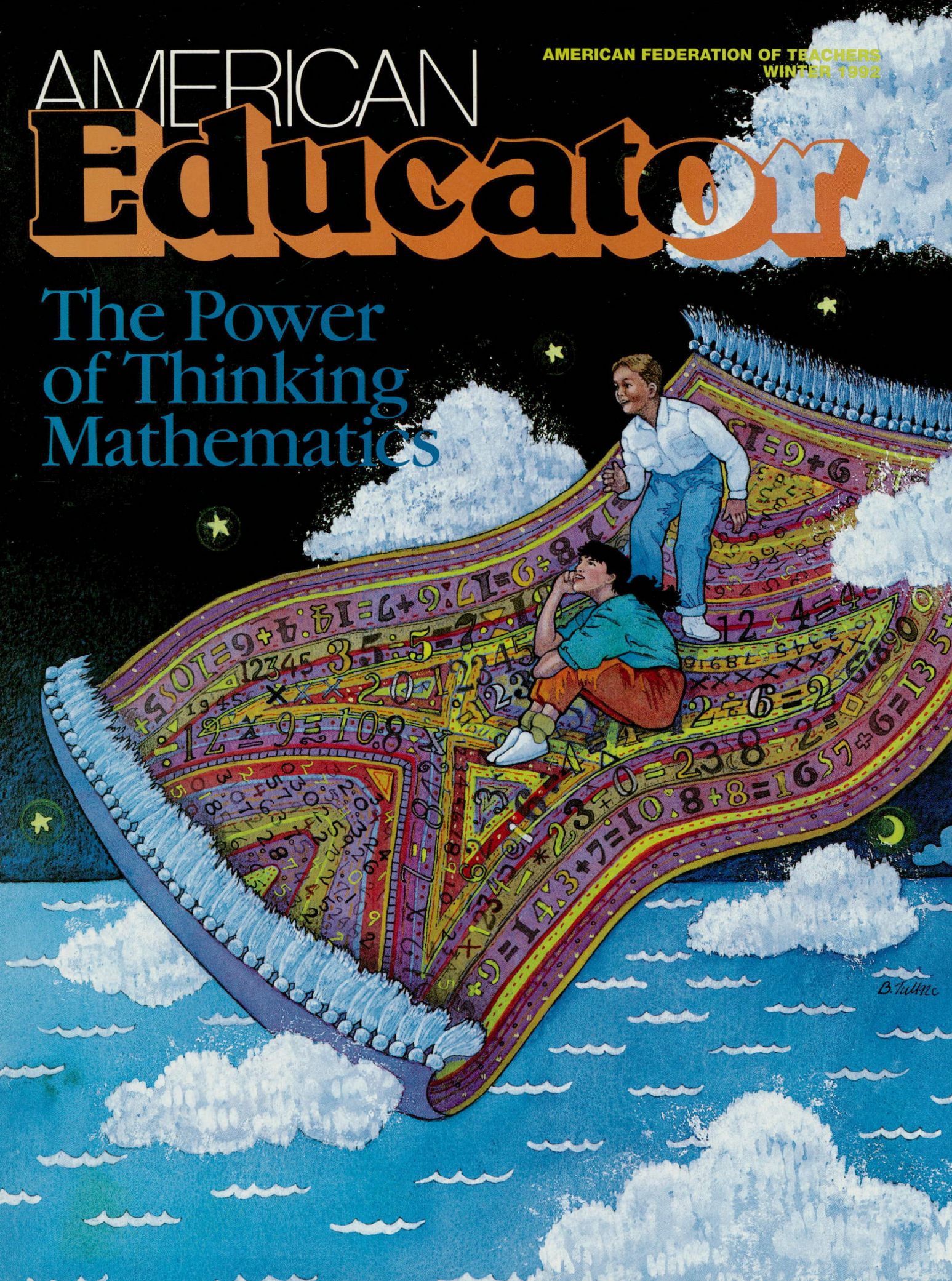
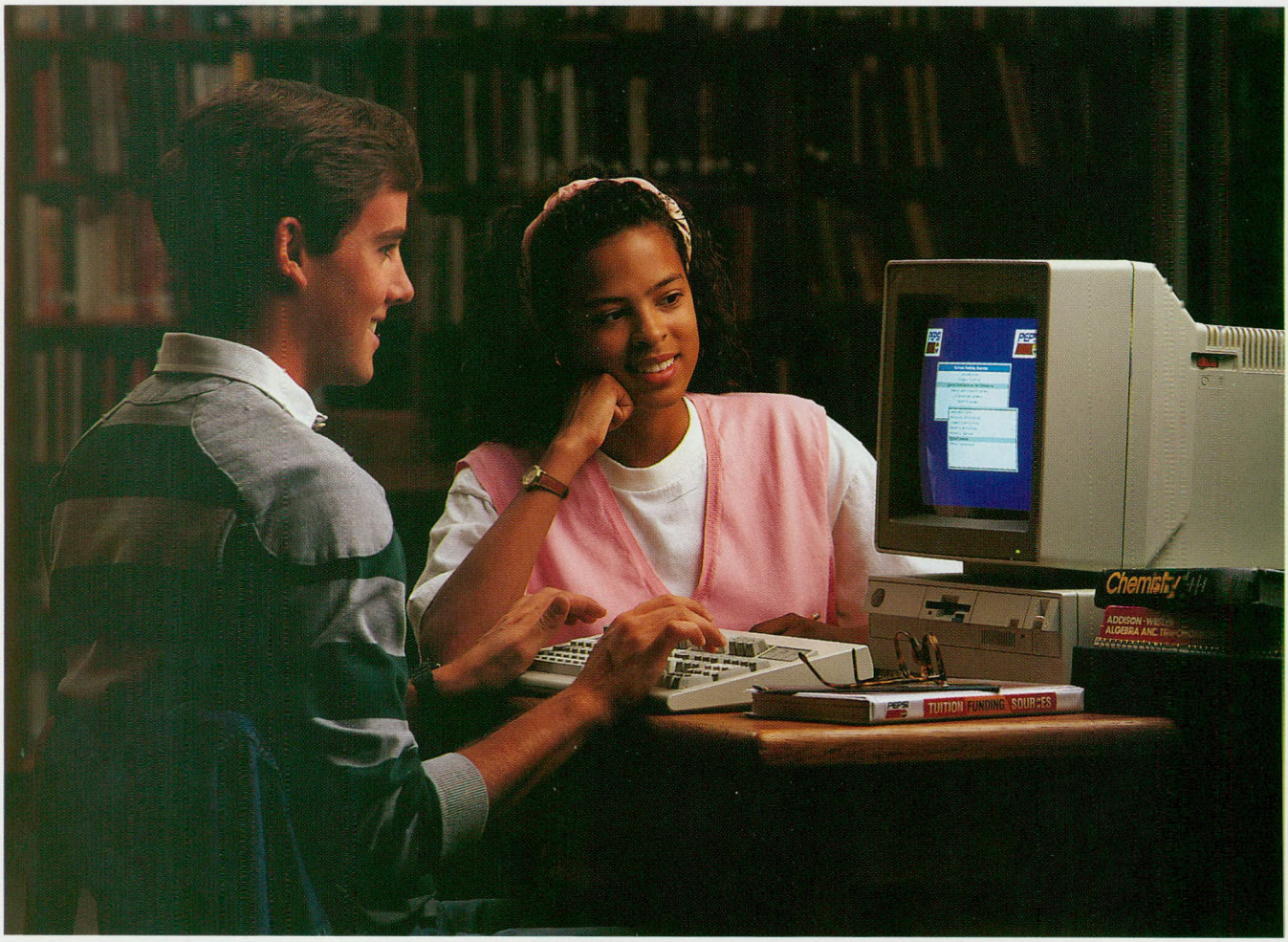
AMERICAN FEDERATION OF TEACHERS
WINTER 1992

AMERICAN Educator

The Power of Thinking Mathematics





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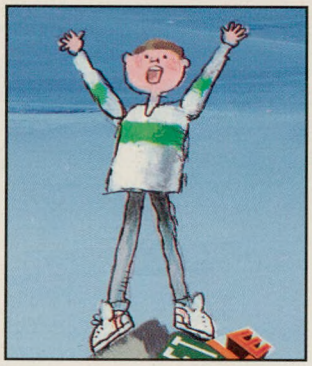

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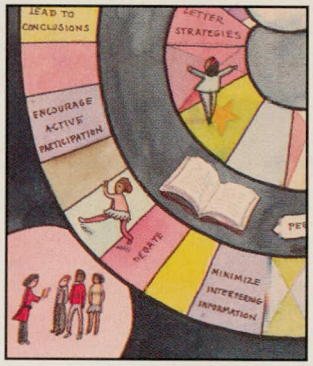

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AMERICAN Educator

NOTEBOOK

Low-level Tests Lead to Low-level Curriculum

A recent analysis of the most widely used textbook tests and standardized tests in math and science for grades four to twelve reveals that 97 percent of the math questions and 77 percent of the science questions tapped only "low-level conceptual knowledge." What gets scant attention in these assessments is the ability "to paraphrase the definition of a concept, generate examples and non-examples, use models to represent concepts, identify critical properties of a given concept," and other higher-order applications.

The importance of what's in these tests is centered on the finding that teachers significantly shape their instruction to fit the tests. This was especially true for classes with more than 60 percent minority students. In these classes, more than two-thirds of the teachers say they alter the emphasis of their teaching to match the topics on the tests.

The result, the study concludes, conflicts with our national concern for equity: "Teachers of high-minority classes reported significantly more test pressure and test-oriented instruction than teachers of low-minority classes. The educational experience of students in high-minority classrooms, therefore, appears to be qualitatively different from that of students in low-minority classrooms and is particularly focused on low-level knowledge and skills."

Entitled "The Influence of Testing on Teaching Math and Science in Grades 4-12," the report was sponsored by the National Science Foundation.

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"I must have an intelligence leak"

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aft Plus

The Power of Thinking Mathematics

By Alice J. Gill and Lovely H. Billups

It was 2:30 on the afternoon of February 14, 1990. In an inner-city classroom in Rochester, New York, Chapter 1 Basic Skills teacher Marcy Miller stepped into the second-grade classroom prepared to conduct her twice-weekly math lesson. She approached the homeroom teacher.

"Mrs. Jones, I know you're having a Valentine's Day party this afternoon. Tell me how much time I have for a math lesson."

"Miss Miller," came the frustrated reply, "these children were so disorderly this morning, I don't think they're going to have a party. You can have the rest of the afternoon." A young girl immediately raised her hand.

"Does that mean we'll have math longer today?"

With conviction in her voice that bespoke a punishment well delivered, Mrs. Jones almost beamed as she affirmed, "That's right!" whereupon, the class began to cheer and applaud.

Seven-year-olds happily forsaking a Valentine's Day party for the opportunity to do more math is not a picture that typifies our classrooms. In fact, report after report casts American youngsters—and adults—as being uncomfortable with mathematics, indeed, often expressing an intense dislike for the subject.[1] Math, they feel, is best left to engineers, scientists, and a small elite group endowed at birth with a talent for the arcane world of numbers.

Alice J. Gill is an assistant director of the educational issues department of the American Federation of Teachers. As a third-grade teacher in Cleveland, Ohio, she was one of the developers of Thinking Math. Lovely H. Billups is director of field services of the AFT's educational issues department and coordinator of its Educational Research and Dissemination program.

It's not surprising that large numbers of Americans have an aversion to math. Most people dislike activities they're not good at, and on that score the figures are stunning. The inadequate achievement of U.S. students in mathematics has been chronicled in headlines, papers, books, and conferences. In a 1991 study conducted by the Educational Testing Service, American nine-year-olds ranked twelfth out of fourteen industrialized nations in math, ahead of only Slovenia and Portugal; American thirteen-year-olds ranked sixteenth out of twenty. On the 1988 International Association for the Evaluation of Educational Achievement, for ten-year–olds, 38 percent of American schools scored below the *lowest*-scoring school in Japan. On the 1991 National Assessment of Educational Progress, fewer than half of the twelfth graders demonstrated a consistent grasp of decimals, percents, fractions, and simple algebra.

Doing something about the American dilemma in math can at times feel like trying to move a mountain; it has been there a long time. Yet, though still rare, the real-life scene described in the opening of this article is becoming more common as efforts proceed to transform America's classrooms into places where children not only look forward to math but master it well enough to successfully compete on a global level.

We go next to a classroom in Lake County, Florida, where students are thinking about a class picnic. They know that twenty-four students and seven adults will be present. One of their tasks is to decide how many six-packs of soda to buy so each person can have a can of soda. In small table groups, they move counters representing the cans and finally determine that they need to purchase half a dozen six-packs. The problem isn't extraordinary. It's a two-step problem that requires stu-

ILLUSTRATED BY BOBBI TULL


4+6=10
4×12 x4=
115
13
5+7=12

dents to make a substantive decision about how the remainder in a division problem should affect the answer. This is one type of problem with which American seventh-grade students have had difficulty on National Assessment of Educational Progress (NAEP) tests[2]. What is unusual in this instance is that the problem was successfully solved by these Lake County first graders.

The lesson was a demonstration of Thinking Mathematics, a research-based approach to teaching mathematics that grew out of a collaboration between the American Federation of Teachers (AFT) and the Learning Research and Development Center (LRDC) of the University of Pittsburgh. The philosophy of Thinking Mathematics, which is consistent with the standards adopted by the National Council of Teachers of Mathematics, is that we can produce not only students who are capable mathematicians but also a populace that appreciates the place of mathematics in their own lives and that is no longer "mathophobic."

In Thinking Math, value is placed on thinking, reasoning, communicating mathematically, focusing on relationships, using what is known to find the unknown. Its content and sequence is shaped by the idea that, right from the start of their mathematical education, children can and should be engaged in the discussion, analysis, and solution of mathematical problems; they need not wait until, step by step, they have mastered a strict hierarchy of basic skills. It draws heavily from the cognitive apprenticeship model, which emphasizes the importance of working on authentic, real-life tasks and of exposing students to the reasoning and strategies that experts employ when they acquire knowledge or put it to work to solve such tasks.[3]

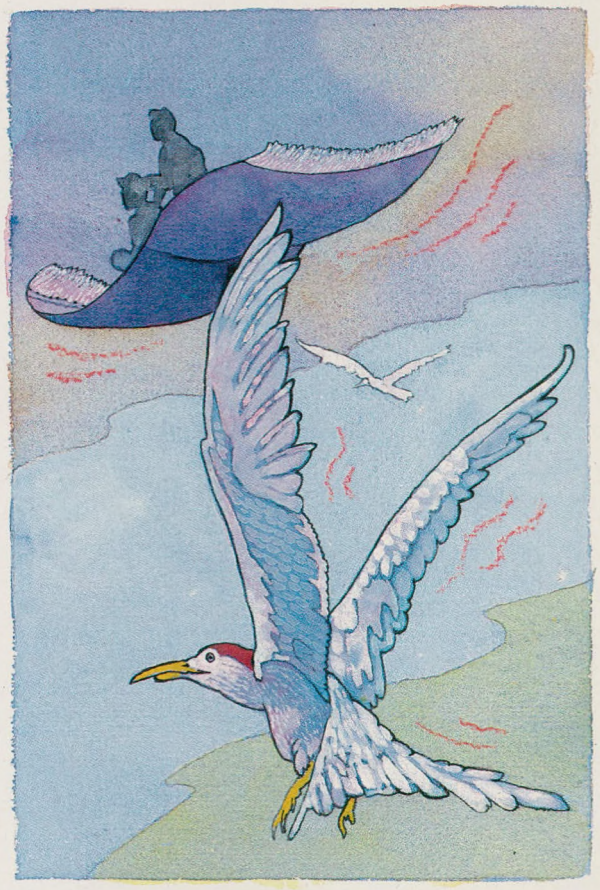
This approach is in sharp contrast to the milieu out of which teachers have come, which emphasized memorization and rote procedures. The majority of elementary teachers have scant background in mathematics. Because it has not been expected of them, few have taken anything beyond high school math, except for a college course in elementary math methods. The common image of the proper way to teach math, held by both teachers and the public, is based on their own memorization and formula-driven school experiences. On the elementary level, the core of activity in math classes centers on what are called "the basics." This consists of memorizing basic facts and rules and performing page after page of computation. Probably 90 percent of the math activities in elementary classrooms have been traditionally conducted to facilitate this memorization and calculation.

In addition, studies indicate that math instruction in the United States is repetitious and poorly organized. Teachers spend weeks and sometimes months each year repeating the content of previous years. In many instances the students appear to have "forgotten," when in fact, they may never have really learned the concepts.

We now know with certainty that this traditional approach to math education will not produce thinkers, interpreters, and users of information.

WHEN CHILDREN come to school, excited and curious, they already have ways of thinking about quantities and numbers. What usually happens is that they encounter a teacher who begins to model and, with the best of intentions, demand that the children mirror "the correct way" to think about and manipulate numbers. If this "correct way" is the child's way, the child becomes a star performer; if not, the child becomes confused, loses confidence in himself, and begins to form a disastrous opinion about his ability to do math. This is not to say that everything a child thinks is true or valid. Yet children play counting games, share, and make purchases at the store before they come to school. They think about numerosity and measurement in the world around them, choosing the biggest piece of pie, the bag with the most cookies, arguing about who's taller than whom. Using the perspective and knowledge that children bring to school is the first of Ten Principles that constitute the Thinking Mathematics approach to teaching mathematics. Although the phrase "start from where the children are" has echoed through the halls of schools for decades, it has referred to where they are in relation to our curriculum and not to how children think or learn.

Right from the start of their mathematical education, children can and should be engaged in the discussion, analysis, and solution of mathematical problems; they need not wait until, step by step, they have mastered a strict hierarchy of basic skills.



The Ten Principles of Thinking Mathematics are:

1. Build from intuitive knowledge.
2. Establish a strong number sense through counting, estimation, use of benchmarks, mental computation skills, and understanding the effects of operations.
3. Base instruction on situational story problems.
4. Use manipulatives and other representations to represent the problem situation; then link concrete and symbolic representations.
5. Require students to describe and justify their mathematical thinking.
6. Accept multiple correct solutions and, in some cases, more than one correct answer.
7. Use a variety of teaching strategies.
8. Balance conceptual and procedural knowledge.
9. Use ongoing, new assessments to guide instruction.
10. Adjust the curriculum timeline.

In addition, Thinking Math (TM) recommends that teachers focus on depth instead of quantity, that math classes be used to look at a few problems from many angles rather than to work many problems the same way. This belief, which grew out of the research findings, is similar to the practices of Japanese and Chinese classrooms where the goal is lasting conceptual understanding and where it is not untypical to devote an entire class period to one or two problems.[4]

The picnic soda scenario described earlier was one part of the exploration that day. In addition to attending to children's intuitions, the lesson visibly incorporated two other principles of TM. First, the students had physical objects (manipulatives) with which they could model and, thereby, strategize about, a familiar situation. Thus, numbers, quantities, and operations had meaning beyond paper. Secondly, the students were grappling with a problem that had meaning to them. In Thinking Math, teachers are urged to write or change problems to reflect their own classroom, school, or city and to incorporate activities about which their students express interest. This not only increases motivation but also shows that math is, indeed, connected to the real world.

As a classroom is opened to students' thinking, there begin to emerge multiple intuitive and inventive ways of solving problems. The encouragement and support of this process is a crucial part of the teaching and learning in TM classrooms. Again, there is a strong parallel to real-life situations. Woe to any commercial enterprise that sees only one way to solve a problem! If that one solution becomes stymied, the business may fold unless an inventive mind finds another way to come at the problem. Both students and teachers come to appreciate this principle. Nine-year-old Brandon, addressing the Anderson, Indiana, school corporation one night, observed, "In Thinking Math, there are a lot of ways of doing a problem so we can choose the *best* way."

In Albuquerque, New Mexico, another nine-year-old who had transferred to the public schools from a private one the year Thinking Mathematics was introduced, shared how he felt about the program. "My other school thought they were real good, but this one is better. They only taught us one way to do a problem, but we learned a lot of ways here." And still another student's voice: "What do I think about Thinking Math? It helps you think a lot better. Not only letting kids do it different ways but letting kids do it their own way . . . you can think with your head and do math the way you need to do it to solve problems and stuff like that."

THESE DIFFERENT strategies lie dormant and unvalidated, however, unless they are shared within a community of learners. Thus, requiring students to explain and justify their strategies is another important Thinking Mathematics principle. This public discussion about mathematics (mathematical discourse) adds power to students and teachers in three ways. It requires the speaker to clarify his own thinking. It allows other students to get additional perspectives on a problem. It gives the teacher information about the level of understanding a student has, information that is not evident when a teacher looks only at computation.

