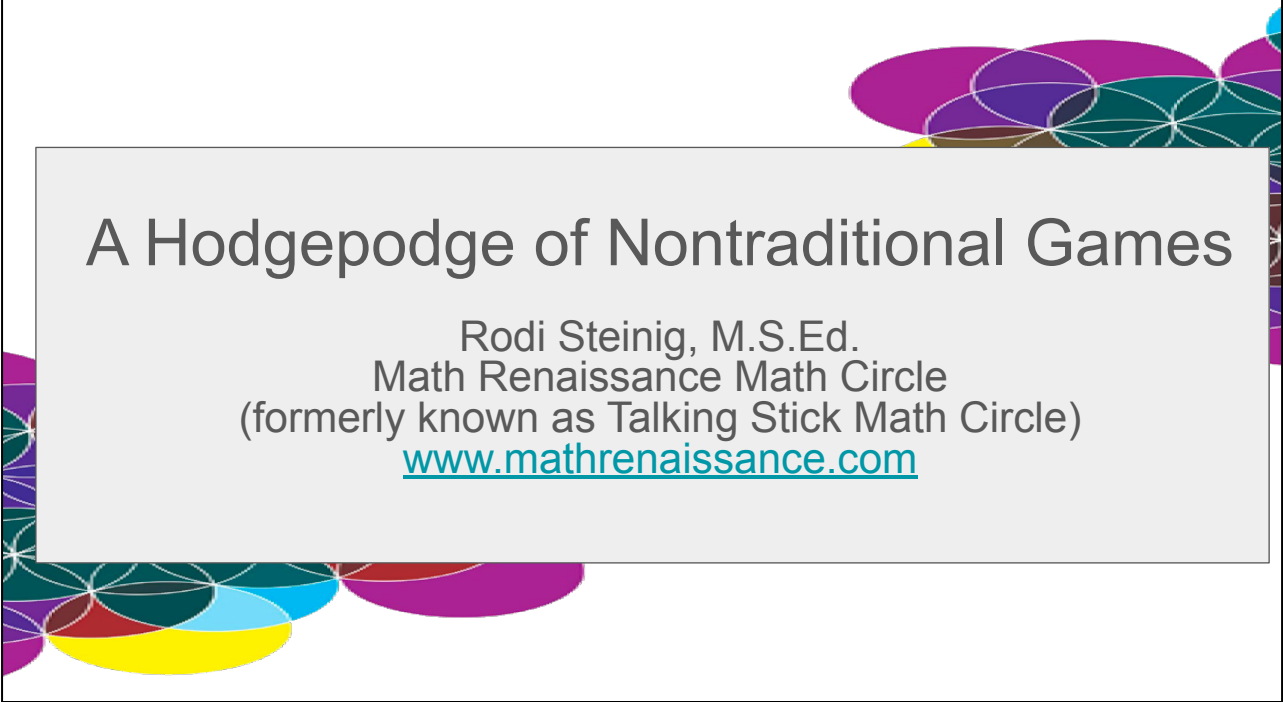




A Hodgepodge of Nontraditional Games

Rodi Steinig, M.S.Ed.
Math Renaissance Math Circle
(formerly known as Talking Stick Math Circle)
www.mathrenaissance.com

Abstract

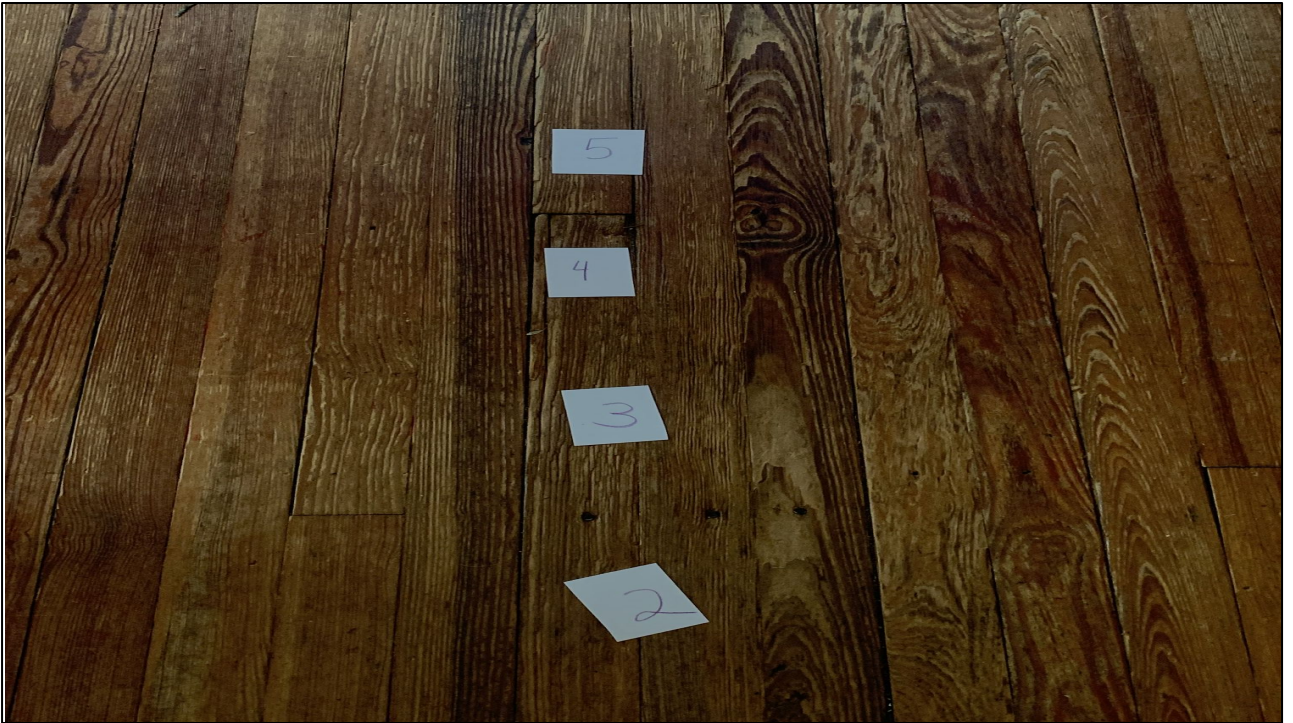
Merriam Webster's definitions of games include the terms "rules," "strategy," "struggle," "procedure," "diversion," and "amusement." **In Math Circles, how can we play games that are cooperative? How can we use role-playing? How can we entice reluctant students into competitive games? What games can we play with the youngest of students? What games can be used to help students focus and build frustration tolerance? How can we add complexity to classic games to facilitate deeper mathematical explorations?** In this session, we'll play "Would You Rather," "Math Lawyer," "Odd One Out," "Knights and Liars with Puppets," "The Need for Numbers," "Mathematician Cards," "Math Red Light Green Light," "Mother May I Addition," "Opposite Simon Says," and "How Is this Math?" What do all these games have in common? Each involves strategies for success and meaningful mathematical thinking. Audience participation is encouraged but not required!

