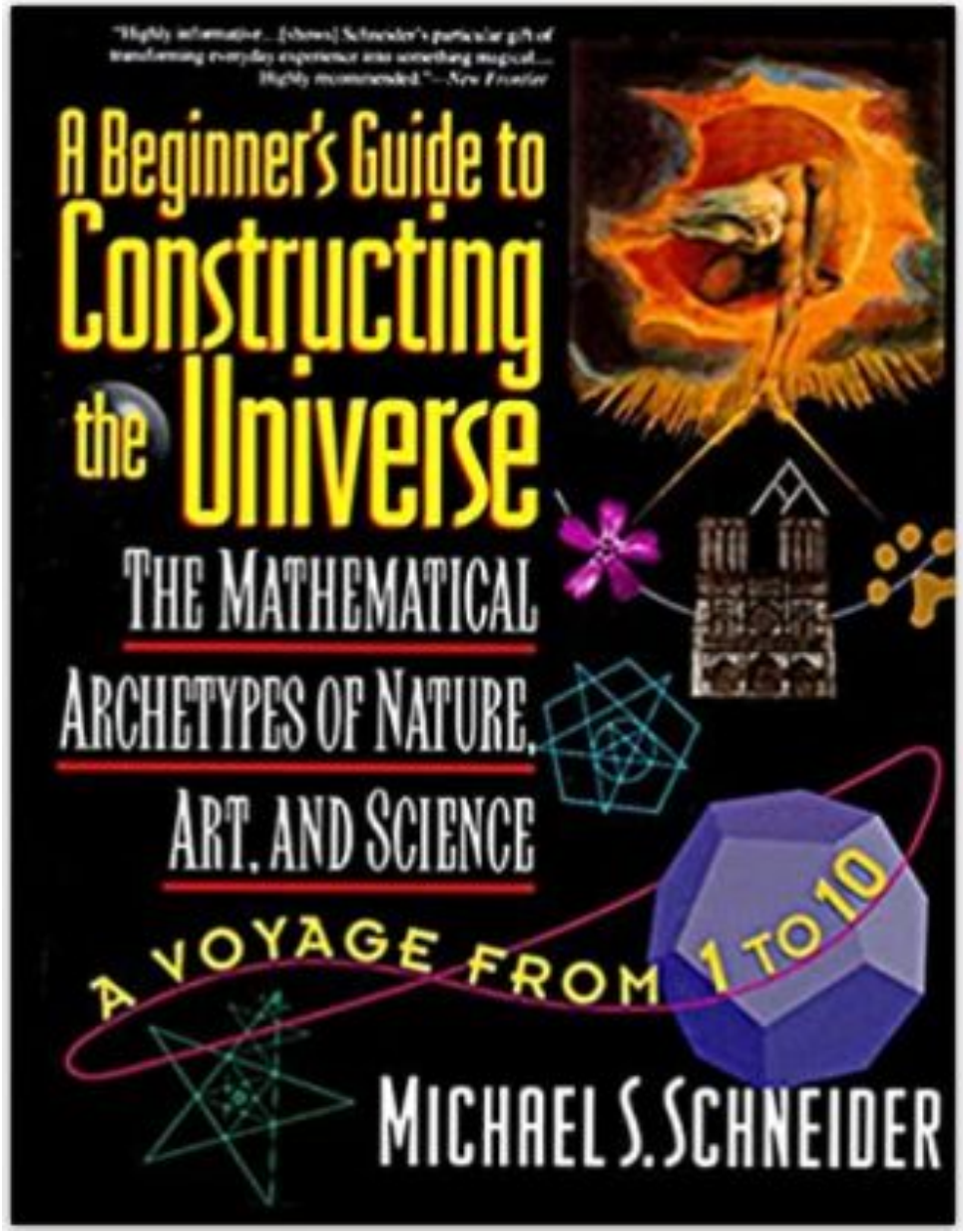
I watched Professor John Conway perform this demonstration a number of years ago. He calls it "Rational Tangles" and there is plenty of information about it on the internet. Since then I have used it myself in classrooms of students of middle school age and older. The underlying mathematics is very interesting, but it is not necessary that the students understand all the mathematics for the demonstration to be educational. In fact, some of the mathematics I do not understand.

This document is intended for teachers or anyone else who would like to do this demonstration and includes some pedagogical advice and tricks I have used to make the demonstration run smoothly.

THE NEXUS OF SACRED GEOMETRY AND HENNA

- Ages 9-14, 88% girls
- What does your sacred symbol look like? Join Gina Gilbert and Rodi as we combine the math of sacred geometry with the ancient art of Henna, also known as Mehndi. A temporary way of decorating the body (or other materials), Henna offers an opportunity to study geometric shapes, patterns, and symbols that have been used worldwide since ancient times. Sacred geometry is based upon the premise that certain patterns, ratios, and geometries are consistently repeated in nature. Students will study the mathematics and history underlying sacred geometries of many cultures. Throughout the course, we will mix henna, devise applicators, and learn application methods. The end goal is the creation of personal sacred geometric symbols. Visiting Instructor Gina Gilbert is a graduate of McGill University in Montreal, Quebec and of Tri-State College of Acupuncture in New York. Like Rodi, she believes that play is essential to learning. As an educator, artist and acupuncturist, Gina is dedicated to exploring and thinking outside of the box.

