



Relative Achievement Effects of Four Early Elementary School Math Curricula

With greater attention being given to the need for all students to meet state proficiency targets, educators are increasingly looking for effective curricula to boost achievement, especially among more disadvantaged students. After one year this study demonstrated that math achievement for grade 1 students was significantly higher among schools using the Math Expressions and Saxon Math curricula than among those using Investigations in Number, Data, and Space and Scott Foresman-Addison Wesley Mathematics.



Many U.S. children start school with weak math skills, and children from poor households lag behind those from affluent ones. These differences grow over time, resulting in substantial differences in math achievement by the time students reach grade 4.

The federal Title I program provides financial assistance to schools with a high number or percentage of students from low-income households, to help all students meet state academic standards. Under the No Child Left Behind (NCLB) Act of 2001, these schools must make adequate yearly progress in meeting state-specific targets for proficiency in math and reading, with the goal of ensuring that all students are proficient in math and reading by 2014.

To provide educators with information that may contribute to making adequate yearly progress, this large-scale national study examines whether some math curricula for early elementary school are more effective than others at improving student math achievement. A small number of curricula, based on different theories for developing math skills, dominate elementary school math

instruction—seven math curricula make up 91 percent of the curricula used by K–2 educators. Although the NCLB Act emphasizes the importance of adopting scientifically based education practices, there is little rigorous research evidence to support one theory or curriculum over another. This study aims to help fill that knowledge gap.

The study

One primary research question guides the results presented in the first report on this study:

- What are the relative effects of different early elementary school math curricula on student math achievement in schools serving disadvantaged students?

The study also examines whether these effects differ for student, teacher, and school subgroups and collects data on teacher curriculum implementation.

A competitive process was used to select four core curricula that represent diverse approaches to teaching early elementary school math in the United States:

- Investigations in Number, Data, and Space (Investigations) is published by Pearson Scott Foresman and uses a student-centered approach encouraging metacognitive reasoning and drawing on constructivist learning theory. The lessons focus on understanding rather than on specific answers and build on students' knowledge and understanding. The curriculum is divided into thematic units of three to eight weeks during which students investigate and discuss problems and strategies.
- Math Expressions is published by Houghton Mifflin Company and blends student-centered and teacher-directed approaches to math. Teachers use objects, drawings, and language to represent concepts and emphasize learning through real-world situations. Students are expected to explain and justify their solutions.
- Saxon Math (Saxon) is published by Harcourt Achieve and blends teacher-directed instruction of new material with daily distributed practice of previously learned concepts and procedures through a scripted curriculum. The teacher introduces concepts or efficient strategies for solving problems. Students observe and then receive guided practice, followed by distributed practice. Frequent monitoring of student achievement is built into the program. Daily routines are extensive and emphasize practice of number concepts and procedures and use of representations.
- Scott Foresman-Addison Wesley Mathematics (SAW) is published by Pearson Scott Foresman and combines teacher-directed instruction with a variety of differentiated materials and instructional strategies. Teachers select the materials that seem most appropriate for their students, often with the help of the publisher. The curriculum is based on a consistent daily lesson structure, which includes direct instruction, hands-on exploration, the use of questioning, and practice of new skills.

An experimental design was used to evaluate the relative effects of these four curricula on the math achievement of students in disadvantaged schools. Schools in each participating district were randomly assigned to one of the four curricula, thereby setting up an experiment in each district. The 39 schools examined in the first study year are in four

districts in four states in three regions of the country. The districts also represent different levels of urbanicity—two districts are in urban areas, one in a suburban area, and one in a rural area. For the first cohort, curriculum implementation occurred in grade 1 during 2006/07. Data were collected from the 131 grade 1 teachers in the study schools and from 1,309 students. About 10 schools with about 33 classrooms and 325 students were assigned to each of the four curricula.

The study does not include a control group of schools that continued to use their usual core math curricula because this group would reflect the variety of curricula used by the participating districts, making it difficult to compare effects of the study's curricula with effects for this group. The relative effects of the curricula were thus calculated by comparing math achievement of students in the four curriculum groups.

To measure the achievement effects of the curricula, the study team tested students at the beginning and end of the school year using the nationally normed math assessment developed for the Early Childhood Longitudinal Study—Kindergarten Class of 1998/99 (ECLS-K). The assessment covers five math content areas: number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probability; and patterns, algebra, and functions.

To help in interpreting the measured effects of the curricula, teachers were surveyed about curriculum implementation. Survey data were useful for assessing teacher training in curriculum, use of the assigned curriculum, and any supplementation with other materials. Teachers also reported on their use of the essential and secondary features of their assigned curriculum, which was valuable in assessing adherence to the curriculum.