GAME: Math Squares

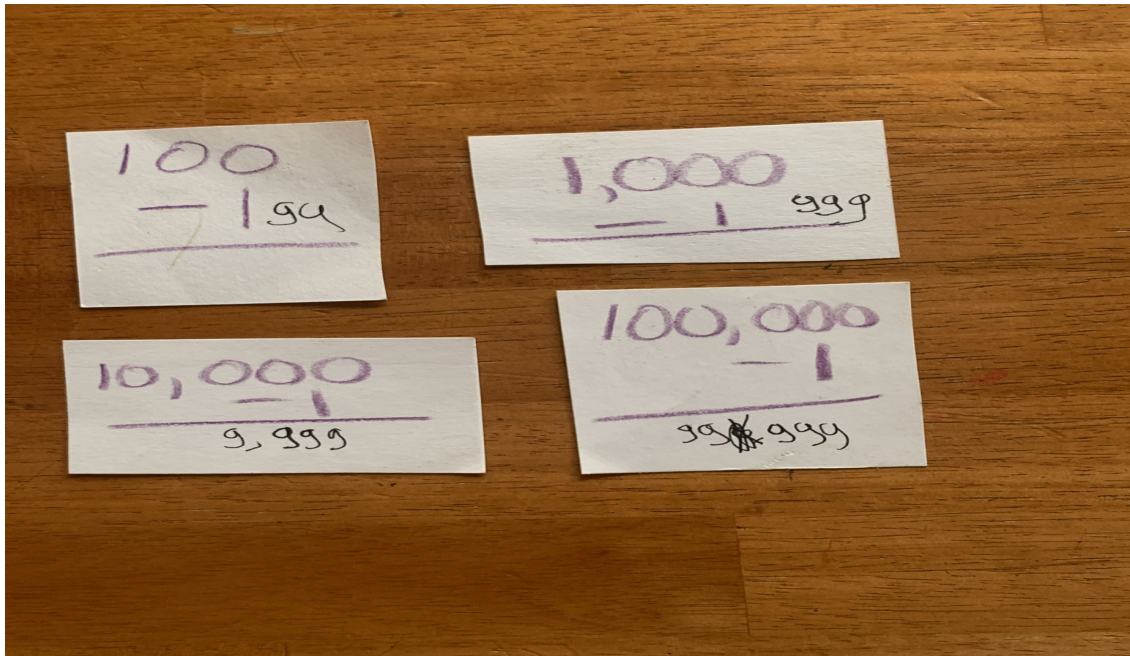


Math Buddies, Girls' Math Circle, Ages 9-10

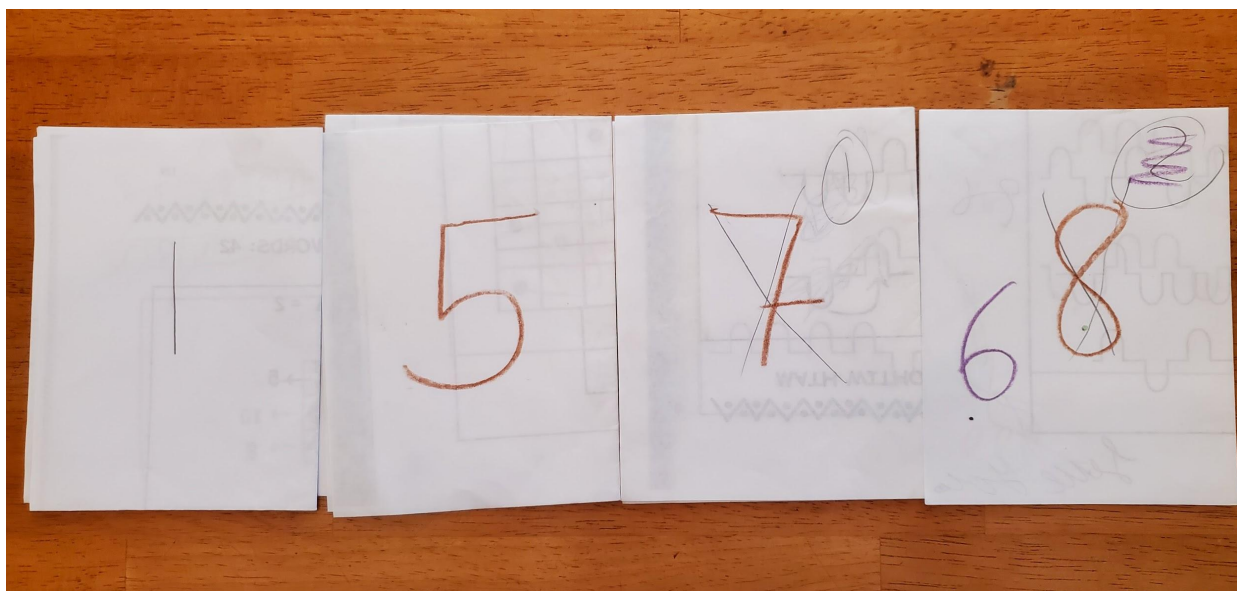
These students invented, tested, and continually developed this game - reluctant math learners.



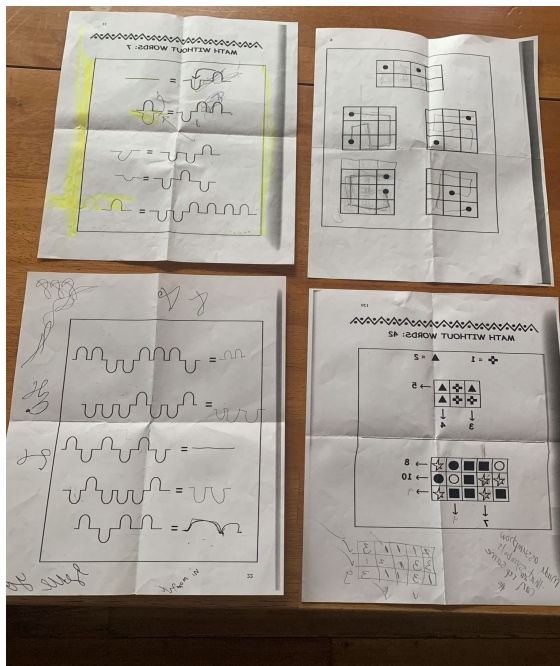
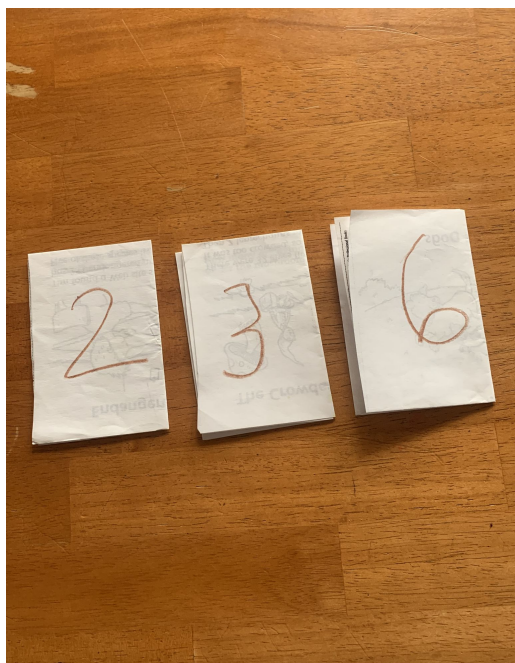
Students asked me to put a math problem on the back of each numbered square. They stand together on #1, uncover it, solve it together, then hold hands as a team and jump to #2. Goal: solve them all before the parents come to pick them up.



