

# **AMTE – Spring 2010**

## **“Moving Beyond Word Problems: What is True Problem Solving?”**



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# The Re-Occurring Problem...



- Problem solving is equated to “word problems” in the field and with current college students.
- Part of the crusade with this presentation is to increase the awareness that problem solving is much more than “word problems.”
- Brahier (2009) states in his math methods book – a problem that a student looks at and does not readily know how to solve the problem or what the answer is, gives a foundation to problem solving.

# What Is a Problem?

## A Problem

Any task or activity for which the students have no prescribed or memorized rules or methods, nor is there a perception by students that there is a specific “correct” solution method.

From J. Hiebert et al., *Making Sense: Teaching and Learning Mathematics with Understanding* (Portsmouth, NH: Heinemann, 1997).

# How does this work?



- Tale of Two Districts
- Tale of Elementary and Middle Grades Coursework for Teacher Preparation



# International



- **TIMMS**

- ✦ **Why are we (U.S) not doing as well as other countries?**
  - Findings - Procedures vs. Making Connections
  - When teachers (8th grade) are giving problem solving scenarios, in all countries that were doing well, teachers will allow students to make connections to the problem. Students need to get to the independent level of making connections to the problem.
  - Question - Do the questions need to have a connection to what we are doing?
  - Answer - Problem Solving needs to be embedded in what is currently going on in the curriculum.

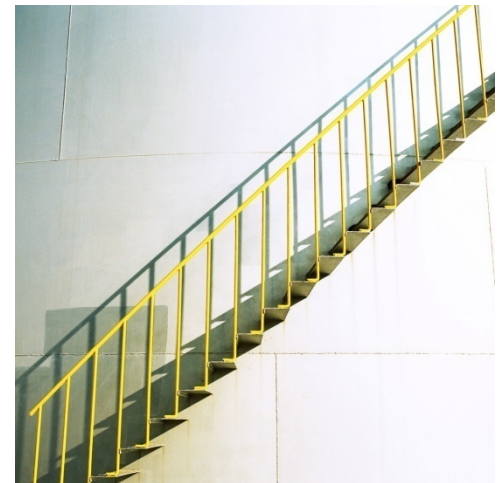
# Great Article to Use in Class!



- Problem Solving research article – “Teaching Mathematical Problem Solving: Implementing the Vision” by McIntosh and Jarret (2000)
  - ✦ Quote on top of page 4 about questioning students to find out what they are thinking
  - ✦ Why teach open ended problem solving?
  - ✦ Pages 15-18 - how to teach problem solving, types of questions to ask
  - ✦ Pages 20-21 - how to find good problem solving tasks

# Levels of Problem Solving

- Word Problems
- Applied Skills – ISTEP+ type problems
- Open-ended Problem Solving
  - Refer to literature
    - ✦ “Teaching Mathematical Problem Solving: Implementing the Vision”



# Word Problem Example

- Number 2 from ISTEP+ 2003 Fall Grade 6:
- Willis earns \$11 a week mowing lawns. He wants to earn enough money to buy a video game system that costs \$110. Find the actual number of weeks it will take Willis to earn enough money to buy the video game system.
- Maps to:
  - Computation:
    - ✦ 5.2.1 Solve problems involving multiplication and division of any whole numbers.
  - Problem Solving:
    - ✦ 5.7.7 Make precise calculations and check the validity of the results in the context of the problem.



# Applied Skills Problem Solving Example

- Willis earns \$11 a week mowing lawns. He wants to earn enough money to buy a video game system that costs \$150. On the lines below, explain how you would estimate the number of weeks it would take Willis to earn the money to buy the video game system.
- 
- 
- 

Now find the actual number of weeks it will take Willis to earn enough money to buy the video game system.

- ***Show All Work***

# Problem Solving Example

- Willis earns \$10-25 a week mowing lawns. He wants to earn enough money to buy a video game system that costs \$150. Give a minimum of 3 ways in which he can earn the money to purchase the game system. (Show work)
- Which way would be the most efficient way to earn the money? Explain.



