

Evaluation: *Ways to evaluate math circles, what we know about how well they work, what we need to have further evidence*

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Goals/Outline of Talk

- Basics of Evaluation
 - Why to Evaluate
 - Qualitative vs Quantitative
- Math Circles for Kids
 - Developing Program Goals
 - Developing Evaluation Framework
 - Resulting Questions
- Math Teachers' Circles

Next: Workshop overview

Why to Evaluate

- Part of feedback cycle
 - What Works, What Doesn't, and How do you Know?
- Required by funders
- Helps to obtain funding

Next:

Types of Evaluation

- Quantitative (numeric)
 - Likert scale surveys
 - Student Assessment of Learning Gains (SALG)
 - Learning Math for Teaching (LMT) instrument
 - Classroom observations with numeric scale
- Qualitative
 - Open ended survey questions
 - Classroom observations – overall impression
 - Focus Group
 - Interviews

Next:

A Few Notes

- **Quantitative** (numeric) data often makes mathematicians feel more comfortable, but it does not address cause, just effect
- **Qualitative** data
 - Can get at causal effects and the “why”.
 - Can be done rigorously
- Be cautious about self-report data on changes

Next:



San Francisco Math Circle Evaluation.

A lesson in moving from “How did it go” to understanding if we met the program goals



SFMC Program Goals

At San Francisco Math Circle we hope to develop a Safe Mathematical Community for individual students and teachers involved in the program which will result in:

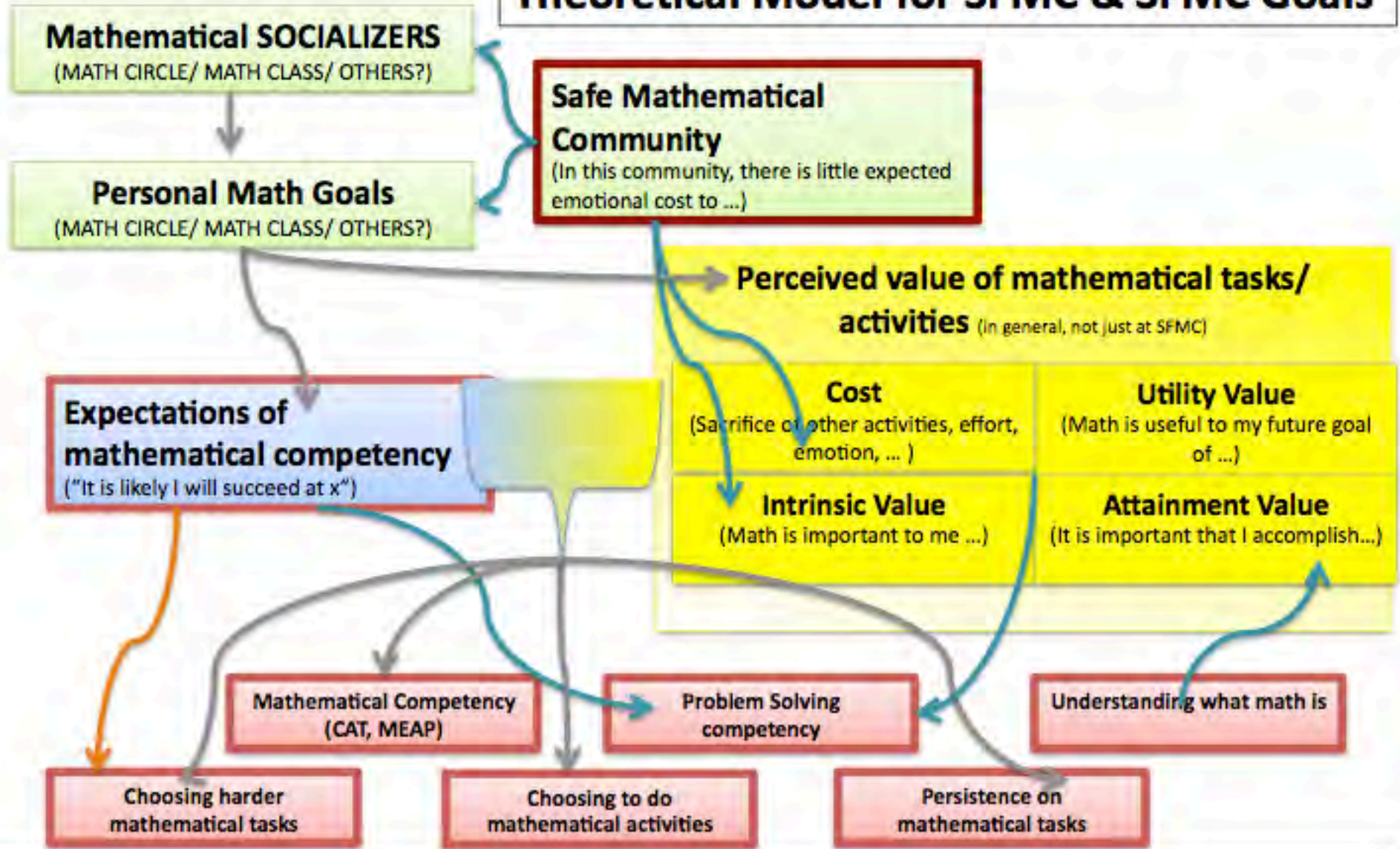
- increased individual mathematical competency;
- increased problem solving competency;
- individual students choosing to do mathematical activities;
- individuals students choosing to explore harder mathematical tasks;
- increased persistence on mathematical tasks;
- an increased understanding of what math is.