First time we played - after having done Exploding Dots.



sl had to keep changing up the order of the squares to have the right amount of time to solve a few before parents arrived for pick-up.

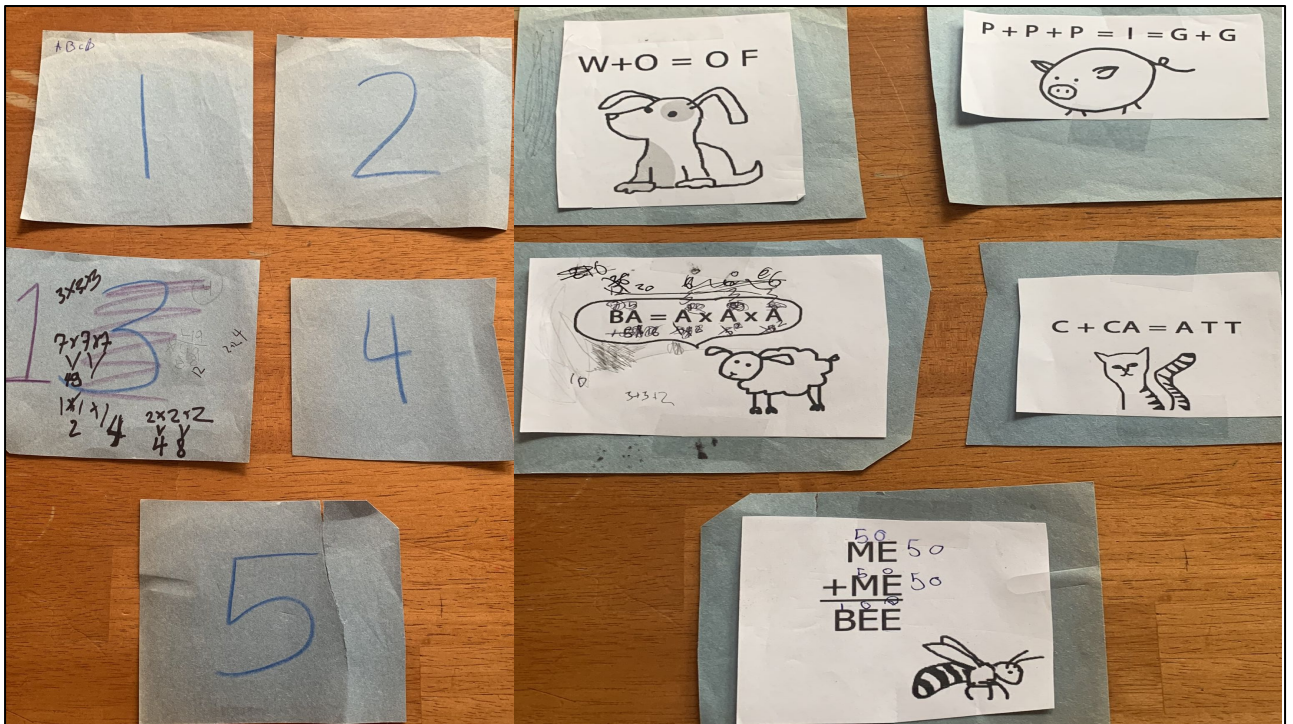


Second time doing the game. We had tried these problems from Math Without Words a few weeks before but the students were too intimidated to persevere. Now in the context of the game they tried all of them.

Math Without Words

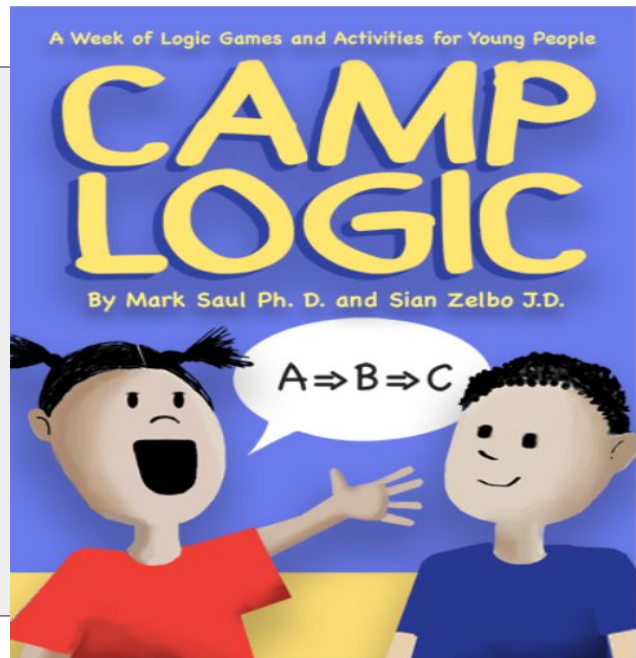
Purely Visual Puzzles to
Confound and Delight

