Best Practices for Teaching Math Story Problems: Schema-Based Strategy Instruction

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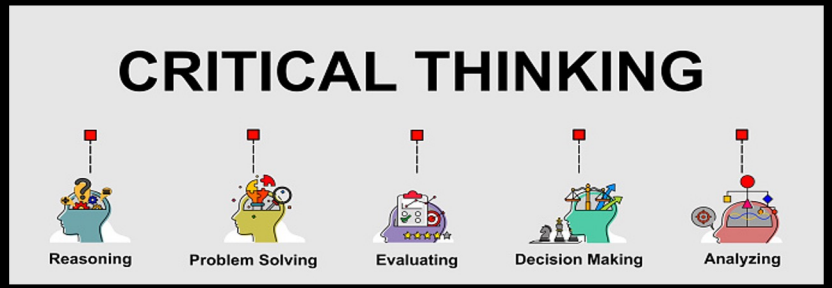
What is a story (word) problem?

Word problems:

- typically defined as written descriptions of problem solutions
- wherein one or more questions are raised the answer to
- which can be obtained by the application of mathematical operations to numerical data available (Verschaffel et al., 2014)

Why is it so important for students to solve story problems?

- Mental representation skills
- Problem-Solving skills
- Analytical and Reasoning skills
- Reading comprehension skills



Why do students struggle with math story problems?

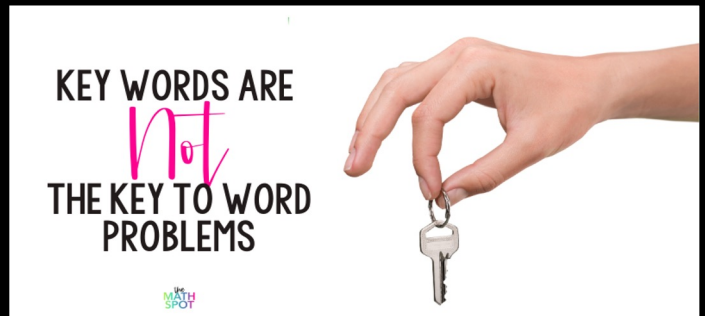
- Complexity of language
- Lack of math knowledge
- Focus on keywords and numbers
- Applied to both deaf and hearing

The Processes of Solving a Story problem (Mayer, 2006)

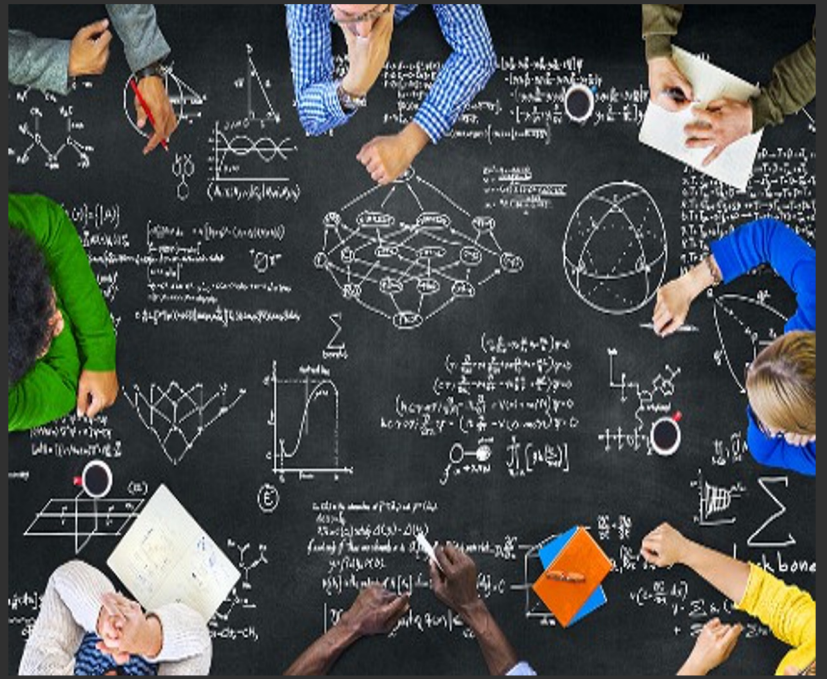
Problem solving	Stages	Knowledge
Problem comprehension	Representing	- Factual knowledge - Conceptual knowledge - Linguistic Knowledge
	Planning/monitoring	- Strategic knowledge
Problem solution	Executing	- Procedural knowledge
	Self-regulating	- Metacognitive knowledge

Why we do not use the keyword strategies anymore!!

