American Institute of Mathematics

Math Teachers' Circle

Great Problems, Great Sessions, Great Circles

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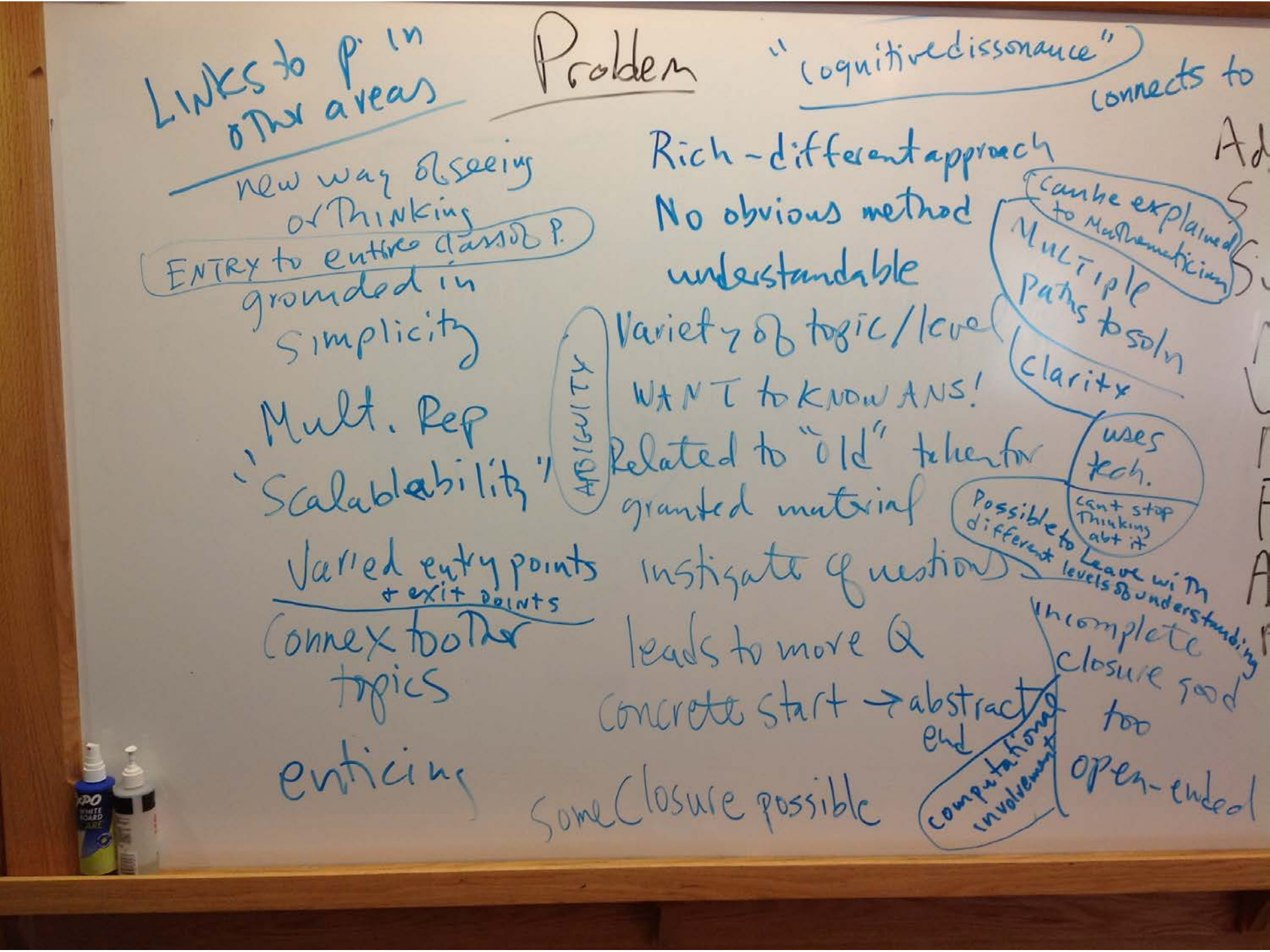
American Institute of Mathematics

