



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

The screenshot shows the 'Math Circles' page on the Math Renaissance website. The header features the 'MATH RENAISSANCE' logo and a navigation menu with links for 'ABOUT US', 'PUBLICATIONS', 'MATH CIRCLES', 'BLOG', 'IN THE COMMUNITY', 'RESOURCES', and 'OTHER SERVICES'. The main heading is 'Math Circles'. Below this, there are two tabs: 'Course Topics' (active) and 'Our Other Circles'. A featured article titled 'Joyful Math – Registration Open' is displayed, with a 'READ MORE' button. To the right, there is a section titled 'What is a Math Circle?' with a detailed paragraph explaining the concept. Below this, there is a section for 'The Math Renaissance Math Circle (formerly Talking Stick Learning Center Math Circle)' and a 'Locations' dropdown menu with a plus sign.

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

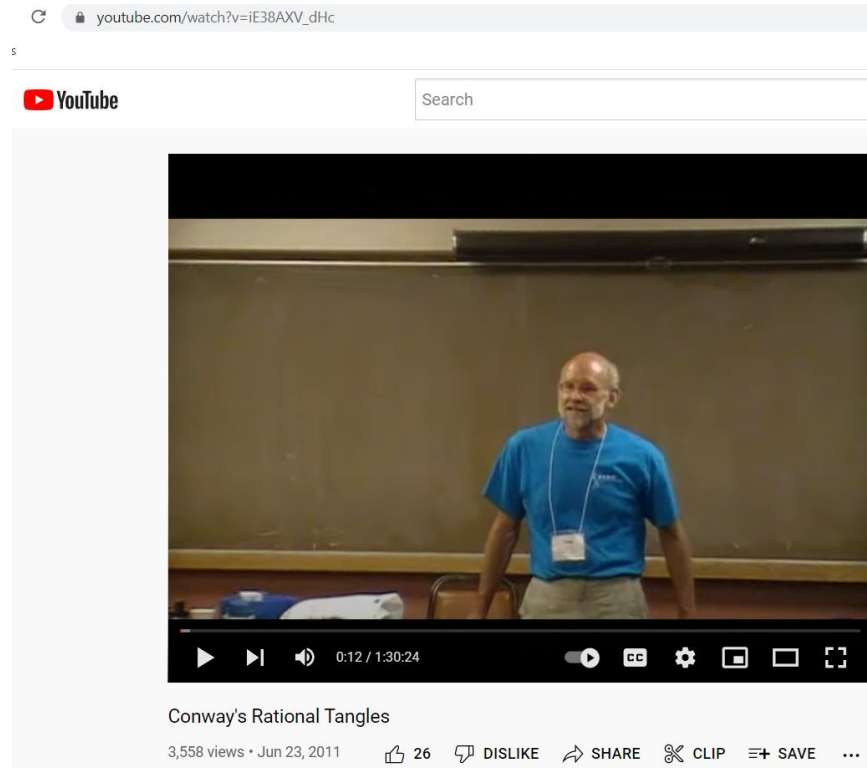


Photo Credit: YouTube

Conway's Rational Tangles

Tom Davis

tomrdavis@earthlink.net

<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.

