Title: NCLB Could Alter Science Teaching
Author(s): Sean Cavanagh
Source: *Education Week*. 24.11 (Nov. 10, 2004): p1.
Document Type: Article
Full Text:

It's a principle that many teachers have come to trust, from the first time their classes filled test tubes with yeast and loaded mini-volcanoes with baking soda and vinegar: When it comes to science, students learn best by doing, not just sitting and listening.

Over the years, however, some researchers and educators have challenged the argument for hands-on learning. They maintain that a more straightforward approach--known as direct instruction--has the potential to help students learn science more effectively.

Soon, schools across the country could face a new, powerful incentive to consider that mode of instruction, some observers suggest. Beginning in 2007, the federal No Child Left Behind Act will require districts to test students in science, a mandate that curriculum and instruction officials say could force schools to consider cutting back on some of the in-class experiments many teachers value.

With those changes coming, new attention is being paid to methods of teaching science, and what works best. The National Research Council is conducting a series of studies aimed at exploring topics such as the role of the laboratory in science classrooms and how states should assess students' knowledge in the subject.

That renewed interest was also obvious with the release of a widely distributed study conducted by researchers at Carnegie Mellon University and the University of Pittsburgh, which was detailed at a national science "summit" sponsored by the U.S. Department of Education earlier this year. The study found that students taught through direct instruction were more likely on average to become "experts" in designing scientific experiments--an important step in the development of scientific-reasoning skills--than those taught through what is often called discovery learning.

Moreover, the students who showed expertise in designing those experiments through direct instruction performed just as well as those who developed similar expertise through discovery paths on a separate test of their broader scientific judgment--countering some previous claims that direct instruction produces weaknesses in that area.

While David Klahr, one of the study's two authors, believes that complex science lessons often require a more direct type of instruction, he also cautions against too rigid an adherence to either method by teachers or administrators. "It depends on what's being taught," Mr. Klahr, a psychology professor at Carnegie Mellon, said in an interview.

To date, much of the debate over direct instruction's role in the K-12 classroom has centered on reading, where that model has found a place in many districts and fed an industry of textbooks and other instructional materials. The direct approach has also influenced the teaching of mathematics and other subjects.

But some educators expect questions over the use of direct instruction in science classrooms to intensify in the coming years.

Questions over its role are "right on the cusp, because the attention to science is right on the cusp," said Gerald F. Wheeler, the executive director of the National Science Teachers Association. When it comes to tougher state and federal standards, he said, "right now, the country is still focused on reading and mathematics."

How to Define It?

The NSTA, a professional organization in Arlington, Va., with more than 55,000 members, encourages a blend of both direct teaching and laboratory experimentation, Mr. Wheeler said.

While descriptions of direct instruction vary widely, it is often defined as a model that promotes highly structured lessons, in which teachers present material to students in an explicit way, rather than having them attempt to arrive at conclusions on their own through in-class experimentation. The strategy evolved out of the work of researchers such as Siegfried Engelmann

at the University of Illinois in the 1960s, who believed that if applied properly, the approach would improve student performance.

Direct instruction tends to contrast with discovery learning, a model that generally asks students to acquire knowledge through laboratory work, experiments, and periodic guidance from teachers. Supporters of discovery learning (sometimes linked with a model called "inquiry-based learning") say the approach encourages students to develop a broad understanding of scientific concepts, which they are likely to retain over time.

The voluntary national science standards, originally published in 1995 by the National Research Council, a division of the federally chartered National Academies, emphasize the importance of inquiry-based learning. Many curriculum experts regard those standards as a premier guideline on how to teach the subject.

Advocates of discovery learning say direct instruction can easily regress into lecture-style teaching, heavy on rote recitation of scientific facts and memorization.

"It's cheaper, faster, and not as effective," contended Wayne Carley, the executive director of the National Association of Biology Teachers, in Reston, Va. "If you want kids to memorize a bunch of facts, it's a great way to learn. ... Science is not just a set of facts, but a process for discovering more facts."

Putting less emphasis on laboratory experimentation may appeal to some school administrators as a way to cut costs, Mr. Carley said, but the vast majority of teachers know the value of that hands-on learning.

In his study of direct instruction, Mr. Klahr focused on a group of 112 3rd and 4th graders who were asked to design several experiments involving balls that could be rolled down ramps of different heights, lengths, and surfaces. Students taught through direct instruction on average devised better experiments than those taught through discovery, according to Mr. Klahr and the study's co-author, Milena Nigam, who at the time was working at the University of Pittsburgh.

