



# Direct Teaching and Scaffolding the Comprehension of Arithmetic Word Problems

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## Abstract

Some children can't solve arithmetic word problems accurately because they don't understand the problem language. Using a single-subject pilot design, we tested a Direct Instruction + Vygotskian Scaffolding approach to facilitate second graders' ability to solve two types of arithmetic word problems. The learning trajectories of two second graders will be discussed.

## Background

- Arithmetic word problems are difficult for all children; even more so for children with low oral language skill (Cowan, Donlan, Newton, & Lloyd, 2005; Samelson, 2009).
- Evidence shows that oral language skill underlies the development of formal mathematical skill (Fazio, 1999; Samelson, 2009).
- To solve an arithmetic word problem successfully, a child must:
  - process and comprehend the linguistic message
  - access background knowledge of the relationships between sets of numbers
  - determine the underlying problem structure/schema
  - select a solution strategy and calculate the solution (Mayer, 2003)
- The comprehension process involves 1) attending selectively to a linguistic signal, 2) creating a mental representation of that input, and 3) integrating this representation with existing knowledge (Cirrin, 2000).
- A child needs to be able to connect word meanings with the formal wording and syntax of a problem (i.e. the 'language' or 'register' for math) before being able to determine the problem structure and select a solution strategy (Schleppegrell, 2007).
- Prior research has demonstrated that children generate a wide variety of strategies to solve problems and depending on the nature of the task and the goals of the child, certain strategies are 'selected' and used (Siegler, 2005).
- Children tend to resort to preferred default strategies when they are not sure how to interpret a word problem (Cummins, 1991).
- Two types of arithmetic word problems that are especially difficult for first and second grade children are *Compare 4* and *Compare 6* word problems (Riley, et al., 1983).

### EXAMPLE PROBLEMS:

- Compare 4:** Tigger has 9 stars. Mickey has 7 fewer stars than Tigger. How many stars does Mickey have?
- Compare 6:** Dinosaur has 7 ice cream cones. He has 3 fewer ice cream cones than Panda. How many ice cream cones does Panda have?
- In *Compare* problems a child must compare the difference between two distinct quantities. Both problems contain the phrase 'fewer than'; however, the child must subtract in one and add in the other. In *Compare 6* problems the child must also interpret the referent for a pronoun in order to solve the problem correctly.

## Approaches

### Direct Instruction:

- Step-by-step process used to assist children who struggle academically
- Break concepts down into smaller tasks
- Manipulate objects to facilitate conceptualization of the problem
- Review skills frequently
- Ask the child questions and allow them to ask questions
- Provide immediate feedback
- Assess progress
- Repeat experience with the words and problem structures to facilitate breadth and depth of meaning

### Vygotskian Scaffolding:

- Structure learning tasks so that task difficulty is within the child's Zone of Proximal Development, i.e. the child's ability to complete the task with assistance
- Responsibility for successful task completion is gradually shifted from adult to child until the child can complete the task independently

## Aims & Methods

To date, very little research specifically combines Direct Instruction and Vygotskian Scaffolding approaches to facilitate the comprehension and solution of basic arithmetic word problems.

### Aims:

- Facilitate a child's ability to solve arithmetic word problems by increasing the child's awareness of specific words in the problems and more-appropriate solution strategies
- Through a combination of approaches, encourage a child to make connections, identify important information, predict solution strategies, and summarize

### Participants:

- Two typically developing second graders who struggle with arithmetic word problems and comprehension in the classroom

### Methods:

- The primary investigator conducted all sessions. An initial baseline measure assessed the participants' ability to solve *Compare 4* and *Compare 6* word problems (presented orally) and identified the participants' incorrect solution strategies.
- An intervention script, incorporating both Direct Instruction and Vygotskian Scaffolding approaches, guided and structured the intervention sessions with each child.
- Individualized scaffolding was provided during each session.
- Successive sessions were modified according to the child's previous performance.
- Probes were conducted at the end of each session to measure performance.
- A final baseline was obtained two weeks post-intervention to measure retention.

### Selected References:

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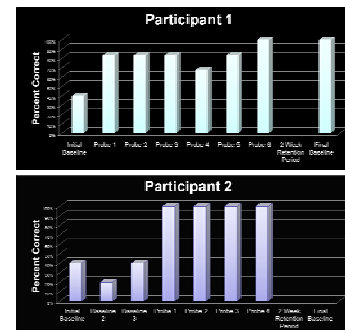
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## Results & Discussion

### Results:



### Anecdotal Observations:

- Results indicated that combining Direct Instruction and Vygotskian Scaffolding approaches facilitated problem comprehension and solution.
- Participants used "math talk" and "think aloud" strategies to solve the problem correctly.
- Participants' verbal explanations increased in complexity from the beginning of intervention to the end of intervention.
- Participant 1: **Probe 1 and 2:** No verbal explanations.
- Probe 3:** "I gave him 6 because the story told me to."
- Probe 4, 5, and 6:** "I'm going to give him 6 because the story told me to. I'm going to give the other guy 6 because I'm starting with the same amount. I'm going to give 4 to the other guy because the problem says 'he (the first guy) has fewer', which means less, but I have to add. I can't take any from the first guy because we already know how many he has."
- Participant 2: **Probe 1:** "I took away 4 and now he has 5."

- Probe 2:** "I gave 8 bones to Dog and 8 bones to Duck because I'm comparing and in the beginning you give them both the same and then you find out the numbers and the words. I took 2 away from Duck and now he has 6. It said 'fewer' so I took 2 away."
- Probe 3 and 4:** "I gave 6 bones to Dog and 6 bones to Duck because I'm comparing and in the beginning you give them both the same and then you find out the numbers and the words and then who has more and who has less. It said 'Duck has fewer', which means less or not as many, so I have to take 2 from Duck. Now Duck has 2 less bones than Dog or Dog has 2 more bones than Duck."

### Future Directions:

- We aim to repeat this study with more participants, followed by a pilot study with children with low oral language skill.

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