"Just tell me how to solve it." The Impact of Including Procedural Instruction in Conjunction with Conceptual Instruction

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BACKGROUND

- Children need to learn step-by-step procedures and **build understanding of central concepts** (Blöte, Van der Burg, & Klein, 2001; Hiebert et al., 1996).
- Many researchers advocate for **direct instruction on both concepts and procedures** (Kirschner, Sweller, & Clark, 2006; Klahr & Nigam, 2004; Roelofs et al., 2003; Sweller, 2003)
- Others suggest that **instruction on procedures** may limit children's understanding by circumventing the need to invent procedures and by drawing attention away from concepts (Hiebert et al., 1996; Schwartz, Chase, Chin & Oppezzo, 2011; Perry, 1991).
- **Opportunities to explore problems** prior to instruction has also been shown to improve conceptual knowledge (DeCaro & Rittle-Johnson, 2012; Schwartz, Chase, Chin & Oppezzo, 2011), and instruction on both concepts and procedures may be more appropriate after opportunities to explore problems.
- **Is it best to combine instruction on concepts and procedures or provide instruction on concepts only? Do opportunities to explore problems first reduce the impact of instruction type?**

METHOD

Participants. 180 second-grade children from 13 classrooms (M age = 7.6 years, range = 6.8 – 8.9; 55% female; 21% ethnic minorities)

Design

- In their math classrooms, children received a **small-group lesson on math equivalence** (i.e., the values on either side of the equal sign are the same amount) in one of four randomly assigned conditions based on crossing two factors:

1. **Instruction Type**:
   - ***Conceptual instruction condition*** received instruction focused on the relational meaning of the equal sign in the context of non-standard equations (e.g., 3 + 4 = 3 + 4). They received two iterations of conceptual instruction to equate instructional time across conditions.
   - ***Combined instruction condition*** received one iteration of conceptual instruction, followed by procedural instruction on a step-by-step procedure for solving two problems.
2. **Instruction Order**: Instruction before or after solving problems
   - ***Instruct-Solve***: Received instruction first, followed by solving a packet of 17 problems independently (see sample pages). Checked their work and changed their answers if desired.
   - ***Solve-Instruct***: Solved the 17 problems independently, with a few hints. Then received instruction. Finally, checked their work on the original problems, changing their answers if desired.

Assessment Materials: Sample Items (Adapted from Matthews et al., 2012)

Item Type	Items	Scoring Criteria
Procedural Knowledge		(α = .85 at retention)
Familiar Problems	8 = 6 + ☐ 3 + 4 = ☐ + 5 7 + 6 + 4 = 7 + ☐	Answer must be within 1 of correct answer
Transfer Problems	☐ + 2 = 6 + 4 8 + 5 – 3 = 8 + ☐ 7 – 2 + 3 = ☐ + 3	Same as above
Conceptual Knowledge		(α = .78 at retention)
Meaning of equal sign	What does the equal sign mean?	1 pt for providing relational definition (e.g., the same amount)
Structure of equations	Judge 3 = 3 and 7 = 3 + 4 as true or false	1 point for judging both equations as true

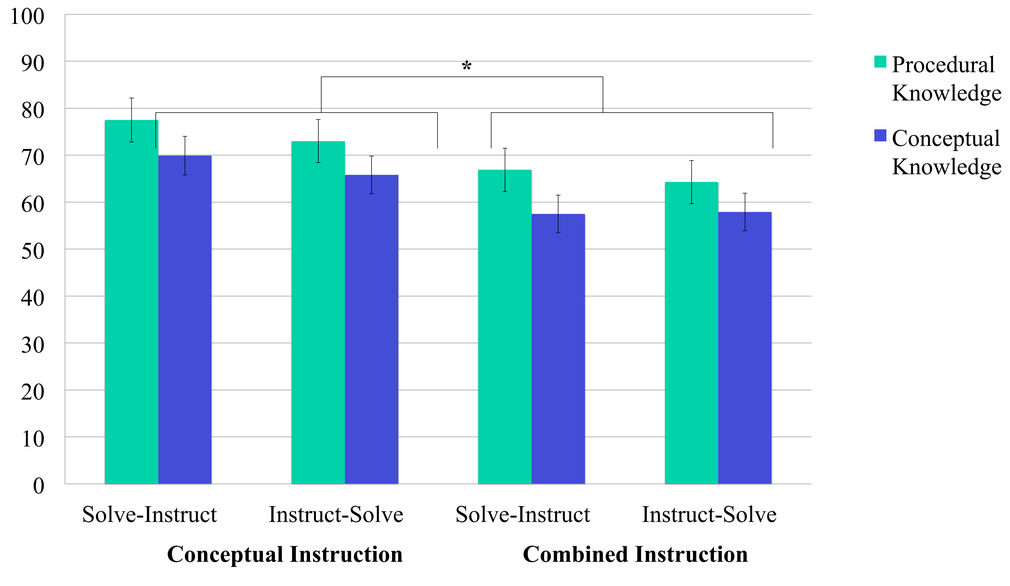
Procedure

Pretest Day 1 → Lesson Day 2 → Posttest Day 3 → Retention Test 3 weeks later

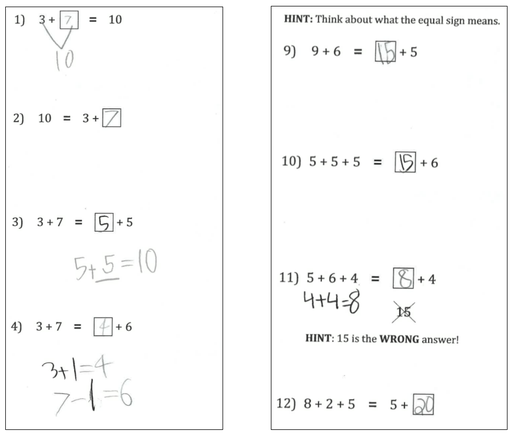
RESULTS

- No reliable differences between conditions at posttest.
- **Instruction type impacted knowledge retention.** Children who received **only conceptual instruction** had better retention of their conceptual and procedural knowledge than children who received combined instruction on concepts and procedures, $F(1, 174) = 6.24$, $p = .01$, $\eta_p 2 = .04$, Hedges' $g = .32$ and $F(1, 174) = 4.22$, $p = .04$, $\eta_p 2 = .02$, Hedges' $g = .26$, respectively (see Figure).
- **Instruction order did not impact knowledge**. Children who solved problems before instruction did not have greater knowledge at retention test than children who solved problems after instruction, and instruction order did not interact with instruction type, Fs < 0.40, ps > .80.

Effect of Instruction Type and Instruction Order at Retention Test



Lesson Materials: Problem Solving Packet



DISCUSSION

- Focusing on conceptual knowledge may support knowledge retention because it is easier to remember things over time that make sense and are integrated with other knowledge (Baroody, Feil, & Johnson, 2007).
- Providing procedural instruction in addition to conceptual instruction may have guided attention away from reflecting on the conceptual instruction. Alternatively, reiterating conceptual instruction may be a more beneficial use of time than procedural instruction because students could easily invent successful procedures.
- Most past research has only compared combined conceptual and procedural instruction to no instruction or procedural instruction alone (Kirschner, Sweller, & Clark, 2006; Klahr & Nigam, 2004; Roelofs et al., 2003; Sweller, 2003). However, the benefits of combined instruction in these cases may be attributable to the lack of conceptual instruction in the control conditions.
- Opportunity to explore problems first did not reduce the impact of instruction type.
- Contrary to previous findings, opportunities to explore problems first did not support greater knowledge.

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