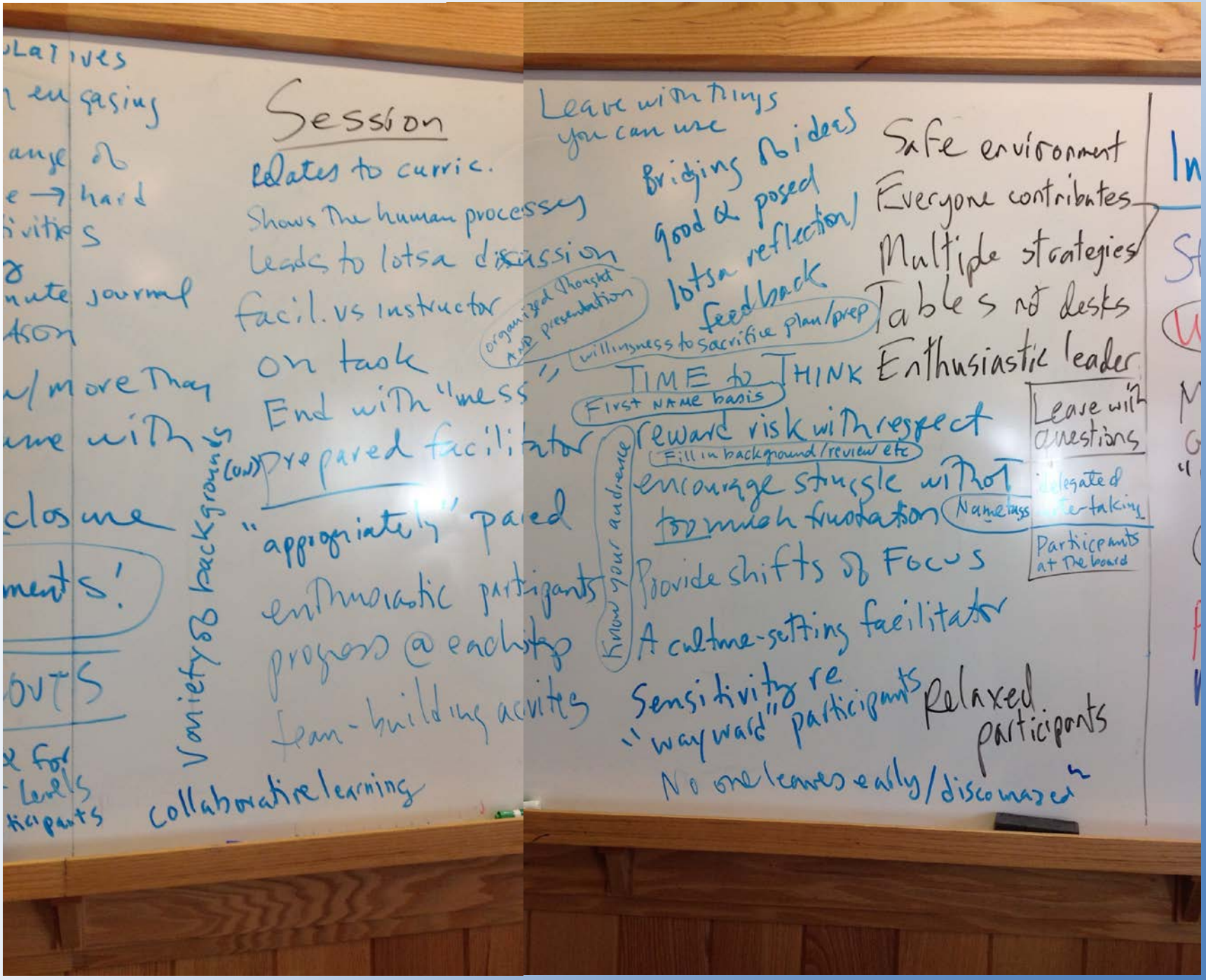
Key Questions

- What makes a great problem?
- What makes a great session?
- How do you go from a great problem to a great session?

What is a problem?