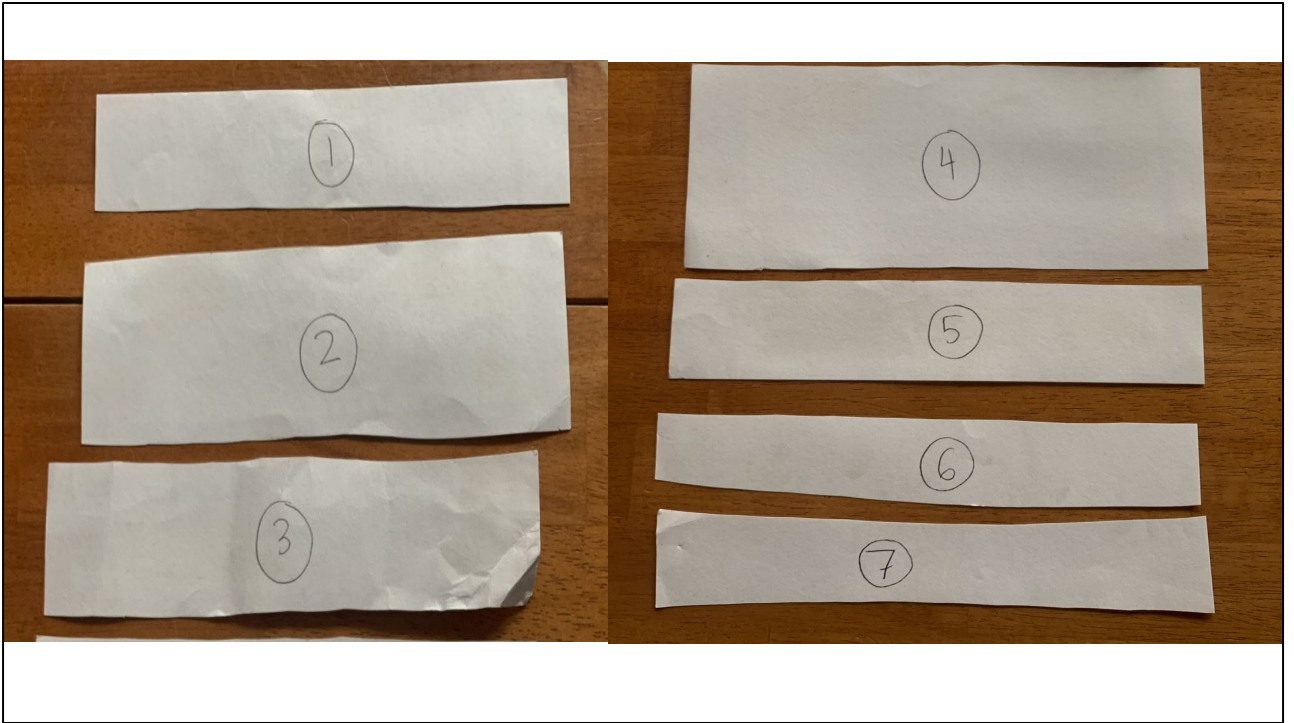
James Tanton



We had done Cryptarithms before to mixes results. One student loved them, one was meh, and the others strongly disliked. Now, in the third week of the game, students happily worked together to solve them. I think it's because I wasn't there - I left the room - maybe the students had more courage to take risks in a game without an adult present. (Even though when present I was uninvolved, I still think it factored in.)

Cryptarithms





Week 4 - game evolved - I started mixing topics, not just one topic.

If a pie has 6 slices, and 4 girls eat want 2 slices, do you have enough?

Lexy and Nigel invent "Dog and Cat Chess." They dispute its name; Nigel wants to call it "Cat and Dog Chess." But they do not dispute how many squares it has. Lexy is in charge of the number of rows. She chooses 6. Nigel is in charge of the number of columns. He chooses 4. How many individual squares are on a "Dog and Cat" (or "Cat and Dog") chessboard?

How many squares are on a traditional chess board?

According to ancient legend, the king of India wanted to show appreciation to the servant who had invented the game of chess for the king's entertainment.

"All I ask, your majesty," said the servant, "is some grains of wheat for each square on the chessboard. Give me one grain on the first square, two on the second square, four on the third, and so on. Double the number from one square to the next until all 64 are covered."

The request seemed simple enough, and the king quickly agreed.

Would you be willing to grant the servant's request if you did not have the wealth of the king? Right now, wheat costs about \$5 per bushel, and there are about 1,000,000 (1 million) kernels in a bushel.

Which of the prior 3 questions, if any, involved multiplication?

If a pie is not sliced, and 4 girls share it equally, how much does each girl get?

If you have 2 pies to split equally among 4 girls, how much does each girl get?

Email me if you can't read these - I can type them into a Google doc.

Endangered Species



Tim found a Web site showing that California has 254 endangered animal species. Five of these species live near Tim.

How many of these species don't live near Tim?

11

Mei Mei's Dogs



Mei Mei has four dogs:
Rags weighs 53 pounds.
Shadow weighs 95 pounds.
Red weighs 27 pounds.
Tuff weighs 67 pounds.

Use subtraction to fill in the dog names below:

_____ weighs 28 pounds more
than _____.

10

The Crowded Mushroom



There were 32 elves living under a mushroom. It was too crowded, so 13 moved out. Then 7 leprechauns moved in.

How many are living under the mushroom now?

3

Week 5 - further evolution of the game - one of the student copied some pages in a book she had at home. She asked me to fold them up and use them for this week's round of Math Squares.

12/4/2014 Who Lives Where? - Kids Korner - Kids Logic Problems - The Logic Zone

The Logic Zone

Home | Logic Problems | Logic Puzzles | Cryptograms | Kids Korner | Community

Who Lives Where?

Three children live at houses with different coloured doors. What colour door do they each have, what Number House do they live at and on what Road?

Child: George, Jake, Sophie
Door: Blue, Green, Red
Number: 1, 2, 3
Road: Bridge Street, Cherry Close, Sandy Lane

[Printable Grid](#) [Interactive Grid](#)

Child	Door	Number	Road
Jake	red	1	bridge st.
Sophie	blue	2	cherry close
George	green	3	sandy lane

Sophie's house No. is 1 lower than Jake's.
 George does not live at House No. 1, but does have a green door.
 One child lives at No. 2 Cherry Close.
 House No. 1 has a red door, but is not on Sandy Lane.



[Answer](#)

http://www.thelogiczoneplus.com/logic_3_90.htm

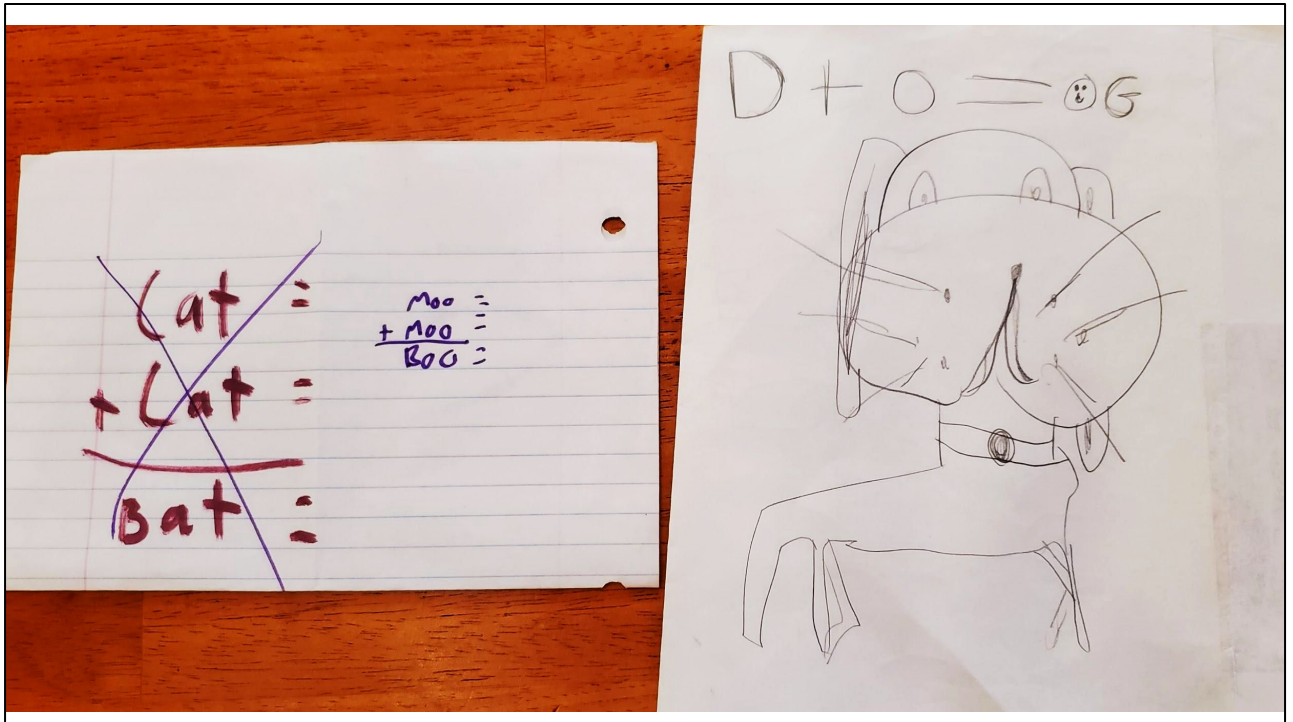
How do you write the conventional number 16 in binary?

