Effective Programs in Middle and High School Mathematics: A Best Evidence Synthesis

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What mathematics programs have been proven to help middle and high school students to succeed? To find out, this review summarizes evidence on three types of programs designed to improve the mathematics achievement of students in grades 6-12:

- **Mathematics Curricula (MC),** such as The *University of Chicago School Mathematics Project, Connected Mathematics, Saxon Math,* and other standard and alternative textbooks.

- **Computer-Assisted Instruction (CAI),** such as I *Can Learn, Jostens/Compass Learning,* and *Accelerated Math.*

- **Instructional Process Programs (IP),** such as cooperative learning, mastery learning, and other approaches primarily intended to change teachers' instructional strategies rather than curriculum or technology.

Key Findings

Overall, 102 studies met the inclusion criterion, of which 28 used random assignment to treatments. These included 40 studies of mathematics curricula, 40 studies of CAI, and 22 studies of instructional process programs.

Mathematics Curricula (MC). Taken together, there were 40 qualifying studies evaluating various mathematics curricula, with a sample size-weighted mean effect size of only +0.03. This is less than the effect size of +0.10 for elementary mathematics curricula reported by Slavin & Lake (2008). There were eight randomized and randomized quasi-experimental studies, also with a weighted mean effect size of +0.03. Effect sizes for the NSF-supported textbooks had a weighted mean effect size of 0.00 in 26 studies. However, the NSF programs add objectives not covered in traditional texts, so to the degree those objectives are seen as valuable, these programs are adding impacts not registered on the assessments of content covered in all treatments.

Computer-Assisted Instruction (CAI). A total of 40 qualifying studies evaluated various forms of computer-assisted instruction. Overall, the weighted mean effect size was +0.08, a modest impact. No program stood out as having notably large and replicated effects. There were few differences among programs categorized as core (weighted mean ES=+0.09 in 17 studies) and

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supplemental (weighted mean ES=+0.08 in 20 studies). Computer-managed learning systems (ES=-0.02 in 3 studies) had lower effect sizes.

Instructional Process Strategies (IP). As was true in the Slavin & Lake (2008) review of elementary math programs, the middle and high school approaches with the strongest evidence of effectiveness are instructional process programs. Across 22 qualifying studies, the median effect size was +0.18. However, outcomes varied considerably by type of approach. Two forms of cooperative learning, STAD (now disseminated as PowerTeaching) and IMPROVE, had a weighted mean effect size of +0.46 across 7 studies, and 4 of these, with a weighted mean effect size of +0.48, used random assignment to conditions. The findings for these cooperative learning programs are in line with those of the elementary review, which found a median effect size of +0.29 for cooperative learning (Slavin & Lake, 2008).

Program Ratings

Listed below are currently available programs, grouped by strength of effectiveness. Within each group, programs are listed alphabetically. The Type for each program corresponds to the categories above (e.g., IP = Instructional Process Strategies).

Strong Evidence of Effectiveness

Rating	Program	Type	Description	Contact / Website
	IMPROVE	IP-Cooperative Learning	A program that combines cooperative learning, metacognitive instruction, and mastery learning that accommodates student diversity in a heterogeneous classroom.	E-mail: mevarz@mail.biu.ac.il

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Rating	Program	Type	Description	Contact / Website
	Student Teams-Achievement Divisions (STAD, now disseminated as PowerTeaching: Mathematics)	IP-Cooperative Learning	A cooperative learning program in which students work in 4-member heterogeneous groups to help each other master academic content. Teachers follow a schedule of teaching, team work, and individual assessment.	Website: www.successforall.org Contact: powerteaching@successforall.org

Moderate Evidence of Effectiveness

None

Limited Evidence of Effectiveness

Rating	Program	Type	Description	Contact / Website
	Cognitive Tutor	CAI	An intelligent tutoring system that emphasizes algebra problem solving. Working on computers, students carry out investigations of real-world problems using spreadsheets, graphers, and symbolic calculators.	E-mail: help@carnegielearning.com Website: www.carnegielearning.com
	Core-Plus Mathematics	MC	Integrated mathematics curriculum that emphasizes applications and mathematical modeling, use of graphing calculators, and small-group collaborative learning through problem-based investigations.	E-mail: cpmp@wmich.edu Website: www.wmich.edu/cpmp

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Rating	Program	Type	Description	Contact / Website
	Expert Mathematician	CAI	A program in which students are taught to use the LOGO programming language and proceed through a constructivist, integrated series of computer and workbook activities emphasizing problem solving and creativity.	Complete contact form at: www.expertmath.org/contact.html Website: www.expertmath.org
	Jostens	CAI	Provides an extensive set of assessments which place students according to their current levels of performance and then gives students exercises designed primarily to fill in gaps in their skills.	Complete contact form at: www.compasslearning.com/Contact/Default.aspx Website: www.compasslearning.com
	Math Thematics	MC	Encourages students to investigate mathematical concepts through exploratory, activity based learning.	Complete contact form at: www.classzone.com/cz/contact_us.htm Website: www.classzone.com/books/math_thematics1/
	Partnership for Access to Higher Mathematics (PATH)	IP	A program for at-risk eighth graders that focuses on improving curriculum and instruction with use of constructivist approaches, manipulatives, and technology.	No website available.
	Plato	CAI	An integrated learning system that has been evaluated as a remedial program.	Complete contact form at: www.plato.com/Contact-Us/Forms/K-12-Learning-Request-For-Information.aspx Website: www.plato.com

