Are diagrams always helpful tools? The effect of presentation format on students’ solutions of algebra problems

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Experiment 1: Method
Participants: 373 middle school students
- 121 Sixth Grade
- 117 Seventh Grade
- 135 Eighth Grade

Procedure
- Written test including many types of problems
- 3 algebra problems presented as equations, story, or story + diagram
- Three counterbalanced forms of the test; each of the three problems was represented in each of the three formats for one of the forms

Background:
- Problem representation is an important educational issue
- Presentation format can have a big impact on students’ learning (e.g., Cummins et al., 1988)
- Two relevant dimensions for solving algebra problems
  - Equation vs. story format
  - Diagrams vs. no diagrams

Verbal Advantage
- Beginning algebra students are more successful solving algebra story problems than mathematically equivalent equations (Koedinger & Nathan, 2004)

Diagrammatic Advantage
- Pictorial representations (charts, graphs, and tables) are often used in math classrooms because they are thought to be useful for helping students communicate and reason about mathematical concepts (Greeno & Hall, 1997)
- Would diagrams help students solve algebra problems?

Purposes:
1. Replicate Verbal Advantage
2. Examine whether there is a Diagrammatic Advantage in solving algebra story problems
3. Determine if there are developmental differences in either advantage
4. Begin to examine mechanism behind why diagrams may or may not be helpful

Experiment 1: Verbal Advantage:
- Story problems easier than equations
  - Story problems: 31.95, p < .01
  - No grade effect; same at all grade levels

Experiment 1: Diagrammatic Advantage:
- Trend toward interaction:
  - 6th graders better without diagrams, 7th and 8th graders better with diagrams
  - F(1, 371) = 3.36, p < .10

Future Questions:
- What is the mechanism underlying the diagrammatic advantage?
- What types of conceptual errors does it protect against, and why?
- Would providing instruction on using diagrams increase the diagrammatic advantage?

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