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Achievement Effects of Four Early Elementary School Math Curricula: Findings for First and Second Graders

First- and second-grade math achievement differed among students in volunteer schools that were assigned at random to use one of four curricula that vary in their instructional approaches: (1) Investigations in Number, Data, and Space; (2) Math Expressions; (3) Saxon Math (Saxon); and (4) Scott Foresman-Addison Wesley Mathematics (SFAW). Among first graders, the results favored Math Expressions over both Investigations and SFAW, but not over Saxon. Among second graders, the results favored Math Expressions and Saxon over SFAW, but not over Investigations.

The policy context

National achievement data show that elementary school students in the United States, particularly those from low socioeconomic backgrounds, have weak math skills (National Center for Education Statistics 2009). This study examines whether some early elementary school math curricula are more effective than others at improving math achievement in schools serving a high percentage of disadvantaged students. Understanding the relative effects of math curricula is important because curricula tend to be aligned with particular strategies for teaching math, yet little rigorous evidence exists to support one approach over another.

Four curricula were examined

This study compared the student math achievement effects of four distinct math curricula that represent several of the diverse approaches used to teach elementary school math in the United States. Generally speaking, the curricula vary in the extent to which they emphasize student-centered or teacher-directed instructional approaches.

1. *Investigations in Number, Data, and Space (Investigations)* is published by Pearson Scott Foresman (Wittenburg et al. 2008) and uses a student-centered approach focused on conceptual understanding, rather than students' abilities to answer problems correctly. Lessons build on students' knowledge and understanding. Students are engaged in thematic units of three to eight weeks in which they first investigate and then discuss and reason about problems and strategies.

2. *Math Expressions* is published by Houghton Mifflin Harcourt (Fuson 2009a; Fuson 2009b) and blends student-centered and teacher-directed approaches to mathematics. Students question and discuss mathematics but are also explicitly taught effective mathematics procedures. There is an emphasis on using manipulatives (such as linking cubes), drawings, and language to represent mathematical concepts and on learning through the use of real-world situations. Students are expected to explain and justify their solutions to problems.

3. *Saxon Math (Saxon)* is published by Harcourt Achieve (Larson 2008) and is a scripted curriculum that blends teacher-directed instruction with an incremental instructional approach in which new concepts are presented to students in small pieces and then practiced in each subsequent lesson. Students are explicitly taught procedures and strategies and hear correct answers. 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.

4. *Scott Foresman-Addison Wesley Mathematics (SFAW)* is published by Pearson Scott Foresman (Charles et al. 2005a; Charles et al. 2005b) and is a basal curriculum that combines teacher-directed instruction with a variety of differentiated materials and instructional strategies. Teachers select the materials that seem most appropriate for their students. 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.

Investigations, Saxon, and SFAW are among the seven most widely used curricula in the United States—the three curricula make up 32 percent of the curricula used by kindergarten through second grade educators (Resnick et al. 2010). Estimating use of Math Expressions is difficult because it is a newer curriculum and market share data are not yet available.

The study approach

The study includes 110 elementary schools spread across 12 districts that were willing to adopt any one of the study's curricula for up to three years. The study team recruited the participating sites, which are not a representative sample of all elementary schools in the United States. However, they are geographically dispersed and located in areas with different levels of urbanicity. The participating schools also serve a higher percentage of students eligible for free or reduced-price meals than the average U.S. elementary school.

Within each of the 12 school districts, participating schools were randomly assigned to implement one of the four curricula. Random assignment of curricula to schools was conducted separately for each participating district, which established an experiment involving all four curricula in each district.

This document summarizes results from analyses that compare math achievement of the different curriculum groups during the first year of the study, during which curriculum implementation in each school occurred in the first and/or second grade. Among the 110 study schools, 109 implemented the curricula in the first grade during their first year of study participation and 71 implemented the curricula in the second grade.