# Grafitti Activity



## Thought #1

- “Students who must resort to memorizing will lack understanding and will likely feel little sense of satisfaction, perhaps withdrawing from learning altogether. In fact, he says, evidence suggests that if students memorize and practice procedures repeatedly in a rote fashion, it’s difficult for them to go back later and gain a deeper understanding of the mathematical concepts underlying those procedures.”

## Thought #2

- “Teachers will sometimes find themselves in the uncomfortable position of not knowing the solution. Letting go of the ‘expert’ role teachers have traditionally played requires experience, confidence, and self-awareness.”

## Thought(s) #3

- There needs to be a shift of what “understanding” and “learning” might really mean.
- “A problem is not necessarily solved because the correct answer has been made. A problem is not truly solved unless the learner understands what he has done and knows why his actions were appropriate.”

## Thought(s) #4

- Selecting good problems is the key – “problems need to be hard enough to present a challenge without being so difficult as to be a total mystery.”
- “Traditional teaching approaches involving rote learning and teacher-centered instructional strategies often do not meet the learning needs of many students who may be active learners or require multiple entrances into the curriculum.”

## Thought(s) #5

- “Often, teachers mistakenly correlate problem solving with word problems.”
- “In open-ended problem solving, the problem will have multiple possible answers that can be derived by multiple solution methods. The focus is not on the answer to the problem, but on the methods for arriving at an answer. Genuine problem solving requires a problem that is just beyond the student’s skills level so that she will not automatically know which solution method to use. The problem should be nonroutine, in that the student perceives the problem as challenging and unfamiliar, yet not insurmountable” (Becker, & Shimada, 1997)



## Thought #6

- “Many students view mathematics as a routine, mundane, static set of facts and rules to be learned primarily through memorization rather than as an evolving, expanding science of inquiry and experimentation that is discovered and created through experimentation and conjecture.”

## Thought #7

- “[Good problem solvers] must learn persistence and the ability to tolerate a certain amount of frustrations. To develop these abilities, students need to experience the frustration and exhilaration of struggling with and overcoming a daunting intellectual obstacle.”

## Thought #8

- “Students in mathematics classes that do not emphasize problem solving are being deprived, as well, of the feelings of exhilaration and empowerment that come from mastering a difficult problems. They are not developing the tools and the confidence they will need to tackle the types of problems that will occur in their working and personal lives. They often fail to gain a deeper conceptual understanding that comes from constructing one’s own mathematical truths through deep thinking.”

# A Shift in the Role of Problems



Away from:

- Explain, practice, then story problems
- One way (the teacher's way)
- Show and tell approach with the student as a passive learner
- Problem-solving problems as a separate activity
- Expecting explicit directions for how to solve problems

# A Shift in the Role of Problems



- Good problems start with ideas that students already have.
- Students learn mathematics as a result of problem solving.
- Children are learning mathematics by doing it!



# Problem Solving



- Teaching for problem solving
  - teaching skills, then providing problems to practice those skills
- Teaching about problem solving
  - teaching strategies
- Teaching through problem solving
  - teaching content through problems (focus of this chapter & theme of the book!)

# Teaching about Problem Solving

**THIS IS AN IMPORTANT PART OF TEACHING THROUGH  
PROBLEM SOLVING**



# Problem-Solving Strategies




- Draw a picture
- Look for a pattern
- Guess and check
- Make a table or chart
- Try a simpler form of the problem
- Make an organized list
- Write an equation





# The Value of Teaching Through Problem Solving



- The focus of the students' attention on ideas and sense making
- Develops the belief in students that they are capable of doing mathematics and that mathematics makes sense!
- Provides a context to help students build meaning for the concept
- Allows an entry point for a wide range of students