- Exercise: Something that can be easy or hard, but that you know how to do
- Problem: Something challenging that you don’t already know how to do


Links to P in other areas
Problem
"cognitive dissonance"
connects to
new way of seeing or Thinking
ENTRY to entire class of P.
grounded in simplicity
Mult. Rep
"Scalability"
Varied entry points + exit points
Connex to other topics
enticing
Rich - different approach
No obvious method
understandable
Variety of topic/level
WANT to KNOW ANS!
Related to "old" taken for granted material
instigate questions
leads to more Q
Concrete start → abstract end
Some Closure possible
AMBIGUITY
can be explained to Mathematicians
MULTIple Paths to soln
clarity
uses tech.
can't stop Thinking abt it
Possible to Leave with different levels of understanding
incomplete closure good
too open-ended
computational involvement


Session
Relates to curric.
Shows the human process
Leads to lotsa discussion
facil. vs instructor
on task
End with "mess"
prepared facilitator
"appropriately" paced
enthusiastic participants
progress @ each step
Team-building activities
Variety of backgrounds
collaborative learning
Leave with things you can use
Bridging activities
good & posed
lotsa reflection/ feedback
organized thought AND presentation
willingness to sacrifice plan/prep
TIME to THINK
First name basis
reward risk with respect
Fill in background/review etc
encourage struggle without too much frustration
Name tags
Provide shifts of Focus
A culture-setting facilitator
Sensitivity re "wayward" participants
Relaxed participants
No one leaves early/discouraged
Know your audience
Safe environment
Everyone contributes
Multiple strategies
Tables not desks
Enthusiastic leader
Leave with questions
delegated note-taking
Participants at the board

What makes a good problem?

PARTIAL CONCLUSION
PROBLEM POSING
STORY/HISTORY
CLASSROOM CONNECTION
CLEAR & AMBIGUOUS
EASY ENTRY POINTS

THE "GOOD PROBLEM" PROBLEM

by Joshua Zucker

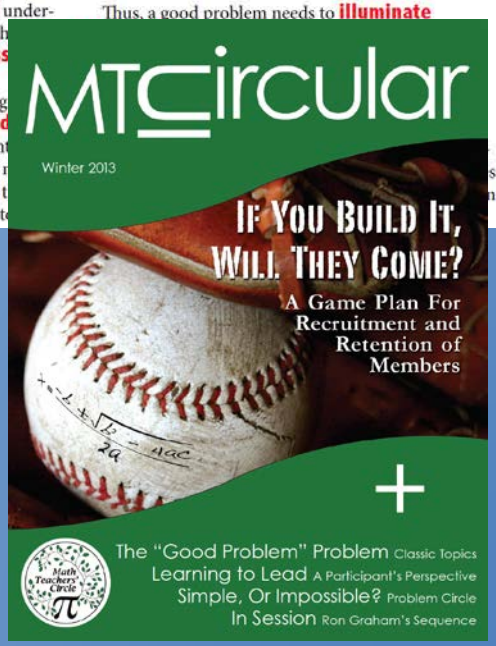
"Where do you get your ideas?" is a question that every writer encounters all too often, and writers of problems for Math Teachers' Circles are no exception. To paraphrase Robert Pirsig's advice about painting in *Zen and the Art of Motorcycle Maintenance*, "You want to know how to write the perfect problem? It's easy. Make yourself perfect and then just write naturally." That's perhaps the most honest—and most useless—possible advice on the topic. It does point in some productive directions, though. What you

While we're looking for problems, we need to keep in mind that we're not hunting down exercises. As Paul Zeitz tells us, "Exercises may be hard or easy, but they are never puzzling" – we are supposed to know already how to approach them. A problem presents us with a novel challenge, where we're not sure what tools we need. By this definition, solving a Sudoku is generally an exercise; it's only the times when we're stuck and need to find a new approach, or a new way to put together old approaches, that qualify as prob-

advises. "It's the psychic predecessor of all real understanding." On the way to that stuckness, though
introduction needs to be **concise and access**
to get everyone involved.

In addition, most in the MTC community ag
that good problems should be **both clear and**
ambiguous, which seems like about as blatant
tradiction as one could have. Perhaps what we
is that the communication should be clear but
question might not be. We shouldn't be afraid

Thus, a good problem needs to **illuminate**



The "Good Problem" Problem, by Joshua Zucker, *MTCircular*, Winter 2013.