THE NEXUS OF SACRED GEOMETRY AND HENNA – source material

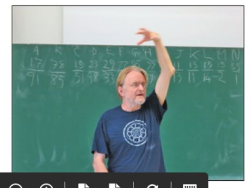


GARDNER

- Ages 9-11, 83% girls
- Before there was Vi Hart, there was Martin Gardner. Celebrate the Martin Gardner Centennial with an exploration of Recreational Mathematics. For 25 years, Gardner wrote the Mathematical Games column in Scientific American, and became legendary for his unconventional approach to mathematics. In this circle, we will explore his life, his influence, and of course, his mathematical puzzles. The goal of this math circle is the same as the goal for all of them: to develop mathematical thinking. Recreational mathematics is yet another avenue for seeking patterns when none are obvious, and for seeking ways to crush seemingly obvious patterns that aren't really patterns at all.

Interview with
John Horton Conway

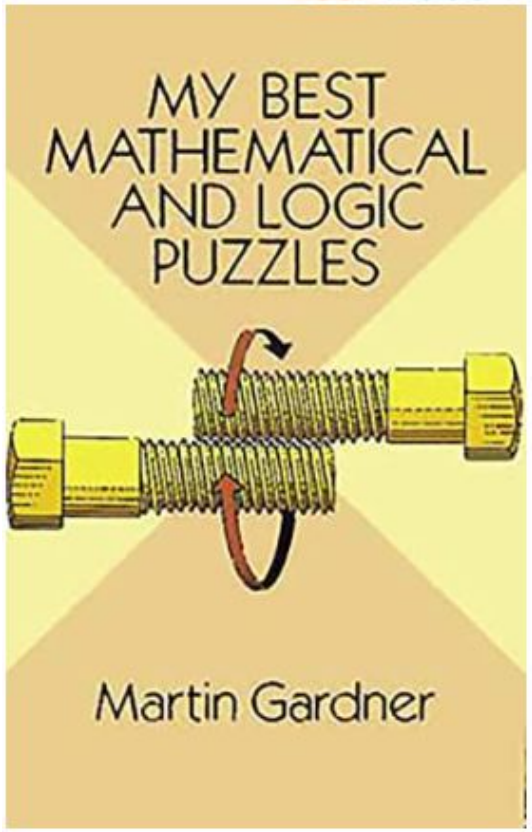
Dierk Schleicher

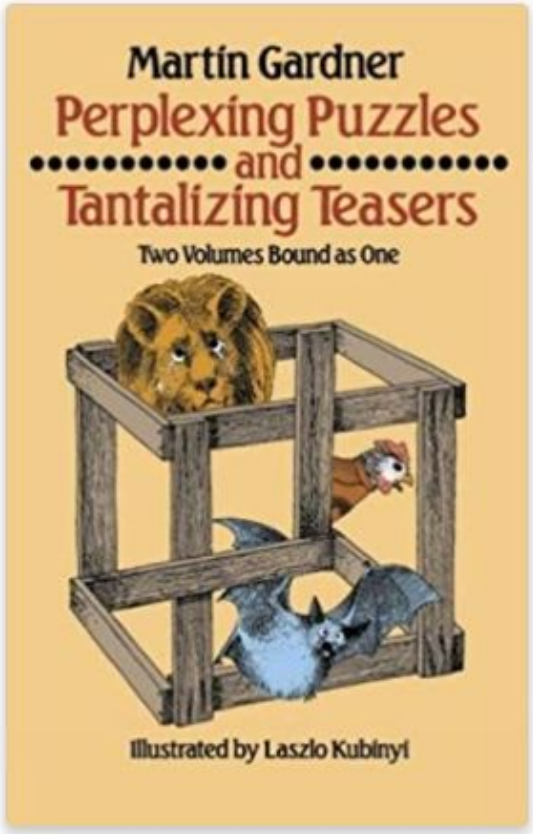


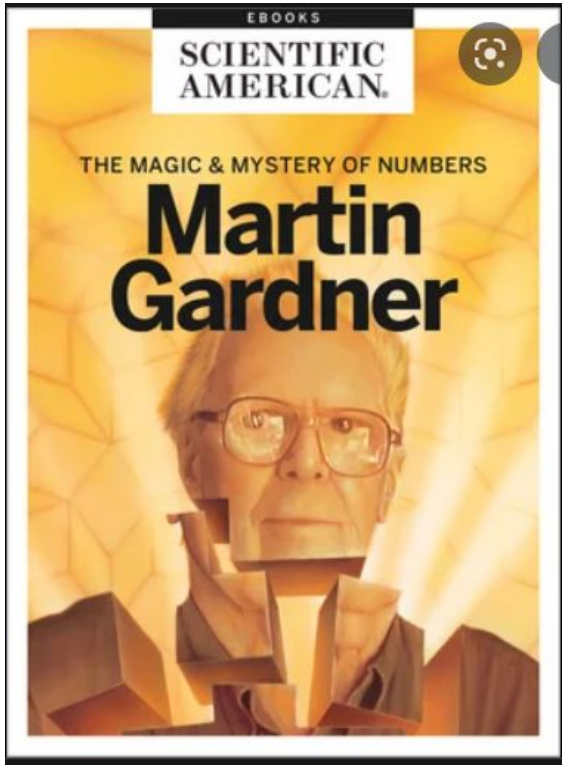
This is an edited version of an interview with John Horton Conway conducted in July 2011 at the first International Mathematical Summer School for Students at Jacobs University, Bremen, Germany, and slightly extended afterwards. The interviewer, Dierk Schleicher, professor of mathematics at Jacobs University, served on the organizing committee and the scientific committee for the summer school. The second summer school took place in August 2012 at the Ecole Normale Supérieure de Lyon, France, and the next one is planned for July 2013, again at Jacobs University. Further information about the summer school is available at http://www.math.
summerschool.

