

Research in Brief:

Effective practices for teaching math in elementary schools



Achievement in mathematics is a growing concern among educators as EQAO math scores have been declining across the province of Ontario in recent years. Research in effective math instruction may help us guide educators in developing effective teaching strategies. Research suggests that instructional process is key to helping students increase their aptitude in math.

What are effective programs and strategies in teaching elementary school mathematics?

The systematic review by Slavin et al., examined research on many different mathematics programs available to elementary educators. The programs were organized into 3 general categories of approaches:

- Mathematics curricula – programs that focus on textbook-based instruction to teach strands of mathematics curricula
- Computer assisted instruction (CAI) - programs that utilize technology to deliver individualized mathematics instruction.
- Instructional process – programs that focus on extensive professional development of teachers.

Key findings indicate that programs designed to change daily teaching practices have larger impacts on student math achievement than programs that emphasize textbooks or technology alone. Effective programs include cooperative learning, classroom management and motivation, and supplemental tutoring.

What is a systematic review?

The purpose of a systematic review is to summarize the best available research to a specific question, by bringing together the results of several studies. Studies included in a review are screened for quality, so that the findings of a large number of studies can be combined.

What did the researchers do?

Slavin and colleagues conducted electronic searches using educational databases (JSTOR, ERIC, EBSCO, PsychInfo, Dissertation Abstracts), web-based repositories (Google, Yahoo, Google Scholar), and math education publishers' websites. The following criteria qualified a study for inclusion in the review:

- Involved elementary (K-5) children, plus sixth graders if they were in elementary schools.
- Compared children taught in classes using a given mathematics program to those in control classes using an alternative program.
- Random assignment or matching with appropriate adjustments for any pretest differences.
- Used quantitative measures for mathematics performance.
- A minimum treatment duration of 12 weeks.

A total of 87 studies were included in the review.

Key Points

- ⇒ ***Research tells us that educators should focus more on how mathematics is taught to improve mathematics performance in their students.***
- ⇒ ***Cooperative learning, or the combination of cooperative learning and individualization (via computer aided instruction), and professional development of teachers show strong positive outcomes on mathematics achievement.***
- ⇒ ***Supplementing classroom instruction with well-targeted supplementary instruction also has strong evidence of effectiveness.***
- ⇒ ***Overall, the authors conclude that the three types of approaches to mathematics instruction (Mathematics Curricula, CAI, Instructional Process Programs) do not conflict with each other and may have additive effects if used together.***

For an in-depth look at effective mathematics instruction see: Slavin, R. E., Lake, C., & Groff, C. (2010). [What Works in Teaching Math? Educator's Guide](#). Center for Research and Reform in Education.



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What did they learn?

Math Curricula

Math curricula programs evaluated for this review fell into 3 categories:

- Constructivist textbooks that emphasize problem-solving, manipulatives, and conceptual understanding
- Back-to-basics textbooks that emphasize mastery of mathematical algorithms, drill, and review
- Traditional commercial textbooks that balance algorithms, concepts, and problem solving

The review found 13 studies, with a median effect size of only +0.10, which was the lowest of the 3 instructional approaches. These findings suggest that textbook based instruction alone may not have a significant improvement on student achievement in elementary school mathematics.

Computer Assisted Instruction (CAI)

CAI strategies are commonly used as supplements to classroom instruction. They identify children's strengths and weaknesses and then provide self-instructional exercises targeting their weaknesses. Characteristics that varied between the programs reviewed include:

- Emphasis on higher-order competencies, *i.e. mathematical estimation, problem solving, and computation*
- Integrated learning systems incorporating curriculum, management, and assessment, which were delivered in 10-20 minutes sessions 3-5 days per week
- Comprehensive computer learning that provides curriculum materials and tools for teachers and administrators to manage, assess, and individualize students' learning process
- Home-involvement programs which incorporates parent training, loaning hardware to parents, and sending home learning games with students
- Computer-managed learning systems that use computers to assess students' needs, assign and assess appropriate assignments, and provide teachers with diagnostic reports to help develop targeted interventions

Most of the 38 qualifying studies evaluated had positive effects on students' mathematic performance. The median effect size was +0.19, larger than the median found for math curricula. There was no significant evidence on any particular CAI approach to recommend one over another. Note that most of these studies are old, and the computer programs used may no longer be commercially available.

Instructional Process Programs

These programs focus on providing teachers with extensive professional development on the use of instructional

process strategies. This professional development is characterized by teaching strategies on changing what teachers do with the curriculum they have according to students' needs, without changing the curriculum in the process.

The instructional programs were divided into 7 categories:

- Cooperative learning: students work in pairs or small groups to help each other master academic content
- Cooperative/individualized programs: combines cooperative learning with strategies for continuously diagnosing students' strengths and weaknesses and giving them material appropriate to their needs
- Direct instruction: emphasizes a structured, step-by-step approach focusing on the "big ideas" of mathematics
- Mastery learning: is an approach to instruction intended to bring all students to a pre-established level of mastery (*i.e.* 80% correct) on a set of instructional objectives. Students are taught to well-defined standards, formatively assessed, then given corrective instruction
- Professional development focused on mathematics content: provide teachers with extensive professional development focused on how children learn math and how to help them build on their intuitive knowledge
- Professional development focused on classroom management and motivation: focus on improving teachers' abilities to use effective instructional and management techniques, to make effective use of time, and to enhance student motivation
- Supplemental programs: approaches that supplement core classroom instruction, taking place either during time scheduled for math or in additional time

A total of 36 qualifying studies on instructional process programs were examined. The overall median effect size was +0.33, having the highest impact on student achievement when compared to the other approaches examined.

Overall, the authors conclude that the three types of approaches to mathematics instruction (Mathematics Curricula, CAI, Instructional Process Programs) do not conflict with each other and may have additive effects if used together. Findings suggest that educators and researchers should place more focus on how mathematics is taught, rather than expecting that choosing a particular textbook by itself will move students forward.

This brief summary was prepared from: Slavin, R. E., Lake, C. (2007). Effective programs in elementary school mathematics: A best-evidence synthesis. Review of Educational Research, 78(3), 427-515. Please see the original document for full details. In the case of any disagreement between this summary and the original document, the original document should be seen as authoritative.