The findings

The study's main findings include information on curriculum implementation and the relative effects of the four curricula on student math achievement.

Curriculum implementation

The implementation analysis showed that:

- All teachers received initial training from the publishers, and 96 percent received follow-up training. Training varied by curriculum, ranging from 1.4 to 3.9 days.
- According to the fall and spring surveys, nearly all teachers (99 percent in the fall, 98 percent in the spring) reported using their assigned curriculum as the core math curriculum, and about a third (34 percent in fall and 36 percent in spring) reported supplementing their curriculum with other materials.
- Eighty-eight percent of teachers reported completing at least 80 percent of their assigned curriculum.
- On average, Saxon teachers reported spending one more hour on math instruction per week than teachers of the other curricula did.

Achievement effects

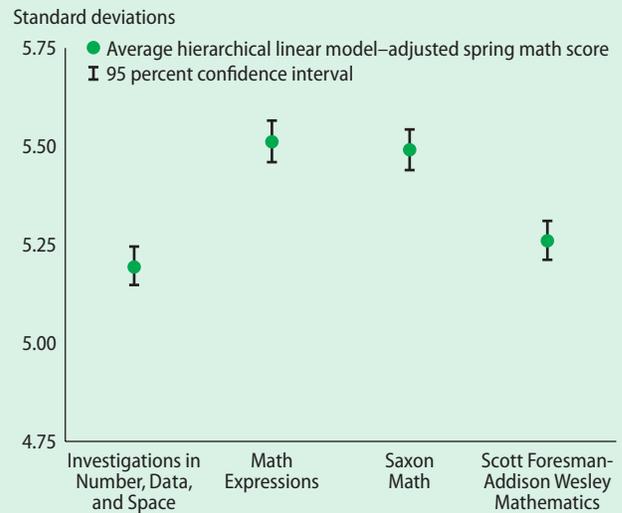
Student math achievement was significantly higher in schools assigned to Math Expressions and Saxon than in schools assigned to Investigations and SFAW. The math achievement of Math Expressions and Saxon students was 0.30 standard deviation higher than that of Investigations students and 0.24 standard deviation higher than that of SFAW students (figure 1). For a student at the 50th percentile in math achievement, these effects mean that the student's percentile rank would be 9–12 points higher if the school used Math Expressions or Saxon instead of SFAW or Investigations.

Math achievement in schools assigned to the two more effective curricula (Math Expressions and Saxon) did not differ significantly, nor did math achievement in the schools assigned to the two less effective curricula (Investigations and SFAW).

The study also examined the effects of the curricula along six baseline characteristics—participating districts, school fall achievement, school free or reduced-price lunch eligibility, teacher education, teacher experience, and teacher math content and pedagogical knowledge measured before curriculum training. These characteristics were used to create 15 subgroups: one for each of the four districts, three based on school fall achievement, and two for each of the other four characteristics.

FIGURE 1

Average hierarchical linear model–adjusted spring math score with confidence interval, by curriculum



Note: Curricula whose confidence intervals do not overlap have significantly different average scores at the 5 percent level of confidence. The results are presented in standard deviations, which means that subtracting the average values (the dots) for any two curricula indicates the effect size of using one curriculum instead of another.

Eight of the fifteen subgroup analyses found statistically significant differences in student math achievement between curricula. The significant curriculum differences ranged from 0.28 to 0.71 standard deviation, and all of the significant differences favored Math Expressions or Saxon over Investigations or SFAW. There were no subgroups for which Investigations or SFAW showed a statistically significant advantage.

The next steps

In 2007/08 (the year after the first cohort of 39 schools joined) another 71 schools joined the study, and curriculum implementation occurred in both grades 1 and 2 in all participating schools. A follow-up report will present achievement results based on all 110 participating schools and for both grades 1 and 2, as well as implementation results based on classroom observations. The study also supported curriculum implementation and data collection during the 2008/09 school year in a subset of schools in which implementation was expanded to grade 3. A third report is planned that will present those results.

For the full report, please visit:

<http://ies.ed.gov/ncee/pubs/20094052/index.asp>

Agodini, R., Harris, B., Atkins-Burnett, S., Heaviside, S., Novak, T., and Murphy, R. (2009). *Achievement Effects of Four Early Elementary School Math Curricula: Findings from First Graders in 39 Schools* (NCEE 2009-4052). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance.

NCEE developed the Evaluation Briefs to offer short synopses of complex technical evaluation reports. This brief was not prepared by the study authors.