# The Value of Teaching Through Problem Solving (*Continued*)

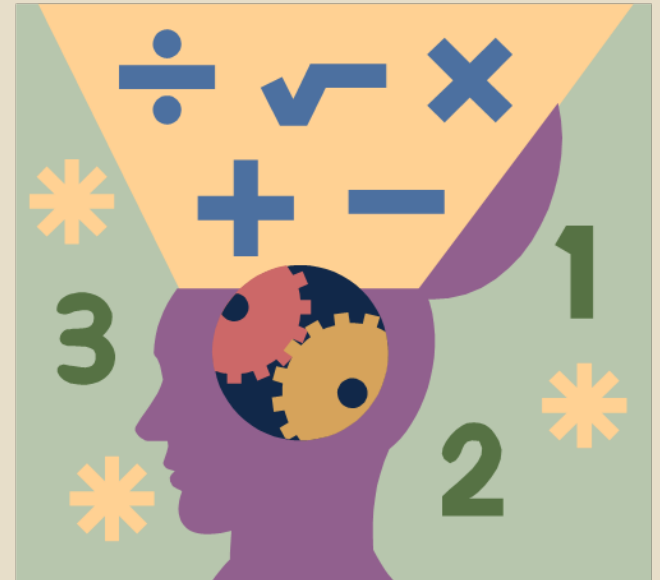


- Provides ongoing assessment data that can be used to make instructional decisions, help students succeed, and inform parents
- Allows for extensions and elaborations
- Engages students so that there are fewer classroom discipline problems
- Develops “mathematical power”
- It is a lot of fun!

# Teaching in a Problem-Based Classroom



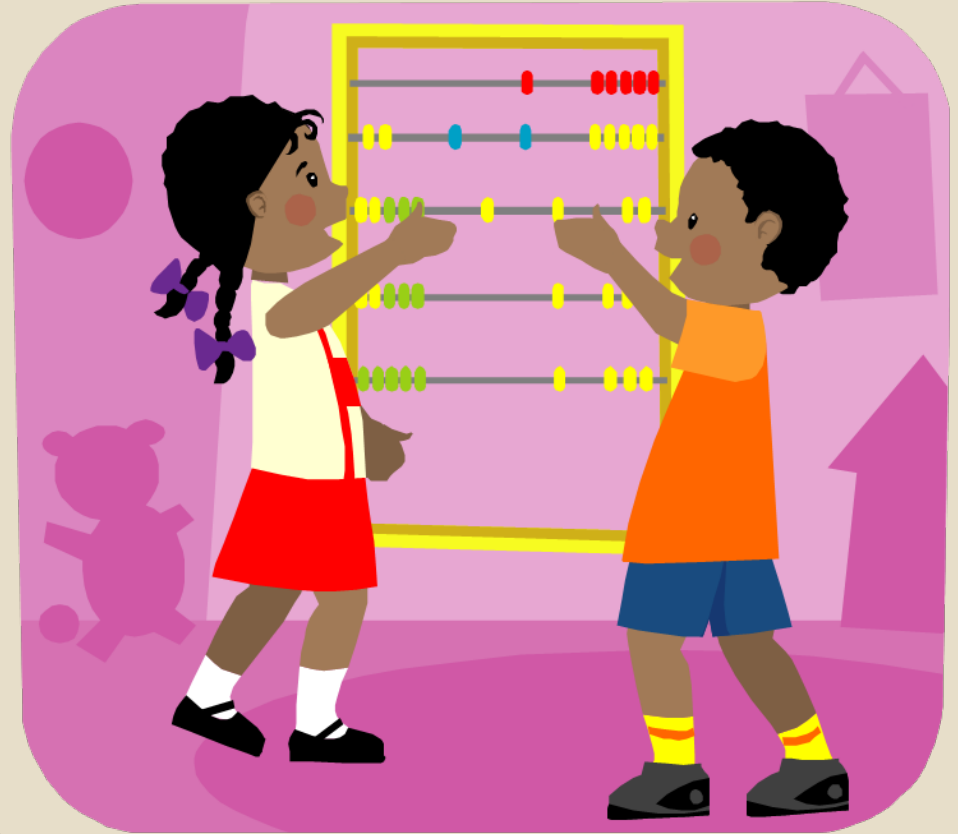
- Let students do the talking
- How much to tell and not to tell
- The importance of student writing
- Metacognition
- Disposition
- Additional goals



# Talk Moves Time to Compare and Share



- Revoice
- Repeat/rephrase
- Agree/disagree
- Add on
- Wait time



Chapin, S. H., O'Connor, C., & Anderson, N. C. (2003). *Classroom discussions: Using math talk to help students learn, grades 1-6*. Sausalito, CA: Math Solutions Publications.