A second-grade class in Lake County, Florida, had worked through a problem that centered on a typical elementary school Valentine's Day occurrence. Children bring in cookies and they are shared by the class. One of the goals of the lesson was to demonstrate how number sense can be used to simplify the solution in a way frequently used by adults but rarely taught in school. When adults buy two items that cost $1.98 each, they often calculate two times two dollars and subtract four cents rather than go through the regrouping algorithm. The problem the second-grade students were solving required them at one point to add 36 and 29, the numbers of cookies brought in by two students. A stuffed replica of Curious George (whom the teacher often used as a friendly voice to introduce other ideas into the discussion in a nonintimidating way) suggested that if you could add 30 instead of 29, it would be a really simple calculation, which he could do in his head.

"36 + 30 is 66."

"Could we do that?" asked the teacher. Not two seconds passed before young Jessica raised her hand and said, "Yes. But you have to take one away from that because you added one too many. So you'd have 65 cookies."

The role of the teacher in these exchanges is extremely important. Encouraging students to do their own thinking and to find many ways to solve problems is not the same as telling students to "go discover" while the teacher stands back and watches. The teacher becomes planner extraordinaire, framer of the circumstances that will enable students to find their way. Generally, the solution strategies are those that are brought forward by students as they think and use the materials provided. In this instance, the teacher interjected "another way" to think about the problem. For the process to avoid turning the classroom into a venue where the teacher is seen as custodian of "the right way," the teacher must know which concepts or strategies students will probably *not* find intuitively and make a judgment about when and how to introduce those ideas.

Finally, the teacher must be capable of moving in directions suggested by student conversation and of focusing that conversation on mathematical ideas, targeted and untargeted. To do this successfully, the teacher must develop a good sense of the mathematical territory and of students' conceptual understanding. The student's explanation must be clear enough for other students to follow the thought. In instances where it is not clear, or

where the teacher believes some students need a concrete model, the teacher appropriately raises questions or asks the solver to concretely demonstrate what has been said.

Leading mathematical discussions is a complex task. Students long accustomed to traditional math classes may be reluctant to express their ideas at first. The quality of discussion improves over time as students become aware that their ideas are valued, as they learn to express themselves, and as teachers, too, learn from actual conversations. Teachers must become knowledgeable about what actually demonstrates understanding. To return again to the 36+29 Valentine cookies problem, an explanation that basically does nothing more than repeat a formula (e.g., 6+9=15, put down the 5, carry the 1; 1+3+2=6; 65) does not show the same evidence of number sense that investing quantities with their proper meaning does (30+20 is 50; 6+9 is 15; 50+15 is 65).

One young man in Cleveland, near the end of the first year of Thinking Math, turned in the following as a solution to a subtraction problem.

541 - 268
500 - 200 = 300
41 - 68 = -27
300 -27 = 273

This youngster had not been taught this method. But he had been in an atmosphere that clearly valued exploring number territory and finding different ways. He would undoubtedly have been a good "traditional" math student. He became, for his short time in Thinking Mathematics, a marvelous inventor who saw how things fit together and what was happening with the quantities in this operation. He knew 41 minus 68 was minus 27, he said, because he took away 41 and then he still needed "fifty-one, sixty-one (*he had raised two fingers*) and 7 more for 68. So that's twenty (*holding up the two fingers, each of which stood for 10*) seven." This student's explanation encompassed a way of thinking about 41 minus 68 that his teacher would not have thought of.

WITH ALL the promise of the current mathematics scene, there still exists a good deal of skepticism. Parents worry about whether their children will learn basic facts and be able to compute, the centerpieces of their own math education. Those whose children are now grown worry about repeating the disastrous path of "new math" from the sixties. It is, therefore, important to clarify the relation of Thinking Mathematics to both of these concerns.

First, the concern about learning basic math computation skills. One of the Ten Principles of TM is to provide a balance between conceptual and procedural learning. This means that, where formerly it was acceptable if students were able to rotely compute even if they didn't understand what they were doing, this is no longer considered exemplary performance. Even the "good" students who went through "drill-or-kill" tactics are unable to compete with their peers worldwide.[5] One of the deficiencies of these students is their inability to reason and solve complex problems.

Teaching for conceptual understanding takes longer than rote learning. It does, however, make it possible for students to also acquire basic knowledge without an overemphasis on unmotivating, unconnected drill and the calculation of bedsheet-length sets of problems. TM deemphasizes the amount of time spent on learning basic facts, believing that students will learn them as they work with them. Walk down the halls of a school where teachers are doing what they have always done and you will find a belief that "until students know those basics" it is a waste of time to turn their attention to something as complicated as word problems. "Thought problems" at the ends of textbook chapters are generally skipped because "there simply isn't time available if the students are to master their facts." Visit a TM class and you will find students engaged in solving problems about familiar situations; some know the facts, others are still learning them, but all can successfully solve interesting problems. You may find some periods of short (5 to 7 minutes) drill on facts. If you do, the drill will often have a thinking

BRANDON'S TEN GOOD REASONS TO LIKE THINKING MATHEMATICS

HI! I'M Brandon Sokol. I come from the family class at Robinson School. I am going to give ten reasons why I like Thinking Math better than traditional math.

1. Thinking Math eliminates the need to memorize a problem cause we don't learn to use paper, we learn to use our heads.
2. In Thinking Math we can make up and solve our own sichawashunol story problem.
3. We are also able to use manipulatives to help solve the problem. In Thinking Math, a manipulative is a small block or tool to help count with. This (displaying a base ten rod) is ten. This is a hundred. This is one. And this is a thousand.
4. We can also use decomposition to break down a problem. Decomposition is breaking down a number, for instance, 378 would be 300+70+8. That would be easier to add to another number.
5. In Thinking Math there are a lot of ways of doing a problem so you can choose the Best way.
6. In Thinking Math we learn to do our math in our head so when we go shopping we can add numbers fast.
7. We discuss a problem to make sure everyone knows the steps to the problem to complete the problem so that the next aren't so hard.
8. In Thinking Math we use our own record book of our knowledge not someone else's.
9. We only need to do 3 or 4 problems during math.
10. With Thinking Math a group of children can all do one problem together.

—BRANDON SOKOL
Age 9
Addressing the Anderson, Indiana, School Corporation Board of Trustees

'The children are so excited! They're always asking to do math. I've never had that happen before.'

schema behind it.

7+8
5+6
8+9

In this exercise, students learn thinking strategy for "near doubles." Doubles are learned fairly quickly. If students know the doubles (e.g., 7+7) they can project an answer that is one more than the double. Or, the drill may promote a mental math skill that will be useful in computation.

17+10
38+10
52+10
69+10

There is evidence that students who spend less time on drill and practice do not suffer when it comes to "the basics." In fact, the Cognitively Guided Instruction project, an approach similar to Thinking Math, found that students in classrooms with a problem-solving focus actually outscored their peers. Additionally, a study by SRI International found:

> By comparison with conventional practices, instruction that emphasizes meaning and understanding is more effective at inculcating advanced skills, is *at least as effective at teaching basic skills,* and engages children more extensively in academic learning (emphasis added).[6]

Even the results of standardized tests—which are not geared to measure the kinds of conceptual understandings Thinking Math aims for—put TM students above their non-TM counterparts. Researchers from the University of Pittsburgh compiled data from student scores on standardized tests for the group of TM pilot classes in 1990-91. The report[7] of this data stated:

> Standardized achievement test scores indicate that project students did at least as well, if not better, than their non-project peers on both Computation and Concepts and Applications subsections.

Class scores were averaged for all students in grades one through five for TM classes and non-TM classes for each of the subsections of standardized achievement tests administered in the local districts;[8] the results are presented below.

Subsection	TM classes	Non-TM classes
Computation	64	59
Concepts and applications	66	50

In addition, the report continued:

> Notable improvements in student problem-solving abilities were indicated by results of the problem-solving test.[9] The percentage of correct answers on the post-test exceeded that to be expected from the item difficulty established by the test makers.
>
> . . . (T)here are multiple indications that student learning and attitudes were enhanced by their participation in the Thinking Mathematics program.

The spontaneous observations that Thinking Math teachers have made not only support the data regarding student achievement gains but also point to qualitative differences as well. One teacher in Brevard County, Florida, observed, "They are so excited! They're always asking to do math. I've never had that happen before." Another commented, "I'm now teaching my children how to think and understand math, not just how to do math."[10] Still another from a pilot class observed, "My students are being exposed to and coming up with skills I would not have thought possible." Another reflected that the students were showing greater appreciation for the use math would have in their lives.

THE SECOND concern about a new approach to teaching mathematics is the lingering aura of distaste from the "new math" of the sixties. There are several ways in which Thinking Math differs. One is that "new math" was imposed upon teachers by people perceived to be out of touch with classrooms. A result of the actual top-down strategy of this movement is that it did not

provide, in time or in substance, what teachers needed to understand the process and the math they were being asked to teach. Because teachers stood at the core of the development of Thinking Mathematics, they were able to identify these needs. Thinking Math also has provided that framework of research that professionals can use to inform what they ought to do and why. While some concepts that were part of "new math" surface again, they surface with a rationale and a professional development effort that allows teachers to make meaning of them. Another prime problem with "new math" was that parents were left out of the equation.

> In discussing the resistance encountered by "new math," the National Research Council notes, "When parents could not or did not understand the need for change or the reasons new curricular emphases (of that program) were chosen, resentment and anger resulted, and a conviction set in that if the 'old math' was good enough for them, it was good enough for their children." Parents have become enthusiastic about programs when they have been given the opportunity to ask questions and have them answered, are involved in their children's learning, and are assured that their children's computational skills and learning outcomes are not suffering.[11]

Thinking Mathematics advises its teachers how important it is to communicate with parents as they begin the program, and, on the whole, they have had a very positive response.

Not only has the developmental process for Thinking Math been different from the one for "new math," there are also substantive differences. As it was implemented in classrooms, "new math" concepts were taught abstractly. Since this is not how children best learn math, the goal of developing a deeper understanding was not achieved. For example, "expanded notation" (e.g., writing 485 as 400+80+5) was often used in "new math." But the instruction was generally based on abstract, contextless figures.

In Thinking Mathematics also, students frequently record solutions using expanded notation. However, this flows from a construction of the meaning of those quantities that starts when students manipulate and group objects; compose, decompose, and recompose numbers many ways *as* they solve problems about familiar things and in ways they understand *before* they are introduced to efficient algorithms. So their understandings of both quantities and operations are richer and more lasting and they can successfully attack unfamiliar situations.

The "new math" also lacked a surrounding system of student dialogue about mathematics that helps children develop and clarify their thinking while allowing the teacher to better see the depth of their understanding and where they falter. Nor was it grounded in a philosophy that accepted and promoted multiple ways of solving problems.

* * *

CHANGE IS never easy. The history of education reform is cluttered with great ideas that never took root in the classroom. Countless manuals, materials, and manipulatives, once imbedded in such hope, are sitting somewhere collecting dust.

Thinking Mathematics is one program that has not suffered such a fate. It is functioning in thirty-eight cities, with a waiting list of dozens more. A 1992 survey of participating teachers found that they were making significant changes in their mathematics instruction. On average, they were using strategies recommended by Thinking Math three times a week, or 60 percent of the time.[12]

To understand why Thinking Math appears to be taking hold where other reforms failed, we have to go back a few years to the start of the American Federation of Teachers' Educational Research and Dissemination program. ER&D began in 1981 with the goal of enhancing teachers' professional development by giving them access to an expanding knowledge base of classroom research and involving them with the educational researchers doing that research. As AFT president Albert Shanker noted at the time, teachers will be denied recognition as professionals until they can demonstrate that their actions and judgments are grounded in a solid professional knowledge base acquired through intensive and continuing study.

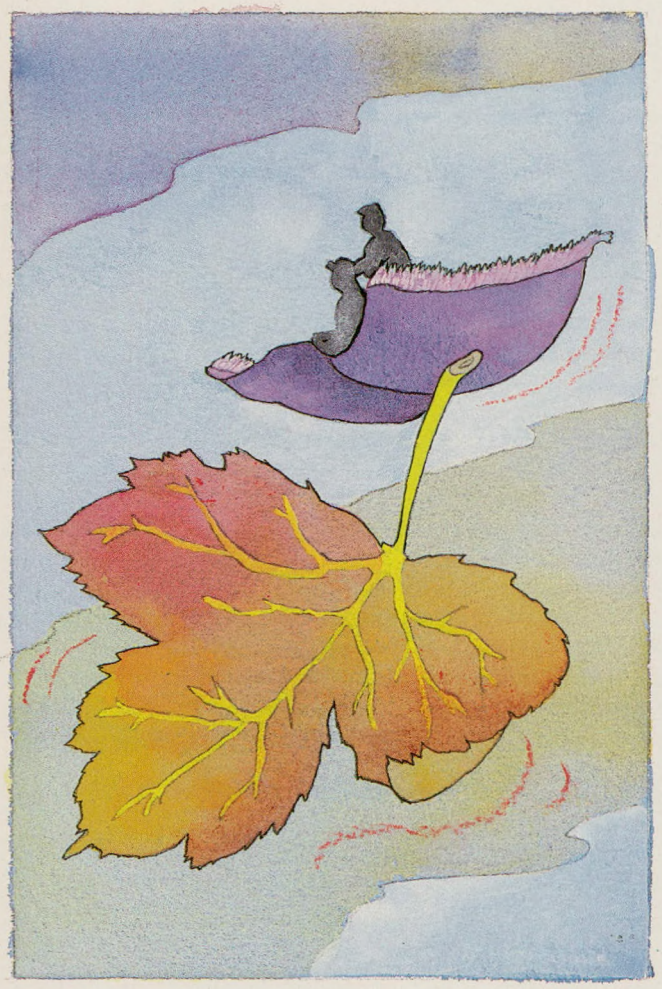
In the past, much educational research was packaged in ways that were remote from teachers' daily experiences. Most studies were abstract and jargon laden, so it's not surprising that teachers tended to find them of little use, if they read them at all. When mandated from above, as many "research-based" teaching programs were, they were met with suspicion from teachers and produced superficial change, at best. For their part, few researchers seemed to know or care about teachers' perceptions and were unable to relate to the realities of the classroom.

AFT's ER&D program sought to reverse those negative trends, to encourage teachers to value the information available from authentic research findings, and to expand their tools of practice. Originally funded by the National Institute of Education, ER&D is a long-range, peer-to-peer, union-sponsored strategy for professional improvement that encourages teachers to become users of research.

A KEY COMPONENT of the program is the development of "research translations" that highlight and interpret the most important research findings in practical ways that teachers can use; translations have been done on a wide array of topics, from cooperative small-group teaching to student motivation. The translations, based on a single work or a group of related works, eliminate ponderous statistics, interpret technical language, and focus on the practical applications of the research. As part of the process of developing ER&D materials, experienced teachers work collaboratively and intensively with researchers from universities and educational research laboratories.

But the translations are only the first step in the process of putting valuable research findings in teachers' hands. Through the ER&D network, teachers in local AFT affiliates receive training in the basic translations and in peer-teaching techniques. Once trained, these teachers in turn establish local programs and train other teachers, spreading the program's benefits to a growing number of classroom teachers. The local trainers meet periodi-

The bottom line of this endeavor is not books or manuals, but the deeper question of actually altering what goes on in the classroom.



cally with AFT national staff to review material, share their experiences, and learn about new research translations. A three-part philosophy guides the ER&D training: Sessions are non-threatening, non-judgmental, and voluntary.

Thinking Math provided the ER&D program's first move into specific subject matter; previous translations had dealt with more generic teaching skills. Started in 1987 through a National Science Foundation grant to the AFT and the Learning and Research Development Center at the University of Pittsburgh, Thinking Math built on the ER&D tradition of close collaboration between teachers and researchers. Lauren Resnick, LRDC's co-director and one of the first researchers to interact with ER&D teachers, describes the experience this way:

> The ER&D program enables teachers to probe, question, and interact with educational researchers about their findings. It is unique because it does not create a difference in rank or prestige between researchers and teachers. It stresses that researchers and teachers need each other—that educational effectiveness is not the exclusive province of either group.

Combining the clinical wisdom of teachers and the rich research background of the cognitive scientists, the collaboration has to date produced two *Thinking Math* volumes, covering counting, estimating, adding, subtracting, multiplying, and dividing. The joint effort has also resulted in the publication of a recent book, *Analysis of Arithmetic for Mathematics Teaching* (Lawrence Erlbaum), that discusses current research knowledge relevant to teaching math in grades one through eight.

THE BOTTOM line of this endeavor, however, is not books or manuals, but the deeper question of actually altering what goes on in the classroom. And here the evidence is cause for optimism. For example, as the survey mentioned above found, only 19 percent of the teachers said they had encouraged their students to solve problems in more than one way before becoming involved with the program; after their TM training, 71 percent were focusing on multiple strategies.

The effectiveness of the training depends in large part on the degree of cooperation between the local affiliate and the school district. The districts where the program appears to be flourishing have provided teachers release time not only for initial training, but also for regular follow-up sessions.

One of those districts is Anderson, Indiana, where the various partners have shared the cost of building a solid Thinking Math program over the past few years. The AFT has paid for training two local Thinking Math coordinators, and the district has picked up the tab for training seventeen other local teachers (including the cost of substitutes and release time once a month to allow teachers to reflect together on their experiences). The Anderson Federation of Teachers has also contributed significant amounts of money in the past three years to expand the program. By the end of this school year, every elementary teacher in Anderson will have had an introductory session on Thinking Math.

The experience of one Anderson teacher of learning-disabled students provides an insight into the power of the Thinking Math approach. The teacher convinced three of her colleagues that all their students could learn together if they taught math the TM way. With the teachers working as a team, the program has proved so successful that it is difficult for an outsider to distinguish the learning-disabled students from their classmates during math lessons.

In Albuquerque, New Mexico, teachers at one school have seen the power of Thinking Math in helping them break their professional isolation. The teachers arranged their master schedules to provide periods of time for teachers of the same grade to collaborate and talk about their math lessons. In the philosophy of the Japanese

(Continued on page 48)

REACH HIGH

Building a movement for excellence

BY JOHN E. JACOB

The remarks that follow are excerpted from Mr. Jacob's keynote speech to the national conference of the Urban League, held this past July in San Diego, California.

WE ARE looking at a situation that may be the most perilous in our history. The world is charging ahead to the twenty-first century. The high-performance new world we are entering requires more than technological skills. It requires self-confident mastery of knowledge and life-long development and learning. In such a world, what you know and how you perform will be more important than class and race.

Are we ready for that world? Some of us are. But far too many of us are not. Four hundred years of racial oppression have taken their toll. Four hundred years of being told we are inferior have settled into too many of our souls.

Many years ago, the great African-American historian Carter G. Woodson put it this way:

> When you control a man's thinking, you do not have to worry about his actions. You do not have to tell him to stand here or go yonder. He will find his "proper place" and will stay in it. You do not need to send him to the back door. In fact, if there is no back door, he will cut one for his special benefit. His education makes it necessary.

Isn't that what we see when some of us give up and retreat into drugs and crime, when some of our young people see academic achievement as a "white thing" and failure as a "black thing," when some of us don't take the risks necessary to get ahead because we think the system or "The Man" will stop us.

Some of us have risen above that racist garbage. We have rejected it completely. We have demonstrated that black excellence is widespread even in a society governed by negative racist stereotypes. But many others of us are joined in a demoralized community of despair instead of a renewed community of resolve.

The pervasive sense of hopelessness and helplessness in so many of our communities requires a radical regeneration of the way we think and act. It requires that we expose the Big Lie of black inferiority. It requires that we confront the institutions in our society and demand that they get rid of the negative stereotyping that holds us back. It requires that we challenge those who hold us to the lower standards and lower expectations that reinforce those stereotypes. But most of all it requires that all African-Americans take control of their own lives and develop their individual potential to the fullest while marshalling our resources as a community.

We've done it before. We are the people who created a civil rights revolution that swept the world. People who had been brutalized and stripped of their basic rights woke up and demanded those rights. They shook off hundreds of years of racist propaganda to demonstrate their moral superiority and their ability to come together as a people behind a vision of a new future.

We need to recapture the spirit that led those proud African-Americans of barely a generation ago to stand up for a goal that was right, to risk their jobs and their lives to secure that goal, to come together as a community to direct their scarce resources to achieve that goal.

WHAT WAS done in the past can be done in the future.

In the 1990s, we need to build a movement for excellence that reaches into every black community and every black home. We need to recognize that our very existence as a people is on the line in the new, challenging world that's being born. We need to ensure the continuous development of African-Americans as a self-confident people whose effective efforts can change our lives and our nation. And we must begin with our children.

In the 1990s, we need to build a movement dedicated to the development of African-American children. We must commit ourselves, our resources, and our lives to developing our children into twenty-first century citizens. Yes, the same children who are bombarded with messages of racial inferiority, who are shunted into special education classes, the same children who are prepared for lifetimes of failure—yes, those same children can be helped to excel and to lead the rest of the nation into a bold new future.