What makes a good session?

Recipe for Success

Gathering the Perfect Ingredients for a Great MTC Session

by Joshua Zucker

What makes a good session? As mathematicians, we tend to spend most of our planning time and energy in thinking about what mathematical ideas and strategies we want the participants to work with, and what problems will lead the group to those goals. However, to create and sustain a successful circle, we need to also spend at least as much effort on our thinking about how to use the time we have, how to facilitate interaction and develop community, and what the participants will take away from the experience. Perhaps the most important element is to ensure that every participant feels that their contributions and efforts are worthwhile and valuable.

Leadership

An important part of the goal of MTCs is to bring together mathematicians and middle school teachers. However, there's often still some distance and separa-

on the math, give people that schedule ahead of time so they know what they're coming for.

The Casco Bay MTC suggests one way to make the start feel important while still allowing latecomers to be brought into the conversation: they warm up with an easier problem, or a game that's on a similar theme, such as a parity game for a session that explores other applications of parity. That way people arriving early can get engaged in the mathematics and later can enjoy discovering the connection between the opener and the main session, while people who arrive late don't miss out on the meat of the session, just the appetizer. Alternatively, some groups start with the literal meat instead of the metaphorical, by opening with dinner and some social time, so late arrivers may miss out on the food but not the mathematics!

Attendance

Small groups can work well, but there does seem to be

that commitment, and it's also easier for organizers to send them repeated reminders if they've registered. Some groups, such as Cincinnati, use a Facebook page for their group and announce their events that way, which gives a very easy way of collecting replies.

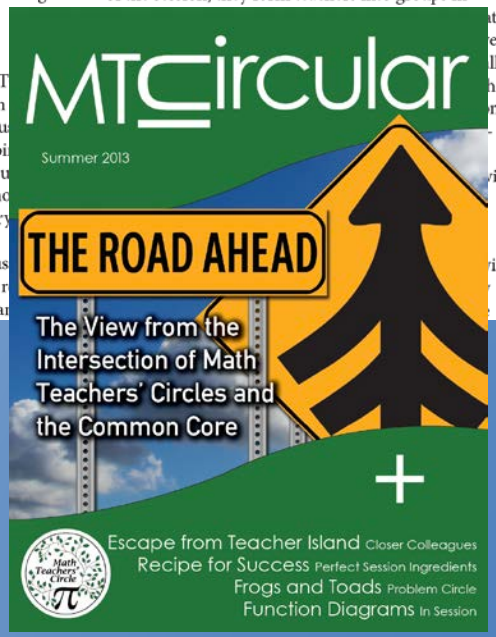
Participation

Perhaps the most vital element of a good MT
is that everyone attending should feel like an
participant. The Twin Cities MTC reminds u
a good topic should "have different entry poi
those with different backgrounds" and of cou
us understand that a good MTC problem sh
a low threshold and high ceiling so that every
start and nobody gets bored.

Even though problem selection was discus
Winter 2013 issue of MTCircular, it's worth r
ourselves that less is more: give the participa

