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Contact: Jess Cook
Phone: 310-451-6913
Fax: 310-451-6988
E-Mail: Jess_Cook@rand.org

RAND
1700 Main Street
P. O. Box 2138
Santa Monica, CA 90407-2138
http://www.rand.org

1200 South Hayes Street
Arlington, Virginia 22202-5050
703-413-1100

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RISING MATH SCORES SUGGEST EDUCATION REFORMS ARE WORKING
STATE ACHIEVEMENT DIFFERENCES TIED TO SPENDING, POLICIES
TEXAS FIRST, CALIFORNIA LAST IN TEST SCORES OF SIMILAR STUDENTS

WASHINGTON, D.C., July 25 — The education reforms of the 1980s and 1990s seem to be working, according to a new RAND report, but some states are doing far better than others in making achievement gains and in elevating their students' performance compared with students of similar racial and socioeconomic background in other states. Texas and Indiana are high performers on both these counts.

The study is based on an analysis of National Assessment of Educational Progress (NAEP) tests given between 1990 and 1996. The authors rank the 44 participating states by raw achievement scores, by scores that compare students from similar families, and by score improvements. They also analyze which policies and programs account for the substantial differences in achievement across states that can't be explained by demographics. Here are the key findings:

- Math scores are rising across the country at a national average rate of about one percentile point per year, a pace outstripping that of the previous two decades and suggesting that public education reforms are taking hold. Progress is far from uniform, however. One group of states – led by North Carolina and Texas and including Michigan, Indiana and Maryland – boasts gains about twice as great as the national average. Another group – including Wyoming, Georgia, Delaware and Utah – shows minuscule gains or none at all. Most states fall in between.
- Even more dramatic contrasts emerge in the study's pathbreaking, cross-state comparison of achievement by students from similar families. Texas heads the class in this ranking with California dead last. Wisconsin, Montana, Iowa, Maine, North Dakota,

Indiana and New Jersey cluster closely behind Texas. Louisiana, Mississippi, West Virginia, Alabama and Rhode Island perform almost as dismally as California.

- Although the two states are close demographic cousins, Texas students, on average, scored 11 percentile points higher on NAEP math and reading tests than their California counterparts. In fact, the Texans performed well with respect to most states. On the 4th-grade NAEP math tests in 1996, Texas non-Hispanic white students and black students ranked first compared to their counterparts in other states, while Hispanic students ranked fifth. On the same test, California non-Hispanic white students ranked third from the bottom, black students last, and Hispanic students fourth from the bottom among states.
- Differences in state scores for students with similar families can be explained, in part, by per pupil expenditures and how these funds are allocated. States at the top of the heap generally have lower pupil-teacher ratios in lower grades, higher participation in public prekindergarten programs and a higher percentage of teachers who are satisfied with the resources they are provided for teaching. These three factors account for about two-thirds of the Texas-California differential. Teacher turnover also has a statistically significant effect on achievement. (California is now implementing class-size reduction and other reforms but these steps began after the 1996 NAEP tests.)
- Having a higher percentage of teachers with master's degrees and extensive teaching experience appears to have comparatively little effect on student achievement across states. Higher salaries also showed little effect, possibly reflecting the inefficiency of the current compensation system in which pay raises reward both high- and low-quality teachers. However, the report points out that salary differences may have more important achievement effects within states than between states. Also, they may have greater impact during periods when teachers are in shorter supply than during the 1990–1996 measurement period.
- To raise achievement scores, the most efficient and effective use of education dollars is to target states with higher proportions of minority and disadvantaged students with funding for lower pupil-teacher ratios, more widespread prekindergarten efforts, and more adequate teaching resources. As for teacher salaries and education, the report adds, "efforts to increase the quality of teachers in the long run are important, but ... significant productivity gains can be obtained with the current teaching force if their working conditions are improved."

- The most plausible explanation for the remarkable rate of math gains by North Carolina and Texas is the integrated set of policies involving standards, assessment and accountability that both states implemented in the late 1980s and early 1990s.