~~1111~~

10000

100 + 200
 + 300 + 400
 ?

Week 6 - game evolved further - students wanted to end with an easy problem, not hard, so the problem in the bottom right corner was the last one.



Week 7 - huge change in the game - the students told me that from now on they would write the problems for the Math Squares and that I and their parents were to solve them. I love that they chose Cryptarithms for their first topic - a topic that at their first exposure that had not embraced.

$$1 + 5 - (10 \times 8) \div 5 =$$

$$= 1 + 5 - \frac{80 + 5}{16}$$

$$= 1 + 5 - 16$$

$$= 6 - 16$$

$$= -10$$

dajo and audrey went to the store and
bought 4 pair of shoes each dajos pair cost
30.10 audrey's pair cost 30.93 please round
the numbers together to see how much
their total will be but you got one hint;
good luck

#20
#31

Jane has a pet Herring
Gull that eats 1 pound of fish
each day. The Gull flew away
and Eric found him. He fed Sam
(the gull) 12 pounds of fish at a
rate of $\frac{1}{2}$ pound per day. How long
did Eric keep Sam?

1 cat bird = 2 Humming birds

1 hawk = 5 Robins

1 Robin = 2 Finches

1 crow = 4 Robins

3 Hummingbirds = 1 finch

7 crows = 1 swan

2 swans = 1 emu

How many finches are equal to
a crow? How many Hummingbirds in a
Robin?

2 F → R → C

1 R → 2 F → 4 H

1 C → 2 R → 4 F

Week 7 - students started writing word problem. They asked their parents to come for pick-up earlier to have more time to participate in the game.

THE MUSICIANS

YOU NEED TO SOLVE WHERE
THEY LIVE AND WHAT STREET

~~WHERE THEY LIVE~~

WHAT STREET DOES
THE VIOLENT LIVE ON
- WHERE DOES THE PIANO
PLAYER LIVE
- WHERE DOES THE GUITAR
PLAYER LIVE

✓ THE VIOLENT DOES NOT LIVE ON HERB
ST OR CHESSNUT ST

✓ THE PIANO PLAYER DOES NOT LIVE ON
PARKWAY AV. BUT STAYS ALOT OF TIMES
MEADOW WAY

✓ GUITAR PLAYER LIVE IN THE ST
BETWEEN CHESSNUT AND MEAD-
OW WAY

✓ CLEAR PARKWAY IS
VERY PRIZY

PERSON	STREET
X	PARKWAY
X	MEADOW WAY
X	CHESSNUT ST
X	HERB ST

what walks
morning tow in
thee at night

on four legs in the
the afternoon and

good luck

OWN FRIDAY
A MAN ROAD
TO A HOTEL
THE NEXT DAY
OWN FRIDAY HE
ROAD BACK

Week 8 - they added in some riddles. And started wishing us luck and offering hints and other support. They really wanted to set us up for success.

The 5 cats

~~Leafkit~~, Girl, Brown and
black, 2 months old

~~Bluestar~~, Girl, White, 6 years

~~Cloudpaw~~, Girl, Cream, 3 years

~~Grasspaw~~, Boy, Tan, 1 year

Squirrelstripe, Girl, Brown, 6 years

Morningkit and Dewkit are born

Pinepaw: Open

Being a warrior and being
run away. ~~Red~~ ~~Flame~~ ~~Leaf~~ ~~Star~~
and make ~~Champion~~. They have
Flie up Right Heaven and
Star

Simple riddle

there was a king a queen a prince and a maid
they lived in a round catset won day
they prince could not found his crown
the king was cheaking his tax paper
the queen was resting in her bed
the maid was dusting counr who took
the prince crown

Week 9 - the problems become more complex.

use the clues to figure out what the animals names are.

Clue: you get to ask 10 clues

	Casey	Gigi	Penny
Cat	X	X	X
Dog	X	X	X
Goat	X	X	X
Horse	X	X	X

✓ 1. The animals names do not begin with the first letter of themselves.

✓ 2. The Horse is not Penny but the animal that is begins with the first letter of another kind of horse.

✓ 3. The goat and Penny are closer in height.

Clue: you get to ask 10 clues

Pin the singer to the song

Directions: match the singer to the song they sing

Singer	Song
dean lewato	one direction
adel	staps dance
talor swift	best song ever
serena gomez	rolling in the deep
neon lights	our song

UNCOVER THE ADULT ITS BY GRAHAM GREENE

HEAR ARE THE WAYS

3. HERE'S ALWAYS ONE

4. MINOR IN LIFE AND

5. THE BOSS OPEN SONG

6. THE BOSS OPEN SONG

P.S. you get 2 HINTS

SATURN.

Week 10 - our final session of the year - the students created tables for organizing info (all their own ideas, of course). The game was a huge hit - I think because students invented it, cooperated, adapted it over time - total ownership!.

Some Categories of Goals

- Focusing
- Conjecturing
- Embodied mathematics
- Role playing
- Strategy

Math Squares was a huge motivator - it got me thinking about other purposed games serve in my Math Circle.

GAME: Mathematician Cards



I've used a lot of focusing games at the Talking Stick Math Circle. These students were doing a different activity - some had wandered away - I set up a round of Mathematician Cards to refocus the group. Here I was about to call everyone back together at the white table. (I also use this game sometimes as a warmup focusing game at the start of the session.)

Mathematician Cards: Variations on Rules

PICK ONE CARD ON YOUR TURN:

- If today is that person's birthday, the game ends.

PICK TWO CARDS ON YOUR TURN:

- If both cards are mathematicians, you keep the cards.

