MATH EDUCATION

Academy Report Aims To Quiet Debate

It's often said that those who walk down the middle of the road risk getting hit from both sides. But a new report* from the National Academy of Sciences on how children learn math flaunts its centrist tendencies in calling for improving how the subject is taught in U.S. elementary and middle schools. Its message is deliberately crafted to quiet the raucous "math wars" by summarizing what researchers have learned about student and teacher competencies and suggesting how to assess their progress. Initial reaction suggests that it may succeed.

"We want to move past the debate over skills versus understanding. It's not one or the other," says panel chair Jeremy Kilpatrick, a professor of mathematics education at the University of Georgia, Athens. "The point is that both are needed, and more, to learn and understand mathematics." Most professional societies fall into the "understanding" camp, exemplified by the most recent standards issued by the National Council of Teachers of Mathematics (NCTM), which stress hands-on learning and the importance of concepts along with mastery of procedures. The California-based grassroots lobbying group, Mathematically Correct, has led the charge for "skills-based" instruction, which puts greater emphasis on getting the right answers, through practice and memorization, than on broader conceptual exercises.

A desire to improve math instruction is a driving force behind broad education reform plans put forward last week by both President George Bush and congressional Democrats. Although the academy report doesn't address either plan directly, it offers a new definition of mathematical proficiency that, if adopted widely, could influence state and federal efforts. The definition bridges the two camps by including both conceptual understanding and procedural fluency. It also emphasizes the importance of solving problems, thinking logically, and seeing math as useful and worthwhile. The report recommends using those same categories to assess teacher performance and urges public officials to spend much more on teacher preparation and professional development.

"I think they did a solid job," says Janice Earle of the National Science Foundation, which along with the U.S. Department of Education funded the $1.58 million study. "In particular, I think that their notion of mathematical proficiency is richer than past definitions. Beyond that, I think they accomplished the goal of bringing together a credible group of people to look at the data and say, 'This is what makes sense.' "

The report, which took 2 years to complete and is 9 months overdue, is the product of a 16-member panel of mathematicians, math educators, cognitive scientists, and practitioners carefully chosen to be broadly representative of their fields. The topic was so sensitive politically that academy officials bypassed a standing body, the Mathematics Science Education Board—which is looked on with suspicion by the skills-based learning camp—and created an ad hoc Mathematics Learning Study Committee to take on the task. Then, to avoid any taint of bias, they formed another temporary body to oversee the selection of panelists and reviewers.

Mathematician and panelist Hung Hsi Wu of the University of California, Berkeley, can testify to the apparent success of that balancing act. Wu has been heavily involved in California's fractious efforts to revamp its math curricula, and his writing is widely cited by Mathematically Correct. Yet he has long insisted that the dichotomy between skills and understanding is "bogus," and he praises the new report for making that point clear. "I think that thoughtful people on both sides are moving toward a middle ground, and this report can help that process along," says Wu. "In my mind, the most important recommendation is that the government spend more money on long-term professional development and get serious about improving math instruction."

Mathematically Correct co-founder Paul Clopton, a statistician with the Department of Veterans Affairs hospital in San Diego, says he has "mixed feelings" about the report, worrying that some of its language echoes the original 1989 NCTM standards. But he couldn't agree more with its focus on teacher preparation. "That's the part I like best. But it's the hardest thing to do, and the thing that will take the longest to accomplish."

The academy plans to discuss the report at a public symposium. It also hopes to issue condensed versions of the 440-page report for targeted audiences including educators, policy-makers, and parents.

–JEFFREY MERVIS

Estimate the answer to adding 12/13 and 7/8. You will not have time to solve the problem with pencil and paper.

Answer: **A) 1**
B) 2
C) 19
D) 21

Fractured thinking. Only 24% of eighth graders, and 37% of high school seniors, chose the correct answer, B. A majority of 13-year-olds answered C or D, presumably after adding either the numerators or the denominators. "It shows the lack of even a basic understanding of what fractions are," notes academy panel member Thomas Carpenter, a math and science education researcher at the University of Wisconsin, Madison. "What we're saying is that without conceptual understanding, the skills will eventually be forgotten, and you'll make bizarre mistakes like this."