- Powell, NamKung, & Lin (2022)'s research
  - Analyzed 747 high-stakes released items across grades 3 through 8 grade
  - 690 text-based items: 69% for directive word problems and 31% for routine word problems
  - Less than a 50 % keyword match rate for one-step problems and less than a 10% match rate for multi-step problems



Group Discussions



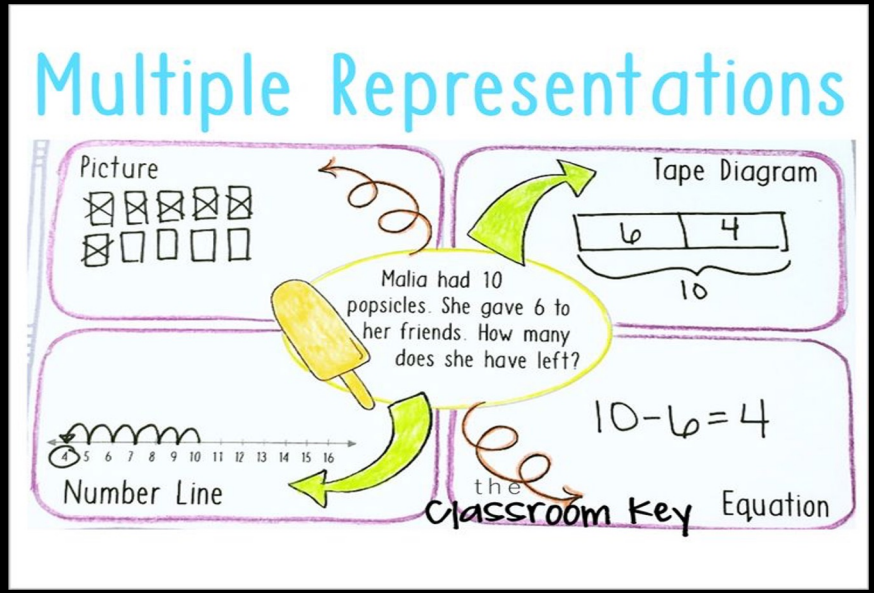
Key word	Associated operation	Used operation	Problem in which the key word strategy fails
Altogether	addition	?	1. Alice bought 4 cartons of eggs with 12 eggs in each carton. How many eggs does Alice have *altogether*?
More	Addition	?	2. Colin had some crayons. Then, he bought 12 *more* crayons. Now, he has 90 crayons. How many crayons did Colin have to start with?
Fewer	Subtraction	?	3. Paulo picked apples. Zach picked 12 *fewer* apples. If Zach picked 20 apples, how many apples did Paulo pick?
Left	Subtraction	?	4. Liz shared 55 candies equally with 3 friends. After sharing, how many candies were *left* over?
Each	Multiplication	?	5. Miles had 3 trays of building blocks with the same number of blocks on each tray. If Miles had 75 blocks altogether, how many were on each tray?
Double	multiplication	?	6. Margaret bought double the songs as her sister. If Margaret bought 12 songs, how many songs did her sister buy?
Share	division	?	7. Salman collected 18 quarters to share equally among his friends. After sharing, he had 3 quarters remaining. How many quarters did Salman share?
Divide	Division	?	8. Cam divided 5 pieces of paper into fourths. How many pieces of paper does Cam have now?