Creating the Theoretical Model of Evaluation of San Francisco Math Circle

The literature has shown a strong connection between the SFMC goals and the measurable values of:

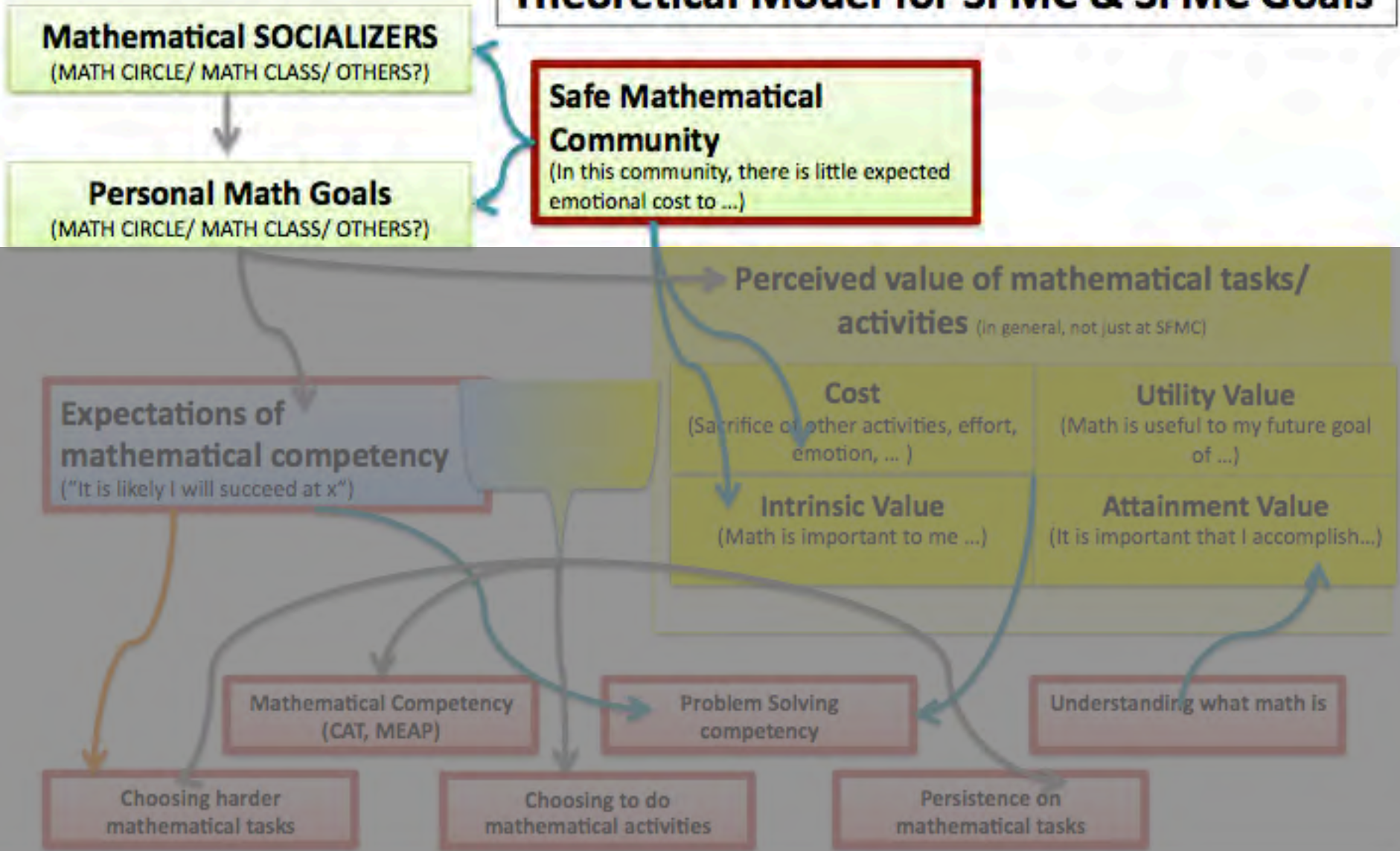
- Personal expectations of mathematical competency;
- Personal values of mathematical tasks and activities.
 - Utility Value – Math is useful for my future goals
 - Intrinsic Value – Math is important to me
 - Attainment Value – It is important that I accomplish...
 - Cost – Sacrifice required to participate in math

