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The Best Ways to Make Schoolchildren Learn? We Just Don't Know

By Sharon **Begley**

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HELEN NEVILLE HAD never heard of "visual math," and even after her seventh-grade son, Justin, tried to explain that it had something to do with imagining squares and cubes of different sizes, the better to grasp number systems not based on 10, she was still perplexed. So she marched down to the middle school Justin attended in Eugene, Ore., and confronted the math teacher.

"What are you trying to teach them?" Prof. Neville, a neuroscientist at the University of Oregon, recalls asking. "What's the evidence it works?" The teacher said she had read that Einstein "visualized mathematics," so this is what she had come up with. "It made no sense," Prof. Neville says, "and some of the kids lost a year of math" as a result. As for Justin, he survived, sort of. He's now a philosophy major at the University of Oregon.

The U.S. spends some $400 billion a year on K-12 education. Yet unlike other big-ticket items such as defense and health care, "education does not rest on a strong research base," as a report from the National Research Council put it with polite understatement. "In no other field are personal experience and ideology so frequently relied on to make policy choices, and in no other field is the research base so inadequate and little used."

PROF. NEVILLE describes the situation even more bluntly: "The approaches that schools implement are completely unempirical" rather than based on research showing what works. "Some have been shown to fail, and for others we have no idea whether they work."

That seems especially true in science. U.S. 15-year-olds performed with their usual mediocrity in the most recent international assessment of science literacy, announced this week, and even worse than they had three years ago. Finland, Japan, Hong Kong, South Korea and 14 other developed nations did better; 10 did worse. It's at least worth considering whether Prof. Neville's diagnosis offers a partial explanation.

It is conventional wisdom in science education, for instance, that the best way to give K-12 students a deep and enduring understanding is through "discovery learning." Although the term has no precise, universally accepted definition, it basically means that the teacher gives the kids a goal and the requisite materials and then tells them to go to it, with the hope that they will uncover principles such as Newton's laws of motion. In contrast, using "direct instruction," teachers explicitly present information to students.

"The idea is that students who acquire knowledge on their own can apply it more broadly and extend it better than if they are told or shown that same knowledge," says David Klahr of Carnegie Mellon University in Pittsburgh.

To test this claim, he and a colleague compared how well the approaches taught 112 third- and fourth-graders a core scientific concept: To discover how one thing affects another, change only one variable at a time. Specifically, the kids had to figure out how to design good experiments that would reveal what properties of a ramp (steepness, length, smoothness) affect how far a ball will roll. The goal was to learn that if you compare a ball rolling down a short, steep, bumpy ramp to one rolling down a long, flatter, smooth ramp, you can't tell if the extra distance comes more from length, angle or surface. To do that, you must change only one property at a time -- varying steepness, say, while holding the length and the smoothness constant.

STUDENTS RECEIVING direct instruction were explicitly told to change one property at a time and were given explanations. The discovery learners got neither. In both cases, the kids worked with ramps and balls, so everyone did hands-on science. The result: Not only did more kids master the control-of-variables lesson from direct instruction, but -- and this strikes at the heart of the claims for discovery learning -- the latter approach did not give kids a deeper, more enduring knowledge. Those who learned the one-variable- at-a-time idea through direct instruction extended and applied their newfound knowledge just as well as those few who discovered it by themselves.

"I'm not saying kids never benefit from discovering something on their own," says Prof. Klahr. "But especially for complicated, multi-step procedures, there are just no data that discovery learning offers any benefit."

Supporters of discovery learning say that Prof. Klahr's study was too extreme, and that in real life students doing discovery learning get more guidance from their teachers. But that just raises another question: What ratio of discovery learning to direct instruction is ideal?

Once again, no one knows for sure.

The mismatch between claims about the best way to get kids to learn and what well-designed scientific studies show is striking. Recognizing that, in 2001 the U.S. Education Department called for making education "evidence-based." Like evidence-based medicine, it means using only teaching methods that are shown to work in solid studies (analogous to clinical trials of new drugs). Or, as Prof. Neville says, "we need the education equivalent of an FDA that would not allow schools to implement a practice unless it had empirical support."

As I'll discuss next week, we're a long way from that.