Grouping

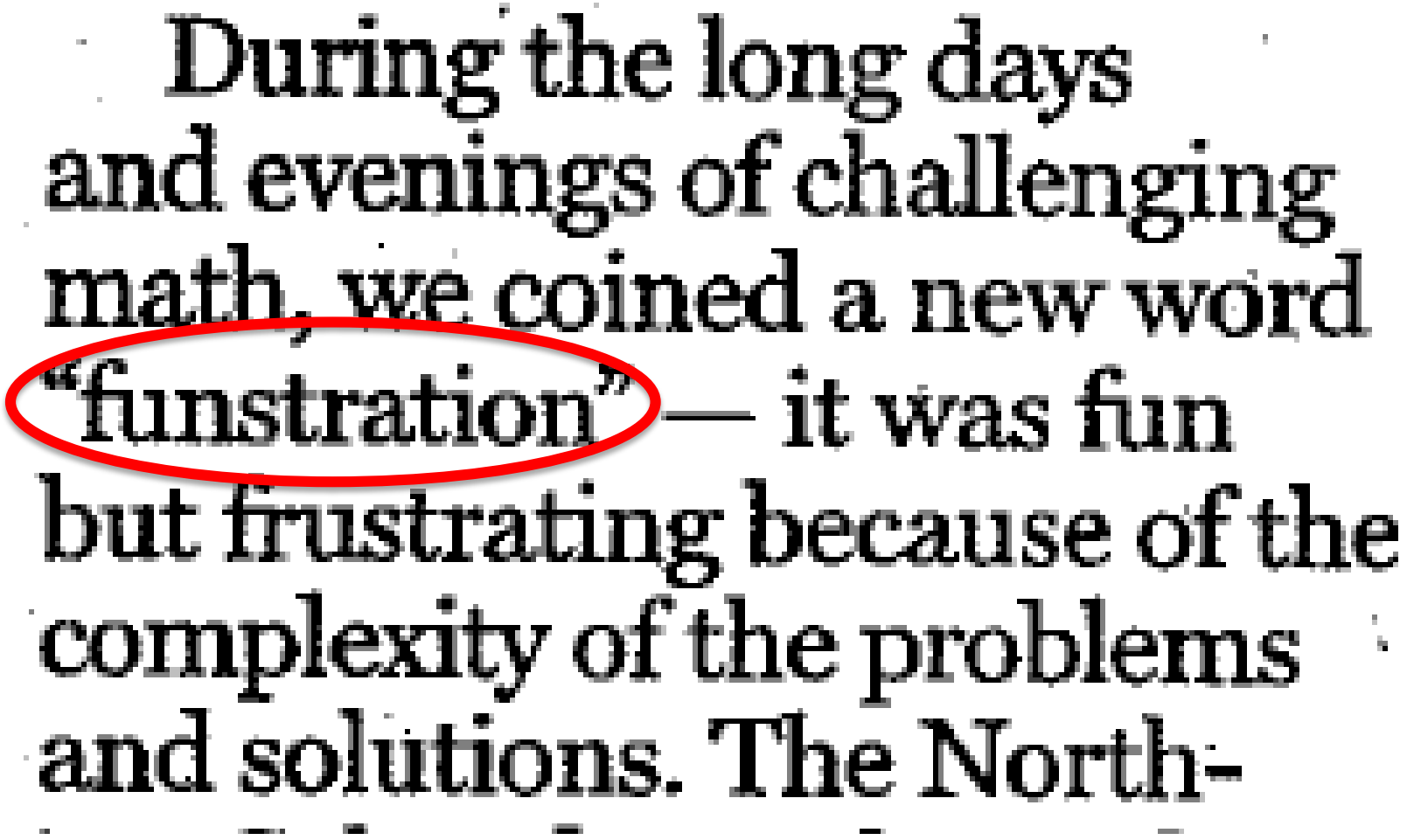
Some circles make a deliberate effort to bring new people into the community and to develop new relationships among the attendees. During the course of the session, they form teachers into groups in



Recipe for Success: Gathering the Perfect Ingredients for a Great MTC Session, by Joshua Zucker, *MTCircular*, Summer 2013.

Great problems are…

- Perplexing


During the long days and evenings of challenging math, we coined a new word "funstration" — it was fun but frustrating because of the complexity of the problems and solutions. The North-

An article about the Northern Colorado MTC in the *Greeley Tribune*.

Theme Song of the Heartland MTC (Olathe, KS)

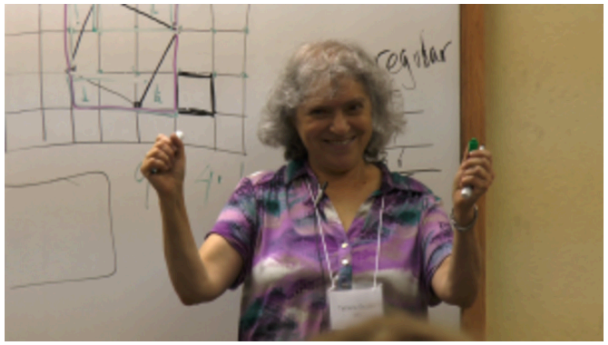
If you're in a math circle,
You're bound to feel funstration!
Even though the answer sets
Are proved by demonstration.
Don't worry, you won't work alone
You'll find cooperation.
If you're in a math circle,
You're bound to feel funstration!