Theoretical Model for SFMC & SFMC Goals



Symbol	Meaning/ Role	Implication for writing evaluation report
→	"influences"	Need to argue why A -> B influences either by a summary (citation) of someone else's work or by your own argument.
Boxes	A theoretical construct	Need to definite it, in a sentence (if applicable) followed by a paragraph of citations for who researched it.
	SFMC GOAL	

Theoretical Model for SFMC & SFMC Goals

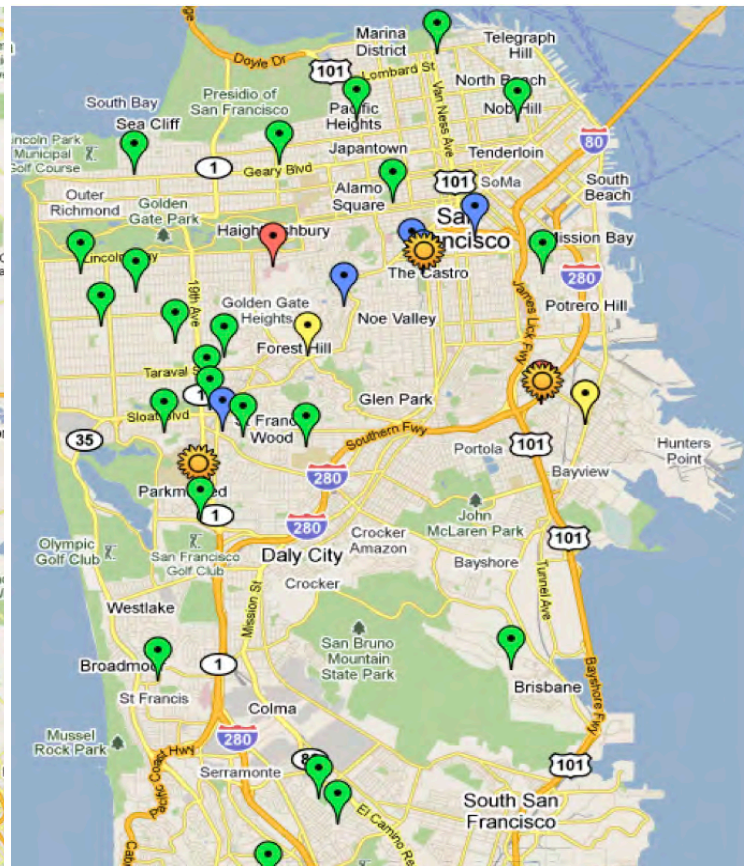
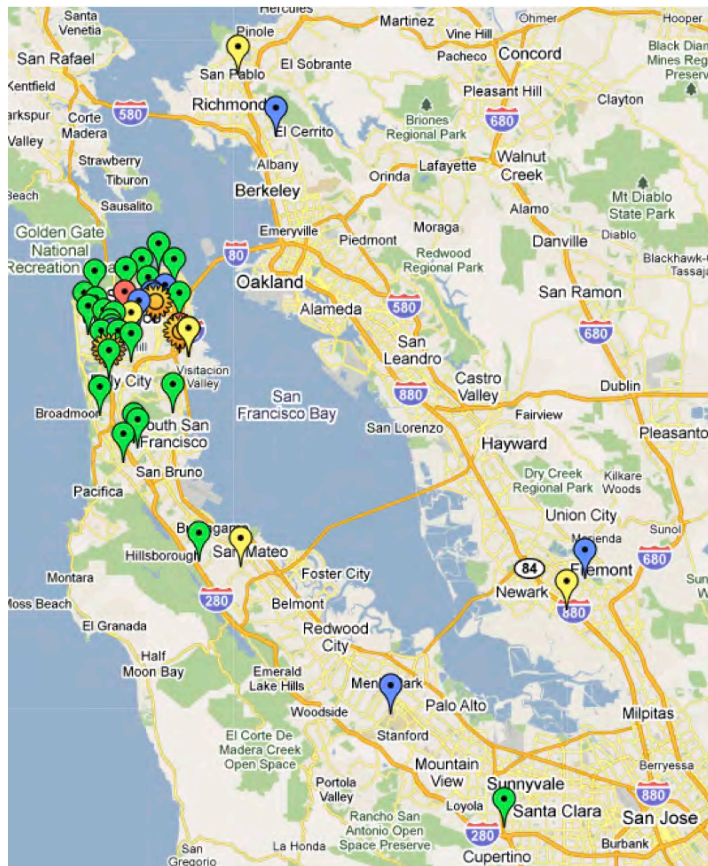