The RAND study, led by David Grissmer, is based on NAEP tests given in 1990, 1992, 1994 and 1996 to representative samples of 2,500 students from the 44 voluntarily participating states. Five tests were given in mathematics and two in reading at either the 4th- or 8th-grade level. Not all of the states took all of the tests. And there were too few reading tests to permit a separate analysis of those results. Taken together, however, the tests provided the first set of data permitting statistically valid achievement comparisons across states. The researchers used data from the census and from the National Educational Longitudinal Survey to establish the student samples' family characteristics.

The 1998 NAEP reading and math scores became available too late to be incorporated in this analysis. "We're examining those data now, however, and we find that the state rankings change little and our findings about which policies make the most difference aren't affected at all," Grissmer declares.

"Our results certainly challenge the traditional view of public education as 'unreformable'," he concludes. "But the achievement of disadvantaged students is still substantially affected by inadequate resources. Stronger federal compensatory programs are required to address this inequity."

Grissmer's coauthors include Ann Flanagan, Jennifer Kawata and Stephanie Williamson. *Improving Student Achievement: What NAEP Test Scores Tell Us* was supported by the ExxonMobil Foundation, the Danforth Foundation, the NAEP Secondary Analysis Program, the Center for Research on Educational Diversity and Excellence and by RAND.

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RAND

Press Briefing

Improving Student Achievement:
What State NAEP Scores Tell Us

9 a.m. Tuesday July 25, 2000

National Press Club
Murrow Room
529 14th Street NW, Washington, DC

Education reform and student achievement are hot political topics in virtually every state as well as in the presidential campaign. A new RAND study examines evidence from student scores on National Assessment of Educational Progress (NAEP) tests to compare performance across 44 participating states. The report ranks the states by raw achievement scores, by score improvements and by scores that compare the performance of students in one state to students of similar racial and socioeconomic background in other states. It also discusses the factors that have the greatest effect on student achievement, identifies some of the state policies and programs that do or don't make a difference, and analyzes which approaches offer the biggest achievement gain for the education buck. Finally, the study builds on these specific findings to reach some broad conclusions about trends in American public education.

Author David Grissmer will discuss the study's findings and respond to questions.