John H. Conway is one of the preeminent the

Photo Credit: ams.org







GARDNER – source material

CANTOR

- Ages 14+, 80% girls
- We'll examine the life and work of this revolutionary mathematician once called a "corrupter of youth." Come and have your teens corrupted with Georg Cantor's ideas: set theory (a concept that seems fundamental and even obvious today); his most famous proof; and more. Cantor's life story is sad because of his struggle with mental illness. In discussing his personal story, we'll question (1) the stereotype that the most successful mathematicians are somehow unbalanced, and (2) the apocryphal "math gene." We will try to do what the mathematician Cantor is most famous for: attempt to make some discoveries about the nature of infinity/infinities using set theory. This course will also delve into math history and the behavioral sciences. And if there's time, I'd like to at least expose students to the idea of using infinitesimal quantities to approximate the seemingly unmeasurable. This is one of the foundational ideas of calculus. However, neither "precalculus" nor "trigonometry" nor even "algebra 2" is a prerequisite for this course. Students should have a basic knowledge of algebra and geometry. Course material will be primarily derived from Dauben's Georg Cantor: His Mathematics and Philosophy of the Infinite.

CANTOR – source material

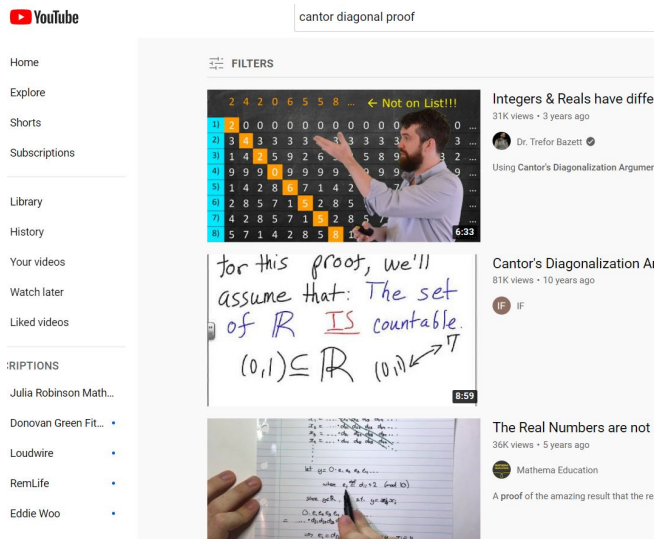
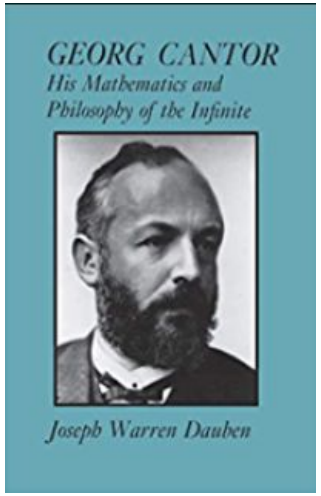