That's not a fantasy. It is a realistic goal. Our children are as capable of learning and of developing their talents

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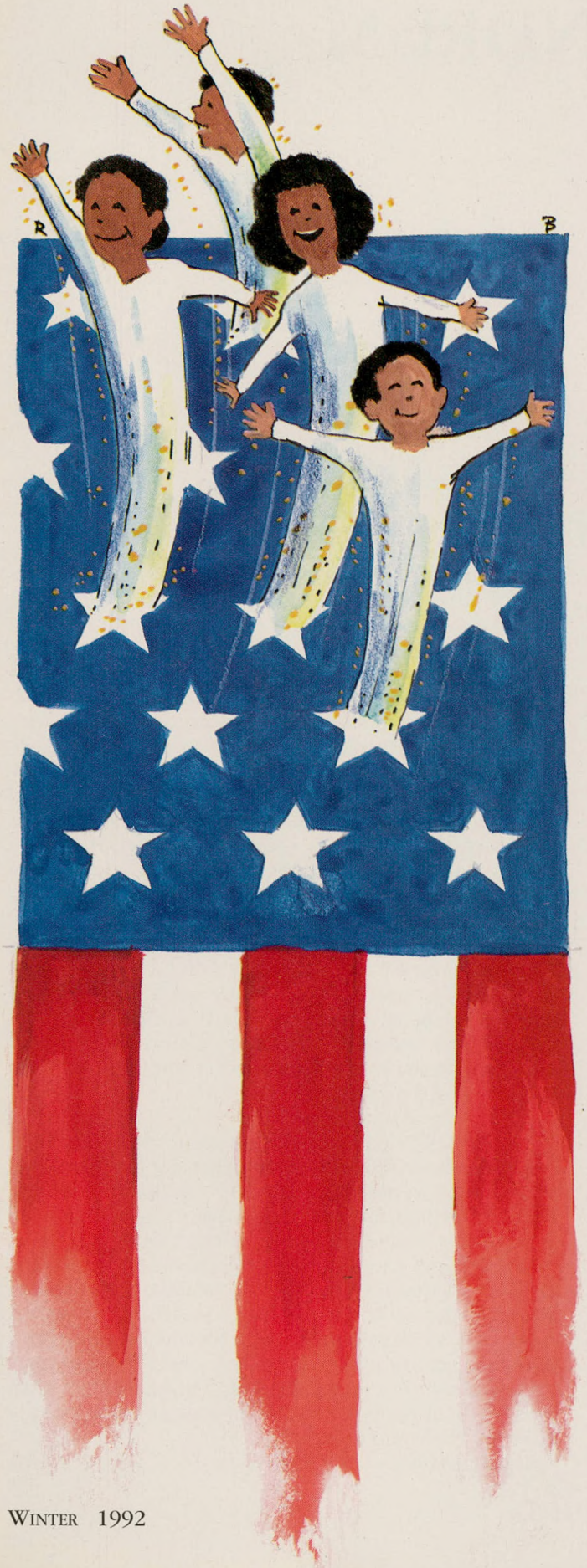
John E. Jacob is the president and chief executive officer of the National Urban League, Inc.



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as any in the world.

If America could take immigrant peasants from the backwaters of Europe and mold them into a people that led the world; if Japan, Korea, and Taiwan could take people racked by poverty and devastated by war and mold them into a global economic powerhouse in one generation; then a committed, dedicated African-American community can help its children develop into the most intelligent and skilled people on the face of the earth.

If we believe we can do it, and if we direct effective efforts toward that goal, then *we will do it.* The time to begin is *now.*

What will it take for our children to develop into outstanding twenty-first century citizens? Let me suggest four basic criteria based on what we know of the challenging demands of the future:

- Every African-American child should graduate from high school with the ability to do calculus;
- Every African-American child should be fluent in a foreign language;
- Every African-American child should be able to research, organize, and write a twenty-five-page essay on a challenging topic;
- Every African-American child should live by strict, high ethical standards.

That's what it will take to make it in the twenty-first century—not just for African-Americans, but for all of America's people. And let me be very clear. We already have all the power, all the resources, and all the laws—right now— to create an America that can produce twenty-first century children. But right now, our society is on a downhill course because it refuses to develop its children—*all* of them. It still thinks that it can get away with categorizing and stereotyping children—with developing a small white elite and writing off African-American children. That won't work any more. It's a prescription for suicide in the world of the twenty-first century.

So we have to pioneer an alternative way. We have to show that a community can take charge of its own destiny and nurture success in its children—all of them. We can demonstrate that black children can meet the highest standards of excellence, and by doing so, we will show the rest of the world how to develop human capabilities. □

THE VOCABULARY CONUNDRUM

BY RICHARD C. ANDERSON AND WILLIAM E. NAGY

EVERY EXPERIENCED teacher is aware that children who don't know many words are unlikely to be good readers or good students. Squaring with teachers' experience, one of the most consistent findings of educational research is that having a small vocabulary portends poor school performance and, conversely, that having a large vocabulary is associated with school success. Vocabulary knowledge is very highly correlated with scores on standardized achievement tests, and so highly correlated with I.Q. test scores that a wide-range vocabulary test can be used in place of a full I.Q. test. Moreover, some measure of vocabulary difficulty is always the major component of readability formulas used to grade the difficulty of textbooks; it will not surprise teachers to hear that research demonstrates that difficult textbooks contain more hard words than easy textbooks.

Naturally, teachers have searched for ways to help students improve their vocabularies, with the hope of increasing their reading comprehension and chances of school success. Championed by such figures as the late Edgar Dale of Ohio State University, vocabulary-building programs have been a fixture in American classrooms from the 1920s onward. They are still in evidence today, although interest in them may have waned, perhaps because of the rise of the whole language movement, or maybe because of the lack of visible champions such as Dale.

In this article, we take a fresh look at vocabulary growth and development, taking a close look at conventional vocabulary instruction and asking: Where and how do successful students learn the words they know? Can vocabulary-building programs make a significant contribution to the growth of word knowledge? What would a sensible agenda to promote vocabulary growth look like?

Virtually every teacher pays some attention to vocabulary, introducing the new words in reading lessons or the technical vocabulary in science or social studies lessons. Beyond this, many teachers have a separate program to build vocabulary. In a typical vocabulary-building program, students are expected to master twenty words a week. The standard approach is for students to study definition of words, compose sentences using the words, and on Friday take a test. In the elementary school, children learn to spell the words as well as learn their meanings; in fact, the program may be called spelling. Vocabulary-building programs usually involve lessons on using a dictionary, analyzing word parts, and marshalling context clues to figure out word meanings while reading. Regrettably, there is accumulating evidence that vocabulary-building programs do not work very well. In the next sections, we consider some of the reasons why this is so.

TO KNOW what to do about vocabulary, you need some basic information about the size of the task students face. If the average high school senior knows eight thousand words, as some people have claimed, then all you have to do is teach twenty words a week for twelve years, and you can cover all of them. But if the average high school senior knows forty thousand words, as other people maintain, you would have to teach twenty words a day to cover them, a much more formidable task. Clearly, if high school seniors know anywhere close to forty thousand words, you can be sure that they didn't learn very many of them in vocabulary lessons or by looking them up in the dictionary.

Hard facts about the size of the vocabulary-learning

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task that young people face have proved surprisingly elusive. The problem has been variation in the procedures used by vocabulary researchers. Basically, what researchers do to estimate vocabulary size is select a source of words, usually a dictionary, that is taken to be representative of the English language; define criteria for selecting a sample of words from this source; devise a test to assess knowledge of the sample of words; give the test to a representative sample of children; and extrapolate the results to all words and all children.

Errors of estimation can arise at any of these steps. Major swings in the size of estimates hinge on the word source. It should be plain to see that a researcher who selects words from a pocket dictionary will conclude that the size of the vocabulary-learning task is smaller than the researcher who selects words from an unabridged dictionary. Those who support the use of small dictionaries say that large dictionaries are filled with archaic, technical, foreign, and extremely rare words. Those who defend the use of large dictionaries counter that a large dictionary contains many useful words, known by literate people, that are not in smaller dictionaries, and that, in any event, the use of a small dictionary begs the question of the size of the task of learning the vocabulary of English.

The second major source of variability in estimates stems from the criteria for what counts as a distinct word in English. Everyone agrees that, for instance, *walk, walks, walked,* and *walking* should not be counted as separate words, because even a preschooler who knows one of these variants will know them all. Beyond simple inflections, however, there has been a lot of controversy about how closely related in form and meaning different items have to be to be considered as instances of functionally the same word. Some scholars take an etymological approach to the relationships among words, positing relationships based on the history of language use, for example, grouping *business* with *busy* and *however* with *how.* When you collapse distinctions among words, the vocabulary-learning task seems smaller and perhaps more manageable. The question that must be raised, however, is the extent to which present-day readers can make use of historical relationships.

We have completed a program of research designed to resolve questions about the dimensions of the vocabulary-learning task. First of all, we finessed the issue of whether to base our study on a large or a small dictionary. Instead of either, we employed a corpus of more than five million running words from a thousand items of published materials in use in schools. The materials sampled included textbooks, workbooks, kits, novels, general nonfiction, encyclopaedias, and magazines chosen to represent, as nearly as possible, the range of required and recommended school reading. We did not mark words as technical, archaic, rare, and so on. There was no need to. We were already dealing with words that are actually part of school English.

We took the position that children reading English today will often not know, or be able to use, information based on the history of the words they encounter. Thus, we analyzed relatedness among words, not in terms of their historical derivations, but in terms of the similarity of their current meanings. We judged pairs of words, attempting to decide whether a student who knew the meaning of only one of the words would be able to infer the meaning of the other word upon encountering it in context while reading. We judged, for example, that most students who knew *clever* would be able to get *cleverness,* but that knowing *busy* would usually be insufficient to get *business.* Compound words were judged in a similar fashion. For example, with just a little help from context, a reader could infer *foglights* if she knew *fog* and *light,* but knowing *dash* and *board* would be of almost no help to her in inducing *dashboard* if she did not already know that compound.

Based on a thorough analysis of a large sample of words from the corpus, we calculated that there are about 88,500 distinct words in printed school English. Our next step was to recalibrate previous estimates of the number of words known by students in different grades, using benchmarks from the corpus that we had analyzed in depth. When we used a common definition of a distinct word in English, most of the variability in estimates of children's vocabulary size disappeared, and we were able to reach the conclusion that the average high school senior may well know about forty thousand words and that the average child in elementary school or high school probably learns 2,000 to 3,000 new words each year.

WHILE THE foregoing estimates are now accepted as at least approximately right by most vocabulary authorities, we must acknowledge that the numbers are still contested by a few. The dispute that still remains centers on the issues already raised—whether to include certain classes of words, such as technical terms and words that are regarded as too rare to be worth bothering with, and the extent to which readers are able to use the information in derivative and compound words.

We believe that the criteria we employed are linguistically, psychologically, and educationally defensible, but we certainly do not wish to set ourselves up as the final arbiters of what counts as a word. Teachers should make up their own minds. The issue with respect to whether to exclude certain classes of words from consideration is whether students will run into any of these words in material they are expected to read or want to read. Consider *artery, electron,* and *statute.* Are these words so specialized that they appear only in physiology, physics, and law treatises? Are there no elementary and high school students who know any of these words? If you are inclined to say that these are exotic words that only specialists know, then shade our estimates downward.

The second issue is the extent to which students will be able to transfer the understanding they have of base words to unlock the meanings of unfamiliar derivatives and compounds. In many cases transfer is easy; in many other cases transfer is impossible. In between are numerous borderline cases where success in figuring out the meanings will depend on the linguistic sophistication and motivation of the student. Examples of easy cases are *colorless* and *washcloth.* In between are such words as *restless* and *handspring.* Examples of impossible cases are *shiftless* and *foxtrot.* Remember, the question is, can you get the meaning of the whole from the meanings of the parts? For instance, suppose you had never seen or heard of *shiftless* before. Would you know its meaning because you know the meanings of *shift* and *-less*? If you

The estimate that there are 88,500 distinct words in printed school English is an order of magnitude larger than the number assumed by proponents of vocabulary-building programs. Yet, we have recently come to the conclusion that the number is too small.

say yes, revise our figure downward.

The estimate that there are 88,500 distinct words in printed school English is an order of magnitude larger than the number assumed by proponents of vocabulary-building programs. Yet, we have recently come to the conclusion that the number is too small. It does not include any proper words, although knowledge of many proper words is assumed by both fiction and nonfiction writers. Writers may not stop to explain the meaning of *Methodist, Amazon, Republican, Egypt,* or *Platonic.*

The number does not include multiple meanings of words, although knowing one meaning of a word is more likely to be a hindrance than a help in recognizing another meaning. For instance, knowing *bear* in the sense of a large mammal does not help a reader understand *to bear a heavy burden* and *to bear a child.*

How much does it add to an estimate of the number of words in the language if you distinguish words by meaning and not just by spelling? It depends on the criteria you use for counting two meanings as distinct. The number of distinct meanings in a dictionary serves as a starting point, but dictionaries can easily be accused of hair-splitting when it comes to counting how many meanings a word has. We found an average of four meanings per word listed in a school dictionary; a larger dictionary would have certainly yielded a larger number. However, many of the meanings listed reflect rather subtle distinctions. For example, among the meanings for *gain* were "to develop or acquire gradually," as in *he gained strength,* and "to come to have," as in *he gained a bad reputation.* When we attempted to count truly distinct meanings—meanings so different that one would not immediately see any relationship between them—we found there to be, on the average, about one and a third meanings per word. We could consider this figure a reasonably conservative estimate; however, it obscures the fact that the most frequent words in the language tend to have large numbers of meanings, whereas less frequent words tend to have fewer.

THE LARGER category previously excluded from our estimates are idioms. We are using the term *idiom* in the most general sense, to cover any expression made up of two or more words whose meaning is not predictable from the meanings of its parts. This definition covers a broad range of expressions beyond just colloquial ones such as *kick the bucket,* which the term *idiom* may suggest. It also covers stock phrases such as *make yourself at home,* technical terms such as *standard deviation,* and the ubiquitous compound verbs such as *put out* (as in *put out the fire*) *put up* (as in *put up the money*), and *put up with.*

Normal language is full of these prefabricated units. Most native speakers use and understand idioms without being fully aware of their frequency or the fact that their meanings are more than, or different from, the sums of their parts. *Take your chances* and *make yourself at home* may sound like perfectly regular, literal phrases, until you realize that *take your risks* and *make yourself at house,* although presumably similar in meaning, do not sound like normal English. Some idioms, such as *by and large,* are completely unanalyzable. Of course, the parts do contribute something to the meanings of many idioms. For instance, to *take someone under one's wing*

is, roughly, to take someone under one's care or protection. It might be said, then, that only the word *wing* has a figurative meaning in this phrase, although it is not a meaning that *wing* takes in many other contexts. But the general point is that an unknown idiom complicates the task of reading in just the same way as an unknown word. Thus, a complete and accurate assessment of the size of the vocabulary of English would have to take account of the number of idioms in the language, including the substantial number of idioms among proper names—names such as the *Grand Banks, Martha's Vineyard, Pony Express,* and the *Round Table.*

Considering all of these categories, how many distinct vocabulary items does English contain? By "distinct vocabulary item" we mean to include 1] basic words: that is, words that are not further analyzable [such as *straight*]; 2] semantically opaque derivatives and compounds: that is, words that are sufficiently different in meaning from the related basic words that a typical student who did not know them would be unable to figure them out from the parts [*shiftless, copperhead*]; 3] multiple meanings of words: for example, the several meanings of *bank*—a financial institution, the side of a river, to tilt and turn an airplane; 4] proper words whose meanings would ordinarily be assumed in a text [*Methodist*]; 5] idioms: that is, expressions whose meanings are not entirely predictable from the meanings of the parts [*put up with*].

There is limited research on how many derivatives and compounds students know and basically no research on how many proper words, multiple meanings of homonyms, and idioms they know. But there can be no doubt that they know thousands of items in these categories. Therefore, estimates of how many vocabulary items students of different ages know will certainly have to be revised upward. Just how far upward must await careful empirical research. In the meantime, we venture the guesstimate that there may be 180,000 distinct vocabulary items in school English and that an average high school senior may know eighty thousand of them.

In 1984, we concluded that "any program of direct vocabulary instruction ought to be conceived in full recognition that it can cover only a small fraction of the words that children need to know. Trying to expand children's vocabularies by teaching them words one by one, ten by ten, or even hundred by hundred would appear to be an exercise in futility." This conclusion seems to us to have even more force today.

ALMOST ALL classroom vocabulary activities involve definitions in some way. Students are told definitions of new words or they look them up in the dictionary. They memorize definitions or produce definitions during discussion. To some extent, the reliance on definitions is unavoidable. Nevertheless, it is important to realize how inadequate definitions are as the foundation for vocabulary instruction.

The unthinking assumption is that knowing a definition is the same thing as knowing a word meaning. Many of the shortcomings of conventional vocabulary instruction can be traced to this assumption. That knowing the definition of a word is *not* the same thing as knowing the meaning is a matter of simple logic in the last analysis, because definitions define words using other words. Eventually the circle of words must be broken if meanings are to connect with actions, objects, thoughts, and feelings.

If knowing the definition of a word were the same as knowing its meaning, then when you encounter a familiar word its definition should spring immediately to mind. We invite you to see whether the definitions of, say, *embarrass* and *if* come readily to your mind. You will probably find that it is quite a struggle to formulate definitions of these words, despite the fact that you know them both well.

Conversely, you can apprehend a definition without knowing the word. This is harder to demonstrate, simply because genuine examples would have to be words you don't know. However, the point can be illustrated approximately with definitions of words you do know. Try to figure out the words that go with these actual dictionary definitions: 1] the ability to do, act, or produce; 2] any perceptible mark left by a past person, thing, or event; 3] suitable to a purpose; 4] happening as a result of or in connection with something more important. The words are listed at the end of this article. You know each of these words, but it certainly will take some work for you to come up with them, and a couple of the definitions may stump you. This should not happen if knowing a definition and knowing a word meaning were one and the same.

Rather than assuming knowing a word's meaning and knowing its definition to be the same, we make the following assertion: *You don't know a new word until you no longer think of the definition when you read it.* When you really know a word, its meaning comes to mind within a quarter second after your eyes land on it. When you really know a word, you know much more than is found in any definition—connotations, how to use it, different shades of meaning depending on the context.

Our estimates of the annual rate of vocabulary growth suggest that students are incredibly adept at word learning. On the other hand, using traditional methods of vocabulary building to teach vocabulary may sometimes feel like trying to drive nails into concrete. We believe that this tells us more about the inadequacy of definition-based vocabulary instruction than about children's potential as word-learners.

In fact, research paints a dismal picture of definition-based instruction. Definition-based instruction does not reliably produce the ability to use a word correctly, nor does it consistently increase comprehension of text containing the instructed words. When you give kids definitions of unfamiliar words and ask them to write sentences, they frequently reveal amazing misconceptions. Given the definition of *meticulous* as "very careful or too particular about small details," one student wrote, "I was meticulous about falling off the cliff." Another student read the definition of *correlate,* "to be related one to the other," and wrote the sentence, "Me and my parents correlate, because without them I wouldn't be here."

Dictionaries are designed as reference works, not teaching aids, and the practical consideration of length limits their informativeness. The need to be brief pushes writers of definitions to use very sophisticated language. Definitions are ordinarily shortened by using

(Continued on page 44)

U.S. Education: The Task Before Us

Improving the Traditional Model, Creating the New Model

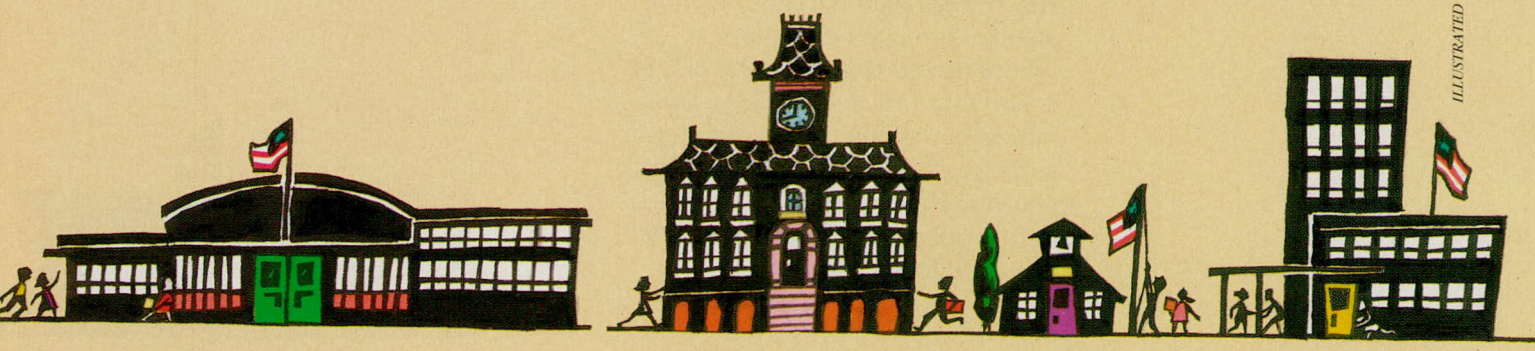
After nearly ten years of sustained effort—some of it fruitful, some of it not—on behalf of education reform, it is possible to distill two primary strategic principles to guide future action. First, we must continue the work to create a different kind of learning institution to replace the traditional school. This effort represents our greatest hope for making a major educational breakthrough. Second, while those efforts continue, we must move ahead with changes that we know will greatly improve our existing traditional schools. In that regard, we have much to learn from the world's other industrialized democracies, whose schools, while quite traditional, continue to dramatically outpace ours on a broad range of educational measures.

