

The CPR of Mathematics

Strategies for LEP Students,
Strategies for ALL Students

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U.S. Department of Education • Teacher to Teacher Initiative • Supporting Success



Outcomes for Session

- Presenting the research and rationale for **imbedding the process standards** into math instruction
- Establishing the need for including **both skills-based and process-based activities** into the **direct instruction** of mathematics
- Participating in strategies & activities for **developing process-based instruction to accompany skills-based activities**

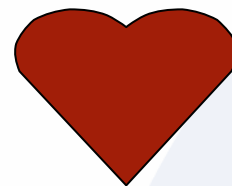


Problem Solving Quiz

1. How do you put a giraffe into a refrigerator?
2. How do you put an elephant into a refrigerator?
3. The Lion King is hosting an animal conference. All the animals attend ... except one. Which animal does not attend?
4. There is a river you must cross but it is used by crocodiles and you do not have a boat. How do you manage it?



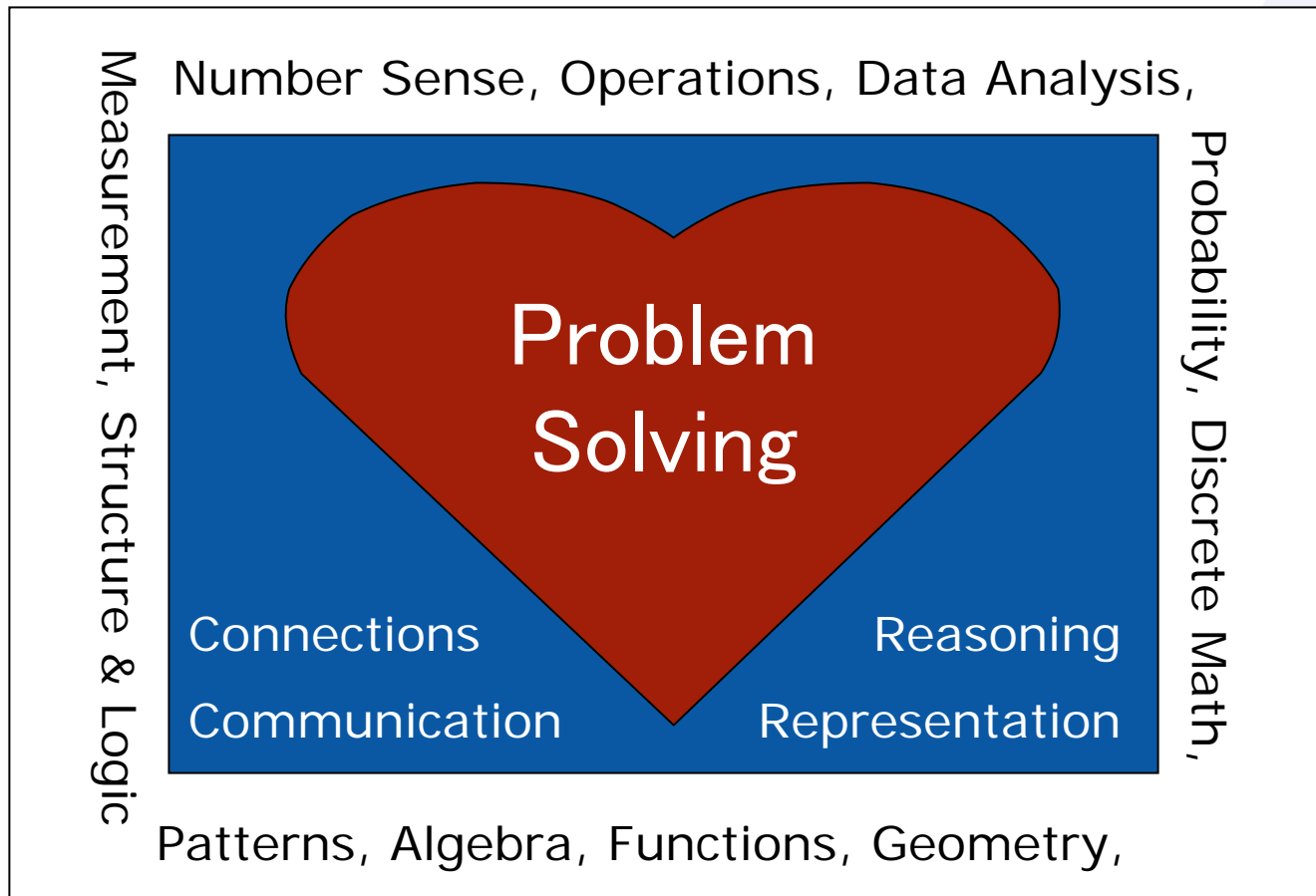
What Are the Five Process Standards?