Photo Credit: Wikipedia.org

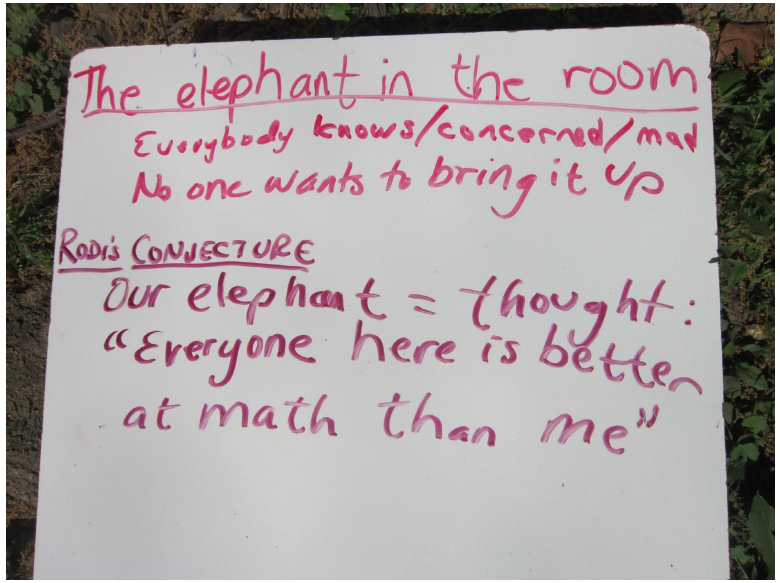


Oregon Public Broadcasting

OPB

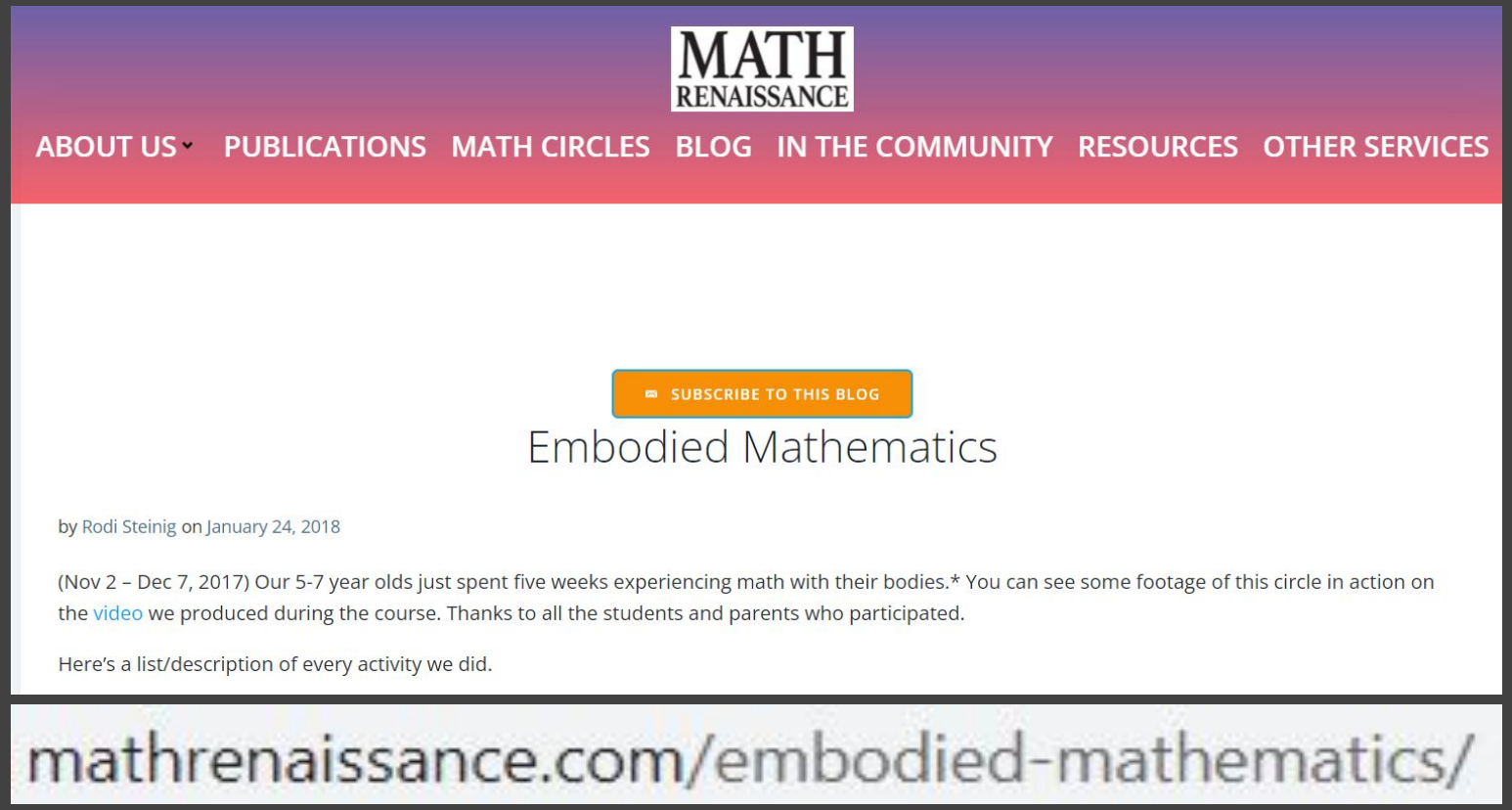
RIVER CROSSING PROBLEMS

- Ages 9-11, 80% girls
- This Math Circle focuses on the concept that classical composers incorporated variations on themes in their compositions just as mathematicians create them in their work. Isopmorphic problems appear dissimilar on the surface, but have the same underlying structure. We'll try out some traditional river-crossing problems, and and attempted to solve them. Then we'll try some problems that are not about crossing a river, and compare and contrast them. Finally we'll try to create our own isomorphs.



EMBODIED MATHEMATICS

- Ages 5-7, 75% girls
- Neuroscience has provided empirical evidence of what we intuitively knew all along: that counting on your fingers enhances learning. The discipline of embodied mathematics employs gesturing and physical interactions with the environment to develop conceptual understanding and to facilitate articulation of mathematical concepts. Year after year, young students come into Math Circle with the idea that mathematics is all about quick computation and nothing else. This course will open students' minds to the reality that math is about more than numbers and can be explored with more than a computational approach. We'll use our bodies and surroundings to examine symmetry, 2D and solid geometry, equivalence, measurement, spatial reasoning, and arithmetic computation.



EMBODIED MATHEMATICS – source material

OPEN QUESTIONS

- Ages 11-14, 75% girls
- At an age when some kids feel disenfranchised from mathematics while others feel empowered by it, we will collaboratively attempt to solve currently unsolved (“open”) questions. The students will be essentially working mathematicians, with the stated hope of making some progress toward a solution and the unstated hope of experiencing joy in mathematics.

OPEN QUESTIONS – source material

- https://mathpickle.com/unsolved-k-12/

Unsolved K-12 Introduction to the conference and the process of selecting the 13 problems – one for each grade K-12.

