Intervention report: The Expert Mathematician

Updated December 1, 2004

Intervention

The Expert Mathematician (now in version 3.4) is a three-year program of software instruction with 196 lessons, each ranging from one to three class periods. It covers general mathematics, pre-algebra, and algebra I. It uses the *Logo* computer language to focus on writing, operating, and applying mathematical procedures to study concepts, investigate logical relationships, and solve problems.

For

Middle school students.

Findings

One randomized controlled trial found, in the one analysis that met WWC evidence standards, no significant difference in score gains between students in *The Expert Mathematician* and those in *Transition Mathematics*, the comparison curriculum.

Evidence base

1 randomized controlled trial meets evidence standards.

0 quasi-experimental design studies meet evidence standards with reservations.

0 studies do not meet evidence screens.

(see symbol key on page 6)

Evidence limits

The evidence base for *The Expert Mathematician* is limited to one small randomized controlled trial (70 students in one school) of 8th-grade students in a suburban middle school in Missouri.

Scope of use

The Expert Mathematician was first implemented in 1992 and first distributed commercially in August 2004. It is used primarily in urban and suburban districts, for high poverty students of various ethnic backgrounds.

Developer and contact

J.J. Baker, Ph.D., www.expertmath.org; email: frstprin@mninter.net; telephone: (612) 872-6741.

Profile

The Expert Mathematician is designed to help middle school students develop the thinking processes for mathematical applications and communication. It uses a software and consumable print materials package with 196 lessons that teach the *Logo* programming language.

The Expert Mathematician is a three-year program of instruction. Each lesson ranges from 40–120 minutes, or one to three class periods.

The Expert Mathematician coursework combines integrated computer software with workbook activities (Baker 1997, p. 72). There is no textbook, only software and printed consumable lesson materials. A test of unit concepts is at the end of each instructional unit.

The developer used the computer program *LogoWriter* to develop the curriculum, which covers general mathematics, pre-algebra, and algebra I. The developer describes the curriculum as covering the range of concepts and content areas in the National Council of Teachers of Mathematics *Curriculum and Evaluation Standards* (Baker 1997, p. 72).

Teaching

To prepare to teach this curriculum, teachers work through each lesson ahead of their students. The developer provides instructions.

Teachers may introduce or review concepts at the outset of class or alternate direct instruction days with generative learning days. The curriculum encourages the teacher to reinforce successes, to gently correct mathematical interpretations of activities, and to suggest investigations to extend learning. The teacher tries to promote critical-thinking skills by prodding students to explain a concept, called the 30-second probe (Baker 1997, p. 73). According to the developer, the curriculum tools do not require extensive training for teachers; instead, the curriculum reduces the teacher's lesson planning (Baker 1997, p. 76).

Typical lesson

According to the developer, the teacher introduces the lesson for the day by using printed materials. Students then work individually or in pairs (using the print materials and the computer) to study new concepts and procedures to write and solve a math problem. Students pick up their folder with the previous day's work from a file box as they enter the classroom.

Students work in pairs, with one typing and the other reading and recording (they alternate roles). They review the previous day's work and practice problems generated by the computer. Then the "reader" reads the next lesson's instruction, and the pair follows instructions to program math procedures in *Logo*, use their programs to solve math problems, and complete their programs and the answers to the problems. The "reader" records the answers to the math problems.

Students use four types of questions as they work: memory, convergent, divergent, and evaluative.

Scope of use

The Expert Mathematician has been implemented in pilot schools as part of studies of its effects. It became available in August 2004.

Cost

As of September 2004, no cost schedule was available.

Study findings

Randomized controlled trial

One small randomized controlled trial (70 students in one school) on *The Expert Mathematician* found, in one of several analyses, that students in *The Expert Mathematician* intervention groups performed better than students in the comparison groups using *Transition Mathematics* when controlling on pretest.

Strength of the evidence base

The WWC collected more than 800 studies for the Middle School Math Curriculum review. Of these, one study on *The Expert Mathematician*, a randomized controlled trial, meets WWC evidence standards as providing strong evidence of causal validity.

Studies were rated according to the strength of their causal evidence. Studies that placed students into the intervention and comparison groups randomly (randomized controlled trials) without notable design or implementation flaws are classified as meeting evidence standards (✓✓[a]). Other studies that use comparison groups (quasi-experimental designs) and randomized controlled trials with notable flaws are classified as meeting evidence standards with reservations (✓[a]).

Studies are further rated for intervention fidelity, outcome measures, breadth of evidence, reporting on subgroups, analysis, and statistical reporting. That information is provided in study reports, but does not affect the overall rating.