The sweeping policy discussion that follows sets forth the rationale for these strategies and describes how we can proceed on both fronts. It was adopted by AFT delegates meeting in convention this past summer. For a copy in brochure form, write the AFT Order Department, 555 New Jersey Ave., N.W., Washington, DC 20001 and ask for item #23.

AS THE crisis in American education continues, it is becoming a national crisis—one that affects our democratic system, our values, and our way of life. As it persists, the gap between what we stand for as a nation and what we really are is widening. A generation is growing up unprepared for citizenship, work, and family life.

We have problems throughout the system—at all levels, with all students. At one end of the spectrum, a huge number of students leave school, either as dropouts or graduates, with such low levels of achievement that their employment prospects are very poor. Many have never overcome the overwhelming social problems they brought with them to school. At the other end of the spectrum, our schools produce among the smallest percentage of high achieving graduates in the industrialized countries. Our average achieving students compare poorly with their counterparts abroad. No policies, whether federal, state, or local, have yet successfully addressed the problem of substantially improving the educational attainment of all of our children.

This is not, as has been suggested, the result of "decline" from some Golden Age, since if a Golden



ILLUSTRATED BY DAN SHERBO

The many careful comparisons that have been made show other countries doing much better with all groups of students.

Age ever existed it existed only for the few. Yet, those who have written recently to say that all is well with American education are not right either. It is true that our schools are performing, in most respects, better than they ever performed before. They are educating more students and more difficult students to levels attained in earlier times by only a small and favored group. But success is not assured merely by doing better than we did in the past.

The real issue is that our schools are not doing as well as they need to do to prepare the citizens of a democratic society and the productive workers of a world-competitive economy. We are simply not doing well in comparison to other industrialized countries.

To be sure, comparisons with other countries are difficult to make. They are imperfect. Some unfairly compare a large (and broadly representative) group of U.S. students who are still in school with a smaller, more select group elsewhere. Nevertheless, the many careful comparisons that have been made show other countries doing much better with all groups of students—those in the top, middle, and lowest achievement groups.

There are five tasks before us:

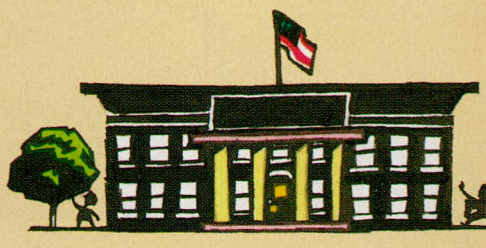
- We must continue the efforts to create a different kind of learning institution to replace the traditional school.
- We must improve our traditional schools so that they are at least as effective as the traditional schools in other industrialized countries.
- We should strive to place both these new and traditional schools in a clear system-wide framework where high national (not federal) standards shape curriculum, where the curriculum to be taught is known to all stakeholders, and where outcomes are set and measured to determine successes and failures. This framework should define policies at the federal, state, and local levels.
- We must convince the American people that the differences in the support for education and children in other countries—the higher percentage of GNP they spend on education, family, and health supports—are part of the reason for their success.
- We must continue to fight against public monies being used to support private schools over which taxpayers have no control.

To pursue these goals, we must do the following:

Create a Different Kind of School

AFT locals throughout the country continue to support major restructuring efforts. These must continue. They represent our greatest hope for making a major educational breakthrough. Schools that require children to sit most of the day, learn mainly by listening, and learn at the same rate and in the same way rarely succeed with a majority of students. This model of schooling has remained relatively unchanged for over a century. A new model must be developed.

Our experience has been that school-based management and shared decision making are necessary, but not sufficient, conditions for school change. By themselves, these innovations don't necessarily lead to school improvement. We have strong evidence that these arrangements and other components of restructuring will not succeed unless we first agree on what all students must know and be able to do. (School-based management and shared decision making are essential in deciding how best to meet aca-



demic standards that have been adopted.) Only then will we know what faculty must know and be able to teach.

Having agreed upon what students should learn, we must develop school structures and teaching techniques that take into account the many obstacles that now impede student learning. In transforming our schools, we should learn from the practices of school systems abroad and we should incorporate into our reforms the kinds of supports we know students and teachers need, including:

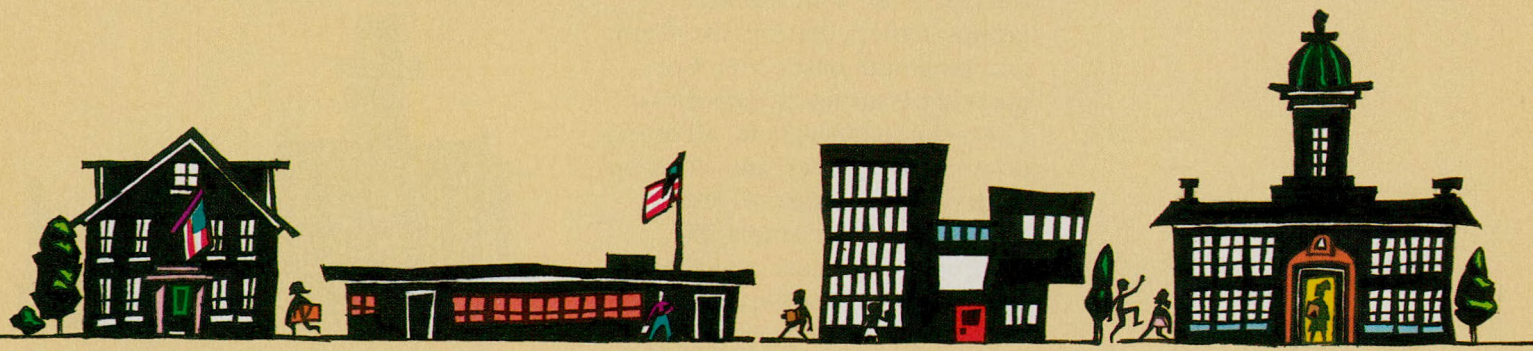
- Agreement by management and union to grant a school that is undergoing serious restructuring efforts freedom from many regulations over a long period of time.
- Substantial time for staff planning, training, and cooperation.
- Professionalization of teachers so that they are capable of using all the alternatives to whole-class teaching, including team teaching, cooperative learning, peer tutoring, and discussion seminars.
- Staff training in the educational use of technology—not just computers, but also audiotapes, video, and Fax.
- Pre-service preparation and staff development that will lead to higher levels of subject teaching skill mastery than have been required up to now.
- An opportunity for school staff to explore alternative school models that combine all or some of these elements, such as the German Köln-Holweide model, Montessori schools, the Key School, some schools featured by the Coalition of Essential Schools, and the one-room schoolhouse.

Improve Traditional Schools: Use Lessons from the Systems of Other Industrialized Countries

Most of the schools in other countries are performing better than ours. They may have some features we identify with restructuring, but generally they are traditional. This demonstrates that those not engaged in developing new types of schools can work to create successful traditional schools. In fact, getting Americans to adopt the key elements of these traditional schools is no less a revolutionary task than school restructuring. We need to work on both—substantially improving the schools we have while at the same time working to create a new model.

What General Motors and the United Auto Workers are doing with cars is very similar. In developing the new Saturn model, UAW and GM are mounting a great effort to create a car that can successfully compete using a new manufacturing process—one that does not resemble the old factory system. While this effort has been going on and is successful, GM has not stopped making its other cars. Many buyers still wanted the traditional models. So GM continued to improve them, too. The changeover from our current schools to those of the future will be evolutionary in the same way.

In improving our traditional schools, we should learn from our school sys-



When assessments are curriculum based and challenging, "teaching to the test" is a constructive way to spend class time.

tem and those of other industrialized countries.

- Schools in other countries are run by professionals, with relatively little regular interference by laypeople or school boards.
- Schools in other countries generally have a national curriculum. Consequently, teacher training, textbooks, and assessments are much more effective than ours because they can be geared to a specific curriculum. Moreover, students know that as they go from teacher to teacher or school to school, there will be continuity.
- Assessments, at least for the college bound, are curriculum-based and challenging. As a result, "teaching to the test" is a constructive way to spend class time.
- Because other countries produce many more students who reach the highest levels of achievement, there is an adequate supply of highly educated people to staff positions in business, government, the military, and educational institutions. These nations can guarantee that all classrooms are staffed by highly knowledgeable, skilled teachers.
- A number of other countries group students by achievement level. In the U.S., student grouping has usually had negative effects on students because students in the "slow" groups are not given challenging work. In other countries, student grouping has positive effects because all students are given challenging work. Also, U.S. student grouping often starts in the first grade with reading groups. Other countries avoid any grouping until much later. Germany starts grouping earlier than most—in the fifth grade. All others do so in later grades, and all group students in high school. Also, in the U.S. there is a danger that grouping of students could be used not for educational purposes but to increase racial separation.
- Good systems in other countries have clearly visible consequences for student performance. There are high college entry standards and clear employment standards. Since success is rewarded in all tracks, all students are expected to work hard—and their teachers and parents push them.
- Schools are relatively safe and free of many of the disruptions of U.S. schools because the legal system supports school regulations needed to maintain a proper educational atmosphere.
- School systems in other countries have much smaller school bureaucracies. In many cases, principals and other supervisors continue to teach.

If traditional U.S. schools are to reach the attainment levels of our industrial competitors, we must try to incorporate these practices, or reasonable equivalents, into our schools. With respect to the above points, these are possible U.S. responses.

1. Experiment with different forms of school governance that free schools from micromanagement by school boards and superintendents. Some of these are discussed in the recent report of the 20th Century Fund. There should be experimentation with various systems of management recommended in the report.

2. States and districts should adopt the best curricula and curriculum frameworks available and require everyone in the system to work faithfully within them. The National Council of Teachers of Mathematics developed such a curriculum. California has

developed outstanding curriculum frameworks in history and language arts. Instead of trying to develop separate curricula in each school, district, or state, we should use the best of what is available. At the same time we should support national and state efforts to produce new and better curricula and develop common national standards.

3. We should use the best kinds of assessments available. As one example, California has developed assessments based on its curriculum frameworks. Advanced Placement exams, the International Baccalaureate, and the older New York State Regents examinations should be used as models while new ones are developed that relate to new, improved curriculum frameworks. AFT should support the commitment of federal, state, and private funds for the development of a national system of assessments—one that also includes assessments for vocational and other non-academic track students.

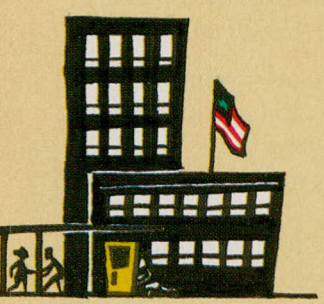
4. Since teacher standards are always related to student standards, we necessarily will need to raise the knowledge and skill levels of many teachers when we raise student standards. While a smaller percentage of U.S. teachers are now adequate to the tasks ahead than in many other countries, we do have a great deal of exceptional talent, and, even when shortcomings are evident, there aren't any replacements with the needed skills, knowledge, and talents available. So, we should encourage some of the same strategies used in the private sector when faced with similar problems.

One answer is teaming and sharing skills—with two, three, four, or five teachers working together in such a way that all students have access to at least one teacher who is top-notch in each area. In some cases technology can help. We should also support "pay for knowledge." This means that, in the future, salary differentials might be based on acquiring the knowledge and skills to teach in an area of shortage. Or, they might be granted to those receiving certification by the National Board for Professional Teaching Standards, which would indicate that a teacher had reached the highest levels of competence in a given field.

5. We need to move away from the ideological debate about student grouping. In fact, there are successful examples of both heterogeneous and homogeneous systems. The basic issue is to determine what practices are needed to make the system work for all students. Heterogeneous grouping can work if there is relatively little teacher talk and if the school is organized around individual student work or by subgroups within the class, much like the one-room schoolhouse or the workings of a Boy Scout troop.

Or, as Harold Stevenson and James Stigler have shown in their book, *The Learning Gap,* whole class direct instruction can also be effective with heterogeneous groups—when very carefully team-prepared lessons are adhered to by all teachers who, instead of trying to cover a great deal, work with the class to carefully review how each student solved a single problem, the different ways of reaching successful answers, and the common pitfalls that led to mistakes. However, if teachers are going to talk a great deal and cover much ground, classes must be grouped homogeneously so that students can follow together.

Where there is grouping, we should follow the practices of other countries. Students are grouped on the basis of achievement—a combination of effort, ability, and level of development and not on the basis of presumed innate ability. Students are not grouped any earlier than the fifth grade, and, for the most part, not at all in elementary school. At the elementary level students are given the same work and are pressed and are helped to do it. At the point where students are grouped, all students in all groups are given challenging work that is designed to have all learn to the maximum of their abilities. Students who do exceptionally well are moved to more challenging groups and, in the best situations, student grouping may be different in each subject to reflect different subject strengths and weaknesses.

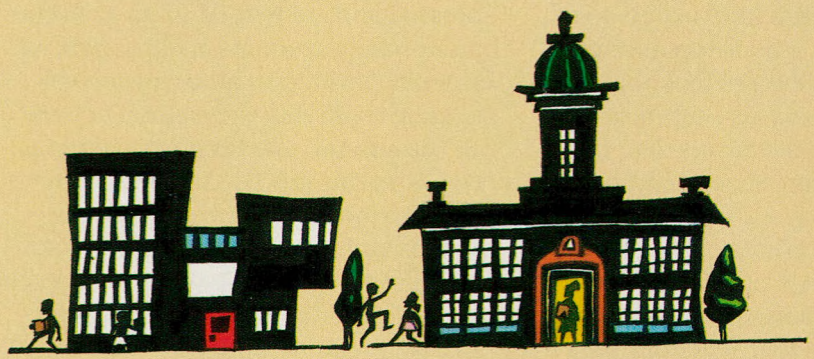


Other countries spend more on elementary and secondary education than we do. We need to spend comparable amounts.

6. AFT should support incentive systems to increase the motivation of students to work hard and achieve in school. We should favor the development of world-class college entry standards over a given period of time. The college graduation rates of other countries lead us to believe that we would not reduce the number of college graduates if we maintained high standards. There should be provisions for ongoing education for those students who do not meet college requirements, and it must be possible for those who do not reach college entry standards by the time they are 18 to meet them at a later time. We also favor the establishment of school-to-work links and legislation that would involve all businesses in providing on-the-job apprenticeships and training programs for all employees.

Extrinsic incentives are needed, but intrinsic incentives are most important. Anticipated college and employment standards are not likely to motivate elementary and middle school students. For them, among the strongest incentives is recognition within a group small enough so that all know each other—something that is further made possible when teachers and students remain with each other for a number of years to develop close relationships.

7. AFT should engage in ongoing meetings with school, parent, civil rights, and other groups in an effort to modify current laws and/or practices that make U.S. schools the least safe and most disorderly in the industrialized world.



Implement Public Policies that Support Schools

Educational results do not depend only on what teachers and schools do. Much of the success of other countries is due to the social and economic context within which education takes place.

- In other industrialized countries, the amount spent on the education of children is about the same throughout the country. In other industrialized countries, the amount spent on a child's education does not depend on local real estate values or the wealth of a local community. Most other countries have national systems in which the same is spent on all children, with the exception of additional funds that are provided for children with special needs. Even where there are some differences, they are very small by American standards. Jonathan Kozol has dramatically portrayed the shameful conditions in thousands of our worst schools. Even if it's not possible in our system to reach equality in spending, at the very least we need a set of high minimum standards that includes special compensation for the most deprived, so that no child is denied an education.
- Other countries spend more on elementary and secondary education than we do. We need to spend comparable amounts.
- The income gap between the top 10 percent and the bottom 10 percent is greater in the U.S. than elsewhere. This translates into different educational chances for students.
- National health care systems in other countries and child and family leave policies provide a system of support that improves school chances.

We do not propose to relieve our schools or our profession of the respon-

sibility for doing better; but we recognize that even if we in education were to do everything as well as others do, without these other external impacts our results are likely to remain worse than those of our competitors.

Monitor the Changes

The National Assessment of Educational Progress (NAEP) should be adequately funded to be able to continue its valuable sample assessments. They are an important and vital indicator of our nation's educational performance. Increased funding for NAEP would permit more essay, performance, and open-ended questions as well as more regular assessments in those areas now rarely tested.

Improve We Must

We face a fight for the very existence of public education. In order to defeat privatization and voucher schemes, we need to do the following:

- Educate our members and the general public as to the potential dangers to our society if schools in the future were to be organized on the basis of race, ethnicity, religion, and class.
- Disseminate information that shows that private and parochial schools: a) have students from higher socioeconomic groups; b) reject students who are difficult; and c) still don't produce results that are much better than the public schools.
- Analyze and take seriously the reasons why parents remove students from public schools so that we can address their concerns with aggressive retention efforts.
- In order to reduce the pressure for private school choice, we should increase choice in public schools.

Since voucher or private school choice plans are under consideration, we must demand freedom from all but essential laws and regulations covering civil rights, health, safety, and quality standards. And we must demand that whatever regulations are deemed necessary and in the public interest must also be required of any non-public schools whose students are publicly funded. The theory of school competition will certainly not work if public schools are saddled with unnecessary, unpopular rules while private schools are not.

We should strive to incorporate into public schools three of the elements of private and parochial school education that are most attractive: the ability to separate out students who are consistently so troublesome as to prevent others from learning, smaller class size, and often the requirement that students take more academic courses.

We need to return to the idea of the common school: the idea that children of all races, religions, classes, and national backgrounds should get a common education and set of values so that they can learn to live together in a diverse democratic society. This means an emphasis on history, civics, democracy, and commonly shared and held values. It means learning about the contributions of all peoples to our multicultural society. It means teaching history accurately, with pride in our national achievement, but also awareness of our past sins and present shortcomings. But it means opposition to those social studies programs that pit groups against each other and stress differences and conflict.

We must also vastly increase our political efforts in opposition to vouchers as well as our cooperative school improvement efforts with business and other groups. Still, we must face the possibility—even the probability—that soon, somewhere, in some state, one of these schemes will pass. AFT should prepare materials on how public schools can effectively compete should such a system be instituted.

A strong public school system is essential for our democracy. To support our public education system we will dedicate ourselves to oppose politically all efforts to use public monies for private schools and to engage in strong and ongoing efforts to create new type of schools and vastly improve existing ones.

QUESTIONS & ANSWERS

Why is it important to make our education system world-class?

■ *To Remain Economically Competitive*

It's no secret that our economy is in bad shape. Our trade deficit is growing, productivity is waning, and the job market is shrinking. Increasingly, we find ourselves being outperformed by such countries as Japan and Germany. Rather than leading, we seem to be struggling just to keep up.

The past two decades have seen a 12 percent decrease in the real average weekly earnings of Americans. These falling wages have primarily hurt low- and middle-income citizens, while those at the top of the income scale have continued to prosper.

Two years ago, the Commission on the Skills of the American Workforce issued a sobering report (*America's Choice: High Skills or Low Wages!*) characterizing the nature of our economic problems. The key to maintaining—and improving—our standard of living, the commission argued, is to increase productivity and our competitive standing in the global marketplace.

As computer and communications technology development make for what is being termed the third industrial revolution, businesses worldwide are recognizing a need to turn to new forms of work organization. In Japan and Germany, for example, companies are cutting middle management and giving front-line workers more responsibility. Such an approach places far greater demands on the skills of employees and, in turn, on the education systems that prepare them. In the United States, by contrast, highly skilled workers are in short supply, so companies opt for low productivity and archaic, labor-intensive work patterns.

If we hope to remain economically competitive and provide a decent standard of living for a larger number of our citizens, we must follow the lead of our competitors. The problem is that we are not presently equipped to do this. Too many students leave our secondary schools—both dropping out and graduating—without a firm grounding in core subjects and lacking the communication and analytical skills necessary for them to become productive employees in any occupation.