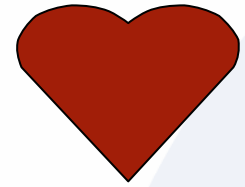
1. Communication
2. Connections
3. Problem solving
4. Reasoning and proof
5. Representation



The CPRs of Mathematics



Big Ideas: CPRs



- **Problem solving is at the heart of mathematics**, and the processes (CPRs) that go along with it are critical.
- True mathematics involves **both skills & processes** (CPRs).
- The mathematics processes (CPRs) help us **connect math skills** to each other as well as to real-life



Relevant Research and Theory

- Students do not talk about mathematics naturally, **teachers need to help them** learn to do so (Cobb, Weed, and Yackel, 1994).
- ELL students may need some **additional support in communicating mathematical ideas**, but if instruction is structured appropriately, they can fully participate (Silver, Smith, and Nelson, 1995).
- Asking children to **explain why incorrect answers are incorrect** are associated with high levels of mathematical learning in Japan (Stigler & Perry, 1990) and in the U.S. (Siegler, 2002).



Relevant Research and Theory

- Marzano (2001) recommends the use of **non-linguistic representations** including
 - Creating graphic representations (Robinson, 1996)
 - Making physical models (Welch, 1997)
 - Generating mental pictures (Willoughby, et. al, 1997)
 - Drawing pictures and pictographs (Macklin, 1997)
 - Engaging in kinesthetic activity (Druyan, 1997)
- **Visual literacy** has long been recognized as a neglected area in education (Box and Cochenour, 1994).
- The ability to use **diagrams** effectively is integral to mathematical thinking and learning (Nickerson, 1994).

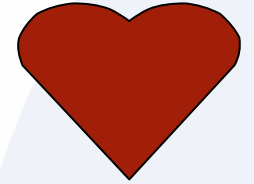


Evidence of Success

- Research from Marzano and others works
- Student achievement at Echo Mountain Primary School in Phoenix, Ariz., in the area of mathematics rose from **48% to 90%** based on state testing (AIMS: Arizona's Instrument for Measuring Success) after implementing several of these strategies



Best Practices: Communication



- Marzano on communication
 - Vocabulary
 - Writing in math
 - Questioning techniques
 - Discourse
 - Reciprocal teaching
 - Cooperative learning
- Other best practices (Zemelman)
 - Reading, writing, listening, presenting
 - Literature-based teaching



Skills-Based Activity

Write the definitions for each word:

