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Effective Instructional Practices For Students with Learning Disabilities or Difficulty in Learning Mathematics

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Division for Learning Disabilities
of the Council for Exceptional Children

**Findings of the National Mathematics
Advisory Panel: Implications for
Instruction and Research**

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Moderated by Kathleen Marshall
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Overview

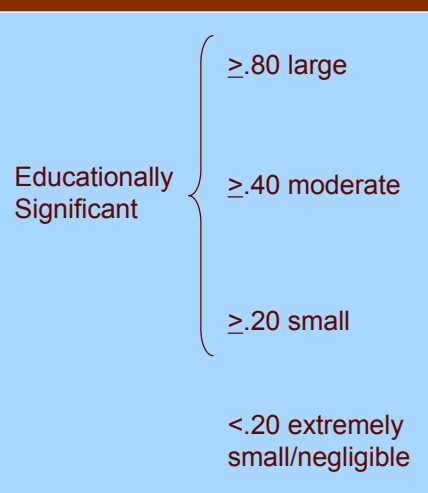
- This presentation discusses effective practices for students with mathematics difficulties (including LD).
- The meta-analysis including over 50 studies all of which employed randomized control trials or high quality quasi-experimental designs.

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?

- The meta-analysis allows us to compare the relative effects of instructional practices using “effect sizes.”
- Effect sizes are a proportion of a standard deviation.



Areas of Major Findings

- Use explicit instruction on a regular basis
- Employ multiple instructional examples
- Have students verbalize decisions and solutions to math problems
- Teach students to visually represent information in math problems
- Teach students to solve problems using multiple/heuristic strategies
- Provide ongoing formative assessment data and feedback to teachers
- Provide peer-assisted learning to students

Effect Sizes for Instructional Variables

Instructional Recommendation	Number and Type of Studies Examined	Mean Effect Size (all Statistically Significant)
Explicit Instruction	10 RCTs; 1 QED	1.22 (Large)
Use Multiple Examples	9 RCTs	0.82 (Large)
Teach Students to Verbalize Decisions and Solutions	7 RCTs; 1 QED	1.04 (Large)
Teach Students to Visually Represent Information in Problems	11 RCTs; 1 QED	0.47 (Moderate)
Teach Students to Solve Problems using Multiple/Heuristic Strategies	3 RCTs; 1 QED	1.56 (Large)
Formative Assessment Data Provided to <i>Teachers</i>	10 RCTs	0.23 (Small)
Peer-assisted Learning	2 RCTs	1.02 (Large)

Use explicit instruction on a regular basis

- Explicit instruction includes:
 - Clear modeling of the solution strategy to a problem
 - Thinking the specific steps aloud to a problem
 - Presenting multiple examples of a problem and their solutions
 - Providing immediate corrective feedback to students on their accuracy
- Explicit instruction should not be the whole of the teaching approaches used with any student, but must be used regularly with students who are experiencing mathematics difficulties.

Teach Students Using Multiple Examples

- Spend time planning, focusing on the selection and sequence of examples
- Provide a wide range of examples of a problem type, highlighting problem variations but noting common and critical features
- Selection and sequencing of examples is particularly important during acquisition

Have Students Verbalize Decisions and Solutions to Math Problems



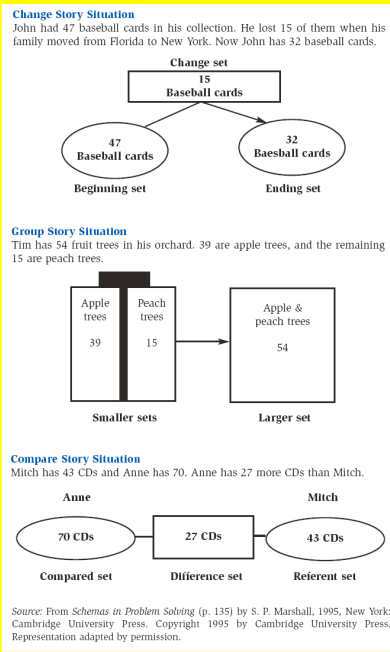
- Encouraging students to think aloud the steps they use in solving a problem (specific and generic)
- Verbalizing steps in problem solving may address students' impulsivity and facilitate self-regulation in learning

Teach Students to Visually Represent the Information in a Math Problem

- Graphic representations or drawings of problems and concepts are widely used
- Effects were enhanced when teachers taught students to select appropriate graphic representation and why a particular representation was most suitable
- This approach appears to be most beneficial when used by both teachers and students.

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.



Teach Students to Solve Problems Using Multiple/Heuristic Strategies

- A heuristic strategy is a “generic” approach to solving a problem (e.g., read the problem, highlight relevant information, translate it into a math sentence, solve, check)
- Usually give students alternative approaches or options for solving the problem
- Typically involve teacher-led student discourse about the appropriateness of the solution chosen

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

References

- Gersten, R., Chard, D. J., Jayanthi, M., Baker, S., Morphy, P., & Flojo, J. (in press). Teaching mathematics to students with learning disabilities: A meta-analysis of the intervention research. *Review of Educational Research*.
- Jayanthi, M., Gersten, R., & Baker, S. (2008) *Mathematics instruction for students with learning disabilities or difficulty learning mathematics*. <http://www.centeroninstruction.org>

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