



Effective Instructional Practices For Students with Difficulties in Mathematics: Findings from a Research Synthesis

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Overview

- This presentation is a summary of major findings from three syntheses of research on effective practices for students with mathematics difficulties including over 50 studies.
- The practices are essential for developing interventions for students who require more than what typical classrooms can provide.

Who can benefit from these findings?

- Students who:

- enter school with very limited knowledge of number concepts and counting procedures
- receive inadequate instruction in previous years of schooling and fall behind their peers
- regardless of motivation, quality of former mathematics instruction, and number knowledge and number sense when entering school still continue to experience problems

How were the effects of particular practices compared?

- These syntheses compared the relative effects of instructional practices using “effect sizes.” Effect sizes are a proportion of a standard deviation.

Educationally
Significant

$\geq .80$ large

$\geq .40$ moderate

$\geq .20$ small

$< .20$ extremely
small/negligible

Areas of Major Findings

- Visual and graphic depictions of problems
- Student think-alouds
- Explicit instruction
- Peer-assisted learning
- Formative assessment

Effect Sizes for Instructional Variables

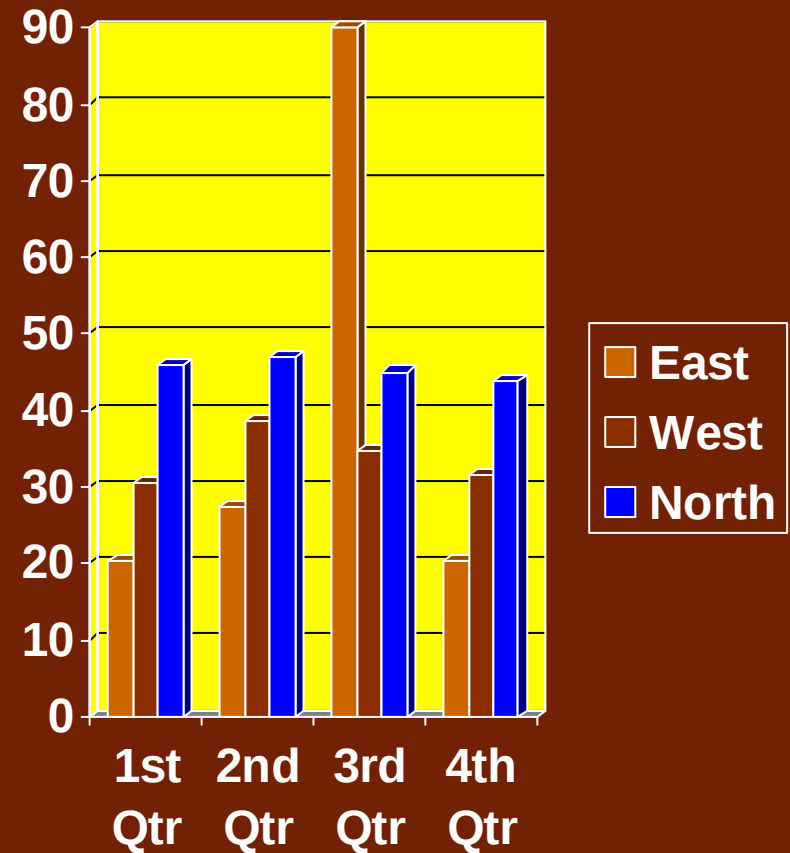
Instructional Strategy	Effect Size For Special Education Students	Effect Size For Low Achieving Students
Visual and Graphic Depictions	.50 <i>Moderate</i>	NA
Systematic and Explicit Instruction	1.19 <i>Large</i>	.58 <i>Moderate to Large</i>
Student Think Alouds	.98 <i>Large</i>	NA
Use of structured peer-assisted learning activities involving heterogeneous-ability groupings	.42 <i>Moderate.</i>	.62 <i>Large</i>
Formative Assessment Data Provided to <i>Teachers</i>	.32 <i>Small to Moderate</i>	.51 <i>Moderate to Large</i>
Formative Assessment Data Provided Directly to <i>Students</i>	.33 <i>Small to Moderate</i>	.57 <i>Moderate to Large</i>

Findings: Visuals and Graphic Depictions of Problems

- Graphic representations of problems and concepts are widely used in texts both in the U.S. and in nations that perform well in international comparisons
- Teaching students to use graphic representations of the underlying concepts of a problem results in ***moderate*** effects.

Findings: Visuals and Graphic Depictions of Problems

- Effects were larger when teachers provided students with multiple opportunities to apply graphic representations to specific problems
- Effects were also enhanced when teachers taught students to select appropriate graphic representation and why a particular representation was most suitable

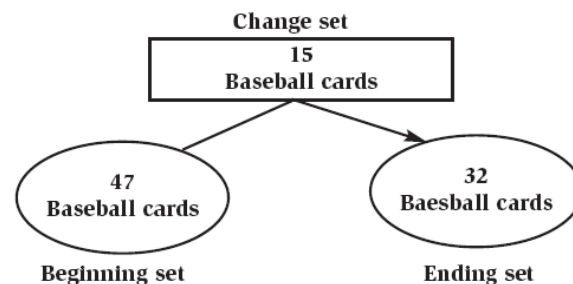


Visuals to depict different problem types.