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Rating	Program	Type	Description	Contact / Website
	Prentice-Hall Course 2	MC	A traditional, seventh grade curriculum that emphasizes proportional reasoning.	Complete contact form at: www.k12pearson.com/contactus/contact_default.cfm?cmpy=PH Website: www.phschool.com/home.html
	Saxon Math	MC	A program that emphasizes teaching in small, incremental steps, ensuring mastery of each concept before the next step is introduced.	E-mail: info@SaxonPublishers.com Website: saxonpublishers.harcourtachieve.com
	Talent Development Mathematics	IP	Standards-based curriculum combined with computer-based mathematics that develops advanced skills in geometry, data, and algebra.	E-mail: lmuskauski@csos.jhu.edu Website: www.csos.jhu.edu/tdhs

Other Ratings

Insufficient Evidence of Effectivennes

Accelerated Math
Connected Mathematics
I Can Learn
Interactive Mathematics Program
Learning Logic Lab
Mastery Learning
Mathematics in Context
McDougal-Littell
PALS/CBM
Prentice Hall Algebra
SIMMS Integrated Mathematics
University of Chicago School Mathematics Project (UCSMP)

N No Qualifying Studies

Adventures of Jasper Woodbury Series
AquaMOOSE

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CAP Mnemonic Instruction
College Preparatory Mathematics
Compass Learning
Connecting Math Concepts
Concepts in Algebra, Everyday Learning
CORD Contextual Mathematics, CORD Applied Mathematics, CORD Algebra 1
Corrective Mathematics
Destination Math
Focus on Algebra, Addison Wesley Longman
Fun Math
Generalizable Mathematics Skills Instructional Intervention
Geometric Supposers
Glencoe Mathematics & Pre-Algebra
Hawaii Algebra Learning Project (HALP)
Heath Mathematics Connection
Heath Passport to Mathematics
Introducing Math Teachers to Inquiry
Mastering Fractions
Math Advantage
Math and Science Academy
Math Blaster Mystery
MATH Connections
Math Corps Summer Camp
Math Matters
Mathematics in Context (6-8)
Mathematics: Modeling our World, COMAP/ARISE
Mathematics Plus
MathFacts
MathScape
MathStar
McGraw-Hill Algebra 1
Middle Grade Mathematics Renaissance
Middle School Family Math
Middle School Math through Applications
Model Mathematics Program
Moving With Math
Multimedia Probability & Statistics
Orchard Software
Pacesetter
Peoria Urban Mathematics Plan for Algebra

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Powerful Connections
Project AutoMath
QUASAR Project
Rice University School Mathematics Project
Saturday Academy
Scott Foresman Middle School Math
SmartHelp
Southern California Regional Algebra Project
SuccessMaker, CCC
TASS Tutorial Program, Blitz
TGT (Teams-Games-Tournament)
Transition to Geometry (summer program)
University of Illinois at Chicago All Learn Mathematics
Voyager Math
Wayang Outpost Interactive Tutoring System
Word Problem Solving Tutor, Apangea

Review Methods

An exhaustive search considered hundreds of published and unpublished articles. It included those that met the following criteria:

- Schools or classrooms using each program had to be compared to randomly assigned or well-matched control groups
- Study duration had to be at least 12 weeks
- Outcome measures had to be assessments of the mathematics being taught in all classes. Almost all are standardized tests or state assessments.
- The review placed particular emphasis on studies in which schools, teachers, or students were assigned at random to experimental or control groups.

Program Ratings Basis

Programs were rated according to the overall strength of the evidence supporting their effects on math achievement. "Effect size" (ES) is the proportion of a standard deviation by which a treatment group exceeds a control group. Large studies are those involving a total of at least 10 classes or 250 students. The categories are as follows:

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Strong Evidence of Effectiveness: At least two large studies, of which at least one is a randomized or randomized quasi-experimental study, or multiple smaller studies, with an effect size of at least +0.20

Moderate Evidence of Effectiveness: Two large matched studies or multiple smaller studies with a collective sample size of 500 students, with a weighted mean effect size of at least +0.20.

Limited Evidence of Effectiveness: At least one qualifying study with a significant positive effect and/or weighted mean effect size of +0.10 or more

Insufficient Evidence of Effectiveness:

N **Insufficient Evidence:** Studies show no significant differences

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