Comprehending Math - What Literacy Instruction Can Show Us About Teaching Math

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We have been teaching students how to become better readers and writers for years. With mentor texts, we teach our students about the different genres, text structures, and features that exist within books. Students learn how to identify characters and plots, retell events, or set up a table of contents to reflect the main idea and details of a new writing piece.

The good news is, we can use these same instructional choices during our math instruction. Just as books have a variety of text structures (narrative, informational, biographical) and features (characters, events, language, labels) so too, do math word problems. When we show students how to identify these structures and features within math problems, we increase their ability to comprehend them, solve them, and eventually become the authors of their own math stories. Research shows that readers who can identify the structure of a text are better able to locate the information they need for successful comprehension (Williams, J.P., 2003). This is exactly the result we are looking for when students are solving word problems. We want students to identify the text structure of a math problem, recognize which part is missing, and use questions and known relationships to solve for the missing value.

Problem Structures

There are four basic structures to math word problems, as identified by Thomas Carpenter and his colleagues in their groundbreaking book, *Children's Mathematics*, published in 1999 (2nd edition 2013):

Join/Separate: In these problems, there is some action. There is a starting quantity; something is added or taken away; and there is a new quantity at the end. The mathematician must decide which is missing and find its value based on the others.

- *There are 3 kittens in the basket. 1 kitten climbs out. How many kittens are in the basket now? (Separate, result unknown)*
- *The teacher sharpened 30 pencils. He put an equal number of pencils into each pencil box. He filled 6 pencil boxes. How many pencils did he put in each box? (Partitive division (similar to separate),amount in each group unknown)*
- *Mark has some money in his wallet. He has $520 in the bank. All together he has $137. How much money does Mark have in his wallet? (Join, start unknown)*

Part-Part-Whole: In these problems, parts make up a whole, but there is no action or change. One or more parts or the whole may be missing.

- *"There are 100 automobiles on a lot. How many could be cars? How many could be trucks?"*
- *"A dealership has 7 rows of cars, with 10 in each row. How many cars are there?*

Comparison: In these problems, two quantities are compared.

- *The average giraffe weighs 750 pounds. That is 15 times as much as the average monkey. How much does the average monkey weigh?*
- *Joseph has 9 dollars. Margaret has 14 dollars. How much more money does Margaret have than Joseph?*

Rate: In these problems, there is a direct relationship between the two quantities. A change in one causes a change in the second.

- *Henry earns $15 per hour. How much will he earn in 8 hours?*

Relating Text Structures to Problem Structures: Join/Separate and Narrative

Let's think about how the basic structures of math word problems mirror those of fiction and non-fiction texts. Part-Part-Whole and Comparison problems have structures similar to those of informational texts. Part-Part-Whole problems are a description of one time and one place, a bit like the main idea and details in a book. Comparison problems have structures similar to compare/contrast informational texts, like a diagram that compares the heights and weights of animals or a book that asks the reader to compare and contrast summer and fall. Rate problems, too, can mirror informational texts.

Right now, though, let's focus on Join/Separate problems. These problems follow a narrative structure and typically contain characters, a setting, and a plot/action in the form of a verb. There is a flow to the problem with a beginning, middle, and end. Think about the kitten problem above: the characters are kittens, the setting is a basket, and the action is one kitten climbing out.

From a very early age children are exposed to narrative text structures; they learn to follow along with the adventures of characters, wonder about problems, and anticipate endings. This exposure implicitly builds children's ability to organize stories in their minds, predict what may come next, and ask relevant questions when meaning breaks down.

For example, research shows that children typically learn to solve start-unknown problems through trial and error (Carpenter, 2003). However, understanding structure can make challenging problems more comprehensible for students. By using graphic organizers to explicitly link narrative text structures to word problems, and annotating the features and structures within them, students are better able to determine the unknown variable and use numerical relationships to solve problems. Additionally, many children are able to apply this knowledge of structure and become the authors of their own math problems.

References

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