SOURCE: NATIONAL ASSESSMENT OF EDUCATION PROGRESS, 1977–78

* "Adding It Up: Helping Children Learn Mathematics," National Research Council, 2001 (www.nationalacademies.org).

REPRODUCTIVE BIOLOGY

Cloning: Could Humans Be Next?

The largely theoretical debate over human reproductive cloning became more concrete last week. Reproductive physiologist Panos Zavos of the University of Kentucky, Lexington, and Italian fertility doctor Severino Antinori told a meeting of fertility experts on 26 January that they, with several unnamed collaborators, would attempt to produce a baby through cloning within the next 2 years. The project would take place in a Mediterranean country, they said.

Although such an effort faces significant hurdles—and high risks—the claim can't be dismissed quite as easily as those of other groups that have declared their intentions to attempt human cloning. Last week's announcement is the first in which the would-be cloners have experience in assisted reproduction techniques. Zavos is co-founder of a fertility clinic in Kentucky and conducts research in male infertility. Antinori is known for his controversial efforts to help postmenopausal women become pregnant—one of his patients gave birth at age 62. Zavos said the team will only help patients who can reproduce no other way, such as a woman whose ovaries had been removed. As for fertile couples who want to clone a deceased child, "I doubt very much that they would qualify under our guidelines," Zavos told *Science*.

Experts in animal cloning say there is no inherent reason why nuclear transfer technology would not work in humans, with enough funding and know-how. "I'm sure it's doable," says Michael Bishop of Infigen, a biotechnology company in DeForest, Wisconsin, that has cloned more than 100 cattle and dozens of pigs. But would it be safe? In animal cloning to date, says Bishop, surrogate mothers do not suffer greater complica-

tion rates, except for higher rates of miscarriage, but the risk for the cloned fetus is another matter. In cattle cloning, approximately one out of seven newborns has potentially fatal complications, such as metabolic disorders and abnormal lung development. What's more, cautions Bishop, the long-term consequences of cloning are still not well understood. Safety aside, Anne McLaren, a developmental biologist at the Wellcome/CRC Institute in Cambridge, U.K., doesn't think human reproductive cloning is ready for prime time. Such techniques are "a step too far in assisted reproduction," she says.

One practical barrier might be obtaining enough human oocytes for the transfer procedure, in which an adult cell nucleus is either injected into or fused with an oocyte from which the nucleus has been removed. Even in the most efficient animal cloning labs, fewer than 5% of nuclear transfer attempts result in live births.

Stay tuned, says Zavos, who intends to announce more details on the project at a meeting in March in Rome. **–GRETCHEN VOGEL**

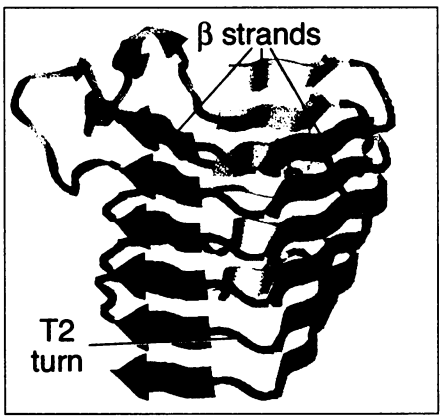
PROTEIN FOLDING

Virtual Molecules Nail Bacteria's Weapon

To understand how proteins work, biologists need to know what shapes they naturally fold into. The straightforward ways of finding out, x-ray crystallography and nuclear magnetic resonance, take as long as a year to reveal a protein's three-dimensional structure. Increasingly reliable mathematical models, however, can now predict parts of the structure much faster. In the latest computer-assisted coup, mathematicians and biologists at the Massachusetts Institute of Technology (MIT) have developed a program that predicts in milliseconds whether a protein folds into a structure called a β helix. To their surprise, they found that a protein with a β helix is like a child with a can of spray paint: It's almost surely up to no good.