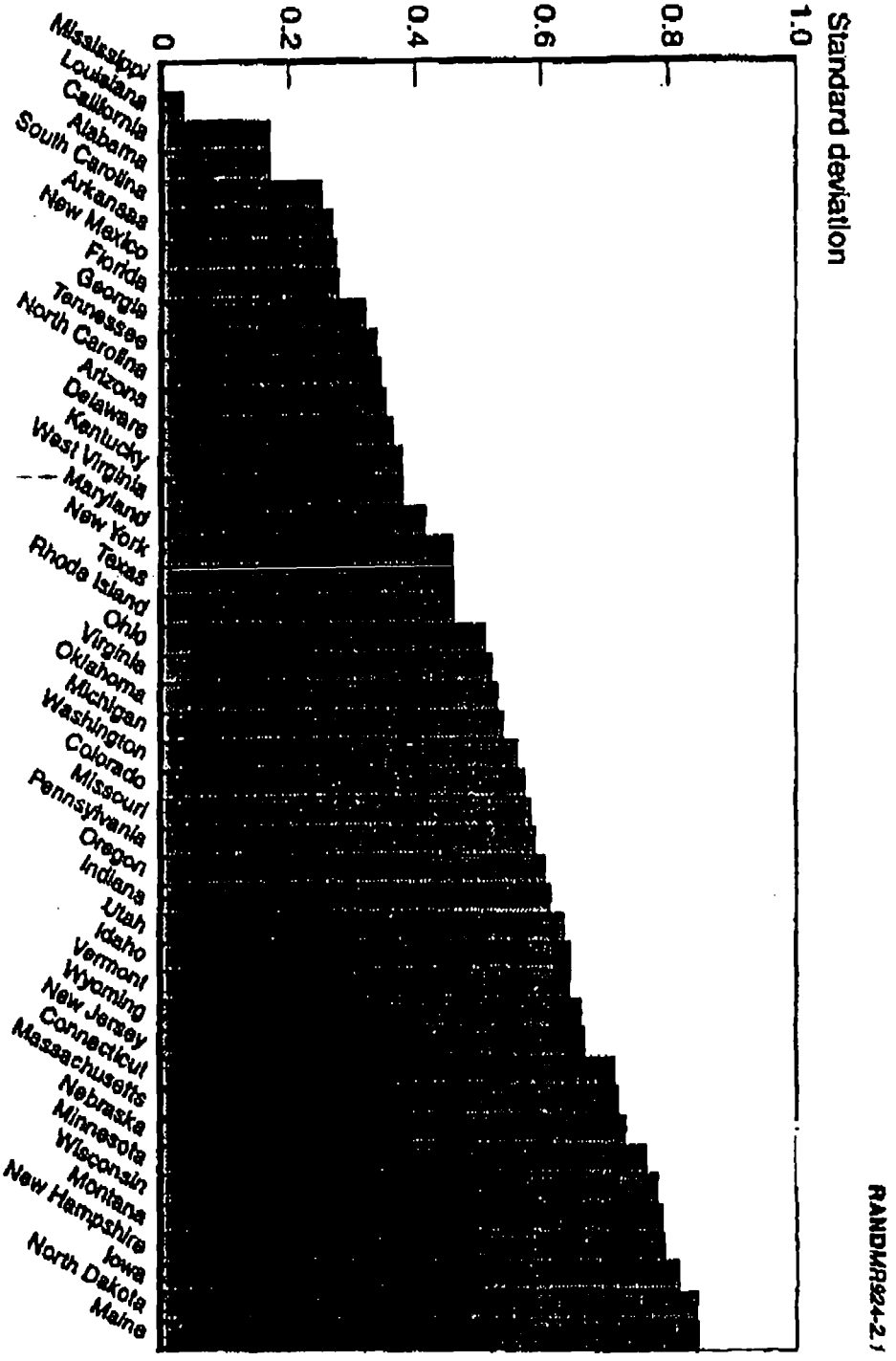


Figure 2.1—Average State NAEP Scores Across Seven Tests

Table 5.4

The Range, Mean, and Statistical Significance of Estimated Annual Score Gains, Math Tests Only

				Significance level				
				Random Effect			Fixed Effect	
	Range		Average	SES	SES-FE	C-N	SES	SES-FE
North Carolina	0.070	0.073	0.072	1	1	1	1	1
Texas	0.056	0.062	0.059	1	1	1	1	1
Michigan	0.057	0.060	0.058	1	1	1	1	1
Indiana	0.048	0.050	0.049	1	1	1	1	1
Maryland	0.046	0.052	0.048	1	1	1	1	1
West Virginia	0.041	0.044	0.043	1	1	1	1	1
Kentucky	0.038	0.042	0.040	1	1	1	1	1
Rhode Island	0.037	0.043	0.040	1	1	1	1	1
Minnesota	0.040	0.041	0.040	1	1	1	1	1
Colorado	0.039	0.040	0.040	1	1	1	1	1
Connecticut	0.038	0.042	0.040	1	1	1	1	1
Florida	0.038	0.040	0.039	1	1	1	1	1
New Jersey	0.034	0.044	0.038	5		5		5
California	0.037	0.040	0.038	1	1	1	1	1
Wisconsin	0.036	0.038	0.037	1	1	1	1	1
New York	0.036	0.038	0.037	1	1	1	1	1
South Carolina	0.031	0.038	0.034	1	5	1	5	1
Tennessee	0.090	0.098	0.093	5	5	5	5	1
Nebraska	0.031	0.036	0.033	1	5	1	5	1
Arizona	0.032	0.035	0.033	1	1	1	1	1
Arkansas	0.028	0.036	0.032	5	5	5	5	5
Louisiana	0.031	0.032	0.031	1	1	1	1	1
Alabama	0.029	0.032	0.031	1	1	1	5	1
New Mexico	0.026	0.032	0.029	1	5	1	5	5
Mississippi	0.025	0.029	0.027	5	10	5	10	5
Virginia	0.025	0.029	0.026	5	5	5	5	1
Pennsylvania	0.022	0.026	0.024					
Massachusetts	0.022	0.027	0.023	10		10		5
Iowa	0.021	0.024	0.022	5	10	5	10	10
Missouri	0.018	0.023	0.021	10		10		10
Maine	0.014	0.024	0.020	10		10		10
North Dakota	0.017	0.021	0.018	10		10		10
Utah	0.016	0.021	0.018					
Delaware	0.015	0.019	0.016					10
Georgia	0.009	0.016	0.012					
Wyoming	−0.008	−0.004	−0.006					

