Drill, baby, drill? Study finds worksheets, practice improve math skills more than fun stuff

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By Maureen Downey - The Atlanta Journal-Constitution

A new study finds traditional math instruction – what many folks call "drill and kill" – is more effective in helping young children struggling in math than group work, peer tutoring or hands-on activities that use manipulations, calculators, movement and music.

Yet, as the percentage of students in a first grade classroom with math difficulties increases, teachers tend to increase their use of these less effective instructional practices, which researchers describe as student-centered.

What worked better for struggling students are teacher-directed activities, which researchers describe as "using textbooks or worksheets, giving students lots of time to practice skills being modeled by the teacher, more explicit types of instruction."

“Student-centered or teacher-directed kinds of instructional activities worked about equally well with first grade students that didn’t have a prior history of learning difficulties in mathematics,” says study co-author Paul Morgan in a good video interview. “Students who had come into first grade classrooms struggling with mathematics, either repeatedly or intermittently, really didn’t seem to benefit from the student-centered instruction that first grade teachers were offering but instead those students seemed to benefit more from teacher-directed instruction.”

Controlling for student socioeconomics and prior achievement, the study found the strategies and approaches teachers use matter to student learning gains in math.

This is an important issue as I increasingly see schools – including those my children attend – tout group learning activities. In many classrooms now, you will see students working at tables together on math.

A friend who teaches in a Title 1 school lamented that her students didn’t do as well in the math CRCT as the classroom next door where the teacher used worksheets all the time. My friend’s classroom was a beehive of fun activities around math, but the worksheet class continually outperformed hers. These new findings help us understand why that might have been.

First this release from the University of California, Irvine.

First-grade teachers in the U.S. may need to change their approach to improving the math skills of students who struggle with the subject, according to new research co-authored by UC Irvine education professor George Farkas.
The study revealed that teachers in classrooms with higher percentages of math-challenged students are actually more likely to use ineffective instructional strategies. They tend to employ manipulative/calculator and movement/music activities, which the researchers found do not boost math skills in children at any level of proficiency.

“Math educators have created many competing curricula, and we have very limited understanding of their relative effectiveness,” Farkas said. “However, activities such as routine practice or drill, math worksheets, problems from textbooks and math on the chalkboard appear to be most effective, probably because they increase the automaticity of arithmetic. It may be like finger exercises on the piano or ‘sounding out’ words in reading. Foundational skills need to be routinized so that the mind is free to think.”

The research showed that only frequent use of teacher-directed instruction – focusing on textbooks, worksheets and other tools to convey facts, skills and concepts – is associated with significant gains for students with math difficulties. The most successful methods are routine practice and drill. The results hold true for first-grade students who had either persistent or transitory trouble with math in kindergarten.

The so-called “math curriculum wars” pit teacher-directed and student-centered activities against each other. The latter involves children working together to discover math skills on their own. This is ineffective when students struggle with comprehension, Farkas said: “Not all children achieve understanding in student-centered activities, and many fail to achieve automaticity with basic arithmetic facts and techniques.”

The growing reliance by first-grade teachers on non-teacher-directed instruction is surprising and troubling, he noted, given what prior research has shown about the learning needs of math-challenged students.

For their study, the researchers analyzed survey responses from 3,635 teachers and data from a subsample of 13,833 children in the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99, a nationally representative data set maintained by the U.S. Department of Education’s National Center for Education Statistics.

It’s important that students with math difficulties be brought up to speed at an early age in order to reach their educational and career potential. Students who complete high school with relatively low math achievement are more likely to be unemployed or paid lower wages, Farkas said, even if they have good reading skills.

Teacher-directed instruction is also linked to gains in children without a history of math trouble. But unlike their math-challenged counterparts, they can benefit from some types of student-centered instruction as well – such as working on problems with several solutions, peer tutoring, and activities involving real-life math.

While previous research has identified instructional practices that increase reading achievement in students both with and without reading problems, few prior studies have examined which teaching methods are best for boosting math skills.
“Our findings provide teachers an indication of what works,” Farkas said. “Students with math difficulties would benefit more from explicit teacher-directed types of instructional approaches rather than from other kinds of approaches that we see teachers using.”

