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To Improve Education, We Need Clinical Trials To Show What Works

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IF THERE IS one thing about science that educators and scientists wish students would learn, it isn't the difference between an isotope and an isomer or any of the hundreds of other facts that pepper textbooks and tests. It is how to think critically about scientific data and concepts, and be able to synthesize and apply them.

So for today's quiz, class, identify the problem with this study: In one class, the teacher encourages the 30 students to be active learners, engaging in scientific inquiry alone and in a group. That's not very likely without some structure. So the teacher -- who has a solid mastery of science and has volunteered for extra training so she can run an innovative class like this one -- helps students formulate questions and devise experiments or observations likely to lead to answers.

In another class, the teacher parrots the textbook, instructing the students explicitly in science facts and principles. He focuses on the acquisition of knowledge, not its synthesis or use.

By year-end, kids in the first class are doing better than kids in the drill-and-memorize classes. You conclude that the first approach is superior.

We pause here to allow you to ponder where you tripped up.

LET DAVID KLAHR of Carnegie Mellon University explain. "Studies of classrooms where teachers use discovery-based learning show that the kids do a little better" learning science, he says. "But to run a discovery-learning class, you need a teacher who really knows the material, who's creative and knowledgeable. If you had that same teacher do traditional instruction, might the kids do just as well?"

As I noted last week, that's the gap in education's research base: well-controlled studies with large numbers of students that account for factors such as the superior knowledge and extra training of teachers in some classes, or even high expectations of student achievement on the part of teachers using a "new and improved" curriculum. Without such controls, observations -- including those in our hypothetical study -- are inconclusive about what really makes the difference in how well kids learn.

"There is not as much good research on what works as [educators] need," says Grover Whitehurst, director of the U.S. Education Department's Institute of Education Sciences. "In science education, there is almost nothing of proven efficacy." The result, says Rodger Bybee, executive director of the Biological Sciences Curriculum Study, a nonprofit corporation in Colorado Springs that develops curriculums, is that "practices in science education can have a mythical quality, or be justified because `it makes sense.' "

In asking what works in science education, I don't mean to ignore the very real controversy over what we mean by "works." Most tests, notably international comparisons, assess recall and comprehension of facts, notes Richard Duschl of Rutgers University, who chairs a National Academy of Sciences committee on K-8 science. Maybe we want our kids to be able to synthesize and explain science, which is harder to gauge. Nor do I mean to denigrate the solid discoveries in cognitive science, developmental psychology and neuroscience about how people learn, nor the NAS science education standards that reflect what successful teachers do.

THE TROUBLE IS, those discoveries have rarely been put to the acid test we demand when discoveries in basic biology serve as the basis for new drugs. Just because a drug looks as though it will cure some disease, based on experiments in test tubes and mice, doesn't mean it will. "Sometimes," says NAS education expert Lisa

Towne, "basic principles don't translate as expected" -- not into drugs, not into classrooms.

Dr. Whitehurst's group at the Education Department is therefore "trying to bring evidence to bear on education decision making," he says.

There are already some robust principles of learning science. "Time on task" matters; students have to put in the hours. Students need challenges -- instruction that aims just beyond what they already know. Also, says Harold Pratt, former president of the National Science Teachers Association, teachers must address students' misunderstandings about how the world works before introducing new information, teach facts and ideas in context rather than in isolation, and have students monitor their own learning.

To be sure, there are small, pilot studies galore of science-instruction methods. In many, hands-on, inquiry-based learning, in which the kids actively think about topics, comes out on top. But this approach, as well as other principles of learning, cry out to be tested in large, randomized, controlled "clinical" trials.

"I'd put the idea that students learn better when they teach others to a rigorous test," says Dr. Bybee. "And no one has ever done the experiment" to vet the presumed superiority of teaching big ideas before bunches of facts. Maybe kids smart enough to teach others, and to learn by deduction rather than induction, learn well no matter how they're taught. You can't tell.

When might we? "Optimistically," says Dr. Whitehurst, "in five to 10 years we might know" the most effective ways to teach science. Medicine is finally becoming evidence-based. Surely it is long past time for education to do so, too.