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Mathematical SOCIALIZERS
(MATH CIRCLE/ MATH CLASS/ OTHERS?)

Personal Math Goals
(MATH CIRCLE/ MATH CLASS/ OTHERS?)

Safe Mathematical Community
(In this community, there is little expected emotional cost to ...)



SFSU students & teachers



Mission students & teachers

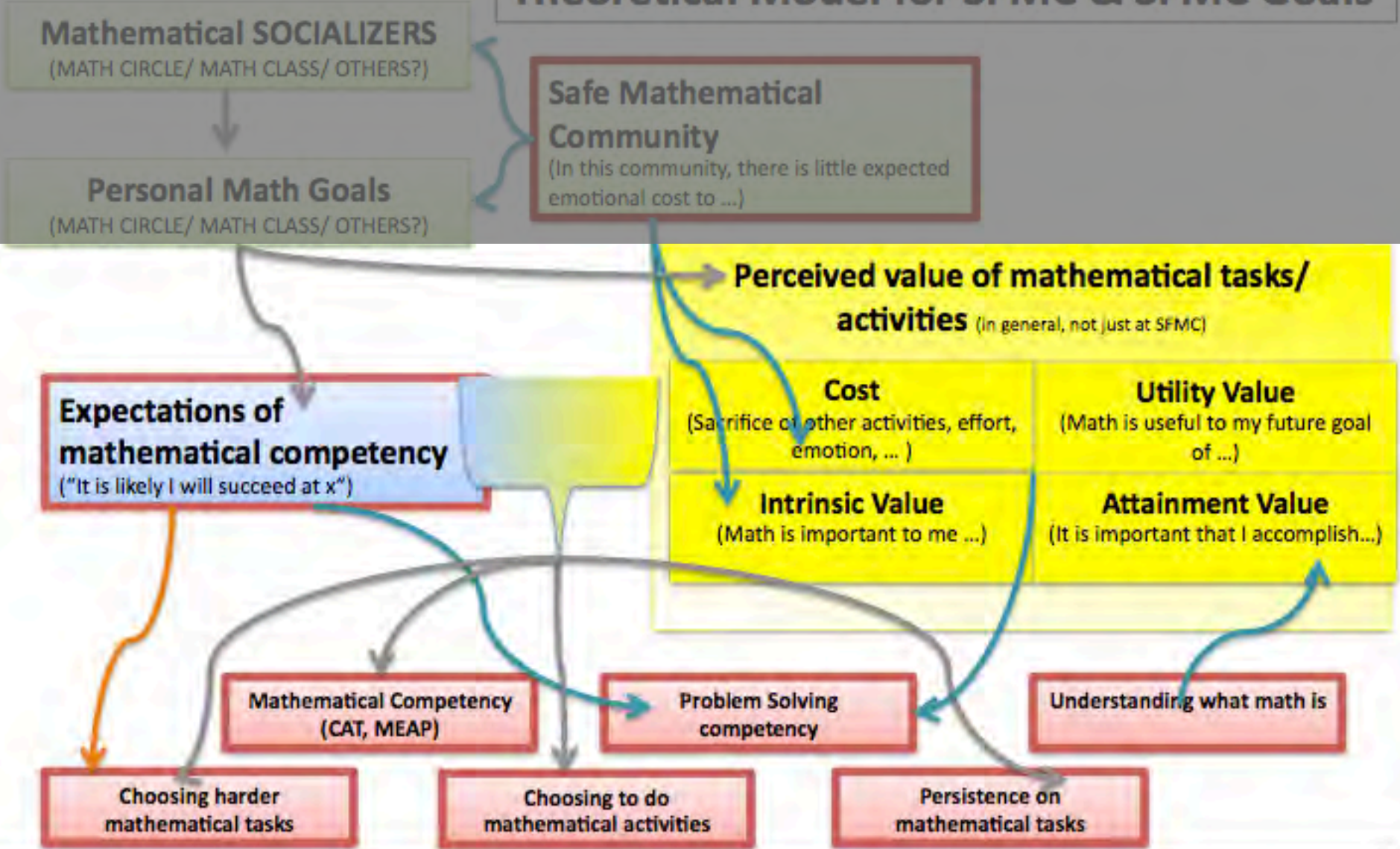


Bayview students & teachers



SFSU teachers

Theoretical Model for SFMC & SFMC Goals



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Perceived Value of Mathematical Tasks/ Activities

Value: Interest

enjoyment the individual gets from performing the task.

Evaluation Questions

- **Q:** I enjoy the subject of math.
- **Q:** I enjoy studying math in my school math class.

Perceived Value of Mathematical Tasks/ Activities

Value: Interest

enjoyment the individual gets from performing the task.

Evaluation Results

- Interest in math increased over the course of the year
- Students in Math Circle, both pre and post survey, have the highest interest in mathematics.
- There is a consistent theme throughout the surveys that the students expressed frustration with classroom mathematics after having been involved in Math Circle.