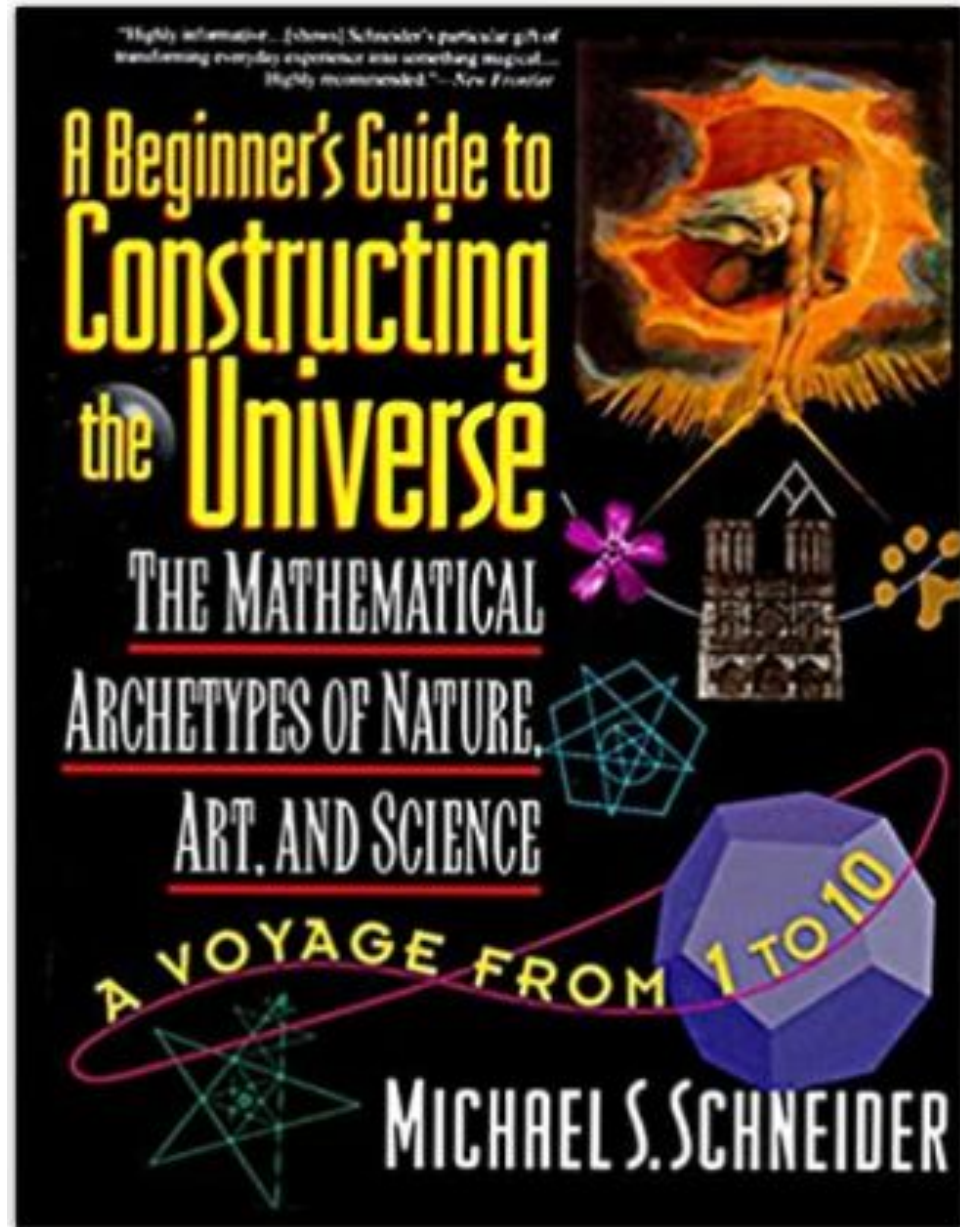
This document is intended for teachers or anyone else who would like to do this demonstration and includes some pedagogical advice and tricks I have used to make the demonstration run smoothly.

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.