polygon

quadrilateral

pentagon

heptagon

line

line segment

ray

angle

edge

vertex

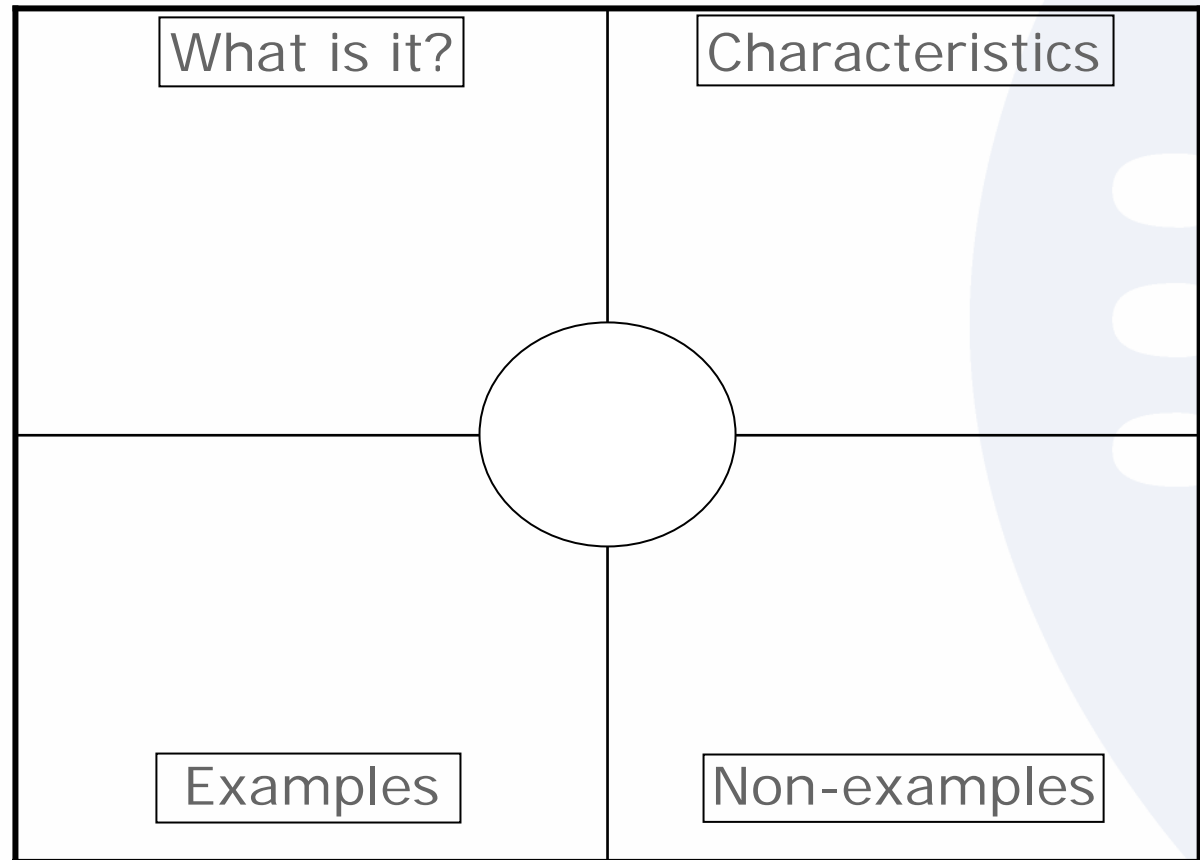
vertices

closed figure









Process-Based Activity

Frayer Model



Skills-Based Activity

Solid	How many?							
	Faces	Edges	Vertices	Triangles	Rectangles	Squares	Circles	Curved surfaces
Cube 								
Rectangular Prism 								
Pyramid 								
Cylinder 								
Cone 								
Sphere 								



Process-Based Activity

The Important Book by Margaret Wise Brown



Best Practices-Connections



- Marzano on connections:
Integrated units
- Other best practices (Zemelman)
 - Connecting math to other subjects
 - Connecting math to the real world
 - Connecting topics within mathematics
 - Applying mathematics



Skills-Based Activity

$75 \times 4 =$

$36 \times 7 =$

$98 \times 3 =$

$34 \times 2 =$

$88 \times 7 =$

$53 \times 6 =$

$92 \times 9 =$

$45 \times 7 =$

$76 \times 3 =$

$38 \times 9 =$

$24 \times 3 =$

$78 \times 8 =$

$63 \times 5 =$

$29 \times 6 =$



Process-Based Activity

Headline News

The headline is ...

$$7 + 4 = 11$$

$$3 \times 8 = 24$$

$$876 \div 2 = 438$$

$$3/4 \div 1/8 =$$

What is the story?