Perceived Value of Mathematical Tasks/ Activities

Value: Utility

how the task relates to future goals.

Evaluation Questions

- **Q:** Math will be useful for me later in life.
- **Q:** I need to have good mathematics problem-solving skills to be successful in the future.

Perceived Value of Mathematical Tasks/ Activities

Value: Attainment,

the importance to the self of doing well on a task.

Evaluation Questions

- **Q:** Being good at problem solving in math is important to me.
- **Q:** It is important to me to be a person who reasons mathematically.
- **Q:** In addition to getting the right answer in mathematics, it is important to understand why the answer is correct.
- **Q:** Compared to most of your other activities, how important is it for you to be good at math?

Perceived Value of Mathematical Tasks/ Activities

Value: Cost

the accumulated negative aspects of engaging in the task, and the amount of effort required to succeed at the task.

Evaluation Questions

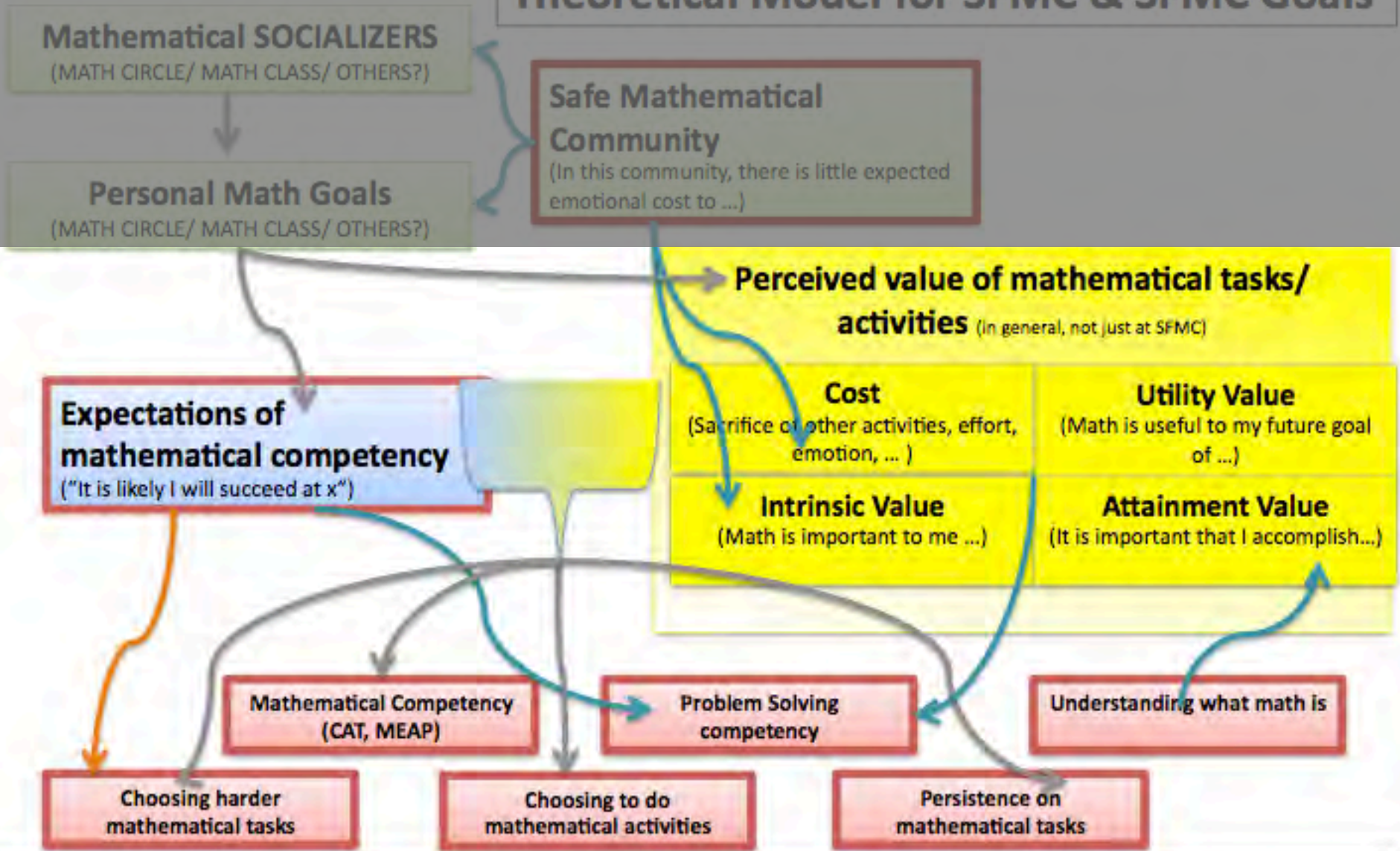
- **Q:** I would rather be in my math class than my other classes.
- **Q:** Hard math problems scare me.