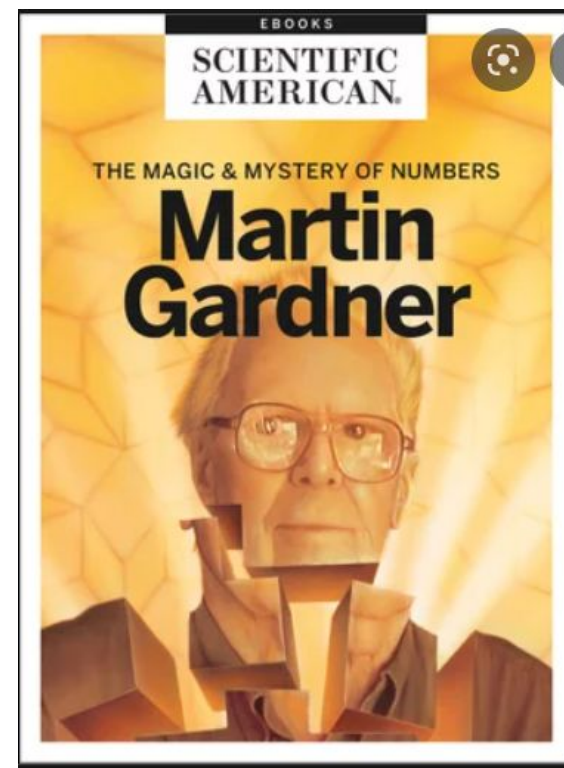
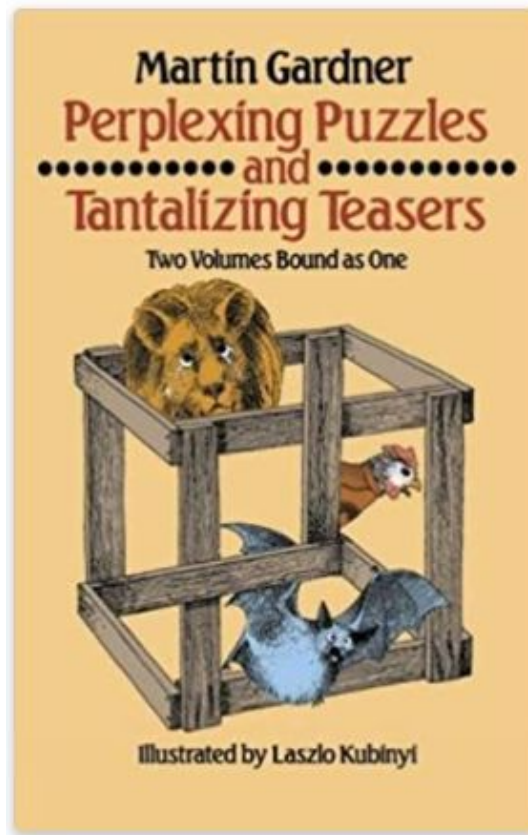
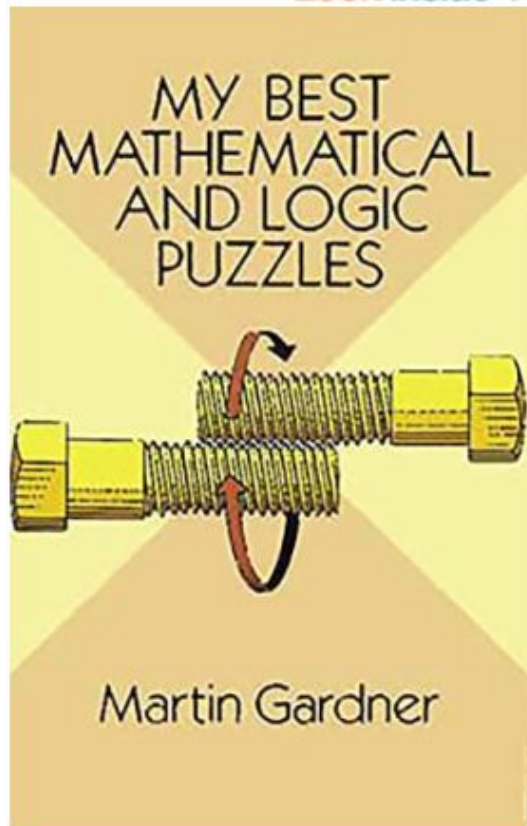
Interview with John Horton Conway

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.uni-bremen.de/summer-school/>.



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

YouTube

cantor diagonal proof

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RemLife

Eddie Woo

FILTERS

	2	4	2	0	6	5	5	8	...	← Not on List!!!
1	0	0	0	0	0	0	0	0	0	0
2	3	4	3	3	3	3	3	3	3	3
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4	9	9	9	0	9	9	9	9	9	9
5	1	4	2	8	6	7	1	4	2	8
6	2	8	5	7	1	5	2	8	5	7
7	4	2	8	5	7	1	5	2	8	5
8	5	7	1	4	2	8	5	7	1	4

Integers & Reals have diffe
31K views · 3 years ago
Dr. Trefor Bazett
Using Cantor's Diagonalization Arguer