Jitendra, A. K., Hoff, K., & Beck, M. (1999). Teaching middle school students with learning disabilities to solve multistep word problems using a schema-based approach. *Remedial and Special Education*, 20(1), 50-64.

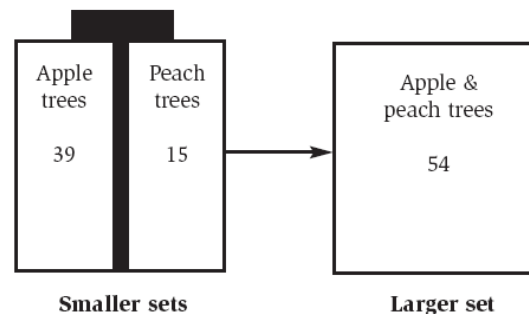
Change Story Situation

John had 47 baseball cards in his collection. He lost 15 of them when his family moved from Florida to New York. Now John has 32 baseball cards.



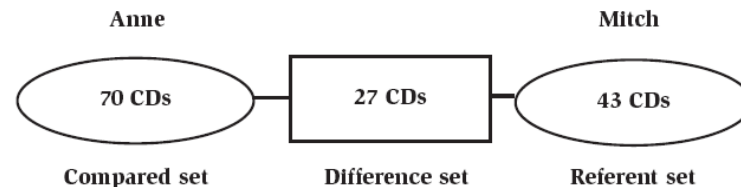
Group Story Situation

Tim has 54 fruit trees in his orchard. 39 are apple trees, and the remaining 15 are peach trees.



Compare Story Situation

Mitch has 43 CDs and Anne has 70. Anne has 27 more CDs than Mitch.



Source: From *Schemas in Problem Solving* (p. 135) by S. P. Marshall, 1995, New York: Cambridge University Press. Copyright 1995 by Cambridge University Press. Representation adapted by permission.

Findings: Visuals and Graphic Depictions of Problems

- When teachers used graphic representations to demonstrate problems, results were much less consistent.
- Visuals were not particularly useful unless students were provided opportunities to practice using them.
- *Concrete-Representational-Abstract (CRA)* approach seems promising based on 3 studies. Teachers model problems with concrete manipulatives to ensure students understand before moving to more abstract representations

Findings: Student Think-Alouds

- Encouraging students to verbalize their thinking and talk about the steps they used in solving a problem – was consistently effective
- Verbalizing steps in problem solving was an important ingredient in addressing students' impulsivity directly

Findings: Student Think-Alouds



- Verbalizing appeared to be most effective when multiple approaches to solving problems were demonstrated and students were encouraged to think-aloud as they solved multiple practice problems.

Findings: Explicit Instruction

- Explicit instruction consistently resulted in large effects both for learning single skills as well as multiple related skills in complex problem solving.
- These findings must be tempered by the fact that the measures on which the effect sizes were calculated were all researcher-developed.

Findings: Formative Assessment

- Formative assessment is the process of collecting data on a randomly selected array of relevant topics at regular intervals (e.g. once per week or twice a month)
- Evidence has shown that this approach is superior to the typical weekly or biweekly unit tests that appear in many texts

Findings: Formative Assessment

- Formative assessment use has consistently lead to low or moderate effects on mathematics achievement
- Feedback based on formative assessment coupled with specific suggestions for intervention strategies (e.g. problems for practice, alternate ways to explain a concept) improved effects
- This type of feedback was consistently effective for special education teachers.

Findings: Feedback to Students about their Performance

- Providing students with feedback about their performance resulted in moderate effects.
- For students with disabilities, these effects were much smaller.

Findings: Peer-assisted learning

- Peer assisted learning provides extensive opportunities for students to practice solving math problems and to interact with peers about mathematics



Findings: Peer assisted-learning

- Results have been consistently positive if:
 - Tutoring is provided by a proficient, trained peer
 - Student's work in pairs and the activities have a clear structure.
 - The pairs include students at differing ability levels.
 - Both students play the role of tutor for some of the time.
 - Students are trained in the procedures necessary to assume the role of tutor.

Findings: Peer assisted-learning

- Peer assisted-learning appears to benefit both lower- and higher-performing learners because:
 - When serving as tutors, less proficient students attended to details of problems and the approaches their partner used to problem solve
 - More proficient students solidified their conceptual understanding of mathematics by having to explain their problem solving to their peers
- Ad hoc tutoring appears to be beneficial when a more experienced peer guides a novice in reinforcing previously learned material or in talking through problem solving
- Though the number of studies is small, the effects of PALs for certified special education students remain unclear

Summary

- Results of these research syntheses suggest that students who are struggling with mathematics benefit from:
 - Verbalizing and use of visuals for problem solving;
 - Explicit instruction in how to use specific skills and multi-step strategies;
 - Their teachers receiving feedback from formative assessment to modify instruction;
 - Peer-assisted learning opportunities in which they focus on problem details, observe models of proficient students' problem solving, or are guided by more proficient peers