Math teachers question role of tests

If 130 schoolchildren are going on a picnic, and 50 can ride in each school bus, how many buses are needed to carry them all?

About 300,000 California sixth-graders were given this test question along with four possible answers: 2, 2 with a remainder of 30, 2 3/5 and 3. Only 39 percent chose the correct answer. Forty-four percent answered 2 with a remainder of 30, 9 percent said 2 3/5 and 6 percent said 2.

It illustrates what many educators say is a major flaw in mathematics education: Students are learning to calculate according to formula, but they're not learning how to think in practical ways. "They cannot relate what they do in the classroom to what they would do in the world," says Tej Pandey, research consultant for the California Assessment Program in Sacramento.

Many educators blame the flaw on math tests. Most test questions — unlike the above example — ask students to perform straightforward numerical calculations only. So by studying to do well on these tests, students do not learn how to solve practical problems.

"There is widespread concern that testing is having more influence on the dynamic of curriculum than one would think it should," says Shirley A. Hill, chairwoman of the National Research Council's Mathematical Sciences Education Board, who opened a national conference on the issue of math testing last month at the University of California at Los Angeles (UCLA). "The question is, do we teach people what we do because testing people have put it on tests or because it's an important educational objective?"

Hill says students should be taught to look for answers, not merely to choose the correct answer from a list. She says they should learn to figure out what kind of information they need to solve real problems. For example, she says, a student might be told that a boat with a sonar device is bouncing a sound wave off the ocean bottom, and that the signal takes 6 seconds to return to the boat. If asked to calculate the depth of ocean at that point, the student should know that he or she must first learn the speed of sound through water.

Hill says teachers have been under great pressure to focus their lessons on multiple-choice test skills, because school boards, college admissions offices and others look mainly at test scores to see how well students are doing. It might be better, she says, if students were assessed, at least partly, by their teachers' observations.

The teachers, mathematicians and math test designers who attended the recent conference agreed that mathematics assessment should be improved, Hill says. And some went so far as to say that improved tests could lead to better math lessons.

Research consultant Pandey, who has been busy writing test questions — like the school bus example — designed to make students think better, believes better tests can challenge both students and teachers to think harder. "These questions show the teachers what their students don't know, and they suggest the kinds of problems that can be done in the classroom," Pandey says.

Thomas A. Romberg of the Wisconsin Center for Education Research in Madison, another speaker at the UCLA conference, says educators should do more than simply write better multiple-choice tests. "We need to quit assuming that the only question we can ask students is the independent, multiple-choice question," Romberg says. "We're really the only country in the world that administers multiple-choice tests."

In Britain, he says, students are given "open-ended" questions, in which they must come up with their own answers. Such questions help students learn "higher order thinking," Romberg says, because they force students to actually solve the problem, not just choose an answer from a list.

He also suggests that math teachers shift their students' focus from computation alone to practical uses for computation. "We need to train people to use the machines that compute for us, so they can handle data, read spread sheets and do a variety of other things," he says. "That doesn't mean we won't teach computation at all, but it means the students don't have to be able to do 200 multiplication problems in 10 minutes."

Many of the conferees further complained that too much classroom time is spent on testing, Hill says. There is the danger that students who are tested too much will stop caring how they perform.

So far, Hill says, teachers have only anecdotal evidence that math tests are improperly influencing curriculum. But the Mathematical Sciences Education Board intends to study the issue during the next few years to see whether there is any empirical evidence for the problem.

"There are so many stories about the bad effects of tests, but we need to know exactly what influence they have on curriculum," she says. *— M. Murray*

Crater and debris linked for first time

Six hundred million years ago, a meteorite smashed into the Lake Acraman region of southern Australia at more than 1,000 kilometers per second, sending shock waves through the surrounding volcanic rock and creating concentric impact ridges up to 160 kilometers across. The impact sprayed rock and dust as far as 300 kilometers away; the debris settled in the quiet sea nearby. Plentiful marine sediments quickly covered the debris, preserving the story of the meteorite's impact from erosion.

Such is the scene depicted in the July 11 SCIENCE by a group of researchers from the University of Adelaide (Australia), the Australian National University in Canberra and the University of Arizona in Tucson. Their discovery, made while they were trying to date volcanic rocks in the region, marks the first time a meteorite impact has been linked directly to its debris and is the most complete record of an impact prior to the Cenozoic era, which began 70 million years ago.

Some geologists have suggested that craters such as the one at Lake Acraman could have formed through volcanic eruptions, which would also spray debris over the surrounding terrain. The investigators at the Lake Acraman site, however, present several arguments in favor of the meteorite theory for the crater in southern Australia.

The volcanic material found among the debris, the investigators report, closely resembles, and probably originated in, volcanic rock from the Gawler Range, the site of the crater. However, the volcanic debris is more than twice as old as the sediments in which it was deposited, indicating it already existed at the time the crater was formed. Moreover, the volcanic fragments do not show the characteristic bomblike shape resulting from an eruption, but do show the cone-shaped fracture lines characteristic of a high-velocity shock that, the researchers write in their paper, only a meteorite could produce.

A complete picture of a meteorite impact could shed light on the role of meteorites in mass extinctions, a topic of continuing debate. "Maybe it can tell us how big a dust cloud [the meteorite] might have created," says geologist Gerta Keller of Princeton (N.J.) University, referring to the idea advanced by Walter Alvarez of the University of California at Berkeley that debris blown into the atmosphere by meteorite impacts periodically cooled the earth and extinguished much of the life on the planet (SN:6/2/79,p.356).

Astronomers can also use the information to refine their estimates of the ages of surface structures on other planets, according to Richard Grieve of the Geological Survey of Canada in Ottawa. By knowing the number and ages of craters on earth, scientists can calculate the frequency of meteorite impacts for specific time intervals, then count the craters on another planet to estimate the age of that planet's surface. *— T. Kleist*