Ability/ Self-Efficacy

Evaluation Questions

- **Q:** Some kids are better in one subject than in another. For example, you might be better in math than in reading. Compared to most of your other school subjects, how good are you in math?
- **Q:** How well do you expect to do in math this year?

Theoretical Model for SFMC & SFMC Goals



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Nature of Mathematics

Evaluation Questions

- **Q:** Have you met a mathematician before?
- **Q:** Describe what a mathematician is. What do they do all day?
- **Q:** Problem solving is an important part of mathematics

Safe Mathematical Community

Evaluative Questions

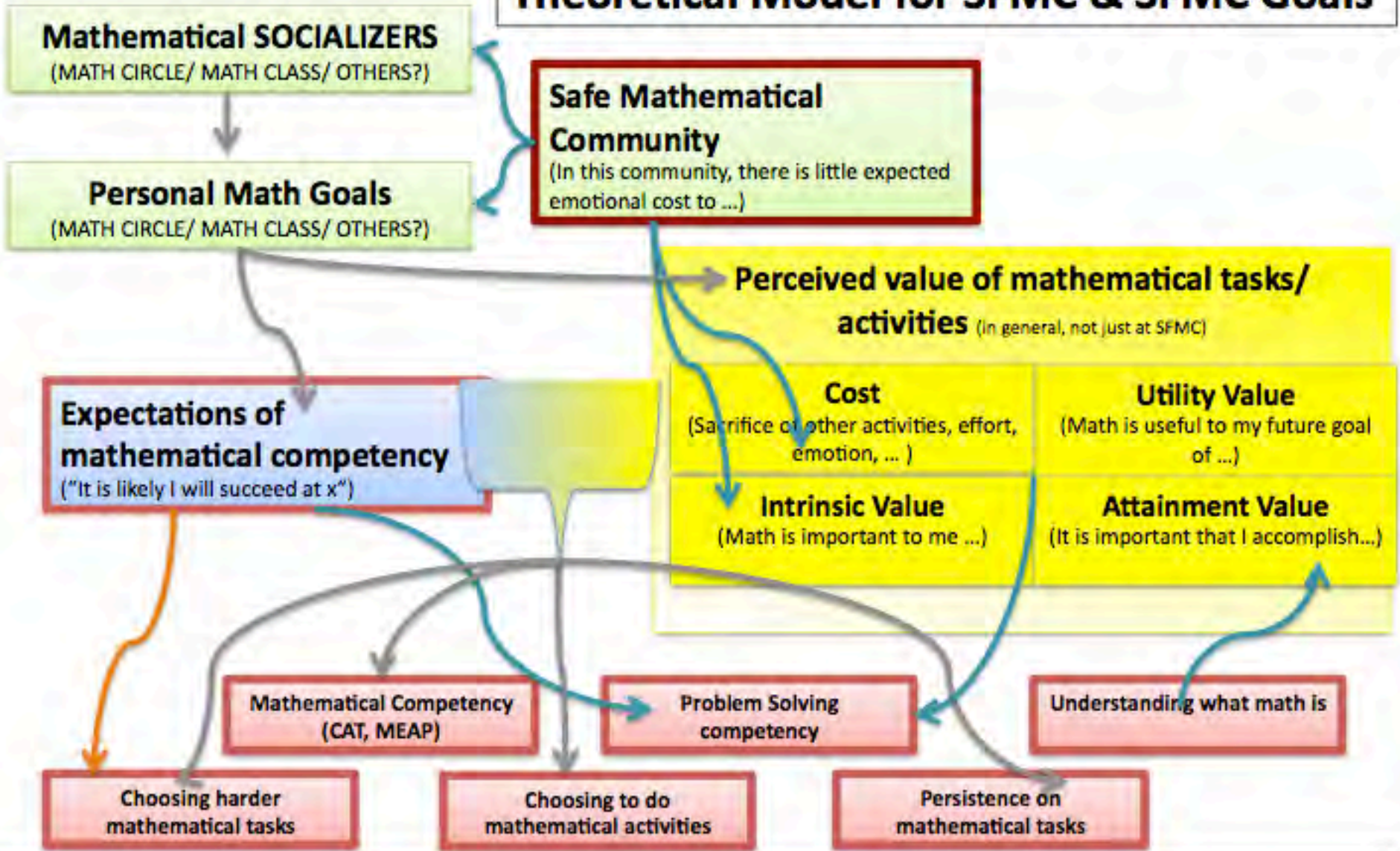
- **Q:** Being a Math Circle participant is a major part of who I am.
- **Q:** In our math class, it's OK to make mistakes as long as you are learning.
- **Q:** In my math class my teachers would like me to do challenging math problems, even if I make mistakes.
- **Q:** I have friends in my Math Class.