Cantor's Diagonalization A
81K views · 10 years ago
IF

The Real Numbers are not
36K views · 5 years ago
Mathema Education
A proof of the amazing result that the re

for this proof, we'll
assume that: The set
of \mathbb{R} IS countable.
 $(0,1) \subseteq \mathbb{R}$ $(0,1) \rightarrow \mathbb{N}$

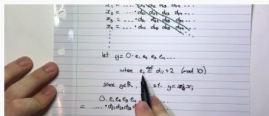
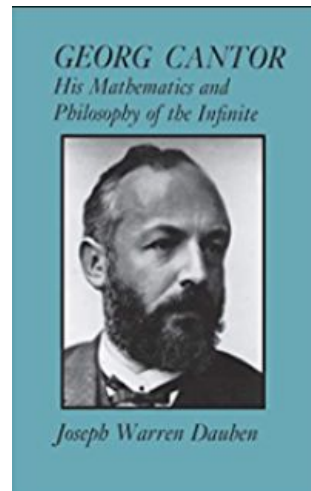
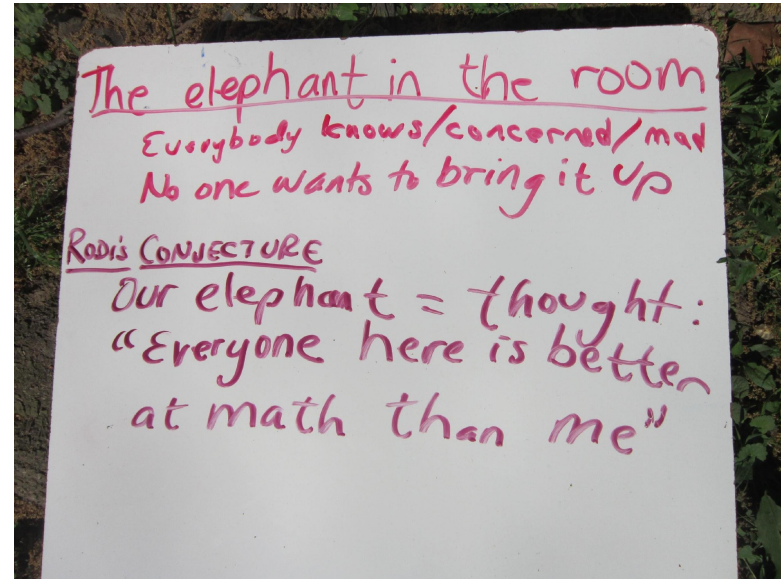


Photo Credit: Wikipedia.org



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. Isomorphic problems appear dissimilar on the surface, but have the same underlying structure. We'll try out some traditional river-crossing problems, 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.



Article [Talk](#)

River crossing puzzle

From Wikipedia, the free encyclopedia

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.





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Embodied Mathematics

by Rodi Steinig on January 24, 2018

(Nov 2 – Dec 7, 2017) Our 5-7 year olds just spent five weeks experiencing math with their bodies.* You can see some footage of this circle in action on the [video](#) we produced during the course. Thanks to all the students and parents who participated.

Here's a list/description of every activity we did.

mathrenaissance.com/embodied-mathematics/

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

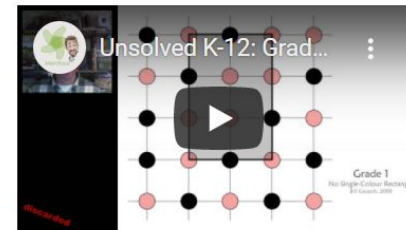
- <https://mathpickle.com/unsolved-k-12/>



