

• **Nothing Works! The Art of Teaching Mathematics**

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• **The Art of Teaching**

• Find your profile!

• Example

• forward motion

review



• More examples

• staying within math vs. making connections

• over-prepared vs. winging it

• routine vs. variety

• enjoyment vs. learning

• correct vs. incorrect answers

• intrinsic vs. extrinsic motivation

• Lose your profile!

• Learn to navigate along these axes

• **Nothing Works**

• Heterogeneous Classes

• **All classes are heterogeneous**

• Pedagogy

• Alliance with the strongest students

• Support for the weakest

• The elevator strategy

• Stop on all floors

• Something too difficult

• Something too easy

• Something "just right"

• Pacing

• **Constant forward motion**

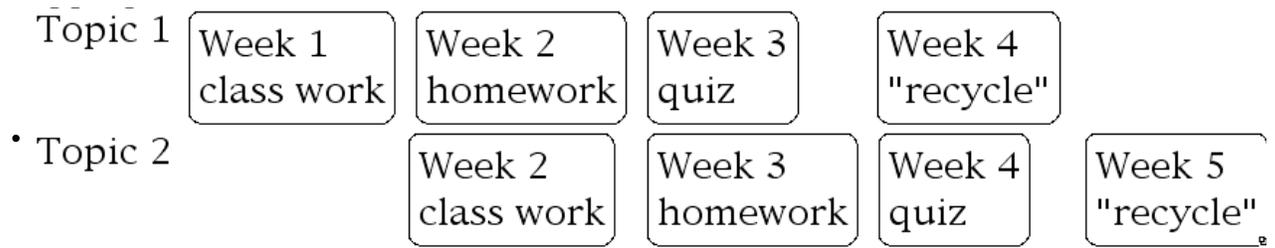
• **Eternal review**

• Curriculum

• "Vertical" activities which provide both access and challenge

- "No threshold, no ceiling"
 - Example: what perimeters are possible for a given graph paper shape?
 - Many more examples on my Web site
- Tools
 - Manipulative and technological tools
 - Calculator: TI-89
 - Manipulatives: cubes, geoboards, Lab Gear, pattern blocks, ten-sided dice, ...
 - Software: Cabri, Fathom, ...
 - Multiple representations of concepts
 - Numeric, symbolic, graphical, geometric, applied, ...
 - To provide an entry point to more students
 - To preview or review concepts
 - To extend exposure
 - To deepen understanding
 - To increase variety
 - To promote engagement
 - However...
 - tools are not magic
- Group Work
 - Random groups
 - new groups every 2 weeks
 - Students mostly work independently
 - are expected to help each other
 - If a group does not function well
 - I intervene directly to get the behaviors I want
 - If more than one group is stuck
 - I stop them all for a class discussion
 - guide on the side vs. sage on the stage
- Discovery
 - Discovery vs. Direct Instruction
 - A false choice: neither works well without the other
 - After exploration, "institutionalization"
 - Make key concepts explicit
 - students may not get there on their own
 - Clarify what is important and worth remembering

- and thus worth writing down
 - Make connections
 - with other representations
 - with previous knowledge
 - "Nothing transfers"
- Verbalizing
 - Putting things in words is crucial to understanding
 - I encourage talking
 - I require writing
- Class Discussion
 - True Discussion vs. Interactive Lecture
 - Creating a safe environment
 - No putdowns
 - I praise participation and risk-taking
 - rather than correct answers
 - "Tell your neighbor..."
 - "Can you restate what X said?"
 - Handling wrong answers
 - write down many answers, then discuss
 - poker face vs. telling
 - "Choose someone to help you"
 - Making 'mistakes' myself
 - Feedback from all
 - votes
 - gestures
 - writing
 - Variety
 - Fanfare vs. total silence
 - New problems, not same as on paper
 - Move around the room
- Homework
 - I keep it reasonable
 - most learning happens at school
 - I keep it separate from class work
 - less rushing, more cooperation
 - "Lagging"



- (constant forward motion, eternal review)

- Assessment

- Purpose

- To improve teaching
 - Diagnose student understanding and skills
 - Figure out next steps and generally fine-tune the course
- To improve learning
 - Let students know where they are
 - Provide learning opportunities

- Also...

- Prepare students for future assessments (!)
 - Rank students / assign grades
 - Justify the grades

- Variations on the quiz/test routine

- Participation quiz
 - Occasional take-home assignments
 - Test corrections

- I keep it manageable

- I give homework a quick look
 - I don't write extensive comments on tests

- because...

- When correcting work, I'm working for one student
 - When planning, I'm working for the whole class
 - A true passion for math and learning is not triggered by assessment or grades

- Sequencing topics

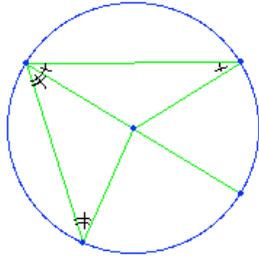
- Overall

- The weight of tradition
 - quadratic formula in Algebra 1,
 - exponential functions in Algebra 2
- Topics can and should move if they are
 - too early (with respect to student's development)
 - too late (more accessible thanks to new approaches)

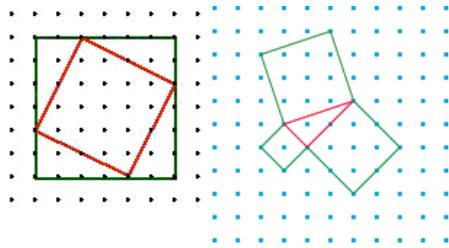
- Within a course

- do important and/or difficult topics early

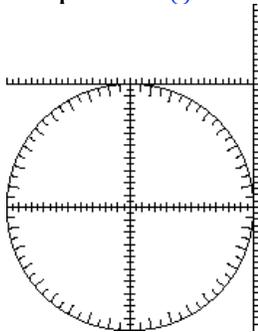
- Example: inscribed angles near beginning of Geometry



- separate related topics
 - tangent / sine and cosine
 - exponentials / logarithms
 - sequences / series
- Navigating a topic
 - concrete to abstract, and back
 - positive whole numbers to rational numbers
 - numbers to variables
 - discrete to continuous
 - Example: [the Pythagorean theorem on the geoboard](#)



- concepts to vocabulary and notation, and back
 - Example: [trig ratios on the ten-centimeter circle](#)



- difficult to easy, and back
- Teaching for Understanding
 - Skills vs. concepts
 - Another false choice!
 - In part because of technology,
 - [speed and accuracy are no longer legitimate priorities for math education](#)
 - understanding is more important than ever

- A student who understands a concept can
 - explain it
 - reverse processes associated with it
 - distribute \leftrightarrow factor
 - flexibly use alternative approaches
 - e.g. to equation solving
 - successfully handle non-rote assessments
 - navigate between multiple representations
- Understanding...
 - is difficult to encapsulate in a checklist
 - cannot be easily conferred by explanations
 - is difficult to assess
 - is not always valued by students and parents
 - **is the most important part of our job**
- Nothing works...
 - ...for every student, every class, every teacher, every day
 - I am skeptical of claims that some particular approach is the answer
 - whether 'traditional' or 'reform'
 - I don't throw away or rule out any technique
 - I try to constantly broaden my repertoire
 - I am eclectic

• **The Art of Learning**

- Teaching / Learning
 - In the end, there is no teaching...
 - ...only learning
 - Thus the goal: self-motivated students
 - Our own learning
 - about math
 - about learning
 - is what makes the job interesting in the long haul
- **There is no one way**