■ *To Strengthen Our Democratic Way of Life*

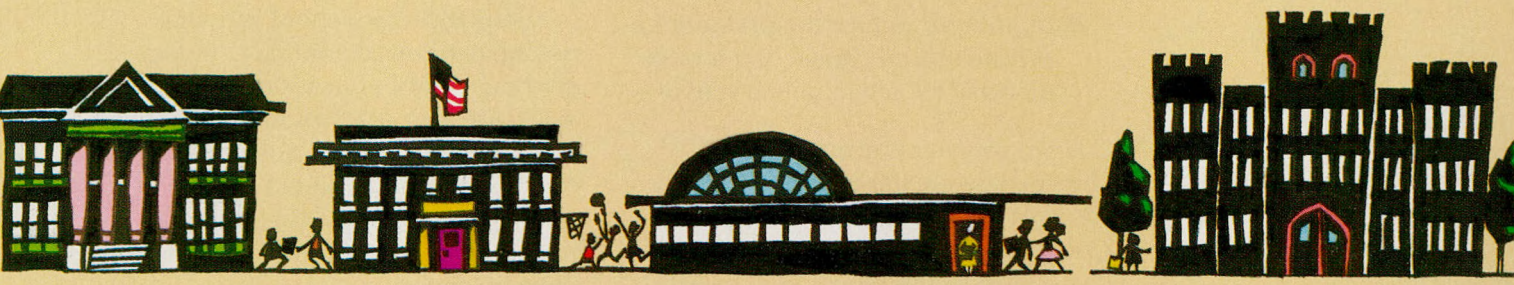
As vital as improving the education of our children is to our economic health, it is also indispensable to our democratic way of life. Democratic government relies on an informed, well-educated citizenry for its strength and substance, and schools are an essential civic resource.

An improved education system is also important in our fight against crime, poverty, drug abuse, and other social ills. To be sure, these problems cannot and should not be left for our schools to solve by themselves, but schools play a significant role in the quest to teach our youth a greater sense of discipline and values.

Are our students really doing worse than their counterparts in other countries?

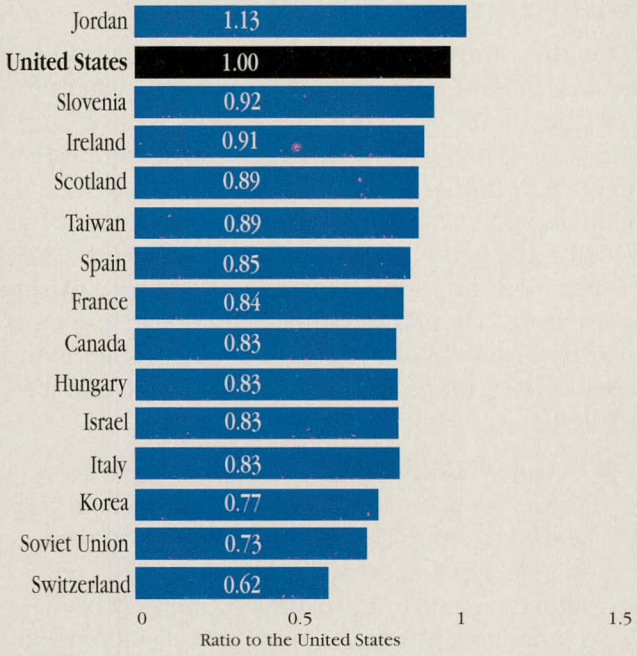
Whether students go to college or not, they must be equipped with the necessary knowledge and skills to become productive members of the work force and responsible, law-abiding citizens of our democracy. Unfortunately, the evidence indicates that our elementary and secondary schools are falling short.

Ever since "A Nation at Risk" disclosed the poor performance of American students 10 years ago, a



The Achievement Gap

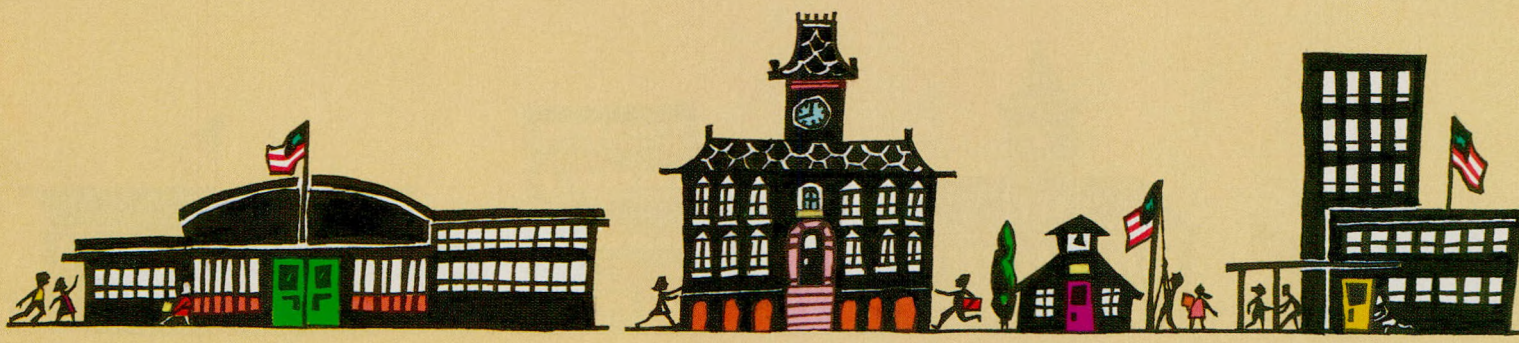
Not only do American 13-year-olds rank near the bottom on international comparisons, but the disparities between the performance of our top and bottom students are also among the largest in the world. As this chart shows, only Jordan has greater disparities among its students in math achievement. Achievement disparity is computed as the range between the performance of the bottom 10th and the top 10th of students, divided by the average for that country. In Switzerland, for example, the gap between the highest and the lowest performing students is almost half what it is in the United States.



Source: International Assessment of Educational Progress, Educational Testing Service, 1992

multitude of reports have emphasized the same point. While in some cases the data may be flawed, the sheer number of studies (a leading testing company estimates the total at more than 150) published—all with similar findings—certainly drives the message home. Consider:

- National Assessment of Educational Progress data from 1990 show that students in the fourth, eighth, and 12th grades couldn't handle challenging subject matter in science or math (*The 1990 Science Report Card* and *The State of Mathematics Achievement*).
- In science, for example, the NAEP results showed that fewer than half the 12th graders demonstrated the ability to apply knowledge to interpret graphs and tables, evaluate and design experiments, or show detailed knowledge of scientific information. In math, fewer than half the 12th graders demonstrated a consistent grasp of decimals, percents, fractions, and simple algebra. Just 5 percent of the seniors showed skills in advanced algebra and geometry necessary for college-level work or high-technology jobs.
- Results from the 1992 International Assessment for Educational Progress (*Learning Science* and *Learning Mathematics*) placed U.S. 13-year-olds 14th out of 15 countries in math (ahead of only Jordan) and 13th out of 15 in science (Jordan and Ireland scored lower).
- A 1988 report from the International Association for the Evaluation of Educational Achievement (*Science Achievement in 17 Countries*), which showed a similar pattern of poor American performance in science, includes a revealing comparison. It takes the lowest-scoring school in the highest-scoring country and compares the results from that school to the performance of all schools in the other countries. The results: for 10-year-olds, 38 percent of American schools scored below the lowest-scoring school in Japan; for 14-year-olds, 30 percent of American schools scored below the lowest-scoring school in Hungary. The numbers are even more striking for American 12th graders: In biology, 98 percent of the schools scored below the lowest-scoring school in Singapore; in chemistry, 48 percent scored below the lowest-scoring schools in Hong Kong, Singapore, and England; and in physics, 89 percent scored below the lowest-scoring school in Hong Kong. Only Italy scored worse across the board.
- Nor do top American students match up very well against countries such as Japan. A 1989 report from the National Research Council



(*Everybody Counts*) showed that the performance of the top 5 percent of U.S. students in math is matched by the top 50 percent of Japanese students. And it found that the top 1 percent of American students scored the lowest of the top 1 percent in all participating countries.

How is the reform agenda outlined in "The Task Before Us" consistent with our existing efforts to restructure schools?

We have one agenda: to create schools that produce students who are among the best educated in the world. Whether they are restructuring or not, all our schools could benefit from examining the traditional schools in other industrialized countries. Much of the success of schools abroad is due to clear educational policies that outline rigorous national standards for all students, define curriculum based on those standards, and assess students' results in reaching those standards.

- Shared decision making, the centerpiece of most restructuring until now, can't succeed until teachers know what they're supposed to do. Once standards are set, shared decision making can focus on establishing policies that help all students reach the standards.
- Other practices we associate with restructured schools would likewise benefit if we establish clear standards and expectations. We could better define the purposes of staff development and explain why teachers need time to improve their subject-matter expertise and related instructional methods. We could shape experiments in cooperative learning, team teaching, peer tutoring, and discussion seminars around a common substantive agenda growing from national standards.

What impact would rigorous national standards—translated into curriculum frameworks and a national system of assessments—have on the mission of our schools to generate equal opportunity? Will some populations—the poor and the disadvantaged minorities, for example—face added hurdles in their struggles to make good on the American dream?

On the contrary, if everyone knew the meaning of success in hard, substantive terms, we could eradicate the double standards that give so many of our high school graduates a false sense of accomplishment. We could no longer delude ourselves into believing that "improvement" equals success because the national standards would make the gap between expectations and true performance glaringly apparent. These tough tools would give us a more realistic diagnosis of the extent of our problems and a better basis for focusing remedial help where it's needed.

- Urban schools that serve the poor have been the least successful in fostering equal educational opportunity. The depiction of their performance gap will be more dramatic once high national standards are in place, making more compelling our arguments that low-income students deserve a level playing field when it comes to resources. It's better to know fully the disastrous predicament of our educationally disadvantaged populations so we can face the consequences head on.
- The basic-skills thrust of the late 1970s and resulting state movements to implement minimum-competency tests are as close as we've come to setting a national learning agenda. As inadequate as these minimum standards were—they were set at low levels and ignored higher-order thinking skills—they contributed to tremendous achievement gains by minorities and the disadvantaged across the country. For example, the gap in reading achievement

between African-American and white students has closed by 50 percent in the last 20 years. High standards and curriculum guidelines that incorporate problem solving and thinking skills should have an even more profound effect.

- Nonetheless, the attachment of serious consequences to student performance on the assessments should be phased in over time, simultaneous to channeling more resources and assistance to schools whose students need the most help to perform well and which are often funded inadequately.

Don't other countries track students in ways that perpetuate inequality? In shaping our system, shouldn't we hold on to our belief that all students deserve a good education and none should be relegated to dead-end tracks?

None of our major competitors track or group children by level of achievement until at least the fifth grade. Many wait until later. In the United States, we give loud lip service to the idea that such grouping is bad, even as we group students as early as first grade.

When other systems begin grouping in the secondary years, many also offer extra instruction, enabling all students to keep up and meet the standards appropriate to their grade level and academic program. And when grouping becomes a matter of practical aspiration in the late secondary years, with vocational and higher education tracks, clear standards ensure that all students, regardless of track, will be exposed to core academic content. Moreover, these standards show students in those countries what they're expected to know and be able to do, and—unlike our general-track students—they know all the tracks will lead to opportunities after they graduate.

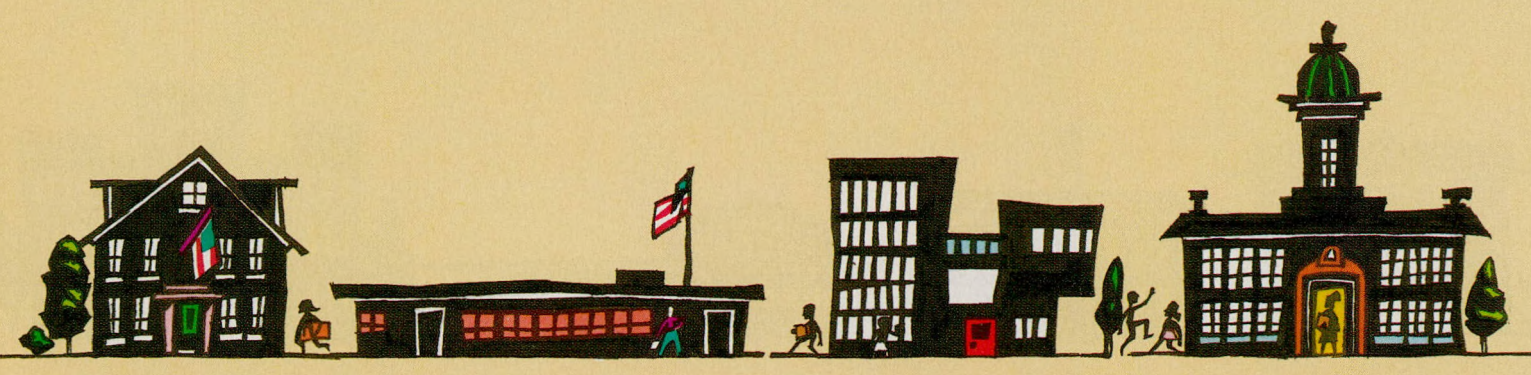
- Even in American elementary schools, we have different expectations for different students, and those expectations translate into watered-down curriculum for students in the slow tracks. The disparities in content become more striking in junior high and high school. A NAEP report on math, for example, pointed out the differences in eighth-grade math curricula. High-performing groups tended to study algebra and functions and learn to use calculators, while low-performing classes were still covering arithmetic and completing work sheets. Most math classes, but especially those with low-performing students, continued to rely on textbooks, work sheets, and frequent tests.

- Achievement grouping is defensible only if all groups are taught in ways that maximize their potential. Practices that relegate low achievers to a dumping ground of low standards and expectations can't be tolerated. Students should be constantly re-evaluated so that they are always placed in a group that challenges them to do their best.

Doesn't the idea of national standards run counter to the traditional American idea of local control?

- In reality, we've already ceded local control of the curriculum—and in effect, standards—to commercial textbook publishers and test developers. Unfortunately, they give us little more than basic skills. Our best chance to displace this minimalist material is by creating an excellent, prestigious curriculum based on world-class standards.

- Even in countries with a national curriculum, local areas and individual teachers retain some discretion over what to teach. And teachers are still free to use whatever methods they think are best for teaching the curriculum. In this country, even with national standards, a large part of the curriculum would continue to be developed locally.



Wouldn't national standards serve to homogenize our unique and vibrant diversity and impede progress toward a more multicultural curriculum?

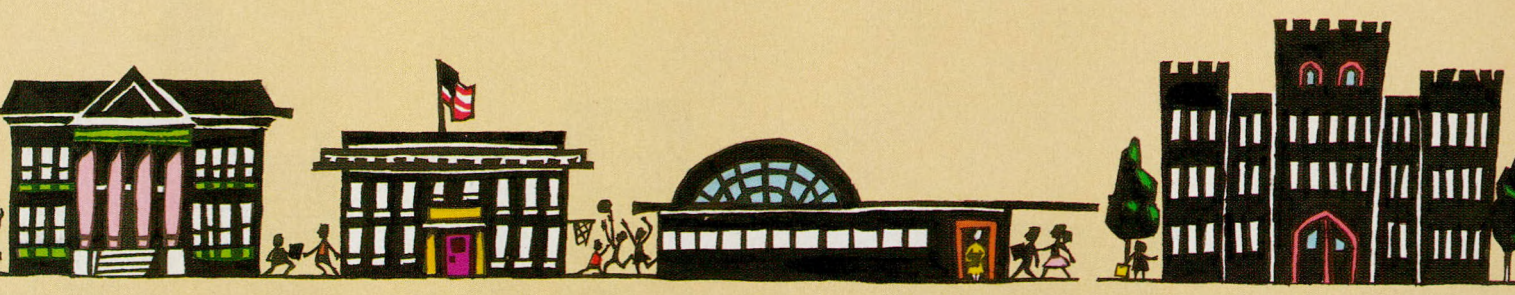
- National standards in the humanities subjects will ensure that all students, of all backgrounds, receive some instruction in common. In the humanities, much of that instruction will relate to our common history and literature. But, as AFT's resolution on multicultural education says, this nation is "one of the world's most diverse multicultural societies." Properly understood, America's common culture is itself extremely multicultural. While there will certainly be difficult and hard-fought debates about the content that should be included in national standards and related curriculum frameworks, we believe that the result would reflect the reality of America's multicultural inheritance.

Why is it necessary to tie college admission and employment to student performance?

- One of the greatest trials of teaching is motivating students who feel they have little stake in learning the material. This is a greater challenge for American teachers than for their overseas counterparts because we are one of the few countries in which students' school performance has so little impact on their future success. In most European and Asian systems, students' ability to get admitted to college or to a good apprenticeship program depends on how well they do in school. As a result, students in these other countries have a strong impetus to work hard in their classes.
- Under our educational system, in contrast, the onus for getting a child to learn is on the teacher, not the student. Most students face no great consequences if they don't do well in school. For those who are college bound, average grades will get them into all but the nation's best colleges. And the work-bound know their potential employers will have little interest in their high school performance. A recent poll by Louis Harris and Associates confirms that belief: Only 24 percent of employers said they "pay a great deal of attention" to the high school records of the average applicant.

Why should teachers be "paid for knowledge"?

- Good teaching requires both pedagogical knowledge and deep understanding of the content area one teaches. If the difficulty of the content is greatly increased, it follows that teachers will need to greatly strengthen their own content understanding. In California, for example, where demanding new curriculum frameworks are now in place, researchers are finding that to successfully teach the new curriculum, many teachers need a stronger grasp of their content area.
- If we substantially raise national standards for students, we will need to create a variety of opportunities and incentives for teachers to strengthen their content knowledge. One way to do this would be to modify current salary schedules so that salary differentials would be awarded only for course work in a teacher's content field, not for methodology courses.
- Once the National Board for Professional Teaching Standards begins issuing credentials, salary differentials could be provided for teachers who meet new advanced certification standards. The AFT has opposed merit pay because it has traditionally been awarded in arbitrary ways. But the National Board offers a vehicle for rewarding excellent teaching performance in a fair, objective way. □



REMEMBERING THE FORGOTTEN ART OF MEMORY

BY THOMAS E. SCRUGGS AND MARGO A. MASTROPIERI

IN THE fifth century B.C., the Greek poet Simonides narrowly escaped death, and in so doing provided the birth of memory strategies. Reciting a poem at a banquet, Simonides was called out of the house for a message. While he was out, the building collapsed, and the diners within were crushed beyond recognition. Asked to help identify the bodies, Simonides noted that he was able to do so by remembering an image of the diners' positions at the table. This inspiration gave birth to the *Method of Loci,* the most ancient of mnemonic techniques.

Ancient Greeks and Romans placed great value on the development of memory skills, partly because the relative lack of printed materials required individuals to commit many things to memory. Throughout the Middle Ages, complex memory strategies took on religious aspects, and sometimes became associated with individuals who dabbled in magic and the occult, such as Giordano Bruno and his secret of "Shadows."

With the development of the printing press, memory skills received less and less emphasis; nonetheless, knowledge of many of these techniques survived, such as those described in 1890 by William James in his *Principles of Psychology.* For a time in American schools, memorization and recitation of inspirational passages and quotations were considered important in developing well-trained minds. Unfortunately, the act of memorizing *per se* is not usually helpful in intellectual development; further, many of the things American schoolchildren were compelled to memorize were decontextualized and therefore of little meaning in themselves. As a result, "memorizing" began to become regarded as a pointless waste of time, as it no doubt was in many cases. Further, "progressive" educators such as John Dewey began rightly to promote the facilitation of "higher-order" thinking skills over the mindless repetition of facts and passages. With the recent renewal of interest in constructivist perspectives and the rise of technological advances in information storage and retrieval, the decline of interest in memory skills has apparently become nearly complete.

With this decline in interest in memory skills, students' memory for important school content also has declined. A recent national report documented the sad fact that American students have become deficient at recall of even the most basic information about history and literature. For example, only one out of three American seventeen-year-olds could place the Civil War within the correct half-century or correctly identify the Reformation or the Magna Carta.

In this article, we wish to provide a different perspective on memory. We define memory skills as techniques for increasing the initial learning and long-term retention of important information. We argue that good memory skills are as important now as they were in Simonides' day; that memory strategy instruction has a very important place in schools, yet unrealized; and that good instruction in memory strategies enhances, rather than detracts from, the facilitation of "higher-order" skills such as comprehension and critical thinking. Indeed, while there are many important things to learn and do in school, and learning and retaining factual information is only one component of the entire school experience, it is our contention that a strong declarative knowledge base is an absolutely critical first step to "higher-level"

Thomas E. Scruggs and Margo A. Mastropieri are professors of special education at Purdue University. Their book on memory techniques is entitled Teaching Students Ways To Remember: Strategies for Learning Mnemonically, *published in 1991 by Brookline Books, Cambridge, Massachusetts.*

skills.