Safe Mathematical Community

Evaluation Results

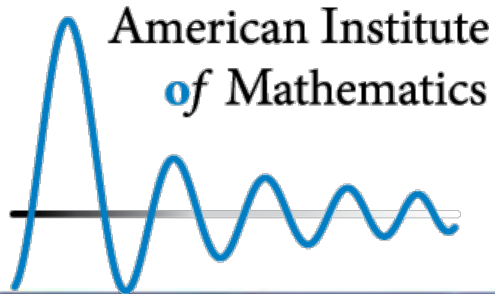
- Students indicate it is safe to make mistakes while learning
- Math Circle students indicate that it is important to think and reason mathematically
- All Math Circle students indicate: In my math class my teachers would like me to do challenging math problems, even if I make mistakes.
- Math Circle students have friends in Math Class

Theoretical Model for SFMC & SFMC Goals



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Math Teachers' Circles



Evaluating MTCs

- Impact on teachers' attitudes, beliefs, and self-efficacy with regard to the teaching and learning of mathematics
- Impact on teachers' Mathematical Knowledge for Teaching
- Impact on teachers' skills related to problem solving and the Common Core State Standard – Standards for Mathematical Practice
- Impact on teachers' classrooms

Next: MKT

What are Educational Standards?

- Educational Standards
 - Provide clear goals for student learning
 - Help teachers ensure students have skills and knowledge to be successful
 - Ensure common learning topics from teacher to teacher, school to school and state to state
- Do **not** prescribe to teachers how to teach, but rather help teachers know what *knowledge and skills* students should develop.

Common Core State Standards

- Significant step toward a nationwide set of criteria and expectations for math learning in grades K-12
- Include both Content Standards and Standards of Mathematical Practice
- NOT a curriculum, suggest different ways curricula could be developed
- Research and evidence-based
- Informed by top-performing countries
- Aligned with college and career readiness

Common Core State Standards – Standards of Mathematical Practice

MP1: Make sense of problems and persevere in solving them

MP2: Reason abstractly and quantitatively

MP3: Construct viable arguments and critique the reasoning of others

MP4: Model with mathematics

MP5: Use appropriate tools strategically

MP6: Attend to precision

MP7: Look for and make use of structure

MP8: Look for and express regularity in repeated reasoning

Mathematical Knowledge for Teaching

“By *mathematical knowledge for teaching*, we mean the mathematical knowledge used to carry out the work of teaching mathematics.” (Hill, Rowan, & Ball, 2005).