# How do we teach Problem Solving?

- Develop understanding of strategies
  - Examine *Problem Solver* materials
  - Examine Textbook Series
  - Look at state and national Standards
- Determine what strategies fit in at what level and to what degree
  - Model, Supported, Independent
    - ✦ “Gradual Release of Responsibility”
- How do we ensure that problem solving instruction does not have gaps and/or overlapping?
  - Scaffolding of instruction between grade levels

# Possible Structure of Problem Solving Instruction?

- Idea: Problem Solving Cycle
  - Example:
    - ✦ 7 – 10 days on one strategy (EX: Four Frames Math)
      - 2 days of modeling
      - 3 days of collaborative partner or small group practice
        - Teacher supported
        - Homogeneous grouping recommended
      - 2 days of independent problem solving
        - Maybe the last is the assessment day
    - ✦ 15 minutes maximum per day every day

# Reflective Quotes!



**WHAT DO THE TEACHER CANDIDATES  
PERCEIVE???**

# Middle Grades Teacher Candidates – As Learners





## Stretched Personal Learning



- “This course has been one of the most difficult courses I have ever taken. I have believed that I am a good math student. I work hard, try to ask good questions and listen to instruction. For this class being a good math student did not make me a good problem solver. This class has stretched my learning capacity. It has taught me to read for understanding, all numbers are not needed for a solution and break problems down into smaller pieces. Sometimes learning is not easy. I believe with practice and hard work learning can become easier and as a better learner I can become a better teacher.”

## Multiple Ways – Multiple Solutions



- “I have learned this semester that there are many ways to approach a problem to solve it. People think in different ways and use different strategies to come up with the answer. There is not always one ‘right answer’ people can interpret the problem in different ways and think differently. Problem solving has really made me realize that when I am teaching in my own classroom it is important to have students solving problems because it requires them to think on a higher level.”

## Have not Been Prepared Up to Now!



- “I remember the day I received my textbook *Crossing the River with Dogs* in the mail. I thumbed through Chapter 1, and I could already feel anxiety beginning to build. Then, I thumbed through Chapter 10, and I thought to myself, ‘There is no way we will make it through Chapter 10 this semester. Is this man a miracle worker?’ I have never considered myself a problem solver in the least. I love math (specifically algebra), but logical thinking and critical thinking type problems have never been my strong suit. Throughout my years in middle school and high school, I remember teachers skipping the longer problems in the ‘back of the chapter.’ At 14, I would think ‘Thank God I don't have to do those problems!’ Now, I feel that those teachers did me a disservice by not expecting me to do more problem solving. Had I been held to that standard, I would have found a way to meet my teachers' expectations.”

# Middle Grades Problem Solving Course Data



- Solve by Steps
  - $6/23 = 26\%$
- Strategies/Multiple Ways
  - $19/23 = 83\%$
- Multiple Solutions
  - $4/23 = 17\%$
- Stretched Own Learning
  - $7/23 = 30\%$
- Manipulatives
  - $1/23 = 4\%$

# Elementary Math Methods



# They Have to Struggle



- “You must allow the students to figure it out for themselves. You can guide them a little bit, but if they never struggle, they may never truly understand the concept.”

# More than One Way to Get an Answer



- “There is more than one way to get an answer. As teachers, we must always try to understand where the student is coming from and why they are thinking or solving the problem the way that they are. Everyone thinks differently, and as teachers, we must seek out every child to make sure that they are understanding the concept being taught. And, if they do not understand, we should try to teach them a different method so that they can understand.”