Whole Discussions

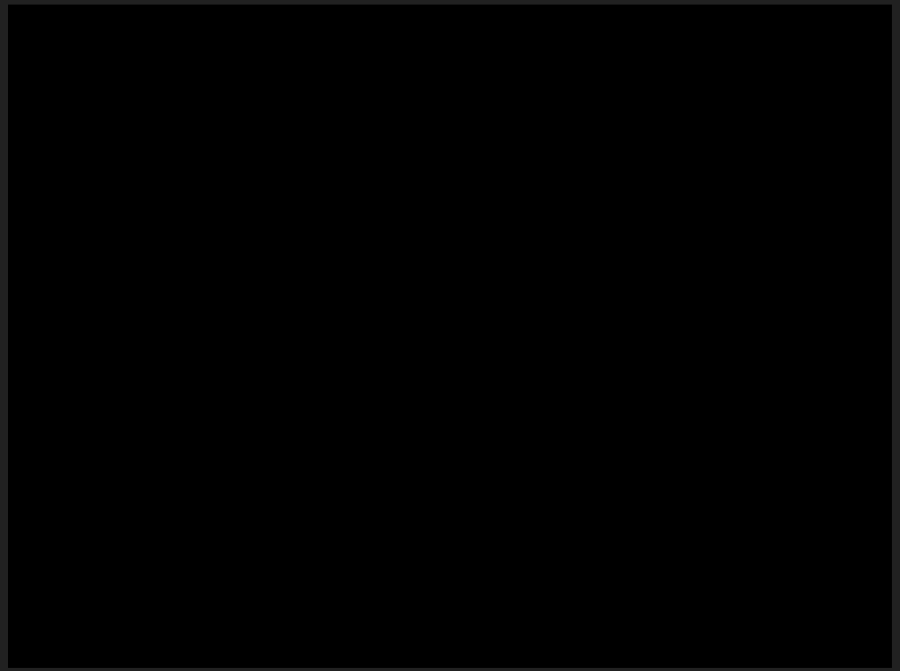
What are your findings on the use of the keyword strategy for math problem solving?

How should we teach math story problems?

Using Schema-based Strategy Instruction:



What is schema-based strategy instruction?



- A method that teaches students to identify problem types based on a given problem’s underlying structure, or schema

- Stress understanding of the situation represented in the problem

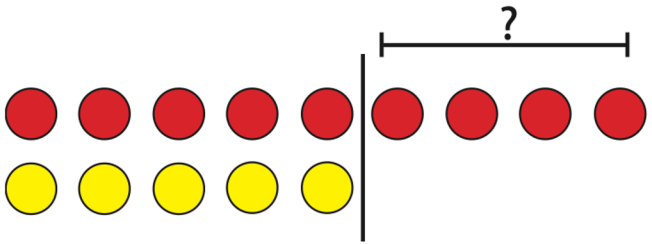
Using schema-based strategy instruction to solve word problems

1. Read and understand the text, including mathematics vocabulary
2. Be able to identify and separate relevant information from irrelevant information
3. Represent the problem correctly
4. Choose an appropriate strategy for solving the problem
5. Perform the computational procedures
6. Check the answer to ensure that it makes sense

(adapted from Stevens and Powell, 2016; Jitendra, et al., 2015)

Example 1.

1. Gillian has 9 red counters and 5 yellow counters. How many more red counters than yellow counters she have?



Think Addition:

$5 + (4) = 9$

5 of the red counters would match the 5 yellow. You would have to add on 4 more to get 9.

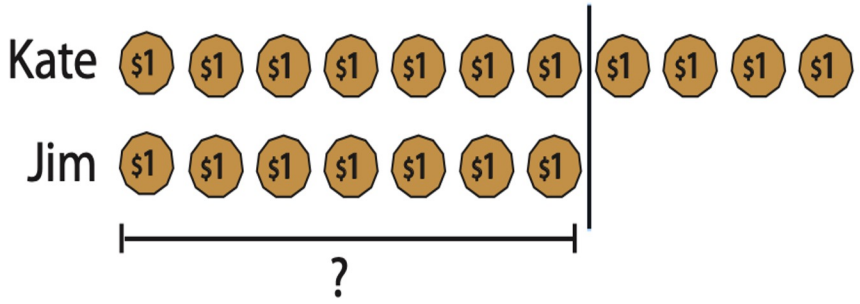
Think Subtraction:

$9 - 5 = (4)$

Subtract 5 red counters that match the yellow 5 counters, leaving you with a difference of 4

Example 2.

Kate has $11. This is $4 more than Jim. How much money does Jim have?



Think Addition:

$7 + 4 = 11$

What plus four is eleven?

Think Subtraction:

$11 - 4 = 7$

Start with the $11 to match what Kate has, then subtract 4 to get the $7 Jim has.

Best Practices for Teaching Story Problems

1. Schema-based instruction strategy
2. Talk and visualize the problem
3. Discuss the relevant vocabulary in contexts
4. Use visual and manipulate materials
5. Use conceptually based signs and avoid inventing signs for vocabulary
6. Allow productive struggles in the classroom
7. Provide non-routine/challenge problems
8. Conceptualize problems visually and discuss the context before selecting strategies to solve them
9. Double check the process of solving the problem and answer

Questions/Answers

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