-OR-

- If both cards reveal LIVING mathematicians, you keep the cards.

- 1) I did the first version on Omar Khayyam's birthday. When a student got his card, we stopped playing the game and talked about some math history.
- 2) In the second version, there needs to be at least a few cards of something that is not a mathematician. Question: can a computer be a mathematician?
- 3) Students always tell me that mathematicians are dead, white, and male. The third version shakes up this assumption.

Version 1.0 (2011)



Emily Peters



Marquis de Condorcet



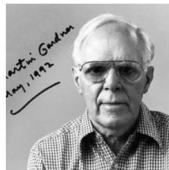
Sophie de Condorcet



Ken Appel



Amanda Serenoy



Martin Gardner



Carl Friedrich Gauss



Jim Tanton



Hypatia



Wolfgang Haken



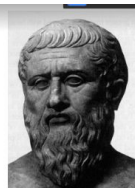
IBM 360 mainframe computer



Maria Droujkova



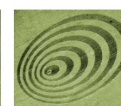
Leonhard Euler (1707-1783)



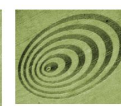
Plato (ca. 427-347 BCE)



Calkbary Ring Crop Circle



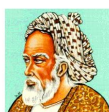
Julia Set Crop Circle



Julia Set Crop Circle



Leonardo Pisano Biglio



امیر - Omar Khayyam (1048-1131)

When I first started doing this game in 2011, the cards didn't allow all of my students to "see themselves in the curriculum" (to quote Dr. Rochelle Gutierrez).

Version 2.0 (2019)



After I heard Dr. Gutierrez talk at MathFest 2019 (“What’s at Stake in Rehumanizing Mathematics?”) I realized i needed to put some new cards in my deck.

Mathematician Cards - ALL OF THEM (so far)



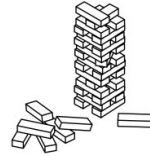
Every card is connected to some mathematical activity that we do in Math Circle.

Some Other Focusing Games

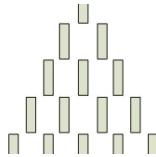
Pick Up Stix



Jenga



NIM



Tens Concentration



Image Attributions: The Noun Project

I usually use these games as students come into the classroom. I stop the activity before it's done to avoid competition. Or I have the students as a group play against me or my student assistant. We also sometimes play the "Takeaway Game," in which I place a bunch of random objects on a tray, ask students to remember what's there, secretly remove one, and ask what's missing.

-

GAME: Opposite Simon Says



I'll be Simon. Do what I say only if I preface the command with the phrase "Simon Says."

Put your hands on the top of your head.

I didn't say "Simon Says!" If you did put your hands there, you shouldn't have.

Simon says, “Put your hands on the top of your head.”

I didn't say

Put your hands back where they were.

Simon says, “Put your hands back where they were.”

Simon says, “Reach your arms to the sky.”

Simon says “Do the opposite of reaching your arms to the sky.”

What is the opposite of this command? Reach to the ground? Be still and don't reach? Do some things have multiple opposites?

Simon says, “Touch something that’s green.”

**Simon says, “Do the opposite of touching something
that’s green.”**

Is there an opposite of touching? Of green? Does everything have an opposite?

Simon says, “Stand on your left foot.”

Simon says, “Do the opposite of stand on your left foot.”

LET’S TALK ABOUT COMMANDS NOW.

ARE SOME COMMANDS ACTUALLY TWO COMMANDS EMBEDDED INTO ONE?

ARE THERE COMPOUND COMMANDS, LIKE COMPOUND FUNCTIONS?

ARE FUNCTIONS COMMANDS?

ARE NEGATIONS AND INVERSES THE EXACT SAME THING AS OPPOSITES?

OPPOSITE SIMON SAYS: Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

<http://www.corestandards.org/Math/Content/1/introduction/>

I think we engage in at least 6 of these Common Core standards for first grade mathematical practices in this game.

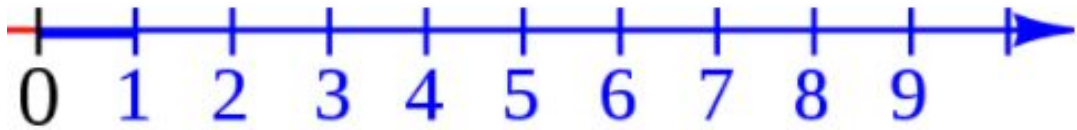
GAME: Math Red Light Green Light



Image Attribution:: vectorstock.com

Let's play - When I say "Green light" I turn my back on you. You can run halfway to the finish line. When I say "Red Light" I turn back and face you and if anyone is still moving, you go back to the starting line. If you go more than halfway of your remaining distance to the finish line, you go back to the starting line. Whoever gets to the finish line first wins. (There's a punch line to this game, so you may only be able to play it once.)

GAME: Mother May I Addition (sidewalk chalk)



https://en.wikipedia.org/wiki/Number_line

MORE EMBODIED MATHEMATICS - a combination of the games "Mother May I" and Sidewalk Chalk Addition.

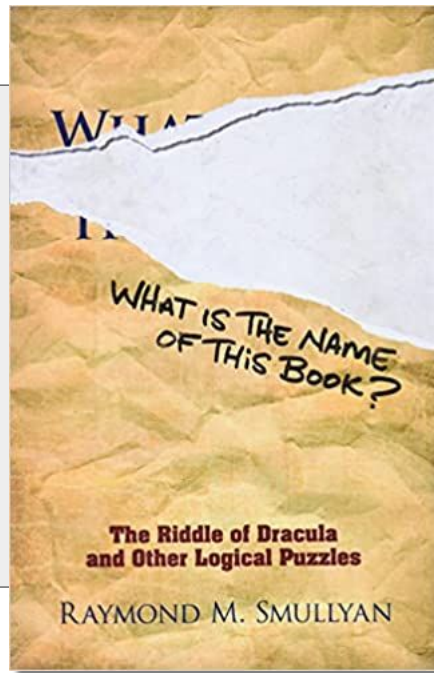
"MOVE FORWARD 3 PLACES. MOVE BACKWARDS 5 SPACES" (BUT STILL FACE FORWARD.)

CAN RAMP IT UP WITH FACING THE OTHER WAY FOR SUBTRACTING (VERSUS ADDING NEGATIVES)

GAME: Knights and Liars (Knaves) with Puppets

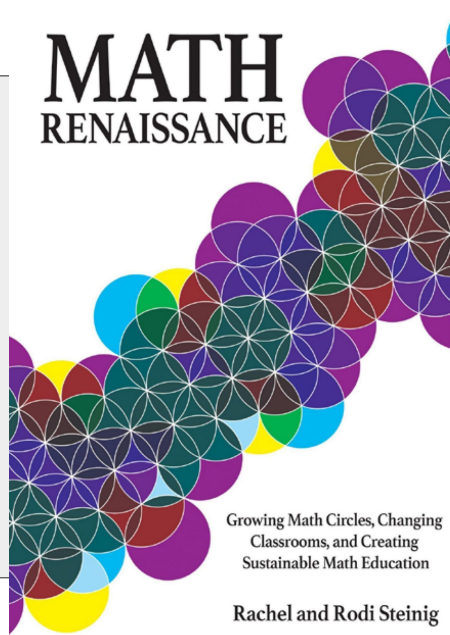


“Waggy do you eat meat?” (role playing, conjecturing, strategy game) - puppets adds a layer of complexity to the classic game.