Kindergarten – non-final selection. This ended up being the grade 1 unsolved problem.

Kindergarten – final selection The final selection for Kindergarten is this unsolved problem posed in 1977 by Krishnamoorthy & Deo.

Grade 1 – non-final selection The selected grade 1 problem is the beetle problem in the middle top row.

Grade 2 – final selection Sum-Free Partitions by Isaii Schur, 1916

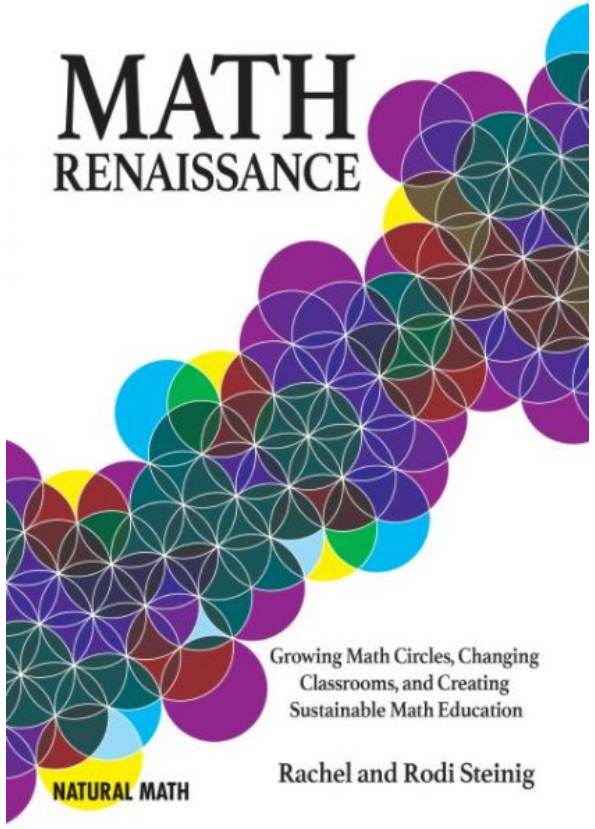
Grade 3 – non-final selection The second problem on this video (the 1967 Graceful Tree Conjecture) is the final selection. The

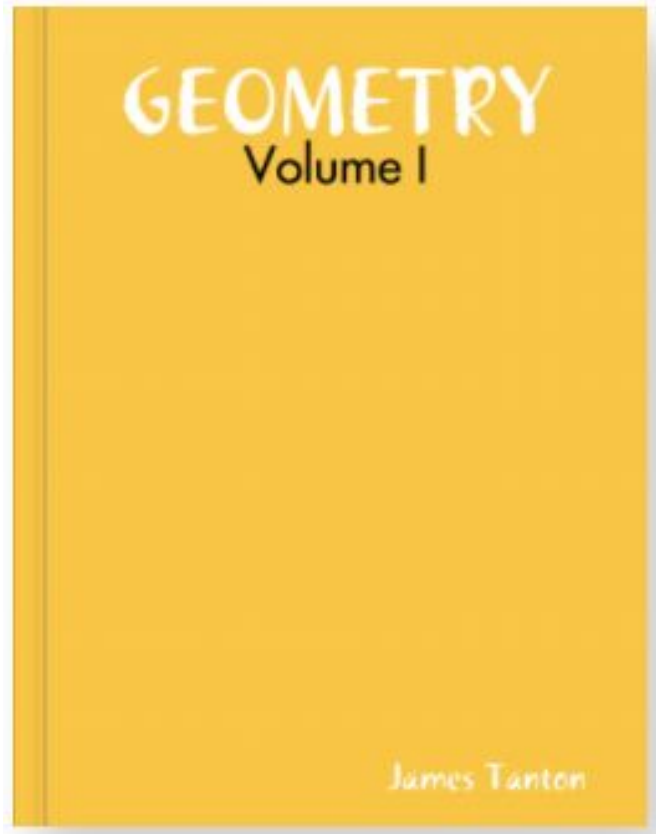
COMPASS DESIGNS AND POLYGON CONSTRUCTION

- Ages 10-12, 75% girls

- Is it possible to construct a spiral using only straight lines? And by the way, what exactly is a straight line? In this class we will explore how to construct polygons with a compass and straightedge, experiment with polydrons, and create Baravelle Spirals. Depending upon the students' interests and the direction their inquiries take them, we may also explore the Snowflake Curve and a classic math problem or two ("The Surfer" or "The Bear"). And, of course, we'll discuss the math history and philosophy relevant to these topics.

