



Effective Programmes in Secondary Mathematics

Educator's Summary

Robert E Slavin **Johns Hopkins University and University of York**

Cynthia Groff **University of Pennsylvania**

Cynthia Lake **Johns Hopkins University**

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Mathematics is a key subject, and it is vital to ensure that all students are able to fulfil their potential. What tools do we have available to intervene in secondary schools to significantly improve mathematics outcomes? Which textbooks, technology applications, and professional development approaches are known to be effective?

This review summarises research on maths programmes for pupils in secondary schools. We looked at *all* available evidence on programmes designed to improve secondary maths achievement, in order to establish what we know works for students aged 11-18. We examined all studies of relevant mathematics programmes from all countries, as long as a report was available in English.* (NB Most studies took place in the US). We were then able to assess and compare the effectiveness of these programmes. Descriptions and ratings for all the programmes are listed further down this summary.

The results of the review show that programmes that change the way the teacher teaches (instructional process programmes) and encourage student interaction have the most significant impact on student achievement. Co-operative learning was particularly effective. In contrast, the effects of using various textbooks and ICT were very small.

The full report (which this review summarises) is available at www.bestevidence.org.uk

Instructional Process Strategies (IP)

(Changing the way the teacher teaches, eg co-operative learning)

The strongest evidence of effectiveness was found for instructional process programmes, as was true in the Slavin & Lake (2008) review of primary school-age maths programmes. Two forms of co-operative learning, STAD 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. (An effect size of 0.20 or more is considered educationally significant).

The findings for these co-operative learning programmes are in line with those of the primary school-age review, which found a median effect size of +0.29 for cooperative learning (Slavin & Lake, 2008). However, outcomes varied considerably by type of approach, and across 22 qualifying studies the median effect size was +0.18. (An effect size of less than 0.20 is weak).

Information and Communication Technology (ICT)

(Programmes based on ICT)

No programme stood out as having notably large and replicated effects. A total of 40 qualifying studies evaluated various forms of computer-assisted instruction. Overall, the weighted mean effect size was +0.08, a small impact. There were few differences among programmes categorised as core (weighted mean ES=+0.09 in 17 studies) and supplemental (weighted mean ES=+0.08 in 20 studies). Computer-managed learning systems (ES=-0.02 in 3 studies) had lower effect sizes.

Mathematics Curricula (MC)

(Textbooks)







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 primary age-level mathematics curricula reported by Slavin & Lake (2008). There were eight randomised and randomised quasi-experimental studies, also with a weighted mean effect size of +0.03. Effect sizes for the US National Science Foundation-supported textbooks had a weighted mean effect size of 0.00 in 26 studies. However, the NSF programmes add objectives not covered in traditional texts, so to the degree those objectives are seen as valuable, these programmes may be adding impacts not registered on the assessments of content covered in all treatments.


*Overall, 102 studies met the inclusion criteria, of which 28 used random assignment to treatments. These included 40 studies of mathematics curricula, 40 studies of ICT, and 22 studies of instructional process programmes.

Programme Ratings


Listed below are currently available programmes, grouped by strength of effectiveness. Within each group programmes available in the UK are listed first, and then the remainder in alphabetical order. The type for each programme corresponds to the categories above (eg IP = Instructional Process Strategies).

Key to Programme Ratings	
	Strong Evidence of Effectiveness: At least two large studies, of which at least one is a randomised or randomised 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 : Studies show no significant differences
N	No Qualifying Studies: No studies met inclusion standards

Strong Evidence of Effectiveness

Rating	Programme	Type	Description	Contact / Website
	Student Teams-Achievement Divisions (STAD)	IP-Co-operative Learning	Structured co-operative learning programme in which students work in 4-member teams.	UK website: www.successforall.org.uk (Product training provided)







Rating	Programme	Type	Description	Contact / Website
	IMPROVE	IP-Co-operative Learning	Developed in Israel, IMPROVE is an approach to maths that combines co-operative learning, metacognitive instruction and mastery learning.	Israeli contact: mevarz@mail.biu.ac.il

MC = Mathematics Curricula, ICT = Computer-Assisted Instruction, IP = Instructional Process Programmes