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



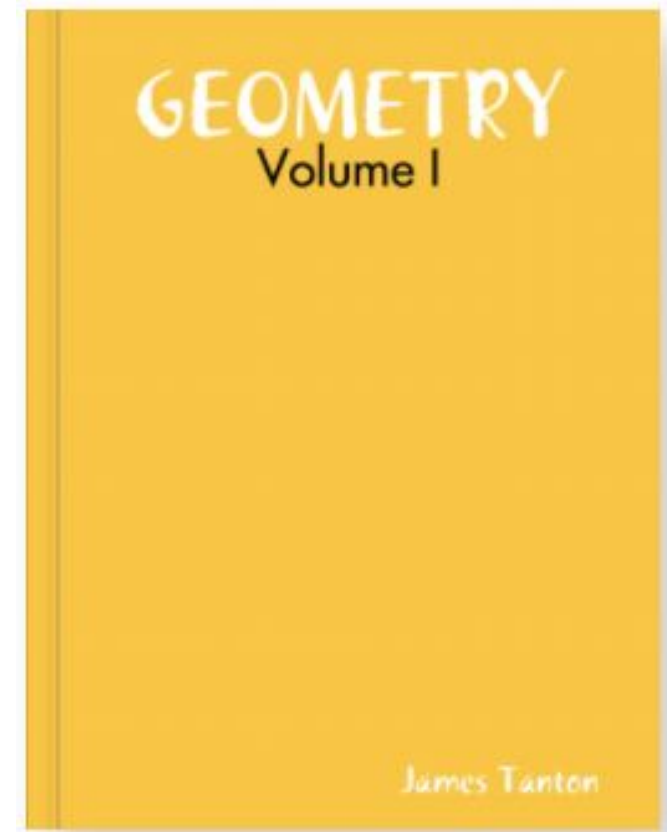
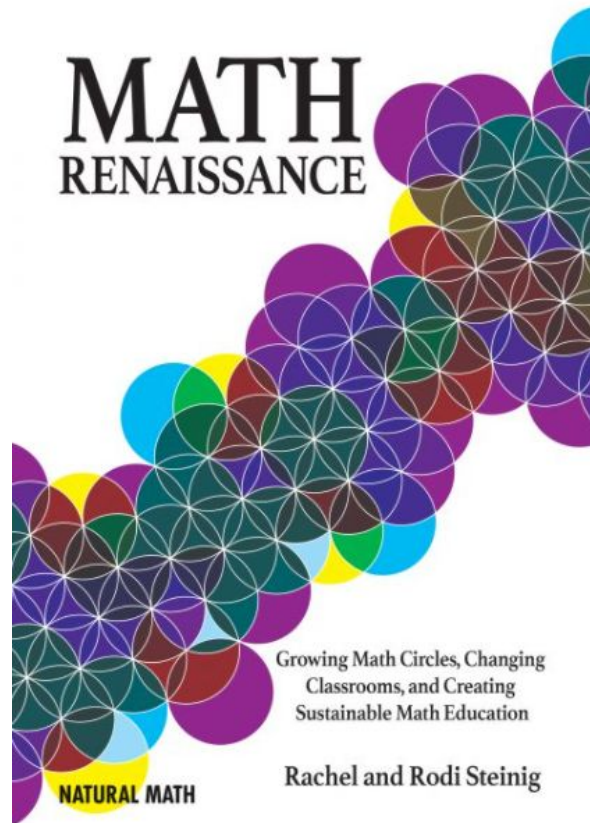
Grade 3 – non-final selection The second problem on this video (the 1967 Graceful Tree Conjecture) is the final selection. The

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 polyhedrons, 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.