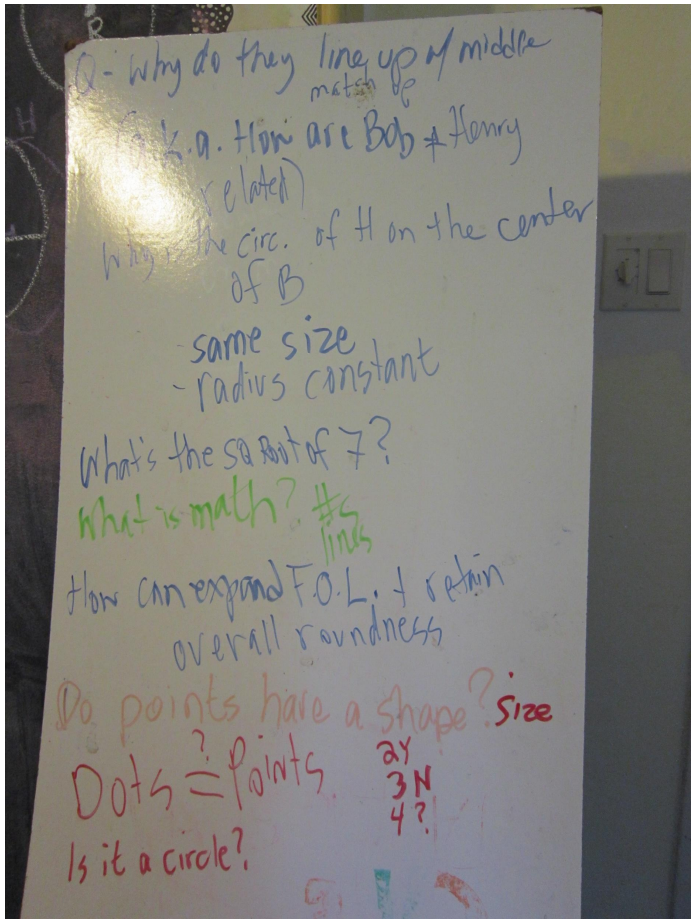
COMPASS DESIGNS AND POLYGON CONSTRUCTION - source material



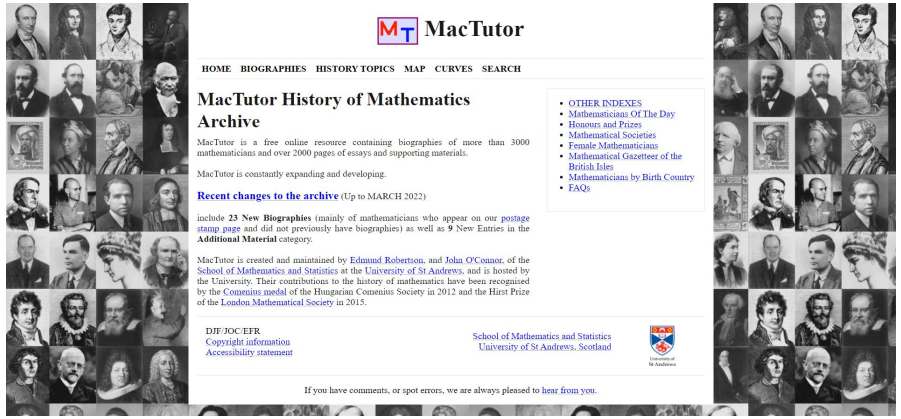


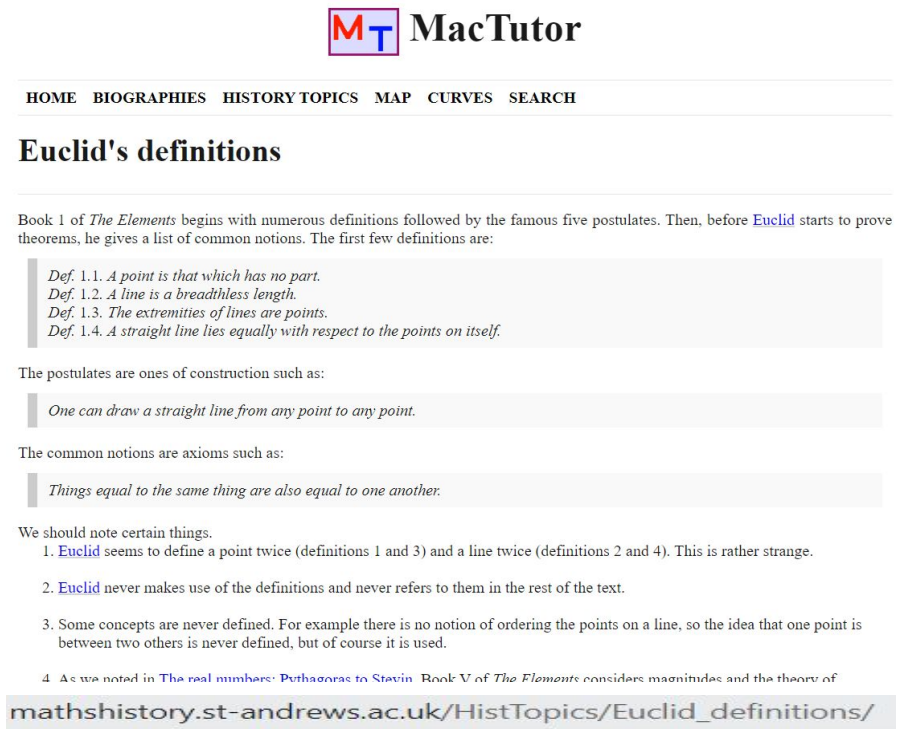
COMPASS ART

- Ages 9-11, 67% girls
- What do Michelangelo, Bernini, Zarah Hussein, feng shui practitioners, mapmakers, architects, astronomers, and mathematicians have in common? They all use compasses to construct and deconstruct circles. We'll create our own compass art while learning about basic circle geometry and some math history. (Each student should bring a compass, sketch pad, and pencils.)