We also provide brief descriptions of nine strategies for promoting strong memory skills.

WE BECAME aware of the critical importance of good memory skills during the course of our work with students with learning disabilities. Many learning-disabled students have some difficulty with semantic memory, or memory for verbally presented information. Clearly, such students face enormous challenges in courses that require vast amounts of verbal information to be "memorized," such as traditionally taught social studies and science courses. In addition, learning-disabled students usually perform poorly on tests of verbal reasoning or higher-order thinking skills. One explanation why these students with average intelligence may do so poorly on verbal reasoning tasks is that they can remember little verbal information to help them on the task. And, it has been well established that content knowledge is one of the best predictors of performance on reasoning tasks. When we trained students in powerful mnemonic strategies to facilitate memory of the core content, we noticed dramatic improvements in their ability not only to remember content information but also to participate actively in classroom discussions that required thinking actively about the subject.

The relation between knowledge and thinking can be further explained by an example. In a recent national educational performance test, one item presented outlines of four birds and asked students to identify the one that probably lives close to water. Students who make effective use of their reasoning abilities could consider the characteristics of such environments, observe the four bird outlines, and correctly conclude that the long-legged bird, physically equipped for wading, was the most likely choice. However, students who remembered important information about birds and their environments could easily recognize one of the birds as a heron and immediately answer the question. Thus, what is a higher-order thinking task to a student lacking background knowledge is a simple recall task to a student possessing the relevant information. As can be seen, the "reasoning" deck is stacked against the student who has not learned, or cannot remember, critical information.

Memory is not only helpful for facilitating thought about academic subjects. One of us remembers the great difficulties he had learning to sail, until he began to master the highly specialized vocabulary associated with sailing. When terms such as *sheet, jib, starboard,* and *boom-vang* became automatic, he began to make rapid progress in sailing. Likewise, we found that students began to make greater progress in vocational skills when they began to learn and remember the specialized vocabulary associated with such areas as rough construction and electricity. Why does verbal knowledge seem to facilitate procedural knowledge, such as sailing and construction? Since we are accustomed to thinking in language, we find it difficult to reflect and elaborate on new information until the relevant language associated with this information has been acquired and remembered. So, it can be seen that a well-established verbal knowledge base is a prerequisite for critical or reflective thinking.

Nor can computer data bases take the place of a broad background of knowledge committed to memory. We often here the refrain, "In a few years, all of this will be unnecessary. Students will wear on their arms a computer no larger than a wristwatch but powerful enough to contain all the information known to mankind." The problem with this line of thinking is that one needs a sufficient knowledge base to know *what* to call forth from the computer, to give form to the endless ocean of information. Research has shown that students who have the most firmly established knowledge base are the ones who can most easily assimilate and apply new information.

Unfortunately, it is not only students with learning disabilities who may find themselves weak in prior knowledge. Students from less-privileged economic backgrounds may come to school not having had the same background experiences as other students. Students for whom English is a second language may have more difficulty expressing their knowledge in English. Finally, if recent national reports are considered, many "ordinary" students exhibit a surprising lack of memory for basic information in school subjects. It seems, therefore, that the argument should not be *whether* to teach memory skills, but *how* memory skills can be best taught. Some recommendations are given in the section that follows.

OUR RESEARCH and experience have shown us that there are at least nine ways that teachers can greatly improve the ability of their students to remember. We will summarize these recommendations in order of complexity. The ninth method, promoting mnemonic strategy use, is the most complicated and will require the most explanation.

1. Promote Attention

Although memory and attention are not the same thing, it is true that things are not likely to be remembered if they are not attended to in the first place. This makes attention an important prerequisite to memory.

There are several methods for improving attention. The simplest include direct appeals ("Please pay attention to what I'm about to say") and follow-up ("What did I say was the assignment for tomorrow?"), and physical proximity to students who are likely not to pay attention. Other strategies for promoting attention include intensifying instruction, with enthusiastic teaching, use of high-intensity visual aids, and providing relevant activities for students, rather than simple listening and note-taking. Teaching is more easily intensified by focusing on a smaller number of critical concepts than by covering a wide range of less important information.

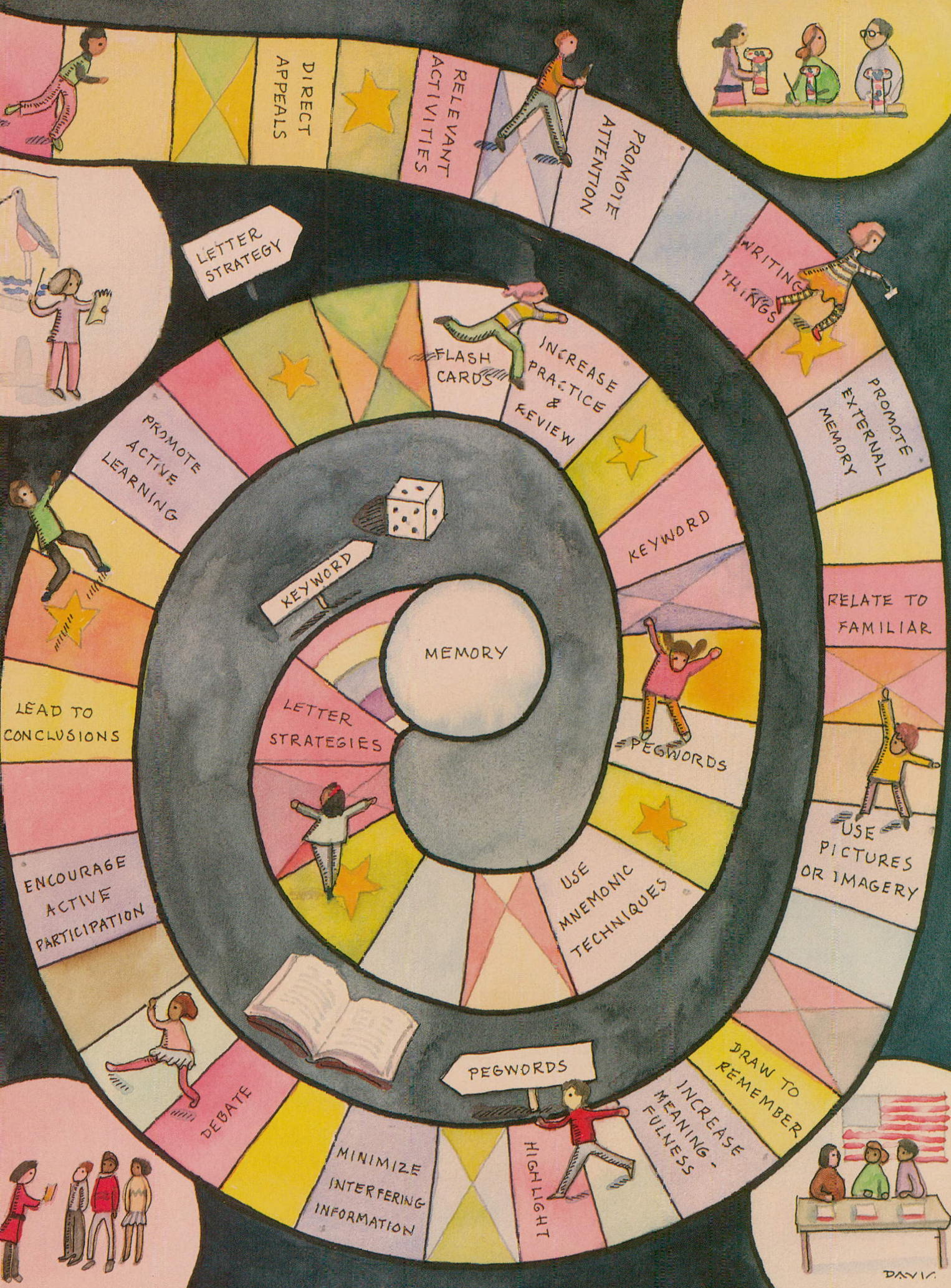
Provide positive feedback for students when they exhibit good attending skills. For more persistent attending problems, teach self-recording of attending, e.g., by having an egg timer go off at random intervals and having students indicate whether or not they were paying attention at that moment.

William James argued, "My experience is what I agree to attend to." Promoting attending will not guarantee improvement in memory, but it is a great place to start.

2. Promote External Memory

One very simple way for students to remember things better is to learn to write them down and refer back when

ILLUSTRATED BY SUSAN DAVIS


DIRECT APPEALS
RELEVANT ACTIVITIES
PROMOTE ATTENTION
WRITING THINGS
PROMOTE EXTERNAL MEMORY
RELATE TO FAMILIAR
USE PICTURES OR IMAGERY
DRAW TO REMEMBER
INCREASE MEANING-FULNESS
HIGHLIGHT
MINIMIZE INTERFERING INFORMATION
DEBATE
ENCOURAGE ACTIVE PARTICIPATION
LEAD TO CONCLUSIONS
PROMOTE ACTIVE LEARNING
LETTER STRATEGY
FLASH CARDS
INCREASE PRACTICE & REVIEW
KEYWORD
PEGWORDS
USE MNEMONIC TECHNIQUES
LETTER STRATEGIES
KEYWORD
MEMORY
PEGWORDS
DAVIS

necessary. This is one method of "external memory," which refers to the use of any device outside the student's own mind used to enhance memory. External memory devices include writing things in notebooks, appointment books, or on cards; placing things to be remembered (e.g., books, notes, self-reminders) in prominent places where they will be noticed; and using physical prompts (e.g., a string on the finger, a watch placed on the opposite wrist), which remind students to think of or do some particular thing. One drawback to external memory is that it is not a substitute for truly remembered information, especially in test situations, in which use of such systems is usually considered cheating.

3. Increase Meaningfulness

Students remember familiar and meaningful information much more readily than non-meaningful information; and students often surprise us by what is not meaningful to them. The most usual way of increasing meaningfulness is to develop experiences with the things

Acrostics at Harvard

SOURED, PERHAPS, by memories of the multiplication tables, college students hate the annual ritual of memorizing the geological time scale in introductory courses on the history of life. We professors insist, claiming this venerable sequence as our alphabet. The entries are cumbersome—Cambrian, Ordovician, Silurian—and refer to such arcana as Roman names for Wales and threefold divisions of strata in Germany. We use little tricks and enticements to encourage compliance. For years, I held a mnemonics contest for the best entry to replace the traditional and insipid "Campbell's ordinary soup does make Peter pale . . ." or the underground salacious versions that I would blush to record, even here. During political upheavals of the early seventies, my winner for epochs of the Tertiary (see table) read: "Proletarian efforts off many pig police. Right on!" The all-time champion reviewed a porno movie called *Cheap Meat*—with perfect rhyme and scansion and only one necessary neologism, easily interpreted, at the end of the third line. This entry proceeds in unconventional order, from latest to earliest, and lists all the eras first, then all the periods:

Cheap Meat performs passably,
Quenching the celibate's jejune thirst,
Portraiture, presented massably,
Drowning sorrow, oneness cursed.

The winner also provided an epilogue, for the epochs of the Cenozoic era:

Rare pornography, purchased meekly
O Erogeny, Paleobscene.*

When such blandishments fail, I always say, try an honest intellectual argument: If these names were arbitrary divisions in a smooth continuum of events unfolding through time, I would have some sympathy for the opposition—for then we might take the history of modern multicellular life, about 600 million years, and divide this time into even and arbitrary units easily remembered as 1-12 or A-L, at 50 million years per unit.

But the earth scorns our simplifications and becomes much more interesting in its derision. The history of life is not a continuum of development, but a record punctuated by brief, sometimes geologically instantaneous, episodes of mass extinction and subsequent diversification. The geological time scale maps this history, for fossils provide our chief criterion in fixing the temporal order of rocks. The divisions of the time scale are set at these major punctuations because extinctions and rapid diversifications leave such clear signatures in the fossil record. Hence, the time scale is not a devil's ploy for torturing students, but a chronicle of key moments in life's history. By memorizing those infernal names, you learn the major episodes of earthly time. I make no apologies for the central importance of such knowledge. □

*There are two in jokes in this line: *orogeny* is standard geological jargon for mountain building; *Paleobscene* is awfully close to the epoch's actual name—Paleocene.

Geologic Eras			
Era	**Period**	**Epoch**	**Approximate number of years ago (millions of years)**
Cenozoic	Quaternary	Holocene (Recent) Pleistocene	
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	
Mesozoic	Cretaceous Jurassic Triassic		65 225
Paleozoic	Permian Carboniferous (Pennsylvanian and Mississippian) Devonian Silurian Ordovician Cambrian		570
Precambrian			

The geological time scale.

Excerpted with permission from Wonderful Life: The Burgess Shale and the Nature of History, *by Stephen Jay Gould (W. W. Norton & Company, 1989).*

being learned and to relate new information in some way to things that are already known. For instance, in describing the components of levers, use see-saws, oars, rakes, and wheelbarrows as examples. Tie examples of abstractions, such as "torque," to everyday things the student already understands.

4. Use of Pictures or Imagery

Most information is more easily remembered when it is pictured. Pictures make concepts more concrete, and, therefore, more easily remembered. Pictures allow students to more easily employ their mental imagery, which also facilitates remembering. Pictures can be shown to all students simultaneously on the overhead or opaque projector. If information is only presented verbally, it is less likely to be stored in students' memories as images, and, therefore, may be more difficult for them to retrieve. If it is not possible to show pictures, describe the information clearly and concretely, and encourage students to make pictures in their minds. If they can draw their images clearly, they are more likely to remember them.

5. Minimize Interfering Information

Highlight the most important information and reduce the number of unnecessary digressions. Provide only the most highly relevant examples. Unfortunately, some textbooks present what appears to be an endless string of facts, concepts, and vocabulary for students to memorize; it has been reported that some science textbooks contain more vocabulary words than are found in foreign language texts! If you do rely on textbooks to cover important class information, prioritize the terminology, facts, and concepts to include those that you consider most important and provide special emphasis on this information.

6. Encourage Active Participation

Concepts are better remembered if students actively manipulate or otherwise act out instances or manifestations of these concepts. For instance, in science, students are more likely to remember about series and parallel circuits if they have actively created these circuits. In social studies, students are more likely to remember information if they assume roles in debating historical issues, such as the U.S. recognition of the Republic of Texas, or current events, such as United Nations policy in the Sudan. Students can also assume roles in historical problem solving, such as problems in pioneer bridge building.

7. Promote Active Learning

Encourage students to reason actively through new information. Promote deductive reasoning when appropriate. Ask students to draw conclusions for themselves rather than simply telling them the information. For example, rather than explaining to students why earthworms are found on the ground after a rainfall, or why the full moon rises shortly after sunset, ask questions intended to lead students to draw the correct conclusions for themselves.

Teachers who are expert in certain content areas may forget how difficult it is to acquire new speech sounds to represent new concepts or facts.

8. Increase Practice and Review

Many teachers require information to be remembered for a weekly or unit test (e.g., spelling, science) but rarely monitor recall of that information after it has been tested. To promote long-term recall of previously learned information, isolate the most critical content and provide brief but regular reviews over a longer time period. Students can review this information individually, question each other with flash cards, ask questions from books, or review with the teacher as a whole class activity. Although finding even small amounts of additional time for such activities may seem unlikely, look for occasions for brief reviews before or after transitions (lunch, recess, assemblies) or while students are standing in line or doing other activities that take minimal mental energy.

9. Use Mnemonic Techniques

Mnemonics are systematic techniques designed to enhance memory, particularly memory for new vocabulary or terminology, facts, and concepts. They are most effective, and most appropriate, when used to facilitate memory of things that cannot be deduced or otherwise constructed by students. Examples include remembering the seemingly arbitrary speech sounds in new vocabulary or terminology, human conventions, or basic facts such as the number and names of continents or planets.

Teachers who are expert in certain content areas may forget how difficult it is to acquire new speech sounds to represent new concepts or facts. Mnemonics often work by impacting on retrieval of the *acoustic properties,* or sounds, of unfamiliar words. A retrieval route is constructed between the sound of the word and the underlying meaning or conceptualization. Mnemonic techniques have been studied empirically over the past two decades and have been shown to be remarkably facilitative in promoting memory objectives.

In our recent book, *Teaching Students Ways to Remember: Strategies for Learning Mnemonically*

Okay, Who Remembers the Five Major Divisions of Vertebrates?

SCIENCE IS an area in which many students experience frustration and disappointment. There are many causes for this. Although science itself is a fascinating subject, many students may fail to become interested because they fail to learn and remember key concepts and vocabulary. Without this foundation, more advanced learning and meaningful applications are impossible. In other cases, the content may be too complex or abstract for some students to readily grasp. Many advocates of science education have stressed the importance of experiment and discovery in science learning. Nevertheless, many key concepts and vocabulary must first be learned to make later experiment and discovery meaningful.

Mnemonic techniques can be very effective in science teaching, since they help make complex content simpler, abstractions more concrete, and seemingly meaningless information more meaningful.

For example, life science, as typically taught, has much to do with the classification, organization, and description of living things. Therefore, much instruction in life science has to do with learning characteristics and taxonomies. This type of learning easily lends itself to mnemonic instruction.

Vertebrates. The study of vertebrates is a relatively easy unit in life science because students usually are familiar with many of the relevant concepts. In fact, most students are familiar with what a "backbone" is, although they may not know the meaning of the word "vertebrate." In this case, a keyword strategy is helpful in teaching this verbal label for an already-familiar concept.

"Dirt" can be used as a keyword for "vertebrate" because it sounds like the first syllable of vertebrate and can be pictured (e.g., a dirt pile). A picture then can show a backbone (or a vertebrate animal with an obvious backbone) sticking out of a pile of dirt, to help students remember this definition of vertebrate.

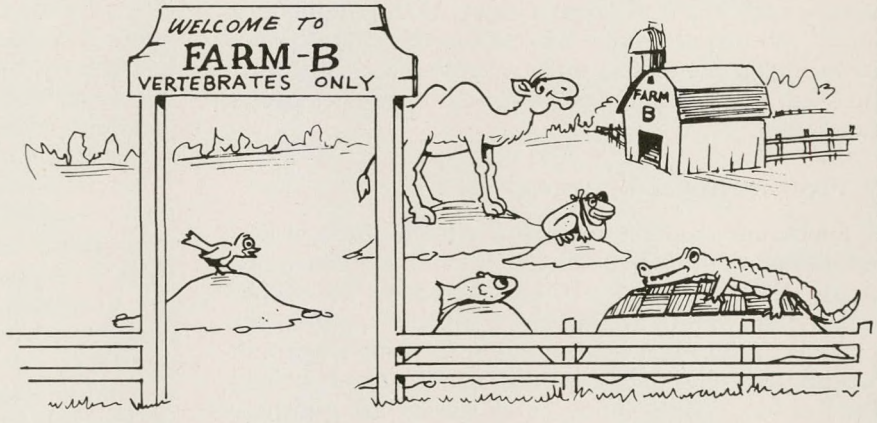
There are five major divisions of vertebrates: amphibians, fish, reptiles, birds, and mammals. Two of the five, fish and birds, are almost certainly familiar to students. Therefore, fish and birds can be shown in *mimetic* or representational pictures, and important concrete attributes, such as scales, fins, and feathers, can be portrayed within these mimetic pictures.

Reptiles are also familiar to many students. However, many other students may not know what reptiles are, or they may not know all the different types of reptiles, such as snakes, lizards, turtles, and crocodilians. If reptiles are as familiar to students as birds and fish, they can be presented in a mimetic picture. If they are less familiar, a keyword elaboration will be helpful. In this case, the word "tiles" could be a good keyword for reptiles, because it sounds like the second syllable for reptiles, and can be pictured. A picture depicting reptiles in some relationship to tiles, e.g., a picture of snakes, lizards, turtles, and crocodilians sitting on tiles, or with tiles for scales, or both, could be effective.

Possible keywords could be "bib" for amphibian (*amplifier* may also be good) and "camel" for mammal. "Bib" is an acceptable keyword because, although a short keyword for a long word, bib sounds very much like the accented second syllable of amphibian. Camel is a particularly good keyword because a camel *is* a mammal.