Moderate Evidence of Effectiveness

None

Limited Evidence of Effectiveness

Rating	Programme	Type	Description	Contact / Website
	Plato	ICT	Supplementary integrated learning system. Also provides computer assisted programmes for home use.	UK website: www.platolearning.co.uk (Product training available)
	Prentice-Hall Course 2	MC	A traditional commercial textbook, based on US National Council of Teachers of Mathematics standards. It offers a balance between concepts and problem solving. Used in the UK – primarily in international schools.	UK contact: Nicola Wookey, Sales & Marketing Executive, International Schools, Europe Pearson Education, nicola.wookey@pearson.com UK websites: www.longman.co.uk www.internationalschools.co.uk (Nb. No product training is available, but they offer teacher's books with step-by-step advice and additional resources).
	Cognitive Tutor	ICT	An intelligent tutoring system that emphasises algebra and problem solving. Students carry out investigations of real-world problems using spreadsheets, graphs, and symbolic calculators.	US website: www.carnegielearning.com US contact: Clay Caroselli Senior Inside Sales Representative, West, ccaroselli@carnegielearning.com
	Core-Plus Mathematics	MC	Four-year integrated curriculum funded by the US National Science Foundation.	US website: www.wmich.edu/cpmp Contact: cpmp@wmich.edu



Rating	Programme	Type	Description	Contact / Website
			Emphasises small-group collaborative learning through problem-based investigations.	
	Expert Mathematician	ICT	Students are taught to use the LOGO programming language, and work through a series of computer and workbook activities emphasising problem solving and creativity.	US website: www.expertmath.org
	Jostens	ICT	Assessments place students according to their current level. Exercises designed primarily to fill in gaps in their skills are then provided. Teachers are provided with information on progress. Typically used for 15-30 minutes per day, 2-3 days per week.	US website: www.compasslearning.com
	Math Thematics	MC	US National Science Foundation- funded programme, based on US National Council of Teachers of Mathematics standards.	US website: www.classzone.com/books/math_thematics1/
	Partnership for Access to Higher Mathematics (PATH)	IP	US programme for at-risk students age 13/14 who need help to prepare them to move into more advanced classes. Includes social work interventions to deal with issues such as attendance, parent support, and behaviour.	
	Saxon Math	MC	US textbook that starts from the basics, and offers a step-by-step approach to mathematics.	US website: saxonpublishers.harcourtachieve.com
	Talent Development Mathematics	IP	Comprehensive school reform model designed to change school organization, management, curriculum, and	US website: www.csos.jhu.edu/tdhs



Rating	Programme	Type	Description	Contact / Website
			instruction and provide professional development to assist secondary schools that have serious problems with attendance, discipline, achievement scores, and drop-out rates. Teachers stay with the same class for multiple years, and are given ongoing professional development.	

MC = Mathematics Curricula, ICT = Computer-Assisted Instruction, IP = Instructional Process Programmes

Other Ratings



Insufficient Evidence

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

N No Qualifying Studies

UK:

- BBC Active, Bitesize (Curr) www.bbcactive.com/SchoolShop/
- Heinemann, Level Up Maths (Curr/ICT) www.heinemann.co.uk/Series/Secondary/LevelUpMaths/LevelUpMaths.aspx
- Longman (Curr) www.longman.co.uk/Secondary.aspx?CourseCode=SMTH
- Edexcel (Curr) www.longman.co.uk/Secondary.aspx?CourseCode=SMTH
- Number Line (ICT) <http://lgfl.skool.co.uk/>
- Mathematical Toolkit (ICT) <http://lgfl.skool.co.uk/>
- Maths Alive! (ICT) <http://www.rm.com/Secondary/Products/Product.asp?cref=PD7370&SrcURL=/mathsalive>

Non-UK:

- Adventures of Jasper Woodbury Series
- AquaMOOSE
- CAP Mnemonic Instruction
- College Preparatory Mathematics, Foundations for Algebra
- Concepts in Algebra, Everyday Learning
- CORD Contextual Mathematics, CORD Applied Mathematics, CORD Algebra 1
- Destination Math



Focus on Algebra, Addison Wesley Longman
Fun Math
Generalizable Mathematics Skills Instructional Intervention
Geometric Supposers
Glencoe Pre-Algebra

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 programme 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 standardised 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.

Programmes were rated according to the overall strength of the evidence supporting their effects on maths 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 Full Report and Further Reading

- For the full report, which this review summarises, see Slavin, R.E., Lake, C., & Groff, C. (in press), Effective programs in middle and high school mathematics: A best evidence synthesis. *Review of Educational Research*. An updated version of the full report is available at www.bestevidence.org.uk.
- For a related ‘What Works Clearinghouse’ review of middle school (11-14 years) mathematics curricula and ICT (US), see www.whatworks.ed.gov