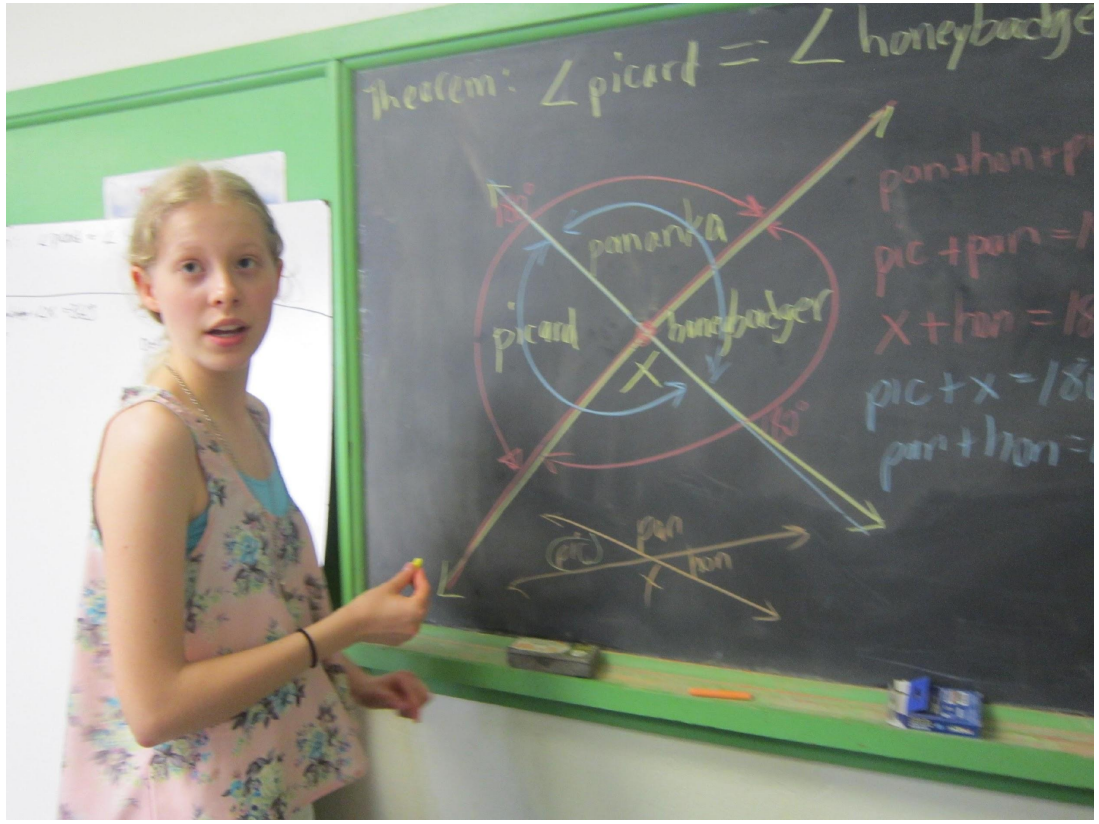
COMPASS ART – source material





PROOFS

- Teens, 67% girls
- How do you know for sure that the commutative property works? In other words, can you prove that ab=ba? And can we really trust the Pythagorean Theorem? And how many prime numbers are there anyway? Is it okay to take things on faith in mathematics? We will do formal proofs collaboratively to begin to understand the underlying foundations of mathematics. Humans have an inherent desire to seek structure. Proofs can satisfy this architectural instinct. It can be very powerful for a teenager to successfully prove something – to know that something is absolutely true, no matter what, no ifs ands or buts. This course requires a basic ability to use variables.



PROOFS – source material

- https://mathrenaissance.com/proofs-1-aspect-ratios-the-golden-ratio-and-zs-tv/
- https://mathrenaissance.com/proofs-2-exponents-roots-pythagoras-theorems-proofs-and-the-kaplans/
- https://mathrenaissance.com/proofs-2-exponents-roots-pythagoras-theorems-proofs-and-the-kaplans/
- https://mathrenaissance.com/proofs-4-finally-starting-to-prove-something/
- https://mathrenaissance.com/proofs-5-debating-the-merits-of-proofs/
- https://mathrenaissance.com/proofs-6-math-as-art-collaboration-and-spectator-event/

TOPICS THAT ATTRACTED LESS THAN 1/3 GIRLS

Course	age group	% girls
Mathematical Models (virtual)	9-12	33%
Modular Arithmentic (virtual)	11-13	33%
Polyominoes and Functions	5-10	29%
Parity	7-8	25%
The Chromatic Number of the Plane	7-8	25%
Infinity	5-6	22%
Mathematics of Social Change	13+	20%
Problem Solving	6-7	17%
Nontraditional Games	6-7	14%
Applied Mathematics (virtual)	11-14	0%
Finite State Machines (virtual)	13+	0%
Mathematics and Truth	8-9	0%