The intervention in this study is well defined and implemented and meets the WWC definition of a middle-school math curriculum. The primary outcome measure, the Objectives by Strand test, appears to be valid and to be aligned with the intervention, though it is not a state or nationally standardized test. The study looks only at 8th-grade students in a suburban Missouri middle school, and no additional studies look at or provide findings for other students or settings. The analysis was appropriate, and the information needed to calculate effects was provided in the study. But the sample was small (70 students), so findings should be viewed with caution.

a See symbol key on page 6.

Table 1

Effects

Study	Measure	Favors comparison group / Comparison group mean / Favors *The Expert Mathematician*
		-2.00 -1.50 -1.00 -0.50 0 0.50 1.00 1.50 2.00
Baker 1997	Objectives by Strand test (N=70 students)	0.35
Approximate percentile ranking		2% 7% 16% 31% 50% 69% 84% 93% 98%

How to read this table: The shaded bar indicates both the direction and estimated size of the effect of the intervention. The estimated effects reported here are standardized differences in the mean values between the intervention and comparison groups. Bars extending to the right of zero denote estimated effects that favor the intervention group, and those extending to the left of zero denote estimated effects that favor the comparison group. The solid line through the shaded bar marks the 95% confidence interval of the estimated effect; when there is no solid line, the study did not provide data to correctly compute the confidence interval. When the line does not cross zero (and the bar is solid, not striped), the estimate is statistically significant. The bar is striped if the effect is not statistically significant or if significance could not be accurately computed. The scale at the bottom of the chart indicates the approximate percentile distribution of students in the comparison group. The percentile ranking at the end of the shaded bar can be used to interpret the standardized mean difference in the outcome. For example, an effect of 0.5 is roughly equivalent to an increase in the mean value from that of the average student in the comparison group (50th percentile) to that of the average student in the 69th percentile.

In Baker (1997) the *Expert Mathematician* group seemed to score lower than the comparison group on an Objectives by Strand test (N=70), but it was not possible to determine whether the difference was statistically significant.

References

Baker, J.J. (1997). Effects of a generative instructional design strategy on learning mathematics and on attitudes towards achievement. *Dissertation Abstracts International, 58* (7), 2573A. (UMI No, 9800955)

Appendix

Table A1 **Summary characteristics and findings from randomized controlled trials on *The Expert Mathematician***

Study	Study sample	Measure	Sample size			Mean outcome		Standard deviation[a]		Estimated impact[b]	
			Intervention group	Comparison group	Total	Intervention group	Comparison group	Intervention group	Comparison group	Mean difference	Standardized mean difference
Baker 1997[c]	8th-grade, regular education students	Objectives by Strand Test[d]	36	34	70 students	45.10	40.80	12.03	12.41	4.3	0.35[e]

a Shows how dispersed the participants' outcomes are. A small standard deviation would suggest that participants had similar outcomes.

b The WWC computed standardized effects, using statistics reported by the study author.

c Means and effects adjusted for pretest differences between the groups.

d This is not a state or nationally normed standardized test, but it appears to be valid and aligned with the intervention.

e The confidence interval cannot be accurately computed.

Table A2 **Characteristics of interventions in reviewed studies on *The Expert Mathematician:* Baker (1997)**

Evidence base rating	Characteristic	Description
✓✓	Study citation	Baker, J.J. (1997). *Effects of a generative instructional design strategy on learning mathematics and on attitudes towards achievement.* Unpublished doctoral dissertation, University of Minnesota.
	Participants	70 8th grade students. Most students were from low-income families and qualified for free or reduced-price lunches. All but three students were white. None were in special education. Students were randomized to the intervention or to the comparison condition.
	Setting	Suburban middle school in St. Louis, Missouri; four classrooms (two intervention classrooms and two comparison classrooms).
	Intervention	The intervention group was taught using a "generative mathematics curriculum" that used *The Expert Mathematician* (version 3.0). Students worked individually or in pairs using the printed materials and the computer to work through the lessons in *The Expert Mathematician*. Sessions, which included one or two lessons, were 85 minutes long and occurred every other day for one school year. Intervention students were taught by the same teacher as those in the comparison condition.
	Comparison group	The comparison group experienced a "linear mathematics curriculum" based on *Transition Mathematics,* the middle school volume of the University of Chicago School Mathematics Project. The author describes this as a traditional, teacher-directed curriculum. The text can cover the first year in a six-year mathematics curriculum.
	Primary outcomes and measurement	78-item Objectives by Strand test, developed by the district. No norming information available. Test was administered at the end of the school year by the classroom teacher.
	Teacher training	None reported.

Symbol key for evidence base rating

✓✓ Study meets evidence standards (randomized controlled trial without notable flaws).

✓ Study meets evidence standards with reservations (randomized controlled trial with notable flaws or quasi-experimental design study without notable flaws).

✗ Study does not meet evidence screens.