Table 6.1

Estimates of Score Differences for Students from Similar Families

	Range		Average	Significance Level				
				Random Effect			Fixed Effect	
				SES	SES-FE	C-N	SES	SES-FE
Texas	0.088	0.212	0.166	1	1	1		
Wisconsin	0.105	0.169	0.142	1	1	1	1	1
Montana	0.095	0.158	0.122	1	1	5	1	1
Iowa	0.071	0.151	0.113	1	1	5	5	1
Maine	0.060	0.143	0.099	10	5	10	5	5
North Dakota	0.037	0.124	0.081	10		5	10	10
Indiana	0.055	0.084	0.074	5	1	10	10	5
New Jersey	0.037	0.079	0.061	10	1		10	5
Nebraska	0.037	0.085	0.056	10			10	10
Missouri	0.044	0.065	0.055	5	5			
Connecticut	0.024	0.091	0.052		10			5
Oklahoma	0.018	0.055	0.040	10				
Georgia	-0.041	0.085	0.039	10	1	5		
Virginia	0.020	0.060	0.037		10	5		
Wyoming	-0.001	0.064	0.034					
Minnesota	-0.003	0.080	0.031					
Massachusetts	-0.013	0.047	0.020					
Michigan	0.000	0.025	0.014					
Pennsylvania	-0.023	0.020	0.005					
Arizona	-0.053	0.039	0.003					
New Hampshire	-0.035	0.033	-0.001					
Colorado	-0.018	0.015	-0.006					
North Carolina	-0.079	0.041	-0.010					
Washington	-0.027	0.008	-0.014					
Idaho	-0.035	0.012	-0.015					
Ohio	-0.031	-0.004	-0.016					
New Mexico	-0.095	0.039	-0.019					10
South Carolina	-0.133	0.033	-0.026					10
Florida	-0.091	0.002	-0.034					10
Oregon	-0.057	-0.018	-0.038					
New York	-0.080	0.005	-0.038					5
Maryland	-0.074	-0.026	-0.055				5	5
Delaware	-0.095	-0.037	-0.064	10			10	5
Utah	-0.115	-0.021	-0.074	1	1	1		
Tennessee	-0.135	-0.043	-0.077	10	10		10	1
Kentucky	-0.129	-0.063	-0.086		5	10	5	1
Arkansas	-0.162	-0.039	-0.087		10	5		1
Vermont	-0.121	-0.085	-0.106	1	1	5		
Rhode Island	-0.131	-0.084	-0.117	1	1	5	1	5
Alabama	-0.229	-0.075	-0.133	5	1	5	5	1
West Virginia	-0.167	-0.108	-0.135	1	1	1	5	1
Mississippi	-0.319	0.006	-0.137		5		10	1
Louisiana	-0.289	-0.069	-0.156	10	1	5	5	1
California	-0.298	-0.117	-0.174	1	1	1	1	1

Table 6.2

Comparison of California and Texas Family Characteristics

	California	Texas
Parents college educated (%)	24.6	22.6
Family income ($000)	40.2	32.3
Black (%)	7.5	12.1
Hispanic (%)	37.5	34.5
Teen births (%)	11.0	15.0
Single mother (%)	19.0	19.0
Residential stability	54.0	55.0
SES predicted score	-0.06	-0.14
SES-FE predicted score	-0.04	-0.10