The game Knights and Knaves is in this book.

MATH RENAISSANCE



Growing Math Circles, Changing
Classrooms, and Creating
Sustainable Math Education

Rachel and Rodi Steinig

This book describes in details playing Knights and Knaves/Liars with puppets - extending the game into formal logic concepts such as negation, inverse, converse, etc.

How Is this Math? (a.k.a Is there Math in Everything?)

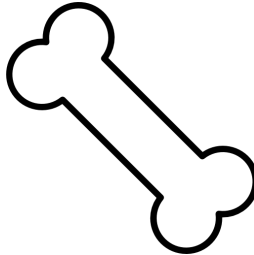
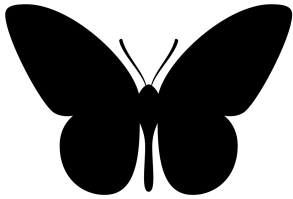


Image Attributions:
The Noun Project
FlatIcon

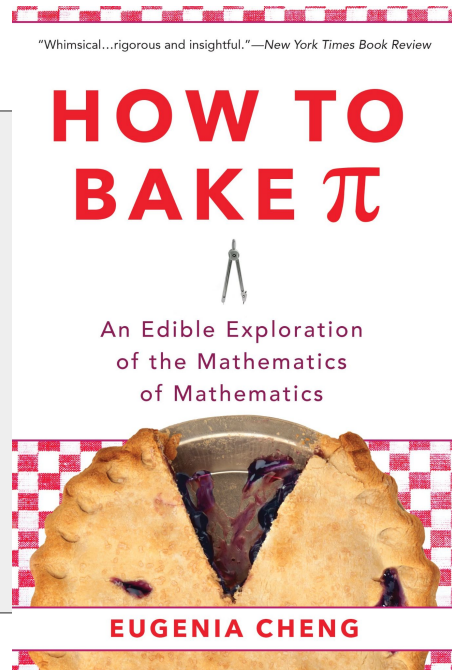
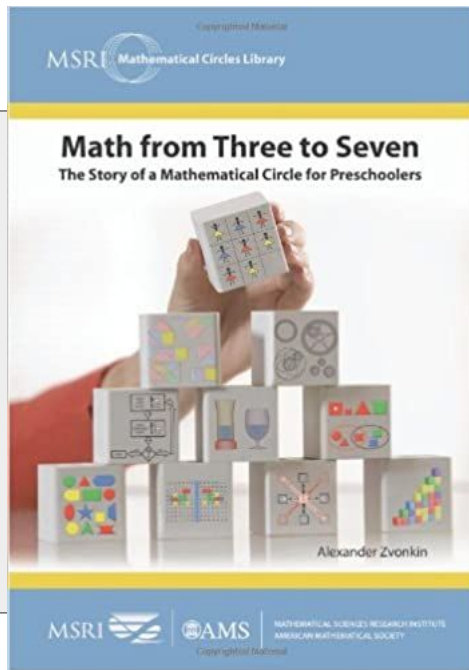
CREATIVE GAME, THINKING GAME - detailed in this blog post:

<https://mathrenaissance.com/meta-pedagogy/>

Odd One Out



CONTEXT MATTERS. The Green pentomino is linear so it must be the odd one out. Green is not a primary color. Red has no symmetry. CHALLENGE: how could the yellow or blue be the odd one out? (Students challenge each other with their own set-ups.)

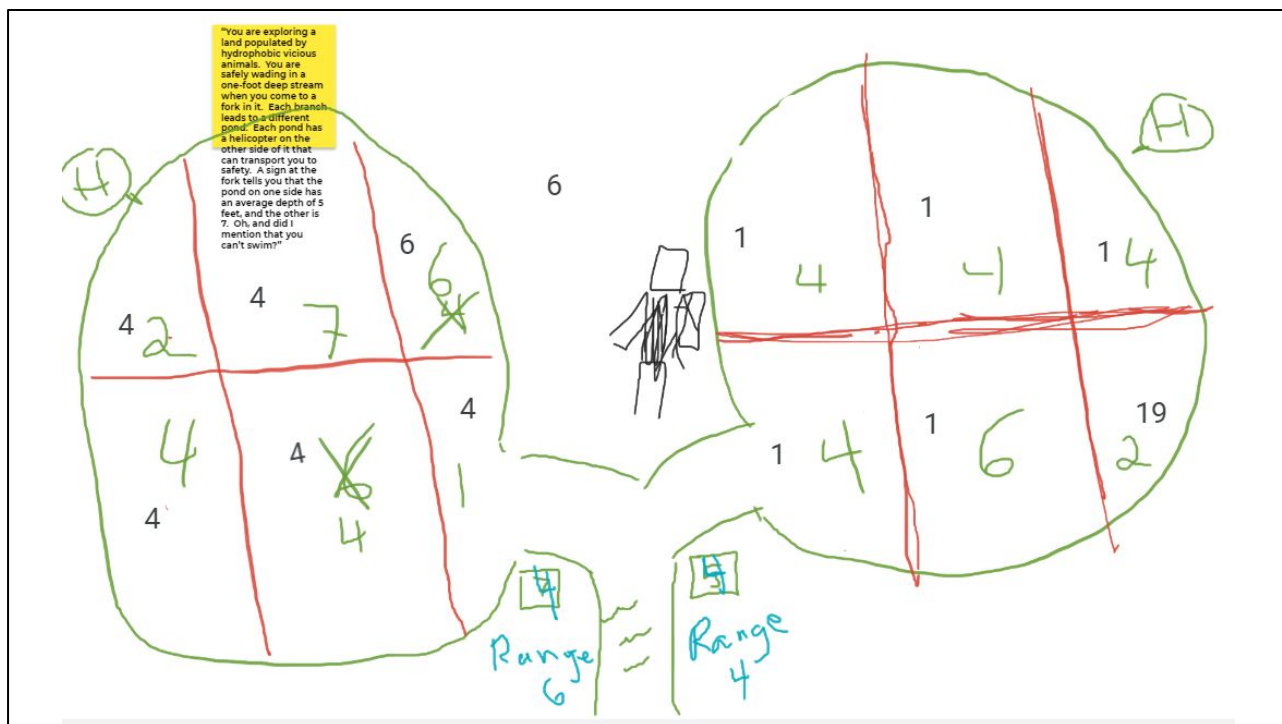


Both these books have good info about Odd One Out.