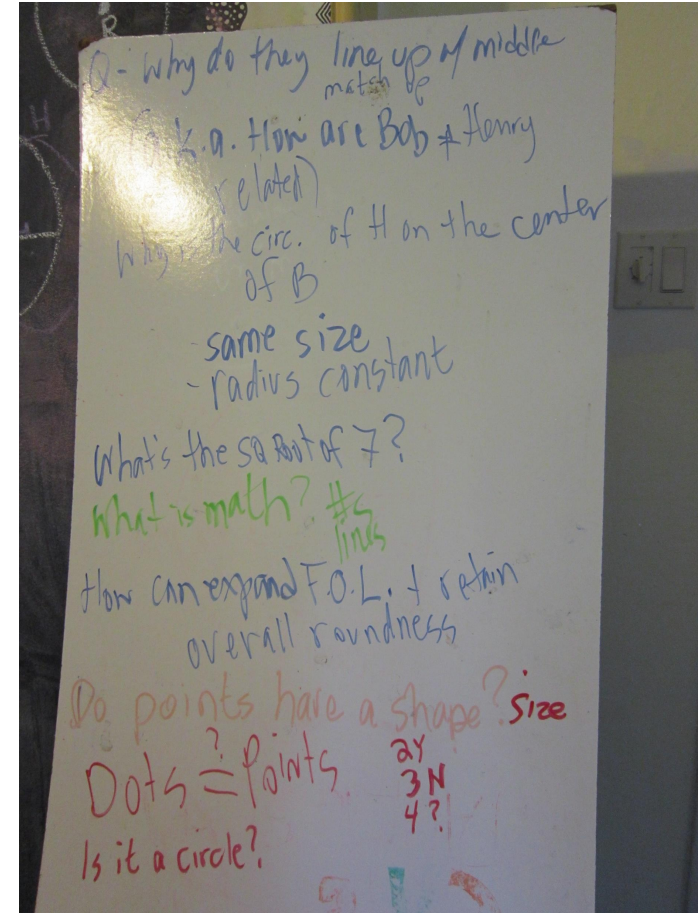


COMPASS DESIGNS AND POLYGON CONSTRUCTION - source material



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

MacTutor

HOME BIOGRAPHIES HISTORY TOPICS MAP CURVES SEARCH

MacTutor History of Mathematics Archive

MacTutor is a free online resource containing biographies of more than 3000 mathematicians and over 2000 pages of essays and supporting materials.

MacTutor is constantly expanding and developing.

Recent changes to the archive (Up to MARCH 2022)

include **23 New Biographies** (mainly of mathematicians who appear on our postage stamp page and did not previously have biographies) as well as **9 New Entries** in the **Additional Material** category.

MacTutor is created and maintained by **Edmund Robertson**, and **John O'Connor**, of the School of Mathematics and Statistics at the University of St Andrews, and is hosted by the University. Their contributions to the history of mathematics have been recognised by the Comenius medal of the Hungarian Comenius Society in 2012 and the Hirst Prize of the London Mathematical Society in 2015.

Dr JOE FER
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Accessibility statement

School of Mathematics and Statistics
University of St Andrews, Scotland

If you have comments, or spot errors, we are always pleased to hear from you.



HOME BIOGRAPHIES HISTORY TOPICS MAP CURVES SEARCH

Euclid's definitions

Book 1 of *The Elements* begins with numerous definitions followed by the famous five postulates. Then, before [Euclid](#) starts to prove theorems, he gives a list of common notions. The first few definitions are:

- Def. 1.1. A point is that which has no part.*
- Def. 1.2. A line is a breathless length.*
- Def. 1.3. The extremities of lines are points.*
- Def. 1.4. A straight line lies equally with respect to the points on itself.*

The postulates are ones of construction such as:

- One can draw a straight line from any point to any point.*

The common notions are axioms such as:

- Things equal to the same thing are also equal to one another.*

We should note certain things.

1. [Euclid](#) seems to define a point twice (definitions 1 and 3) and a line twice (definitions 2 and 4). This is rather strange.
2. [Euclid](#) never makes use of the definitions and never refers to them in the rest of the text.
3. Some concepts are never defined. For example there is no notion of ordering the points on a line, so the idea that one point is between two others is never defined, but of course it is used.
4. As we noted in [The real numbers: Pythagoras to Stevin](#) Book V of *The Elements* considers magnitudes and the theory of

mathshistory.st-andrews.ac.uk/HistTopics/Euclid_definitions/

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

<u>Course</u>	<u>age group</u>	<u>% girls</u>
Mathematical Models (virtual)	9-12	33%
Modular Arithmetic (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

<u>start date</u>	<u>Course</u>	<u>age group</u>	<u>% girls</u>
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	Inspiring 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	Inspiring 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



Clipboard Font Paragraph Styles

Q Is it possible to have a negative # of M+Ms?

Rule/Function

$Y = 2$
 $N = 4$

Modeling Death of M&M's					
Iteration	# M&M's at start of iteration				
0	50	50	50	50	50
1	31	32	37	34	34
2	40	25	21	34	27
3	24	16	19	26	25
4	23	18	11	24	22
5	23	19	15	23	25
6	19	23	20	21	23
7	16	21	9	21	19
8	24	24	10	24	24
9	22	25	13	22	21
10	23	22	17	24	15

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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