1/3 girls < TOPICS < 2/3 girls

start date	Course	age group	% girls
1/6/2015	Escher	11-13	64%
9/18/2012	Probability and Statistics	11-14	63%
1/17/2012	Platonic Solids and Euler	8-10	63%
9/17/2013	Eye of Horus	8-9	62%
1/24/2019	Queen Dido Problems	10-13	60%
9/20/2018	Classic Math Circle Problems	5-7	60%
2/26/2013	Logic for the Very Young (mini-course)	4-6	60%
2017-18	Invariants	7-8	60%
4/18/2017	Functions	10-13	58%
9/15/2011	Voting Theory, Four-Coloring Theorem, and Unicorn Problem	6-7	57%
3/22/2018	The Platonic Solids	10-14	57%
9/21/2020	Inspriring Mathematics: The Cookie Monster Problem (virtual)	9-11	57%
4/24/2012	Fibonacci	7-8	56%
11/6/2012	The Signalling Problem (Exploding Dots)	9-10	56%
1/15/2013	Logic (with puppets)	8	56%
9/7/2017	Our Algorithmic Culture	13-17	56%
10/24/2019	Number Systems	8-10	56%
1/15/2012	Vi Hart	11-13	54%
10/31/2016	Fermat's Last Theorem	14-18	50%
4/22/2014	What is a Number	6-7	50%
10/25/2018	Category Theory	10-14	50%
11/2/2020	Inspriring Mathematics: Toilet Paper Math (virtual)	7-9	50%
9/22/2022	Axioms of Mathematics	8-10	50%
9/19/2019	Fractals and Infinity	5-7	45%
3/18/2014	Modular Arithmentic	5	43%
11/5/2013	The Math of Life and Death	13-17	38%

ANALYSIS OF COMMON WORDS

WORD in course description	mentions in GIRL-dominated courses	mentions in NOT-GIRL-dominated courses
Attracted more girls:		
HISTORY/LIFE STORY	5	1
GEOMETRY	5	1
NUMBER/FRACTIONS/ARITHMETIC/NUMBER	6	2
ALGEBRA/VARIABLES	5	2
ART	2	0
SYMMETRY	2	0
CALCULUS	2	0
Attracted fewer girls:		
PROBABILITY/STATISTICS	0	2
SOCIAL ISSUES	0	2

WORD ANALYSIS: no significant difference

MYTHOLOGY

UNSOLVED/OPEN

FUNCTIONS

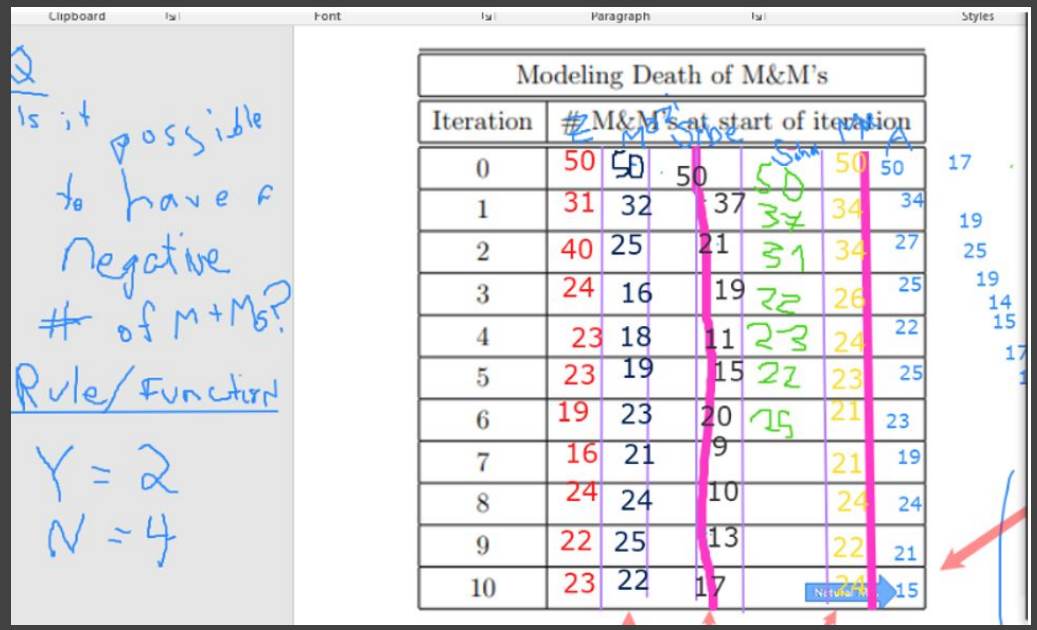
COMPUTER SCIENCE

EMBODIED MATHEMATICS

PROBLEM-SOLVING

POSSIBLE FACTORS BESIDES TOPIC

- Friend groups?
- Word of mouth?
- Gender of leader or guest speaker?
- Scheduling?
- Continued enrollment?
- Virtual versus in-person?
- Other factors identified by Akin



POTENTIAL FACTORS BEHIND WOMEN IN STEM GAP (AKIN)

- -Confidence
- -Self-Assessment Bias
- -Stereotype threat
- -Interest
- -Bias in hiring practices
- -Role Models

SOURCE: Dr. Tori Akin (Duke). “Accessible Approaches to Tough Problems: Doing Math and Talking about Gender with Middle Schoolers,” presentation to Kutztown Association for Women in Mathematics, 12/6/2021

https://bassconnections.duke.edu/virtual-showcase/building-girls%E2%80%99-confidence-stem

https://bassconnections.duke.edu/project-teams/improving-girls%E2%80%99-math-identity-through-problem-solving-and-mentorship-2020-2021

https://bassconnections.duke.edu/project-teams/assessing-and-improving-girls-and-womens-math-identity-2021-2022

CONCLUSIONS

Certain topics might appeal to girls.

Leading these topics is very do-able.

Lots more questions to be asked!

THANK YOU!

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