Would You Rather?

You are exploring a land populated by hydrophobic vicious animals. You are safely wading in a one-foot deep stream when you come to a fork in it. Each branch leads to a different pond. Each pond has a helicopter on the other side of it that can transport you to safety. A sign at the fork tells you that the pond on one side has an average depth of 5 feet, and the other is 7. Oh, and did I mention that you can't swim?

“Would you rather wade through the pond with the 5 foot sign or the pond with the 7 foot sign?”



I like to expand this problem with talk about range, not just average, to make the distinction between measures of central tendency versus dispersion. This is some work students did in a recent virtual Math Circle.

GAME: Math Lawyer

“A square and a rectangle are the same thing.”

Lots of role playing - defendant, prosecutor, judge.... (a conjecture goes on trial)

GAME: Math Lawyer

“A square and a rectangle are the same thing.”

“Diameter as a concept is unnecessary, since it’s just a function of the radius.”

Multiple groups of students have invented this game. In both of these shown, students came up with the statements to put on trial.

GAME: The Need for Numbers

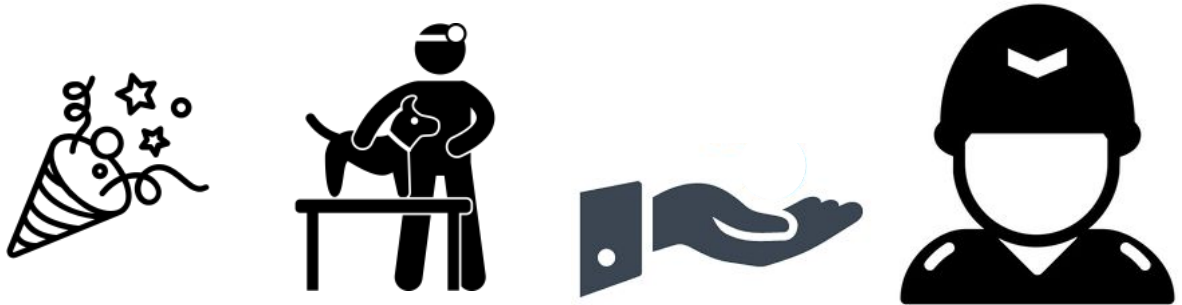


Image attributions:
The Noun Project
PNG Wing

Role-playing math game

The basics of this game:

<https://mathrenaissance.com/role-playing-the-need-for-numbers/>

Spreading the game out over 5 weeks:

<https://mathrenaissance.com/embodied-mathematics/>

The Need for Numbers: Ramping up the Difficulty

Week 1: no numbers allowed

Week 2: no numbers, no pictures

Week 3: no numbers, no pictures, no names of shapes

Week 4: no numbers, no pictures, no names of shapes, no comparison words, no approximations

Week 5: all of the above allowed (phew!)

STUDENT DEBATES: IS "A" A NUMBER? IS ONE A NUMBER? IS A WORD LIKE
HERD AN IMPLIED NUMBER? Point? Line? Few? Side? Shape? Herd?
(ramped up newer version from my students)

CONJECTURING GAMES

What's the rule, the function, the thing being defined...

- Euclidian Definitions
- Fruit Vendor
(<http://mathmaniacs.org/lessons/fsm/index.html>)
- Function Machines

Euclidian Definitions: read a definition from Euclid's Elements. The students have to figure out what geometric concept is being defined. (And see if they can come up with their own definitions.) Fruit Vendor is a game about Finite State Machines. It is a LOT of fun to act it out - we did this in a virtual course. I wrote about Function Machines extensively in the book Math Renaissance.

Some strategy games that can be played cooperatively

Blokus



Backgammon*

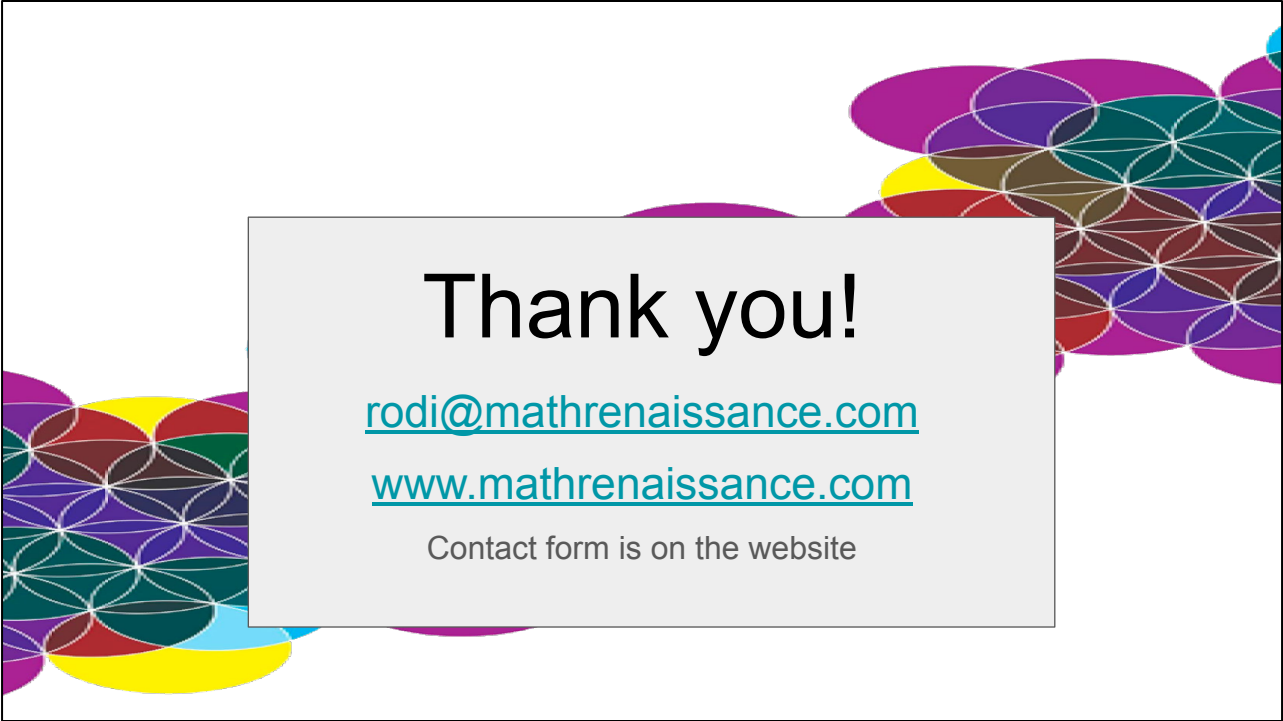


Go



* Image Attribution: Shutterstock

I've played these games with students against me. When I had students play Go in pairs (on the right, above) it didn't go so well. But when we all played it together it was a hit.



Thank you!

rodi@mathrenaissance.com

www.mathrenaissance.com

Contact form is on the website