Step-by-Step Math to Mastery™ is research-based.

5 recommendations taken from research are put into practice:

1. Explicit Instruction
2. Explicit Instruction on Word Problems
3. Visual Representations
4. Example Selection and Sequence
5. Student Verbalizations

Lessons are scripted with explicit instruction. . .

1. Explicit Instruction

Defined as:

a. The teacher demonstrates a step-by-step plan (strategy) for solving the problem.

b. This step-by-step plan is specific for a set of problems (as opposed to a general problem-solving heuristic strategy).

c. Students are asked to use the same procedure/steps demonstrated by the teacher to solve the problem.

Looks like:

a. Clear modeling

b. Thinking the specific steps aloud during modeling (for example, "That is a plus sign. That means I should. . .")

c. Presenting multiple examples of the problem with different characteristics (easier to more difficult)

d. Students receive extensive practice in new skills

e. Students are provided with immediate feedback on their accuracy

Outcomes:

a. Improves the performance of students in computation, word problems, and transferring known skills to novel situations.

- The Center on Instruction examined 11 studies in the area of explicit instruction (10 randomized controlled trials and 1 quasi-experimental design). The mean effect size of 1.22 was statistically significant ($p<.001$; 95% CI = 0.78 to 1.67)

- The National Mathematics Advisory Panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. Explicit Systematic Instruction is identified in The Final Report of the National Mathematics Advisory Panel as one of the defining features of effective instruction for students with learning disabilities.

Word problem types are taught explicitly. . .

2. Explicit Instruction on Word Problems

Defined as:

a. Students are taught about the structure of various problem types, how to categorize problems based on structure, and how to determine appropriate solutions for each problem type.

b. Students are taught to recognize common underlying structure between familiar and unfamiliar problems and to transfer known solution methods from familiar to unfamiliar problems.

Looks like:

a. Explicitly teach word problem types including: change or sequence, comparison, simple action, classification, equal groups, multiplicative comparison, time intervals, multi-step

b. Teach students to solve multi-step and more difficult word problem types using the familiar procedures from easier problems.

Outcomes:

a. "These techniques typically led to significant and positive effects on word-problem outcomes for students experiencing difficulties in mathematics across grade levels."

- Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides/.

Visual representations are used to teach concepts and solve problems. . .

3. Visual Representations

Defined as:

a. Visuals designed specifically to address a particular problem type, such as number lines, arrays, and diagrams

b. Students use the visual representation while solving the problem, or the teacher uses the visual representation during the demonstration of how to solve the problem

Looks like:

a. Students are taught explicitly taught how to use a visual representation to solve a problem

b. Students may use concrete manipulatives first and move toward visual representations (pictures) before graduating to more abstract representations such as equations

Outcomes:

a. Students conceptually understand and solve problems.

b. When used with word problems, students learn to represent essential information with a diagram, then translate the diagram into a math sentence and solve for the unknown.

- The Center on Instruction examined 12 studies on visual representations (11 RCTs and 1 QED). The mean effect size of 0.47 was statistically significant ($p<.001$; 95% CI = 0.25 to 0.70).
- The National Mathematics Advisory Panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. According to The Final Report of the National Mathematics Advisory Panel visual representations when combined with explicit instruction tended to produce significant positive results

Sequence of lessons and example types are from an expert source. . .

4. Example Selection and Sequence

Defined as:

a. Examples are presented in a specified sequence such as concrete to abstract, easy to hard, and simple to complex

b. Multiple examples of a problem type expose students to many possible variations

Looks like:

a. Teach preskills for a strategy before teaching the strategy and teach easy skills before more difficult ones

b. Separate the introduction of information or strategies that are likely to confuse

c. Provide examples that help students recognize *when* to use new skills (for example, determine if regrouping is necessary)

d. Lesson scope and sequence is based on recommendations in the text: *Direct Instruction Mathematics* (Stein, M., et. al, 2018)

Outcomes:

a. Scaffolds student success during early acquisition of new skills

- The Center on Instruction examined 9 studies on range and sequence of examples (all RCTs). The mean effect size of 0.82 was statistically significant ($p<.001$; 95% CI = 0.42 to 1.21).
- The National Mathematics Advisory Panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. The panel recommends that teachers, as part of explicit instruction, carefully sequence problems to highlight the critical features of the problem type

Students are prompted to verbalize the steps. . .

5. Student Verbalizations

Defined as:

a. Some studies gave students very specific questions to ask themselves, based on each problem type.

b. In other studies, students were provided with general guidance, for example, “Have I written an equation?”

Looks like:

a. Students are encouraged to verbalize specific steps that lead to the solution of the problem

b. Students are encouraged to verbalize general steps that are common across problems, for example, “Now I need to check my answer.”

Outcomes:

a. Verbalization may facilitate students’ self-regulation during problem solving. Many students with learning disabilities are impulsive when faced with multi-step problems. Verbalization helps them implement a solution step-by-step rather than randomly combining numbers.

- The Center on Instruction examined 8 studies in the area of student verbalizations (7 RCTs and 1 QED). The mean effect size of 1.04 was statistically significant ($p<.001$; 95% CI = 0.42 to 1.66).
- The National Mathematics Advisory Panel reviewed 26 high quality studies (mostly RCTs) on effective instructional approaches for students with learning disabilities and low-achieving students. The panel recommends that teachers, as part of explicit instruction, allow students to think aloud about the decisions they make while solving problems

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Sources:

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