# Modeling Problem Solving



- “On important aspect I learned is to specifically model a problem-solving strategy to students. During my problem-solving lesson is my original format, I neglected to do this. When I included it in the lesson I taught, I found that students were more able to complete the problem solving lesson with greater ease and support.”



# Lack of Exposure



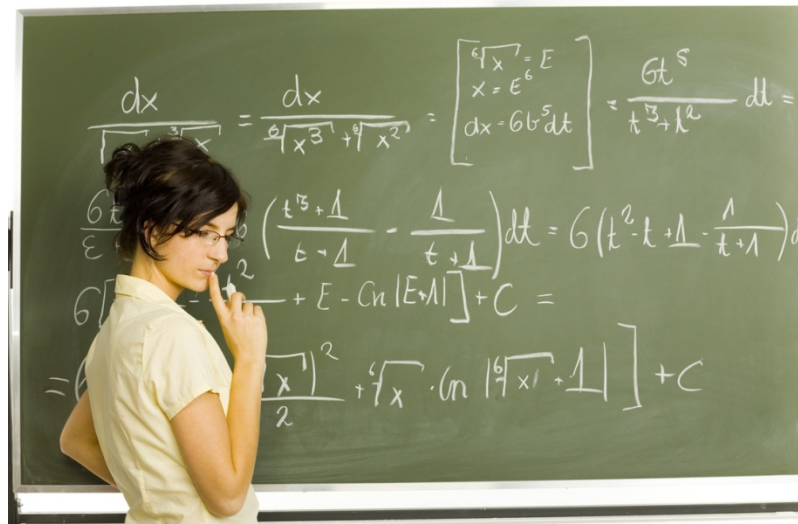
- “The most important aspect about problem solving is that it should be used regularly. My students struggled because they had never been exposed to problem solving before. This made my activity difficult. I learned that children need to be challenged constantly with problem solving, in order for them to be successful at solving a simpler problem.”

# Elementary Math Methods Course Data



- Solve by Steps
  - $1/72 = 1\%$
- Strategies/Multiple Ways
  - $67/72 = 93\%$
- Multiple Solutions
  - $2/72 = 3\%$
- Stretched Own Learning
  - $5/72 = 7\%$
- Manipulatives
  - $16/72 = 22\%$

# Middle Grades Math Methods – As Teachers



# More than Memorization and Repetition



- “My philosophy of teaching mathematical problem solving has changed quite a bit. I used to always think math was a lot about memorization and repetition because that is how I learned how to do math. I have now realized it’s much more important to focus on concepts and problem solving, and it’s okay if students have to use calculators (the last one has been difficult for me to recognize). Problem solving will be essential in my classroom.”

# Different for Everyone



- “To remember that problem solving is different for everyone. That people can read the same problem differently & that you should be open to differences from your students.”