Great problems are…

- Perplexing
- Swimming pools

Grid Power

Tatiana Shubin



View the playlist…

Synopsis: In this session, led by Tatiana Shubin (San Jose State University), a sheet of grid paper and a simple counting question reveal some deep mathematical surprises.

Length: *1 hour, 17 minutes*

Session materials:

- Grid Luck, Tatiana Shubin

Middle school curriculum materials:

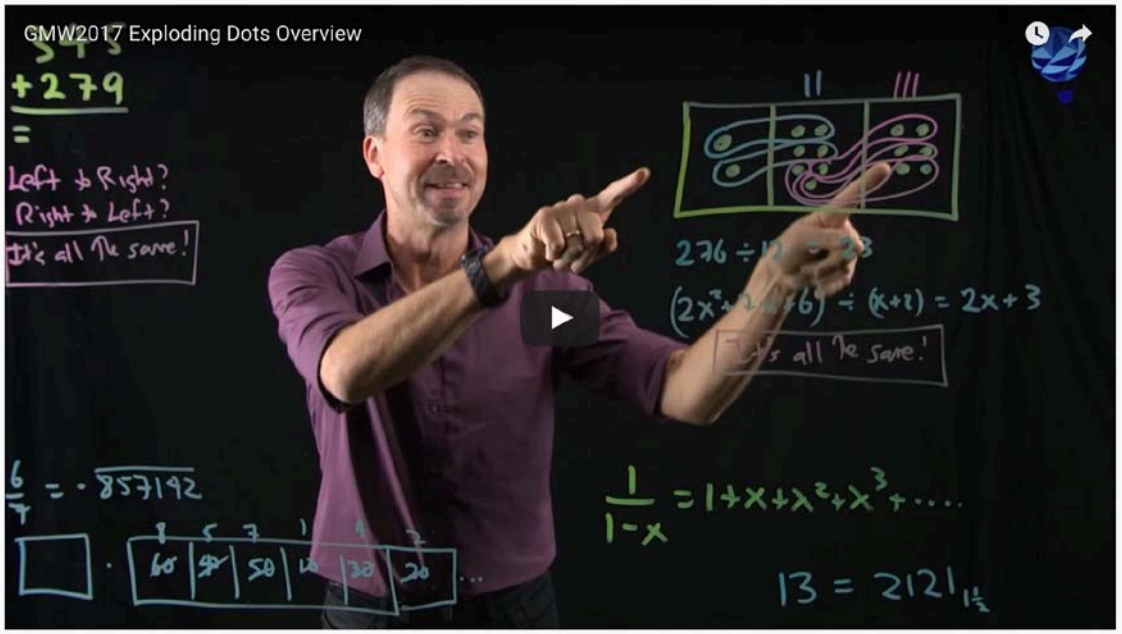
- Grid Paper Exploration, by Randy Lomas (Harvest Park Middle School; AIM MTC). Published in the California Mathematics Council *ComMuniCator*, 40(4), June 2016.

Resources and session video available at
http://www.mathteacherscircle.org/resources/videos/

Great problems are…

- Perplexing
- Swimming pools
- Gateways to mathematical landscapes

Exploding Dots



Resources and videos available at www.globalmathproject.org
(and sign up for Global Math Week while you are there!


Tuesday, July 19
Afternoon Planning

Great sessions…

- Give participants time to think

Great sessions…

- Give participants time to think
- Have landmarks along the way

An Introduction to Problem Solving

Joshua Zucker

View the playlist…

Synopsis: Joshua Zucker (Julia Robinson Math Festivals) leads a session on the 1-to-100 problem. Along the way, many problem-solving strategies are revealed, including trying a smaller problem.