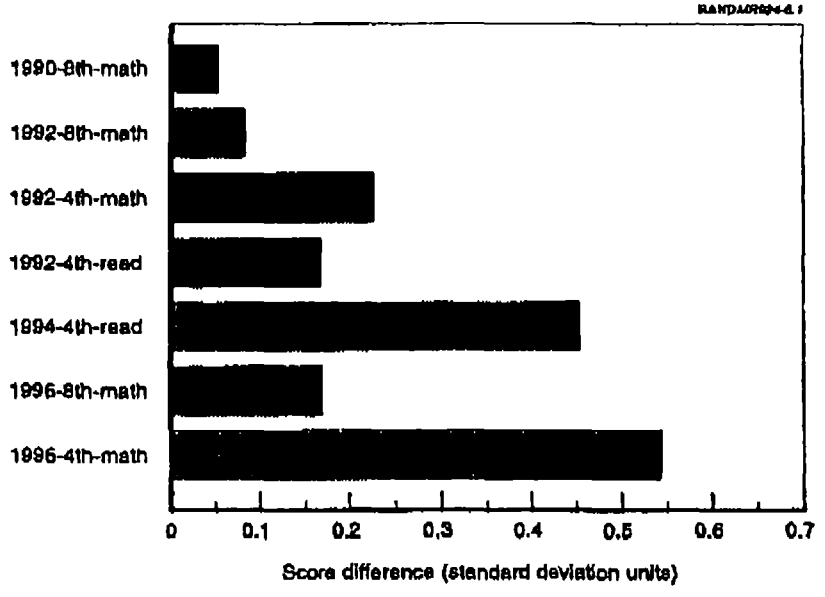


Figure 6.1—Raw Score Differences Between Texas and California Non-Hispanic White Students on Seven NAEP Tests

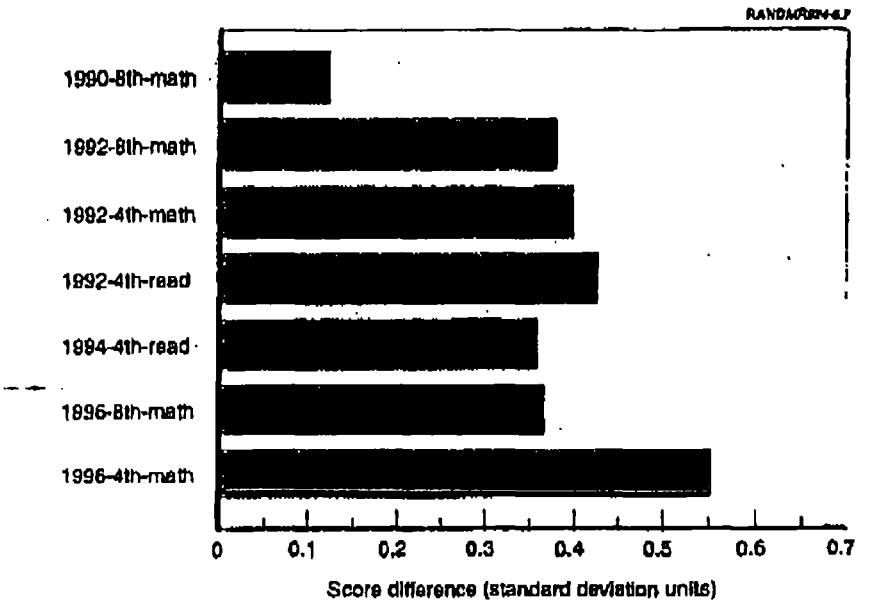


Figure 6.2—Raw Score Differences Between Texas and California Black Students on Seven NAEP Tests