# Problem Solving – Beyond Math



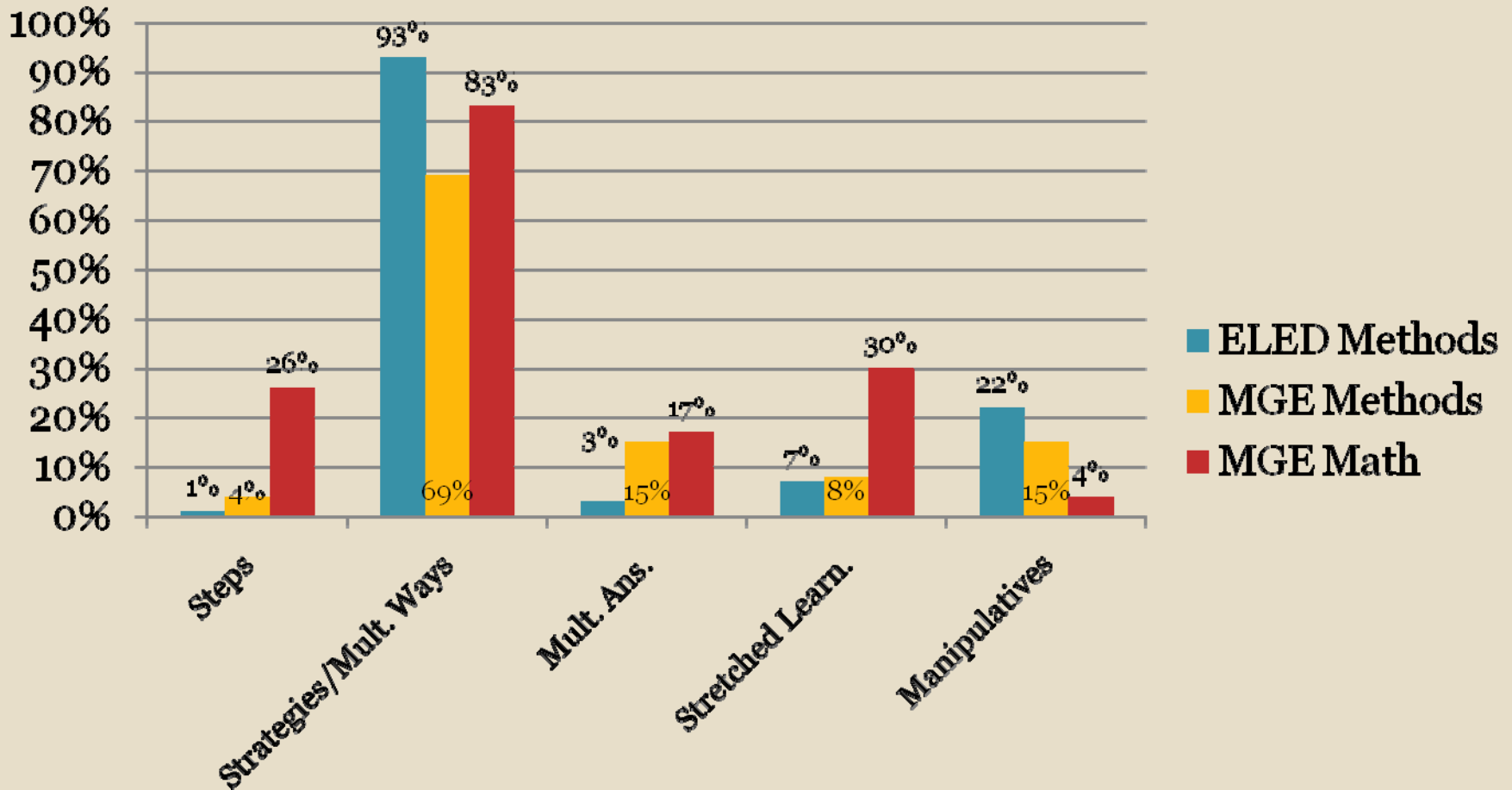
- “My philosophy...hard to put in a few words. But I’m convinced that problem solving is essential to being a rational–logical person, not just in the realm of mathematics. In teaching problem solving I know how to remember students need to struggle to learn and there are more ways than one to arrive at a solution.”

# Middle Grades Math Methods Course Data



- Solve by Steps
  - $1/26 = 4\%$
- Strategies/Multiple Ways
  - $18/26 = 69\%$
- Multiple Solutions
  - $4/26 = 15\%$
- Stretched Own Learning
  - $2/26 = 8\%$
- Manipulatives
  - $4/26 = 15\%$

# Summary of Data from Quotes





# Concerns in the Comments



- “Though problem solving is a key component of mathematics, I think it’s difficult to teach lower (academic) level middle school students such concepts.”
- “I also know how hard it is to teach, but I’ll keep at it.”
- “All of math is problem solving.”
- 1. read the problem carefully and understand it
  2. transfer into the math language as numbers
  3. apply the concept or get a pattern to solve the problem.

# Questions and Suggestions?



**WHAT DO YOU FIND INTERESTING FROM THE  
DATA?**

**WHAT DO YOU BELIEVE WOULD BE GOOD  
NEXT STEPS FOR US?**