He co-authored the work with Paul L. Morgan and Steve Maczuga of Pennsylvania State University. Funding was provided by the National Center for Education Statistics and the Eunice Kennedy Shriver National Institute of Child Health & Human Development, one of the National Institutes of Health.

And here is the release from the American Educational Research Association:

First-grade teachers in the United States may need to change their instructional practices if they are to raise the mathematics achievement of students with mathematics difficulties, according to new research published online today in Educational Evaluation and Policy Analysis, a peer-reviewed journal of the American Educational Research Association.

“Which Instructional Practices Most Help First-Grade Students with and without Mathematics Difficulties?” by Paul L. Morgan of Pennsylvania State University, George Farkas of the University of California, Irvine, and Steve Maczuga of Pennsylvania State University, examined nationally representative groups of first-grade students with and without MD to determine the relationship between the instructional practices used by teachers and the mathematics achievement of their students.

The study, funded by the U.S. Department of Education and the National Institutes of Health, found that first-grade teachers in classrooms with higher percentages of students with mathematics difficulties were more likely to be using ineffective instructional practices with these students.

When first-grade classes had larger percentages of students with mathematics difficulties, their teachers were more often using non-traditional instructional practices, in which students use manipulatives, calculators, movement, and music to learn mathematics. The researchers found these types of practices were not associated with achievement gains. These practices were ineffective for both mathematics difficulties and non-mathematics difficulties students.

Instead, the researchers found that only use by first-grade teachers of more traditional, teacher-directed instruction — in which teachers used textbooks, worksheets, chalkboards, and routine practice to instruct students in mathematics facts, skills, and concepts — was associated with achievement gains for students with mathematics difficulties.

According to study findings, the most effective instructional practice that first-grade teachers could use for students with mathematics difficulties was to provide them with routine practice and drill opportunities to learn mathematics. The findings held true for first-grade students who had shown either persistent or transitory mathematics difficulties in kindergarten. Results were extensively controlled for students’ prior mathematics and reading achievement, family income, and other factors.

“Use by first-grade teachers of non-teacher-directed instruction is surprising and troubling, given our findings and what prior research has shown about the instructional needs of students with mathematics difficulties,” said lead study author Paul L. Morgan. “It suggests that first-grade teachers are mismatching their instruction to the learning needs of students with mathematics difficulties.”
“Our findings suggest that students with mathematics difficulties are more likely to benefit from more traditional, explicit instructional practices,” Morgan said, “This is particularly the case for students who are more likely to persistently struggle to learn mathematics.”

“Effectively instructing students with mathematics difficulties at an early age matters immensely to their future academic achievement and opportunities in life,” said Morgan. “We know that students who continue struggling to learn mathematics in the primary grades are highly likely to continue to struggle throughout elementary school. Others have reported that students who subsequently complete high school with relatively low mathematics achievement are more likely to be unemployed or paid lower wages, even if they have relatively higher reading skills.”

For students without a history of mathematics difficulties, teacher-directed instruction is also associated with achievement gains. However, unlike their schoolmates with mathematics difficulties, the mathematics achievement for these students is also associated with some, but not all, types of student-centered instruction, which focuses on giving students opportunities to be actively involved in generating mathematical knowledge.

Student-centered activities associated with achievement gains by first graders without mathematics difficulties include working on problems with several solutions, peer tutoring, and activities involving real-life math. Students without mathematics difficulties benefited about equally well from either more traditional teacher-directed instruction or less traditional student-centered instruction.

While previous research has identified instructional practices that can be used by elementary school teachers to increase reading achievement for those with and without reading difficulties, very few empirical studies have tried to identify instructional practices being used by teachers that are effective in increasing the mathematics achievement of their students with and without mathematics difficulties.

Maureen Downey is a longtime reporter for the AJC where she has written editorials and opinion pieces about local, state and federal education policy for 12 years.