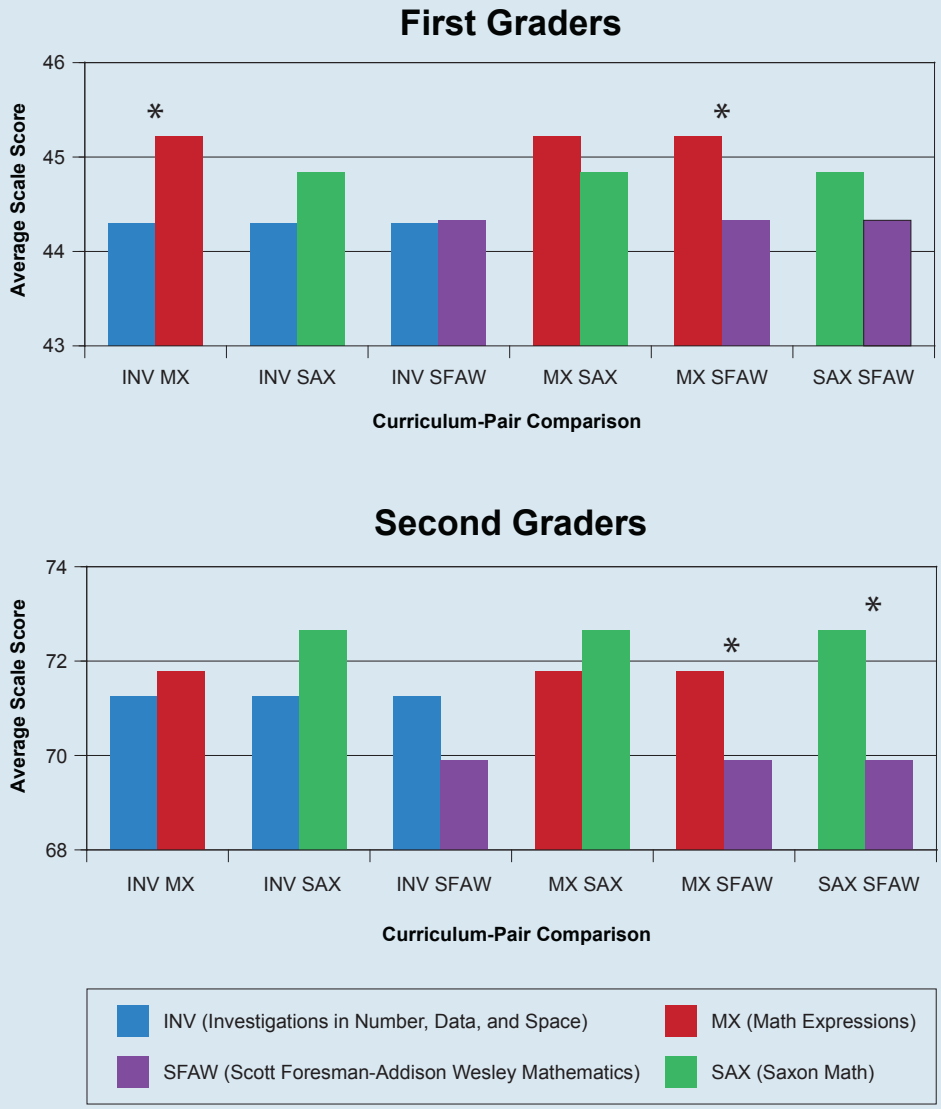
The results are based on six curriculum-pair comparisons: (1) Investigations relative to Math Expressions, (2) Investigations relative to Saxon, (3) Investigations relative to SFAW, (4) Math Expressions relative to Saxon, (5) Math Expressions relative to SFAW, and (6) Saxon relative to SFAW. To measure these relative curriculum effects, the study team administered to students the math assessment developed for the Early Childhood Longitudinal Study—Kindergarten Class of 1998–99 (ECLS-K) (West et al. 2000).

The findings

Figure 1 presents the average spring math score for each curriculum-pair comparison, separately for first and second graders. The following summary describes curriculum-pair differences in average achievement in standard deviations (or effect sizes) to facilitate comparison of the results with results from other studies of math achievement.

- **During the first year of implementation, the curriculum used by the study schools mattered.** In first-grade classrooms, students taught using Math Expressions scored an average of 0.11 standard deviations higher on the ECLS-K math test than students taught using either Investigations or SFAW (Figure 1). This difference in test scores is equivalent to moving a student from the 50th to the 54th percentile.

Figure 1. Average spring student math scale score, by grade and curriculum pair comparisons



NOTE: An asterisk above a curriculum pair comparison indicates the two curricula being compared have significantly different average scores at the 5 percent level of confidence, which means there is no more than a 5 percent chance that the differences occurred by chance.

In second-grade classrooms, students taught using Math Expressions and Saxon scored an average of 0.12 and 0.17 standard deviations higher on the ECLS-K math test than students taught using SFAW, respectively. These differences are equivalent to moving a student from the 50th to the 55th or 57th percentile, respectively.

None of the other curriculum-pair differentials in average ECLS-K math scores are statistically significant for students in either first or second grades.

- **One curriculum resulted in more math instruction.** Saxon teachers reported spending an average of one hour more per week on math instruction than teachers using other curricula. However, there were no significant differences in average math instruction time among teachers using the other three curricula.

- **The curricula affected instructional practices in expected ways.** Based on classroom observations conducted by the study team, student-centered instruction and peer collaboration were highest

in Investigations classrooms; teacher-directed instruction was highest in Saxon classrooms.

The study in context with other research

There is little rigorous evidence about the effectiveness of elementary school math curricula. As of October 2010, the What Works Clearinghouse (WWC) had reviewed 465 studies of interventions designed to improve math achievement of elementary school students (http://ies.ed.gov/ncee/wwc/). The WWC examined 40 studies about the effects of Investigations, 20 studies about Saxon, 12 studies about SFAW, and one study about Math Expressions.

However, as the WWC reviews show, only the earlier report produced by this study (Agodini et al. 2009) is based on a design that meets evidence standards and makes curriculum comparisons examined in this current report. The earlier report examined first-grade effects during the first year of curriculum implementation among the 39 cohort-one schools and found that there were significant differences in achievement across the curriculum groups. In particular, average spring first-grade math achievement of Math Expressions and Saxon students was similar and 0.30 and 0.24 standard deviations higher than average achievement of Investigations and SFAW students, respectively. Achievement of the latter two groups (Investigations and SFAW) was not statistically different.

We also identified one other study, not yet reviewed by the WWC, that compared two of the curricula included in this study—Saxon and SFAW—and the findings of that previous study are, generally speaking, the opposite of this study. Bhatt and Koedel (2009) used a nonexperimental design to evaluate the relative effects of three curricula, two of which were Saxon and SFAW. They found that average math achievement of students taught using Saxon was 0.09 standard deviations *lower* than that of students taught using SFAW; in contrast, we found that average second-grade math achievement of Saxon students was 0.17 standard deviations *higher* than SFAW students.

Looking ahead

A future report will examine the relative effects of the curricula during the second and third years of implementation. That report will be based on the fraction of schools that participated in the study during the second and third years, when curriculum implementation was repeated in grades in which it began and expanded to the third grade.

IES develops these briefs to offer short, accessible summaries of complex technical evaluation reports. For the full report with technical details, see: http://ies.ed.gov/ncee/pubs/20114001.

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