"This program found a very interesting subset of proteins—whooping cough virulence factors, *Helicobacter pylori* toxins, ragweed pollen allergens, and so on," says Jonathan King, a biologist on the team who specializes in protein folding. King speculates that the β helix, a long spike, is used for attaching to or penetrating cell membranes. The work is "a tremendous accomplishment," says Peter Kim, a protein biologist who recently moved from MIT to direct Merck Research Laboratories in Rahway, New Jersey. "The bottom line is that a computer scientist has drawn attention to a class of proteins involved in human disease, which are potentially of medical significance."

The first known β helix was reported in 1993 by Frances Jurnak, an x-ray crystallographer who now works at the University of California, Irvine. It turned up in a bacterial protein called pectate lyase, which breaks down the pectin in plants' cell walls. Since then, a handful of other proteins with β helices have been found. One of them is pertactin, made by *Bordetella pertussis*, the bacterium that causes whooping cough. Because it elicits a strong immune response, pertactin has been incorporated into a new vaccine against that disease. But with only 12 known examples out of 12,000 solved proteins in the Protein Data Bank, β helices remained "low on the totem pole for structural biologists," King says.



Do the twist. Parallel β strands wrap up into a β helix.

The MIT group saw things differently. To them, the orderly structure of β helices made them ideal candidates for computational prediction. A β helix is made up of "rungs," consisting of three β strands (flat, uncoiled pieces of protein that stack into sheets with a water-loving side and a water-repelling side). A typical helix contains from 7 to 16 triangular rungs, which twist around gradually to the right. β sheets in general are hard to predict from an amino acid sequence, because residues that are widely separated in the protein's sequence may lie in adjacent rungs. Residues that lie in adjacent β strands usually match, but the residues on the "turns" between strands need not match at all. Because the turns have unpredictable lengths, it is hard for biologists to know where to look for the matching pairs. Fortunately, in the β helix each rung contains an easily recognized landmark: a very short turn, usually only two amino acid residues long, called the T2 turn.

Bonnie Berger, Lenore Cohen, and Phil Bradley in the MIT mathematics department incorporated this information into a computer program called BetaWrap. The program first identifies a likely T2 turn and assigns a score to the adjacent regions based on the probability that they will form β strands. Then it scans farther down the sequence for strands that have a high probability of stacking well onto the two already found. The program computes this probability by analyzing hundreds of known β sheets in the Protein Data Bank, but *not* the 12 known β helices. Tested to see whether it could pick the known β helix–bearing proteins out of a lineup, BetaWrap scored 12 out of 12—a feat no rival program could match.

Next, Berger turned the program loose on the larger SWISS-PROT database, consisting of proteins with unknown structure. BetaWrap found hundreds of β-helix candidates, some of which scored even higher than the known β helices. When Berger showed the list to King, he was astounded to see that the top 100 candidates were all bacterial proteins—even though Berger's team had no way of telling bacterial proteins apart from mouse or human proteins. "That's when he believed us, because we produced these things that made biological sense," Berger says. Berger announced the results at this month's meeting of the American Mathematical Society in New Orleans.

BetaWrap's predictions still must be checked by crystallography, a process that will probably take at least a year. But some researchers already plan to use the program's results as a springboard for new research. "I'm immediately going to run BetaWrap on viral genome sequences," Jurnak says, to see whether bacteria are indeed the only source of β helices. **–DANA MACKENZIE**

Dana Mackenzie is a writer in Santa Cruz, California.

PHILANTHROPY

Gates Gives Booster Shot to AIDS Vaccines

DAVOS, SWITZERLAND—In a huge boost for efforts to develop an AIDS vaccine, Bill Gates announced at the World Economic Forum here on 27 January that the foundation named after himself and his wife, Melinda, will give $100 million to the International AIDS Vaccine Initiative (IAVI). The 5-year grant—the largest single philanthropic donation ever for AIDS research—helps put the New York City–based nonprofit on track to launch clinical trials of three of its most promising AIDS vaccines by 2007.

Unsolicited grant. Gates announcing $100 million to IAVI.

With $21 billion in assets, the Bill and Melinda Gates Foundation gives away hundreds of millions

CREDITS: (TOP TO BOTTOM) BONNIE BERGER/MIT; HERBERT KNOSOWSKI/AP