Because the ability to design experiments is just one piece of scientific thinking, the researchers took the student experts and nonexperts from the first experiment and gave them another task: analyze and attempt to improve upon a series of science-fair posters, which had been designed by another group of students. Students from that first group who had become experts through direct instruction did just as well in critiquing the posters as expert discovery learners, the study found. So in the end, not only did direct instruction produce a higher percentage of experts in designing experiments, but those students did not show any resultant lack of scientific-reasoning skills, compared with discovery-taught students, as many have maintained.

Mr. Klahr emphasized that the type of direct instruction used in his experiment should not be linked to the very highly scripted, "extremely controlling" models he has seen espoused by some advocates. For him, direct instruction necessitates some combination of direct explanation of material and classroom experimentation.

From Reading to Science?

Just as definitions of direct instruction vary, so do estimates of its prevalence in science classrooms. An organization that follows the topic, the National Institute for Direct Instruction, in Eugene, Ore., did not have an official estimate of its use in science courses nationwide.

But others, who define direct instruction broadly, say its use is quite common. Rowena S. Douglas, the NSTA's assistant executive director for professional development, estimates that a strong majority of science teachers nationwide rely heavily on textbooks to guide their lessons, supplementing them with lectures and laboratory work--an approach that qualifies as a form of direct instruction. Most science textbooks also use a method that probably contributes more to direct instruction than inquiry-based learning, said Rodger W. Bybee, the executive director of the Biological Sciences Curriculum Study center, in Colorado Springs, Colo., which evaluates science teaching from kindergarten through college.

Today, many of the districts that use direct instruction in reading, math, and other subjects have found that it has the greatest benefits for elementary-age pupils, particularly those who may be struggling academically, said Mr. Engelmann, one of the pioneers of the instructional model. To date, its application in science has been more limited, partly because the more in-depth study in that subject is typically reserved for middle and high school, he said.

But Mr. Engelmann, who retired last year as a professor of special education at the University of Oregon, sees a place for direct instruction in the teaching of science, too. Teachers of science subjects would not be asked to abandon classroom experiments, he said, but rather save that work until they were certain students had a mastery of the basic material.

"In the time it takes them to do one experiment or one relationship," Mr. Engelmann said, "you could probably do 20 relationships."

Explain and Experiment

Directors of the Baltimore Curriculum Project, a nonprofit program that works with three schools serving both elementary and middle school students in that city, have been using direct instruction for the past six years in subjects from reading and language arts to mathematics.

Leaders of the project, which largely serves students from low-income families and has seen an improvement in test scores among its participants in recent years, plan to use direct instruction in science over the next few years, said Muriel Berkeley, the president of the curriculum project. Teachers will still use lab experiments, but only after making sure their students have a strong foundation in the basic scientific concepts first, she said.

California state officials have recently debated how best to lead students through those basic scientific concepts. Earlier this year, state officials settled on a guideline for instructional materials that says at least 20 percent to 25 percent of K-8 class time be devoted to hands-on activities, as long as those experiments are connected to state standards. One district there, Manhattan Beach, has encouraged science teachers for years to use direct-instruction techniques. The 7,400-student school system began emphasizing that approach as it sought to set more definite academic standards across many subjects, Superintendent Gwen E. Gross said.

Although no mandate is in place to teach using direct instruction, 8th grade science instructor Sara L. Ford said she adopted that model over time, after realizing that her students seemed to take more from lab experiments when she had spent 10 to 15 minutes introducing a scientific concept to them.

During one recent class, that approach was as simple as Ms. Ford's beginning a class with an explanation of elements and compounds, with definitions and examples sprinkled throughout, then having students move to laboratory work, using a flame to heat test tubes and expose changes in the color of different elements. "They need to understand it isn't just some magical process," said Ms. Ford, a teacher at Manhattan Beach Middle School. "Otherwise, what is the meaning of it?"

School systems and educators are too quick to put labels on teaching techniques, in Ms. Ford's view. When she and her teaching colleagues talk about what works in the classroom, they generally speak of what worked, without assigning labels to their methods.

"You don't go around saying, 'Today, I'm doing direct instruction, then I'm doing cooperative learning,' " said Ms. Ford, who has taught for 31 years. "If you're teaching, you have to have a bag of tricks and a variety of strategies."

Sean Cavanagh

Source Citation
Cavanagh, Sean. "NCLB Could Alter Science Teaching." *Education Week* 10 Nov. 2004: 1. *Academic OneFile*. Web. 30 Apr. 2012.

Document URL
http://go.galegroup.com/ps/i.do?id=GALE%7CA215121215&v=2.1&u=cmu_main&it=r&p=AONE&sw=w

Gale Document Number: GALE|A215121215

Top of page