Length: *1 hour, 54 minutes*

Session materials:

- The 1 to 100 Problem, Tom Davis and Joshua Zucker
- An Introduction to Problem Solving, Joshua Zucker

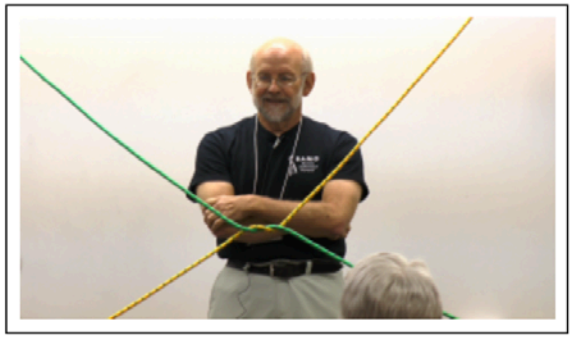
Resources and session video available at
http://www.mathteacherscircle.org/resources/videos/

Great sessions…

- Give participants time to think
- Have landmarks along the way
- Have a little magic

Conway's Rational Tangles

Tom Davis



View the playlist...

Synopsis: Tom Davis (AIM Math Teachers' Circle) presents a mathematical rope dance with two moves: twist and rotate. Given that "untwist" and "unrotate" aren't legal moves, is it always possible to return to an untangled state?

Length: *1 hour, 35 minutes*

Session materials:

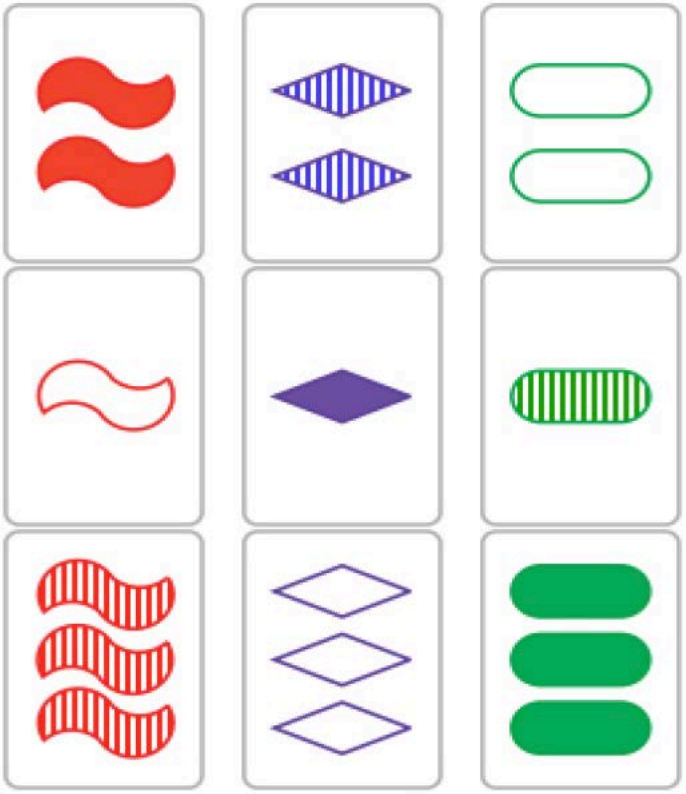
- Conway's Rational Tangles, Tom Davis
- Understanding Rational Tangles, James Tanton
- Slides from a presentation by Altha Rodin (MTC Austin) on Rational Tangles using individual tabletop tangle cards

Middle school curriculum materials:

- Blog post by middle school math teacher Fawn Nguyen (Thousand Oaks MTC) on doing "Rational Tangles" with middle grades students

Resources and session video available at
http://www.mathteacherscircle.org/resources/videos/

The Evolution of a Session: SET



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The Original SET Contraption

In the beginning…

- Didn’t allow enough time for people to play the game
- Focused on our own questions and interests (e.g., how many cards can you have without having a Set?)
- Also spent a lot of time coordinatizing the cards and using that to explore characteristics of sets (lines), planes, etc.

Over time…

- Built in more time to play
- Provided a chance toward the beginning of the session for participants to brainstorm questions
- Focused on the most magical part: the geometry!

Major Changes

- Respect the need for participants to play.
- Provide time for problem posing.
- Focus on the magic!

Thank you!

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