Organization. Much of life science instruction involves teaching which of several types of plants or animals go together. With respect to the *vertebrates* examples, above, students may be required to "have the five types committed to memory." Once the names of these animals have become familiar, a first-letter strategy is appropriate. The first letters of the five vertebrates cannot be combined to make a "real" word, but together they do form the acronym (suggested by Roy Halleran) "FARM-B." Now, FARM-B does not convey any particular meaning to us, other than, say, an unusual name for a farm; nevertheless, with a little practice this can become a very effective mnemonic for retrieving *f*ish, *a*mphibian, *r*eptile, *m*ammal, *b*ird. To integrate this idea with the concept "vertebrate," place a picture of each animal on a pile of *dirt* (keyword for vertebrate). Also, to reinforce the keywords in the acoustically transformed animal names, show the amphibian with a *bib,* the reptile on *tiles,* and a camel for the *mammal.* □

Excerpted from Teaching Students Ways To Remember: Strategies for Learning Mnemonically.



Types of Vertebrates = Fish, Amphibians (bib), Reptiles (tiles), Mammals (camel), Birds (FARM-B)

Research has consistently indicated that mnemonic techniques help students perform better on comprehension tasks.

(Cambridge, MA: Brookline Books), we describe a variety of effective mnemonic techniques and provide examples of how they can be applied in classroom settings (see sidebar). We will provide here some examples of *keyword, pegword,* and *letter* mnemonic strategies.

Keyword strategies. Keyword strategies are employed by creating an acoustically similar proxy (the keyword) for a new vocabulary word, proper name, fact or concept, and linking the keyword to the relevant associated information through an interactive picture or image. For instance, to help students remember that ranid (rā′nid) refers to the family of typical frogs, create a keyword for ranid that sounds like ranid and is easily pictured, e.g., *rain.* Then, show the rain and the frog interacting in a picture, e.g., a *frog* in the *rain.* Then remind students, when they hear the word ranid, think of the keyword, rain, think of the picture with rain in it, think what else was in the picture, and retrieve the response, *frog.* Have students practice until they can retrieve the information backwards, i.e., frog = ranid. For another example, to help students remember that *olfactory* refers to *sense of smell,* create a keyword for olfactory, e.g., "oil factory," and show or prompt imagery of a *smelly oil factory.* Verbal elaboration is also helpful. In this case, a person could be pictured walking past a smelly oil factory, holding his nose, and commenting, "That *oil factory* is bothering my *olfactory* sense!" When students hear the word olfactory, they can think of the keyword, oil factory, think of the picture of the smelly oil factory, and remember that olfactory referred to sense of smell. Keywords can also be used to promote foreign vocabulary learning and to help remember the names of important people and places in history. In a recent investigation, we found that pictured keywords for place names (e.g., Ticonderoga = Tiger) on maps promoted better recall of historical locations than the place names alone.

Pegwords. Pegwords are rhyming proxies (one is *bun,* two is *shoe,* three is *tree,* etc.) for numbers and are used in remembering numbered or ordered information. For example, to help students remember that a *rake* is an example of a third-class lever, show a picture of a rake leaning against a *tree* (pegword for three). To help them remember that a wheelbarrow is an example of a second-class lever, show a picture of a wheelbarrow on a *shoe* (pegword for two).

Letter strategies. Letter strategies, particularly acronyms, are the strategies most commonly used by adults to remember things in clusters or series. Most everyone knows the HOMES strategy for remembering the names of the Great Lakes or that the name ROY G. BIV can help retrieve the colors of the spectrum. Acronyms can also be combined with keywords and pegwords. For example, you can help students remember the names of countries in the World War I Central Powers Alliance by using the acronym TAG (T = Turkey, A = Austria-Hungary, G = Germany). This acronym can be linked to the Central Powers by depicting children playing TAG in Central Park (keyword for Central Powers). To remember freedoms guaranteed by the First Amendment to the Constitution, have students think of a contemporary singer who RAPS (R = religion, A = assembly and petition, P = press, S = speech). To effectively tie these freedoms to the First Amendment, portray a singer who RAPS about *buns* (pegword for one).

In addition to acronyms are acrostics, which expand rather than condense representations. One example is *M*y *V*ery *E*ducated *M*other *J*ust *S*erved *U*s *N*ine *P*izzas," to represent the planets in order from the Sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto. Another is "King Phillip's Class Ordered a Family of Gentle Spaniels," to remember the classifications Kingdom, Phylum, Class, Order, Family, Genus, and Species, in order. Letter strategies are helpful whenever information can be clustered and when the information itself is relatively familiar.

IN SPITE of their success in facilitating memory, mnemonic techniques have often been criticized for promoting simple recall at the expense of conceptual understanding. However, research has consistently indicated that mnemonic techniques do not inhibit comprehension and actually help students perform better on comprehension tasks, probably because students employing these techniques can use more information in answering questions. Of course, it is possible to remember information that is not comprehended, and it is advisable to ensure that all information to be remembered is meaningful to students and that coursework is not overloaded with excessive amounts of facts and vocabulary to be memorized. On the other hand, it is not possible to comprehend or use information that is not remembered. To address this potential problem, memory strategies are appropriate.

Good memory skills have benefited humanity for thousands of years, and no doubt will continue to do so for thousands more. Although memory objectives can certainly be overemphasized in school settings, it is time to place appropriate emphasis on the importance of memory in school learning, as well as the skills that allow us to remember effectively. □

They Can But They Don't

Helping Students Overcome Work Inhibition

By Jerome H. Bruns

As many as 20 percent of American public school students may be work inhibited—that is, they can but they don't do the work of school. They may have the intellectual capability necessary to understand the concepts their teachers present, they may have well-educated parents who want them to do well, and they may have no learning disabilities. Something, however, is blocking them from succeeding. They do not stay on task, do not complete class assignments, do not finish their homework on their own.

Over a period of eight years, in my work as a school psychologist, I conducted a broad series of experimental and empirical studies concerning work inhibition. The impetus for this work came from a series of failed attempts to help teachers and parents by using traditional approaches to make work-inhibited students comply with the demands of school. I observed that the teachers and parents of these students felt defeat and frustration and that it was not unusual for them to go to war with each other over who was responsible for the child's failures.

Jerome H. Bruns has more than twenty years of experience as a teacher, counselor, and school psychologist. For a more in-depth treatment of the problem of work-inhibited students, with chapters devoted to what teachers, parents, and counselors can do to help, see his recent book, on which this article is based: They Can But They Don't—Helping Students Overcome Work Inhibition, *published by Viking Penguin and available now in bookstores.*

The term "work inhibition" was coined because the problem is unrelated to abilities, knowledge, or skills. Certain students have no trouble learning; they just have extreme difficulty engaging in the work of school. This condition stirs a range of feelings—from puzzlement to rage—among teachers and parents over generally articulate and able children who do not sustain independent effort to complete school tasks.

Even outstanding teachers have difficulty getting these students to engage in the work of school. One such teacher described her experiences with Jason, a third-grade pupil:

> Jason is never a problem in class or at recess. During oral reading, he enjoys being called on and reads fluently and with meaning. He usually has an appropriate answer or question, and he loves just about any game. His major problem—or maybe it's my problem—is completing assignments.
>
> I always make sure he understands what is required. For example, during math I go to his desk and ask if he understands the directions. If he says, "Yes," I ask him to do the first problem. While I'm kneeling beside him, he invariably completes the problem correctly. I give him an encouraging pat and tell him to continue working. I then go about the room seeing to the other students.
>
> After a period of time, I come back to Jason to see how he is progressing. He usually hasn't completed anything beyond the one problem we began with. I ask him why, and he usually just shrugs or says something like, "I don't know."

ILLUSTRATED BY ROBERT BARKIN

When teachers talk about students like Jason, they rarely share tales of success. Rather, they speak of their frustrations getting these children to complete almost any assignment on time or as directed. Since these students are always forgetting, teachers ascribe the behavior to disorganization and memory problems.

"I don't know what else to do. I've tried everything." This teacher spoke of how she kept students in from recess when they hadn't completed their work. She went so far as to make special transportation arrangements for some students to stay after school to finish their assignments. But when 5:00 P.M. arrived and one student had not yet begun to work, it was time to throw in the towel. "I gave up," she said. "There was no way I could make him do the work."

The defeat and frustration teachers often feel is minor compared to what many parents experience. Most parents want their children to be successful, and when they receive negative reports from the school, they usually take it upon themselves to see that their child improves. When efforts fail, their frustration grows and they begin to blame the child and the teachers. Teachers, in turn, frequently believe it is the parents who hold the key, and they expect them to do more to help.

WHO IS WORK INHIBITED?

When I began my studies in 1985, the focus was to discover how many students were work inhibited and if they shared any common traits. Were these children of below-average intelligence? Did they tend to be the students who caused discipline problems in the classroom?

The subjects of the studies resided in Falls Church, Virginia, a small (population 9,500) suburb of Washington, D.C. In general, residents of this city are white middle-class, well-educated professionals.

The community's school system is considered by many to be excellent. A favorable ratio of teachers to pupils enables classes to be small, average scores on national standardized tests are high (in the 70th and 80th percentiles), almost all students are on grade level for reading skills, and less than 1 percent of all students drop out of school.

The first step in my study was to undertake an extensive survey identifying students suffering from work inhibition. To this end, teachers and counselors reviewed the work history of their charges and prepared lists of students in grades three through twelve who routinely submitted significantly less work than typical students. To be considered work inhibited, a student had to have a history of not completing school assignments in all subjects for at least two years. The student's whole record—report cards, notes from parent conferences, plus additional interviews with teachers and parents—was used to analyze the work patterns.

Once identified, further information was sought through student records to determine any distinguishing factors that could explain their work inhibitedness.

The findings surprised parents and teachers alike.

- Nearly 20 percent of the school population met the definition for work inhibited.
- Three of every four work-inhibited students were boys.
- Work inhibition appeared across the continuum of students' abilities and skills (including gifted and learning-disabled). Most of the work-inhibited students not only had good cognitive abilities but had above-average to superior thinking skills, as measured by tests of intellectual ability.
- Work inhibition did not appear to be a function of socioeconomic class.
- Work inhibition is not related to birth order.
- In spite of a history of work inhibition, these students frequently had good academic knowledge and skills. Even for students who hadn't done much work for years, they continued to obtain above-average standardized achievement test scores. The skills most likely to suffer were math computation, spelling, and written composition.
- The overwhelming majority of work-inhibited students were not disruptive in the classroom. Discipline records revealed that work-inhibited students were sent out of the classroom because of disruptive behavior nearly as often as the general student population.

Demographic studies revealed that the advantages of high socioeconomic status, good solid intellectual abilities, and excellent educational opportunities do not insulate students from becoming work inhibited.

Personality Characteristics

In an effort to develop a descriptive profile, parents and teachers were invited to provide descriptions of work-inhibited students. Other methodologies included case studies, two experimental studies, a correlation study, and clinical interviews.

Dependency

Work-inhibited students will do their work if their teacher is standing or sitting right next to them. Under these circumstances, even chronically work-inhibited students will do their academic assignments.

Teacher after teacher recounted similar experiences at all grade levels. One fourth-grade teacher gave up her daily break to supervise one of her students during recess. Although Philip liked playing with the other students and clearly enjoyed recess, he was kept in almost daily because he failed to complete his morning class assignments.

The teacher was repeatedly amazed, however, at how well Philip worked when they were alone and next to each other; Philip finished each assignment with minimal effort. But on occasions when his teacher was not able to remain in the classroom with him during recess, Philip did not complete his work. He only finished his assignments when his teacher was right next to him.

Self-Esteem

Parents and educators invariably note poor self-esteem as a central characteristic of work-inhibited students. The behaviors associated with dependency are also frequently associated with poor self-esteem.

Work-inhibited students express their poor self-esteem in many ways. Some are obviously self-conscious. They hold back not only in the completion of assignments, but also in opportunities to lead games and discussions. These students are often constricted; they find

Work inhibition did not appear to be related to socioeconomic class, birth order, or intellectual ability.

it difficult to express their feelings and opinions and seem to want to evaporate or disappear from the classroom. When they do interact, they are often silly and immature. Their classmates may laugh at them. Shy, fragile, and preoccupied with feelings of self-doubt, these students often prefer the company of younger children.

Other work-inhibited students express a bravado. They declare that much of their schoolwork is beneath them: "Why bother with this drivel my teacher asks us to do? Who needs it?" "I can do it when I want to. I just have more important things to do!"

In contrast, students who do their work not only share a strong desire to succeed, they also have confidence in their abilities to persevere, solve problems, and complete their work. They have an openness that contrasts with the work-inhibited students' bravado. While these successful students may not all be outgoing, they usually don't appear fragile. They are willing to take risks, do not fear failure, and are confident.

The studies of self-esteem were conducted in a community in which parents placed a high value on education. Failing at endeavors that are most valued by one's parents exacts a great emotional toll. It is possible that parents contribute to a lowered sense of self-worth by reminding their work-inhibited children of their frequent failures to do well. Many of these children feel they are not successful in their relationships with their parents; they report significantly less approval from their family than do students who are successful at school.

Passive Aggression

Another characteristic of many work-inhibited students—and one that is often misunderstood—is the dimension of passive aggression. Passive-aggressive behaviors are subtle, indirect expressions of anger. Passive-aggressive people cannot openly express anger because it frightens them to do so. They may feel it is better to deny the feelings than to allow them to surface.

The paradox is that the passive-aggressive person *does* express anger, but not openly. Passive-aggressive children are not likely to say no or to openly refuse to follow the directions of teachers or parents. Instead, the passive-aggressive student is more likely to smile, say yes, and then "forget."

Passive-aggressive behaviors take many forms; being forgetful is just one of the most common. Some kids play verbal lawyer. They argue any point—often just for the sake of doing so. These children are very good at picking out the exception to almost any rule. Once a teacher spends considerable time explaining complex directions, this verbal lawyer will introduce some highly unlikely, but plausible, exception. After hearing the student's exceptions, the teacher then has to redirect the class before continuing the lesson.

Another powerful weapon in passive-aggressives' battles is withholding. Such children *will* do what is asked, but they take forever doing so. One father called his son "Dilly Dally" since the boy always took so much time to get ready or to do any chore.

Sooner or later the persistent tactics of the passive-aggressive child will result in temper tantrums. But it is not the child who has the tantrum—it's the parent or teacher. When this happens, the child is bewildered and does not really understand why the parent or teacher is so angry. The child is also frightened, because it's scary to see an important adult out of control. Furthermore, the angry response confirms for the passive-aggressive child that feelings of anger are dangerous and should be denied or kept under control.

Some children are maddeningly passive-aggressive; in others the problem may be less severe. It may seem paradoxical that these passive-aggressive children are often likable and engaging, yet these negative behaviors are not to be denied. The passive-aggressive child wants to please, but angry feelings push up to the surface in maladaptive ways. The child is often unaware of the depth of these angry feelings and doesn't understand their cause.

In Perspective

Most parents and teachers believe that most work-inhibited students are not severely emotionally disturbed. Rather, they have emotional conflicts. In spite of their burdens, endearing qualities are often evident. For example, they clearly want to do better. Just ask work-inhibited children or teenagers what they would like to change about their lives. "I'd get better grades. The problem is I don't do the work. I could if I wanted to. It's like I get up and tell myself that I'm going to do it today! And then, I don't know. I put it off and then it's too late."

One parent told of how happy her son was when he did finish a lesson. Others have noted that work-inhibited students relished their occasional good performances. These students want to be successful—just as successful as their parents' dreams for them.

A personality questionnaire given to both work-inhibited and achieving students showed that most personal-

ity traits common to work-inhibited students are no different from those of achieving students, with some important exceptions.

As a group, work-inhibited students lack persistence and drive; instead, they are expedient, self-indulgent, and have difficulty in delaying gratification. These students are very insecure. They feel guilty and troubled about their inability to take care of themselves, to do their work, and to live up to their own expectations and those of others. Work-inhibited students are not tough or resilient. In general, they lack the emotional fitness to stay the course when faced with difficult tasks and are unable to assert themselves. They need far more help than most students—not only in doing their work, but also in developing a sense of adequacy.

Do not let the work pile up. If possible, collect any work, both complete and incomplete, and go on.

ETIOLOGY OF WORK INHIBITION

"Why is it so difficult for my son to spend just a few hours a week doing homework? I know he isn't stupid!"

It is clear that the cause of work inhibition is not related to intelligence or to a specific weakness in reading or mathematics. Nor is it due to parental neglect. Most work-inhibited students come from homes where academic success is stressed as an important pursuit, and parents are actively involved in "helping."

Case histories reveal that the beginnings of this problem occur early in children's development. Although the manifestations of work inhibition are not always apparent until the third or fourth grade (the time when the demand for independent academic work becomes substantial), the origins begin during infancy.

Some children come to school secure and ready to be on their own. Others do not. Why do some children have the socially and emotionally adaptive skills to engage in independent schoolwork while these skills are lacking in others?

At the earliest stages of human development, babies are highly dependent upon adults for food, warmth, attention, and affection. Yet very early, infants display an amazing interest in their world and derive satisfaction from exploring their environment.

One of life's major struggles is the quest for independence. Growth toward autonomy becomes particularly evident in the second year of a child's life. The child is motivated to explore, understand, and control its world. The two-year-old's desire to do things in his or her own way is easily remembered by parents: This period is often referred to as the "terrible twos."

The success a young child experiences in becoming psychologically separate from his or her parents is very important to the child's future. A person who has been successful in separating psychologically from parents is equipped to function independently in both play and work.

With work-inhibited students, a breakdown in the independence process appears evident. Something has gone awry to keep these children from developing the social and emotional skills necessary to function well apart from their parents or other significant adults. Perhaps there is something in a child's unique makeup that makes it difficult for him or her to be independent. Perhaps some children receive tacit messages from Mom and Dad that separation from them is not safe—that they won't do well on their own.

Work-inhibited students have not developed the *emotional* skills necessary to do independent schoolwork, which often requires children to be on their own, apart from others, doing a task that is neither easy nor pleasurable. Over time, children who are not autonomous do not develop a healthy sense of self-esteem. The problem evolves into a vicious cycle. As they experience failure to initiate independence successfully, children do not receive the positive reinforcement of a job well done that will, in turn, provide them with the encouragement and good emotional feedback to continue going forth with new tasks.

While standard educational practices are not in themselves the root causes for work inhibition, these practices typically exacerbate the problem. Vulnerable, sensitive, weakly assertive children have difficulty in environments that stress competition rather than cooperation, that are more negative than positive, that reject rather than embrace, that fail rather than encourage, and that blame rather than understand.

As educators begin to understand the dynamics of work inhibition, they will have the opportunity to work in concert with parents to solve this bewildering problem. It certainly would be a relief to parents if positive programs of early intervention existed, so that parents and teachers could join together to help children before undue harm occurred.

HELP FOR WORK-INHIBITED STUDENTS

IDENTIFICATION

Work inhibition is rarely diagnosed as the reason for children's inability to do work; its symptoms are often confused with other educational disabilities. Parents can certainly recognize when their children have difficulty settling down and doing their work, but they rarely know what causes the problem. Even teachers who observe these children daily are often perplexed. At times both parents and teachers suspect that a child's failure to do work is caused by a subtle learning disability, attention-deficit disorder, or perhaps a fine-motor coordination

weakness that impairs the ability to write and complete assignments. These questions must be answered if a child is to be helped.

A successful system for evaluating work-inhibited students must accomplish two major objectives. First, educators must identify those students who do not engage in the work of school. Second, educators, working with parents and mental health professionals, must devise and implement a plan to ensure that each of these students is individually understood.

What Teachers Can Do

For work-inhibited students, sitting down and doing schoolwork is painful. It simply is the worst part of their life. They hate it. For many, this problem is of long standing and simple quick fixes are not in the cards. Teachers can, however, make a difference.

Work-inhibited students may be helped in a number of general ways. They benefit from positive relationships with their teachers; they achieve more with supportive help to complete tasks; they benefit when they are actively helped to become independent; and they benefit from opportunities to develop their individual strengths.

Build Nurturing Relationships

In order to grow toward independence, work-inhibited students need friendly, positive, and optimistic relationships with important adults, including teachers. It is reassuring and important to them to feel that their teacher is in their corner.

Most people tend to do better work, or at least enjoy it more, when they work with someone who likes them. Providing work-inhibited students with friendly hellos, greeting them each day with a smile, finding a way to extend unconditional positive regard nurtures a student's sense of well-being.

A teacher's friendliness may be positively disarming to these students. They usually have long histories of negative self-perceptions and do not expect their teachers to be truly interested in them. In response to their teachers' friendly "hello"—away from the classroom, where teachers are not obligated to take notice of them—the students feel a bit better about their teachers and about themselves. Such friendly, inviting greetings in themselves can improve attitudes toward school and pave the way for further positive dialogue.

There is probably no better way to convey interest and nurturance than through listening. Most teacher-student social exchanges are momentary—just a few words and a smile. But sometimes the opportunity presents itself to be with a student in a situation that has nothing to do with schoolwork. Exploit such opportunities to be attentive to remarks about the student's interests. The act of really listening is a tremendous compliment and a powerful tool in building a relationship.

