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Teaching math two ways at the same time boosts learning

Researchers at the University of Chicago have come up with a technique for teachers to use that increases student understanding of mathematics: explain how to solve a problem in one way, and also provide an alternative approach through gesture.

Students who were taught to solve arithmetic problems by teachers using mismatched gesture and speech learned twice as well as students who received instruction in speech only. The technique also helped students learn better than students who received instruction that was the same in speech and gesture, the researchers report in an article, "Children Learn When Their Teacher's Gestures and Speech Differ," published in the current issue of *Psychological Science*.

"Teachers gesture when they teach, and those gestures do not always convey the same information as the speech they accompany," writes Susan Goldin-Meadow, the Irving B. Harris Professor in Psychology at the University and co-author of the study. "Gesture thus offers students a second approach to the problem at hand," said Goldin Meadow, who co-wrote the article with Melissa Singer, a 2004 Ph.D. graduate of the University of Chicago, and now a researcher at the University of Illinois at Chicago.

"Our findings make it clear that children can take advantage of the offer—children profit from gesture when it conveys information that differs from the information conveyed in speech," Goldin-Meadow noted.

Goldin-Meadow said a mismatching gesture provides an additional explanation and is effective because it visually illustrates another way to solve the problem being explained. Teachers often use mismatching gestures with their speech spontaneously without realizing it, she said.

For the study, researchers tested 160 students who were finishing third grade or beginning fourth grade in Chicago public and parochial schools. The students were given arithmetic problems to



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Melissa A. Singer and Susan Goldin-Meadow

solve and then were asked to explain their solutions at a chalkboard.

The students were taught to find a missing number in an equation with two separate approaches. For example, the problem $6 + 4 + 3 = _ + 3$ can be solved in two ways: either by following the algorithm “add up the numbers on the left side of the equation and subtract the number on the right,” or by following the principle “both sides of the equation must add up to the same number.”

This is how the mismatched gesture-and-speech lesson worked:

A child was given the equation and the teacher explained the equalizing principle by saying both sides need to have the same numerical value. But at the same time, the teacher pointed at the 6, 4 and 3 on the left side of the equation and then produced a “flick away” subtract gesture under the 3 on the right side of the equation, which signaled the “add-subtract” algorithm.

In addition to teaching with mismatched gestures and speech, teachers also instructed students in the two problem-solving approaches verbally and by using matching gestures and speech.

“Surprisingly, teaching children two problem-solving strategies in speech was significantly worse than teaching one strategy, suggesting that children may have been overwhelmed by the additional spoken strategy,” write Goldin-Meadow and Singer. For example, on average, students taught through two verbal explanations without gesture answered one out of six problems correctly. Children who learned the two problem-solving strategies with mismatched gestures and speech solved three out of six problems correctly.

Goldin-Meadow’s work also has shown that gesture helps make learning easier because it relieves some of the mental effort students expend in processing spoken lessons.

“Given previous work establishing the breadth and depth of gesture production across many tasks and ages, these data open the possibility of a heretofore unappreciated technique to improve learning in and out of the classroom,” Goldin-Meadow writes.

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<http://www-news.uchicago.edu/releases/05/050215.gestures-math.shtml>
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