■ Examples

- Explaining terms and concepts to students
- Analyzing students' solutions
- Judging and correcting textbook treatments
- Using representations accurately in the classroom
- Providing students with examples of mathematical concepts, algorithms, or proofs

Next: LMT Study Description

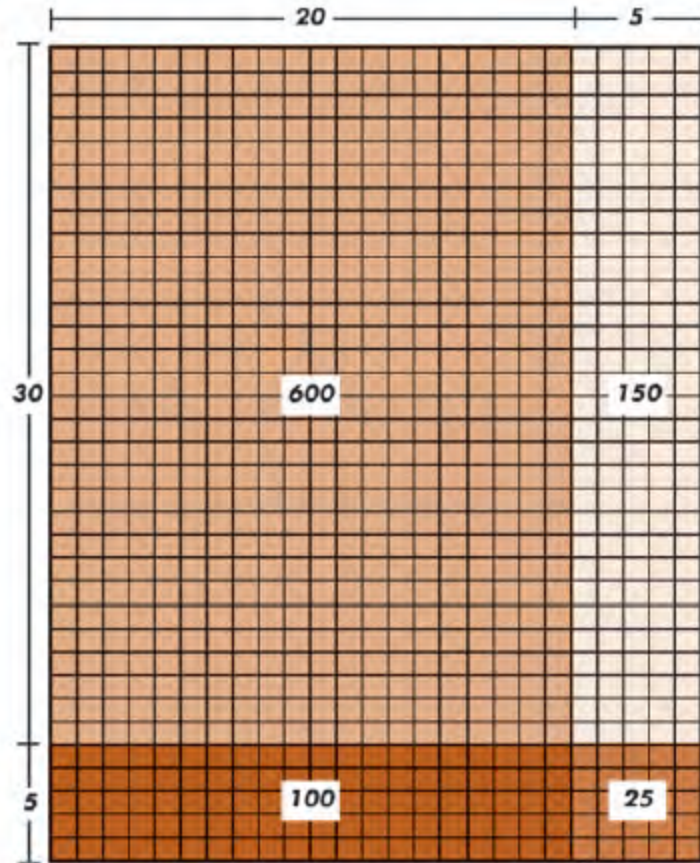
Analyzing Student Solutions

- Determine if each student is using a method that could be used to multiply any two whole numbers.

Student A	Student B	Student C
$\begin{array}{r} 35 \\ \times 25 \\ \hline 125 \\ +75 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 175 \\ +700 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 25 \\ 150 \\ 100 \\ +600 \\ \hline 875 \end{array}$

Next: Analyzing Student Solutions

Using Representations in the Classroom



Judging and Correcting Textbook Treatments

- An *equilateral* triangle is a triangle with sides of equal length, angles of equal measure, and where each interior angle is 60 degrees

Analyzing Students Solutions

- There were 64 teams at the beginning of the NCAA basketball tournament. There are 5 starting players on each team. How many starting players were there at the beginning of the tournament?
 - That would be 64 times 5. I use one 10 because I know 5 times 10 is 50. Then you do that six times. That's 30, I mean 300. Then you add 4 five times, which is 25, no 20. I added it all together and got 320.
 - 64 means 60+4. So I did 60 five times, for 300. Then 4 times 5 is 20, so the answer is 320
 - I split 64 into four parts – 20, 20 , and 20. I did each separately: 20 times 5 is 100, 20 times 5 is 100, 20 times 5 is 100. Then the last part, 4 times 5, is 20. All together 320.

Next: Research Questions

Learning Math for Teaching Instrument

- Measures Mathematical Knowledge for Teaching
- Developed at University of Michigan
- Extensively tested to establish psychometric soundness
- Has been linked to increased student achievement in a large scale study (Hill, Rowan & Ball, 2005)

Next: Study Results

Qualitative Data

- End of workshop evaluation forms
- National survey: Fall 2010
 - 169 teachers from 13 MTCs
- Final summer immersion workshop surveys: Summer 2010, Summer 2011
 - 49 teachers, 3 sites and ~120 teachers, 6 sites

Next: Content Knowledge

Surveys – Summer Workshops and Annual Survey

- Method of Analysis - Constant Comparative Method
- Main Categories of Responses
 - Participant as Learner
 - Participant as Teacher
 - (Participant as Mathematician)
 - Other

Next: Mystery Quote

Future Directions and Goals

- Replicate and expand quantitative piece on Mathematical Knowledge for Teaching
- Continue annual survey and final workshop surveys
- Changes in teachers' problem solving
- Case studies and classroom observations of teachers who participate in MTCs – impact on classroom practices, especially with regards to mathematical problem solving

Key Ideas

- Learn about the culture & environment of your audience.
- Set and know your goals – BEFORE.
- Use what is already done – don't start from scratch. Use others as resources!
- Think critically about what you are doing and why – both implementation and evaluation.

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