Connecting Math Ideas

Number sense and operations	Data analysis, probability and discrete math	Patterns, algebra and functions
Geometry	Measurement	Structure and logic



Best Practices-Problem Solving



- Marzano on problem solving
Hypotheses
- Other math best practices (Zemelman)
 - Problem solving steps
 - Problem solving strategies
- Problem solving
 - **Word problems** with a variety of structures and solution paths
 - **Everyday problems** and applications
 - Problem-solving **strategies**
 - **Open-ended problems** and extended problem-solving projects
 - **Investigating** and **formulating questions** from problem situations



Problem Solving Steps

- Understand
- Plan
- Solve
- Check

Problem Solving Song

Problems come along
In many different ways
Follow these steps and you'll
find

Solutions all your days
State the problem, find the
facts,

Choose a strategy
Solve, then check your
answer so it's

All that it should be.



Problem Solving Strategies (Process Problems)

1. Draw a picture
2. Make a chart/table
3. Make an organized list
4. Act it out
5. Work backwards
6. Look for a pattern
7. Solve a simpler problem
8. Use a model
9. Use logical reasoning
10. Guess and check
11. Use numbers



Skills-Based Activity

Continue each pattern.

3, 6, 9, 12, _____, _____, _____, _____, _____

1, 2, 4, 8, _____, _____, _____, _____, _____

98, 95, 92, _____, _____, _____, _____, _____

121, 232, 343, _____, _____, _____, _____



Process-Based Activity

Miss Spider's Functions



Best Practices-Reasoning & Proof



- Marzano on reasoning and proof
 - Discourse
 - Writing in math
 - Presentations
- Other math best practice (Zemelman)
 - Drawing **logical conclusions**
 - **Justifying** answers and solution processes
 - Reasoning **inductively** and **deductively**



Skills & Process-Based Activity

Solve

$$34 \times 7$$

Math Talk



Skills-Based Activity

Use pattern blocks to create a pattern. Then label the pattern with numbers or letters.



Process-Based Activities

- Miss Spider's tables
- Mathematician's notebook

Also known as

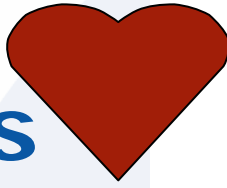
- Writing journals (Writing-to-Learn)
- Representation journals (Representing-to-Learn)
- Learning logs
- Math journals

Record a daily record of what was done in math

- Patterns (with or without labels)
- Pictures of sorted groups
- Pictures of story problems (glue problem strip onto pages)
- Organized lists (e.g., addition facts)



Best Practices-Representations



- Marzano on representations
 - Pictorial
 - Non-linguistic
 - Charts, tables, graphs
 - Graphic organizers
 - Imagery
- Other math best practices (Zemelman)
 - Discuss the problem in **small groups** (language representations)
 - Use **manipulatives** (concrete, physical representations)
 - **Act it out** (representations of sequential actions)
 - Draw a **picture, diagram, or graph** (visual, pictorial representations)
 - Make a **list or table** (symbolic representations)



Skills-Based Activity

Solve each story problem. Write each answer with a number and a label.



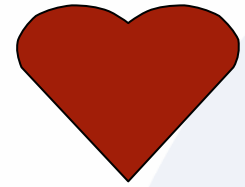
Process-Based Activity

“Miss Spider’s Number Books”

Multiple representations of numbers



Let's Review: One-Minute Madness



- What is at the heart of mathematics?
- What does true mathematics include?
- How can I connect all the math skills with each other and with real life?



Implementation Activities

- **3** – List 3 new things you learned from this session
- **2** – Select 2 things you'll try with your students
- **1** – What is the 1 thing you can't wait to run out of here and try?