Help Students Develop Stick-to-it-tiveness

Work-inhibited students need help in learning persistence—to stay on task, to withstand failure, and to forge ahead. They need to learn the skills of stick-to-it-tiveness more than academic skills.

Teachers may choose among a variety of strategies to assist the work-inhibited student to move slowly, incrementally, toward competence. Sometimes an entire class may have the same assignment—which a work-inhibited student may well be able to complete if it is broken down into small incremental steps. As the student completes each part, the teacher gives a pat on the back, a bit of encouragement—an emotional "pick-me-up"—to proceed on to the next step. The teacher tries to extend the student just a little bit.

This method is much like training to run faster. Runners set intervals during which they run hard and fast for a brief period, and then recover. Then they repeat the pattern. The goal is to run faster for short distances and then gradually extend the distance.

Varying the approach helps. Students like novelty. Surprise the child by insisting that only three questions be completed. Set up a challenge to work quickly. Use a timer and ask the student to beat the clock. Highlight or underline certain items and ask the student to finish only those that are so marked.

Maintain a careful record of assignments completed and graph the results. Student and teacher alike may be surprised and positively reinforced by viewing a graph that shows progress.

Do not let the work pile up. At the end of each period, go on to the next activity. If possible, collect any work, both complete and incomplete, and go on. Work-inhibited students easily feel overwhelmed and are unlikely to tackle a tableful of incomplete assignments. They do need to learn to tackle longer and longer assignments, but it is foolish to encourage work-inhibited students to climb a mountain when they are still unable to scale a hill.

Working incrementally means always taking it one day at a time. It means the teacher is pleased to see a work-inhibited student increase effort 100 percent when going from two minutes to four minutes, while most of the other students are able to work independently for half an hour. Bit by bit, focusing on successes, breaking assignments into smaller units, giving assignments that may be completed—this is the direction in which success lies.

Offer Helping Hands

Through positive regard and problem-solving conferences, a work-inhibited student's readiness for accepting help may improve. But a teacher with twenty-five students in a classroom can spend only a fraction of the day being next to and assisting any one individual. Therefore, it may be useful to recruit helpers to assist work-inhibited students. The classmates of work-inhibited students may be a rich resource. Pair classmates and encourage them to assist each other. Older work-inhibited students often welcome the opportunity to tutor younger children with similar weaknesses. It not only adds variety to their day but tutoring also helps them feel important. In high school, members of the National Honor Society, Key Club, or other service organizations may be ready and willing to give tutorial assistance. Each school is filled with helping hands.

Providing positive, effective feedback to students is a powerful tool but not necessarily easy to use. For praise to be effective, certain rules should be remembered.

Reward the action or product, not the person, with positive attention. Comment specifically about what it is the student has accomplished. Comments should not be exaggerated or insincere, but rather true and to the point. "Nineteen out of twenty correct! You really understand!" "Your use of shading in this painting gives the scene perspective and a sense of distance." "Your paragraph included three funny examples of what can happen on the first day of school." "Joe, your speech kept everyone's attention."

Sometimes positive reinforcement does not require words. Just a smile or a pat on the back may keep a student working. What is important is to notice what the student is doing or has accomplished.

Teachers are not the only ones who may give positive reinforcement. Everyone in the class might do it! Encourage classmates to support each other by modeling positive communication. The goal is to create a climate of encouragement.

Empower the Child

Work-inhibited students need all the help they can get in order to bolster their weak egos. These students benefit from opportunities to develop their individual strengths—to feel empowered. Encourage work-inhibited students to participate in extracurricular activities and provide them with opportunities for leadership (safety patrols, office helper).

Another important facet of feeling empowered relates to decision making. In high school, students have opportunities to make important decisions as to what courses they will take and what career paths they may embark on. At all levels, it is important to empower students to make decisions regarding daily activities, including how to accomplish tasks and what is to be studied. Being asked "What do you think?" or "What do you want to do first?" imparts a sense of importance to students and fuels feelings of control and independence. The goal is to promote autonomy so that students may stand on their own and feel a sense of adequacy.

Practices To Avoid

Our schools should not be reluctant to change those practices that are not in the best interests of students. If students are able to demonstrate their acquisition of knowledge and skills without certain homework assignments—give up those assignments. Requiring a child to repeat a grade for failure to complete assignments, punishing children by keeping them in for recess or by denying them access to extracurricular activities are not likely to promote the growth of their interests or their sense of well-being in their school.

In communicating to parents, provide clear descriptions of the student's strengths and weaknesses. Parents need to know that their children have allies in the school. Don't blame. Rather, be objective about the instructional setting and the requirements for success. Parents need to know that school work is not their responsibility. Parents can set the stage by providing a place and establishing a schedule for homework; but they should tell their children that the contract for doing school work is between students and teachers; and then nurture, love, and encourage. □

The Vocabulary Conundrum

(Continued from page 18)

abstract nouns, which allows stating a predicate without specifying the arguments. For example, the glossary in a widely used basal reader defines *habits* as "usual behavior" rather than "what a person or animal usually does." Although the abstract wording saves space, it diminishes the instructional value of definitions. The conventions for writing definitions are likely to be unfathomable to many younger and less-able learners, the very ones most in need of help with word meanings.

A further complexity is that many words have multiple meanings. Words may have wholly distinct senses, as do a couple of examples already cited, *bear* and *bank,* or they may have slightly different senses that overlap in meaning. An example of the latter type is *give.* According to Webster's New Third International Dictionary, the primary meaning of *give* is "to confer ownership of something without receiving a return." This definition works just fine with *Mary gave John a present,* but already there is a problem with *Mary gave John $10 and he gave her $2.57 change.* The definition does not cope with the fact that "receiving a return" of goods or services, as well as a return of change, is expected in this context. The problem is even more acute in *Mary gave John a kiss. Give* seems to be used here in a perfectly ordinary way, but does one really want to mean that Mary "conferred ownership" of a kiss? The manifold complexity of the meaning of *give* does not end here. Compare its use in *Mary gave John permission* and *Mary gave John a shove.* If the meaning of *give* were exactly the same in these uses, you could substitute the same synonym in each sentence and preserve the meaning. However, you can say *grant John permission,* but it would be weird to say *grant John a shove.* Whatever this may mean, it does not mean to give him a shove, at least not in the same sense of *give.*

Give is a typical, not an exceptional, word. Most words in ordinary use have multiple shades of meaning depending upon the context. Large dictionaries try to accommodate multiple meanings by having a different subentry for each distinguishable sense of a word. In one of its two main entries for *give,* Webster's starts with "to confer ownership . . ." and follows with no fewer than fifty-five subentries in fourteen major groupings, as well as a number of idioms. An entry in a large dictionary can be an impenetrable thicket for the less-able student. School dictionaries and glossaries try to accommodate multiple meanings through simplification, we dare say oversimplification, presenting one or a few senses of words with multiple meanings. Now the student's mystery can be how to fit an over-general definition with an actual encounter with a word, how to understand, for instance, what it could mean "to confer ownership" of a kiss.

IT IS IMPORTANT to distinguish unfamiliar words that are new labels for already-known concepts from unfamiliar words that represent new concepts. The former often *can* be learned from simply reading definitions. For example, it seems likely that most students in the middle grades and beyond would be able to grasp the meaning of *tow* from the definition "to pull something behind you." However, as soon as a word meaning contains any

Fifth graders were given definitions from widely used school dictionaries and asked to use the words in sentences. An astonishing 82 percent of the sentences were unacceptable.

subtle conceptual content, it becomes increasingly problematical that a student will get the meaning from simply reading a definition, as students' mistakes with words such as *meticulous* and *correlate* illustrate.

Often you need to understand a whole network of concepts to grasp the meaning of a word. An example from ordinary life is the word *cousin.* A child has to know a lot about kinship relations in order to truly appreciate what a cousin is. The same is true of most technical vocabulary. For example, to learn anything from the definition of a *standard deviation* as "the square root of the arithmetic average of the squares of the deviations from the mean in a frequency distribution," you must possess some other knowledge about statistics.

Have we overstated the problems with definitions? Some teachers may think so, but consider the possibility that they may have skewed information about how well definitions are working. The words that are included in exercises on how to use the dictionary are set up to be easy. For instance, the words may be ones that students already know. A student can seem quite erudite explaining the definition of a known word. Multiple-choice tests presenting definitions students have memorized may not reveal misunderstandings. Thus, we feel that some teachers may have been lulled into false optimism about the efficacy of definitions.

So, what should be done? First of all, school dictionaries and glossaries should be improved. There is just no excuse for a dictionary for children to define *furious* as "full of fury or wild rage" when it could say "very, very angry." Research shows that careful rewriting of definitions does enhance student understanding. In one study, fifth graders were given definitions from widely used school dictionaries and asked to use the words in sentences. An astonishing 82 percent of the sentences were unacceptable. Then, the definitions were painstakingly rewritten and given to another group of fifth graders. The rate of unacceptable sentences went down to 50 percent. While this is an improvement well worth the trouble, notice that students were still confused half of the time.

Second, we must do a better job of teaching students how to use the dictionary. The typical program does a satisfactory job explaining guide words and helping students locate words in the dictionary. But once a word is located, instruction peters out and the student is on her own in figuring out the definition. Instruction has to go deeper if we want students to be able to choose among multiple meanings or understand words that entail new concepts.

Third, we must honor the dictum that a dictionary is a reference work. It is meant to be used by a reader to help with unknown words in an otherwise meaningful text or by a writer who knows full well what she is trying to say. For these purposes, a good dictionary is a valuable tool. But, a dictionary is not designed to be a stand-alone source of meanings for words that are isolated from a comprehensible context, and it serves this purpose poorly. Therefore, we must abandon the belief in contextless vocabulary-building programs in which students try to memorize the definitions of lists of unrelated words.

UP TO THIS POINT, we have summarized evidence that word-list drill is a dubious means for promoting vocabulary growth and that, in any event, growth in knowledge of word meanings is too rapid for direct vocabulary-building programs to be making much of a contribution. The best available estimate is that children learn two thousand or three thousand new words a year throughout the school years, or perhaps even as many as four thousand to six thousand if proper words, multiple meanings, and idioms are included. Yet, research suggests that in the typical classroom direct instruction is provided on only about three hundred words during the course of a school year, and of these perhaps two hundred are learned well enough for students to check correct answers on a multiple-choice test.

For a long time, the strongest reason for believing that most vocabulary is picked up while reading was a "default argument." That is, if children are learning several thousand words a year, and they are only learning a few hundred from any sort of explicit vocabulary instruction, where else could they be learning all these words?

Strictly speaking, it would be very difficult to prove that most vocabulary growth came naturally through

reading, since it is next to impossible to assess how many words children learn from the oral language. However, there is evidence that a substantial amount of children's vocabulary growth probably comes through reading.

In a series of studies on natural learning of word meanings, we have proved that children of all ages and ability levels do learn new words as the simple, incidental byproduct of reading. We have ascertained that the overall probability that a student will learn a previously unfamiliar word while reading is about one in twenty. This figure is averaged over a number of different kinds of texts. The probability of learning an unfamiliar word from a narrative text matched to the reader's level of comprehension is perhaps twice as high. Conversely, when the text is a difficult exposition, the likelihood of learning an unfamiliar word is close to zero.

How easily a new word is learned from context is, in part, a function of its conceptual difficulty. That is, it is easier to learn a word like *apologize* from context (assuming that you already understand the concept of saying you are sorry), than it is to learn a word like *mitosis* (assuming that when you try to learn this word, you do not already have a grasp of the process of cell division). How easily a new word is learned from context also depends on the informativeness of the context and the number of times the word is encountered. Our one-in-twenty figure holds for a single encounter; the likelihood of learning a word increases as it is seen more often.

To be sure, the chance of learning any particular word while reading is much lower than the chance of learning the same word through direct vocabulary instruction. Thus, if the goal is to help a student learn the meaning of some particular word, waiting for the student to encounter it while reading, hoping that this will be the one word in twenty actually learned, would be a long shot.

However, the apparently low rate of natural word learning must be viewed in terms of its cumulative effects given even modest amounts of daily reading. It has been estimated that if all categories of reading are included, the median fifth grader spends somewhere around twenty-five minutes a day actually reading. This number is certainly lower than would be desired, but it translates into about a million words of text covered in a year. Assuming that at least 2 percent of the words this fifth grader reads are unfamiliar (a conservative assumption), that amounts to twenty thousand new words. If one in twenty of these is learned, we have accounted for at least a thousand words a year, a sizable fraction of the average child's annual vocabulary growth. An avid reader might spend an hour or two a day reading, and thus cover four or more times as much text. The rate of learning from context for self-selected text is likely to be closer to one unfamiliar word in ten than one in twenty. For children who do a fair amount of independent reading, then, natural learning could easily lead to the acquisition of five to ten thousand words a year, and thus account for the bulk of their annual vocabulary growth.

Even smaller amounts of reading can provide valuable encounters with unfamiliar words. Research has shown that children who read ten minutes a day outside of school experience substantially higher rates of vocabulary growth between second and fifth grades than children who do little or no reading.

Our conclusion is that the best way to foster vocabulary growth is to promote wide reading.

ARE WE ABOUT to reach the conclusion that all vocabulary instruction is fruitless, or even harmful? No, we are not. But, we do urge a shift in perspective, away from a preoccupation with the number of words that you force students to cover. We believe that the goal of instruction should be to develop what one lexiphile has termed *word consciousness.* Encounters with words should be playful, so as to provoke curiosity and an interest in word study. Figuring out an unknown word should be treated as an exercise in problem solving, so as to promote independence in word analysis.

Word consciousness is a concept that includes understanding how the parts of words contribute to their meanings. Even the youngest students understand the function of *-s* and *-ed.* A functional understanding of derivational suffixes such as *-tion* and *-ly* develops later. By the time they have reached the fourth or fifth grade, good readers are aggressive in using the information in word parts to try to figure out words while they are reading. The knowledge and the disposition to use word parts

is slower to develop among less-able readers, and no doubt skillful instruction could help speed development. What we have in mind are lessons in which children explore the relationships in families such as *act, react, action, reaction, actor, actress, active, inactive, radioactive,* and *hyperactive.*

Vocabulary instruction that aims to develop a deep understanding and appreciation for words must seize teachable moments. Try to reconstruct what went through your mind when you encountered the word *lexiphile* in the first paragraph in this section. Many readers, if they are honest, probably stumbled momentarily and then read on without ever clearly formulating a meaning for the term. Anyone who looked for the word in a dictionary was frustrated, because it is a word we made up. Readers who are disposed to treat an unknown word as an interesting puzzle may have paused to notice that *-phile* is a part of *Francophile,* which they know means a person fond of things French, or *bibliophile,* a book lover. These readers may also have noticed that *lexi-* appears in *lexicon* and *lexicographer* and must have something to do with words. With a little help from the context, they may thereby discover that *lexiphile* probably means a person fascinated by words.

So, to heighten word consciousness, be on the lookout for interesting, complex words in the books your students are reading. Occasionally challenge them to formulate hypotheses about the meanings of these words from what they know of the parts and what they can infer from the context. We invented *lexiphile* to challenge adults. An example of a word that may be at the right level of challenge for the middle-grade student is *geographer.* Literally rendered, *geographer* means "a person who draws the earth" or map maker. For a younger student, *Thanksgiving* may provoke insight; many young children have failed to notice that *Thanksgiving* has anything to do with giving thanks.

Word parts seldom completely determine the meanings of words. Seeing the *radio* in *radioactive* helps a lot with pronunciation, but is likely to mislead about meaning, conjuring up images of boom boxes operating at full blast, unless one remembers the less obvious relationships of *radio, radiate,* and *radiation.* The key to using word parts successfully is flexibility, and always taking care to triangulate information from word parts with the context and what you already know about the topic. You need to respect hypotheses offered by students that are inventive if not entirely accurate, but keep bringing them back to the main issue: Does this interpretation of the word make sense in this context based on everything you know?

Another important facet of word consciousness is sensitivity to nuance of meaning. The student who reads that a character swaggers into a room, and gets only that he came into the room, is missing a lot. Students can learn much about nuance of meaning from examining and attempting to express the differences in meaning among related words. For instance, consider *see, look, glance,* and *glimpse.* What distinction does *look* convey that is not conveyed by *see*? One answer is that looking is a deliberate act of seeing. Now, compare *see* and *glimpse.* The difference is that to glimpse is to see for a short time. Next, compare *glance* with the other three words. It falls neatly into place, sharing the feature of deliberateness with *look* and the feature of shortness with *glimpse.* At this point, depending upon the age and sophistication of your students, you can enrich the discussion by considering other verbs of visual perception such as *examine, stare, ogle,* and *gawk.*

HOW SHOULD the technical vocabulary of the sciences and the social sciences be approached? When reading gets difficult, unfamiliar words are the first obstacle to comprehension mentioned by most students and many teachers. But the problem is not so much one of unfamiliar words as it is of unfamiliar concepts. Thus, to be successful, teaching must honor the primacy of concepts. Students must be helped to construct complex, unfamiliar concepts from simpler concepts they already know. The teacher's and the book's explanations must be clear and complete. Because concepts come in clusters, or interacting systems, the interrelationships need to be illuminated with analogies, diagrams, or physical models. The teacher needs to be alert for gaps in understanding and the possibility that a student may concoct a totally different theory to link concepts together. Every topic should be approached in a spirit of inquiry. Skillful teachers will arrange for students to make at least some small discoveries on their own. When a domain is at all complex, covering it once will not be enough. Students need to criss-cross the domain again and again, until they can explain concepts in their own words, solve fresh problems, and apply principles to new situations.

Whereas concepts are primary, the surface form of words is one source of difficulty for the novice. A long, unfamiliar word can be difficult to pronounce, hard to remember, and may seem to have an arbitrary association with the concept it represents. Although technical vocabulary may seem strange at first, the truth is that most technical terms wear their meanings on their sleeves. Most have Greek or Latin roots. When students learn this principle and master even a small number of specific roots, technical terms can actually become aids to learning and memory. Consider *photosynthesis.* It consists of *photo,* meaning "light" (not "picture of me in the yearbook") and *synthesis,* which means "a putting together." Thus, photosynthesis is a process that involves putting things together using light. Occasionally pausing to reflect about the meanings of technical terms will help to make them the friends, rather than the enemies, of comprehension. In general, we endorse approaching technical terms in the same reasoned, logical spirit that ought to pervade all subject matter instruction.

Our conclusion is that the best way to foster vocabulary growth is to promote wide reading. Time spent in reading will lead to gains in fluency, in knowledge, in familiarity with written language, and in appreciation of literary genres, as well as vocabulary growth. A comparable amount of time spent in a traditional vocabulary-building program, whatever word knowledge it produces, has none of these benefits. In place of vocabulary-building programs, we advocate vocabulary instruction that promotes word consciousness, a sense of curiosity about word meanings, appreciation of nuances of meaning, and independence in word analysis. □

1] power 2] trace 3] good 4] incidental

THINKING MATHEMATICS

(Continued from page 11)

teachers who carefully hone each lesson to perfection, they call this their "polishing time."

Rhode Island provides another promising model. There, the Rhode Island Federation of Teachers has brought a Thinking Math team to the state to work with teachers from several districts. As the local teachers wrestle with their own initial implementation of the program, they will be able to meet monthly throughout the year, which will provide a level of mutual support for the teacher leaders that had not been possible for other teams.

THESE STORIES illustrate the kind of commitment that Thinking Math requires. The program asks teachers to rethink their most basic beliefs and assumptions about teaching and learning mathematics. Such radical change cannot be brought about by one-shot "professional development" workshops or by plopping manuals into teachers' laps. There is no substitute for the collegial and research-based process that permeates the ER&D training; it provides a forum and support network for solving the problems that arise when teachers make substantive changes. To get past the inevitable bumps in the road that accompany change, there also needs to be a non-threatening atmosphere, sufficient training that continues after the initial training is done, and opportunities for regular interaction with colleagues.

Some teachers who are trained in Thinking Math have been troubled when they do not return home with a set of discrete and sequenced activities. But they come to realize that the program requires that they reconstruct their teaching, using their local curriculum, from their new knowledge and beliefs. More than 90 percent have been able not only to make this adjustment for themselves but also to successfully inspire, train, and pass on their ability to their peers.

Reforming the way mathematics is taught would be accomplishment enough for the program. But its effects are more sweeping. Thinking Math has convinced those intimately involved with it that the best route to genuine education reform is through a new look at content. When teachers passionately believe that new approaches are necessary and productive in their daily teaching (of math, in this case), they begin to see that changes must be made in the entire structure of schools to accommodate and support those new approaches. They begin to rethink how the school day should be organized; they come head to head with standard assessment practices and realize they need overhauling; they redesign staff development and consider new ways of organizing school staff. Whatever stands in their way gets close scrutiny, and what starts as Thinking Math often adds up to much more. □

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