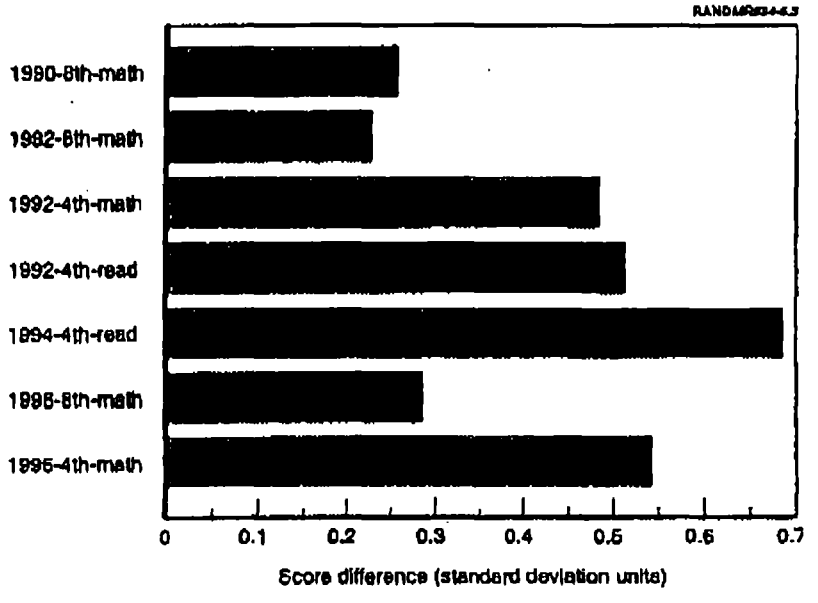


Figure 6.3—Raw Score Differences Between Texas and California Hispanic Students on Seven NAEP Tests

Interpreting State Performance in the RAND Report

The report, *Improving Student Achievement: What State NAEP Scores Tell Us*, contains three performance measures for the states that are included in the sample. The first is the ranking by the average *raw* achievement scores across the seven tests given from 1990 to 1996. This ranking averaged across all seven tests is shown in Figure 2.1 on page 14. Appendix A (Figures A.1 to A.7) shows the ranking for each of the seven tests separately.

The ranking of a state on this measure of raw scores is primarily influenced by the student's family characteristics. States that rank high usually have a combination of higher levels of parent education, higher family income, lower teen births, lower mobility, and smaller proportion of minority students. Appendix A (Figures A.8 to A.15) has the rankings by state of these family measures. For instance, Maine, North Dakota, Iowa, and New Hampshire have the highest raw scores, and also have among the lowest minority populations, above-average college parental education levels, and below-average proportions of parents without a high school diploma, medium-to-above average family income (except North Dakota), low teen births, low single-parent families, and low mobility.

Raw scores are an important measure for states, because they will determine college and labor market opportunities. However, since family characteristics is such a dominant factor in determining this measure, it is not a good measure of the quality of school systems.

The second measure we provide is the ranking of states by our estimates of the scores that students from similar families have across states. This measure eliminates the influence of family characteristics and is a measure of the influence of factors outside families on test scores. Presumably the most important non family factor is the quality of schools.

Table 6.1 gives the estimates of scores for students from similar families across states. The score difference between Texas (the highest rank) and California (the lowest rank) is about 11 percentile points. That is, students from similar families would score about 11 percentile points higher in Texas schools than California

schools. There are three groups of states that can be statistically distinguished. The top 10–12 states show statistically distinguishable higher scores than the middle group of states, and the bottom 10–12 show statistically distinguishable lower scores than the middle group. Differences in ranking of 6–8 positions are unimportant. States ranked high on this measure are more likely to have school systems that influence achievement.

The third measure is whether states are showing improvement in scores from 1990 to 1996. That measure is given for all seven tests in Table 5.3 and for math tests only in Table 5.4. Not all the states in the previous two measures are listed in these tables because we needed to have states participate in six or seven tests to measure a trend. Most states show statistically significant math gains with an average of one percentile point a year, but some states are making two percentile point a year gains while others are making little or no gain. This measure primarily picks up the effect of educational reform measures from 1985 to 1993–4. States ranked high would more likely have effective reform measures. However, it is important to realize that the effects of many reform efforts will take years before effects are expected to show up. So it may be too early to make judgments about state reforms.

The ideal situation for a state would be to have high rankings on all three measures, but no state is among the top states on all three measures. However, several states have above-average to high rankings on all three measures. These states include (in no particular order) Wisconsin, Minnesota, Maine, Connecticut, New Jersey, Indiana, and Nebraska.

Many states have high rankings on two measures, and there tends to be a pattern in this. States with high raw scores and high scores for similar students often have lower improvement trends. It may be harder to improve scores of states that already have high raw scores and high scores for students from similar families. These states with high scores but little improvement from 1990 to 1996 include Maine, North Dakota, Iowa, and Montana. The other pattern is for states to have high scores for students from similar families and high improvement, but lower raw

scores. Texas has among the highest improvement and scores for students from similar families, but because of their high minority population have lower raw scores.

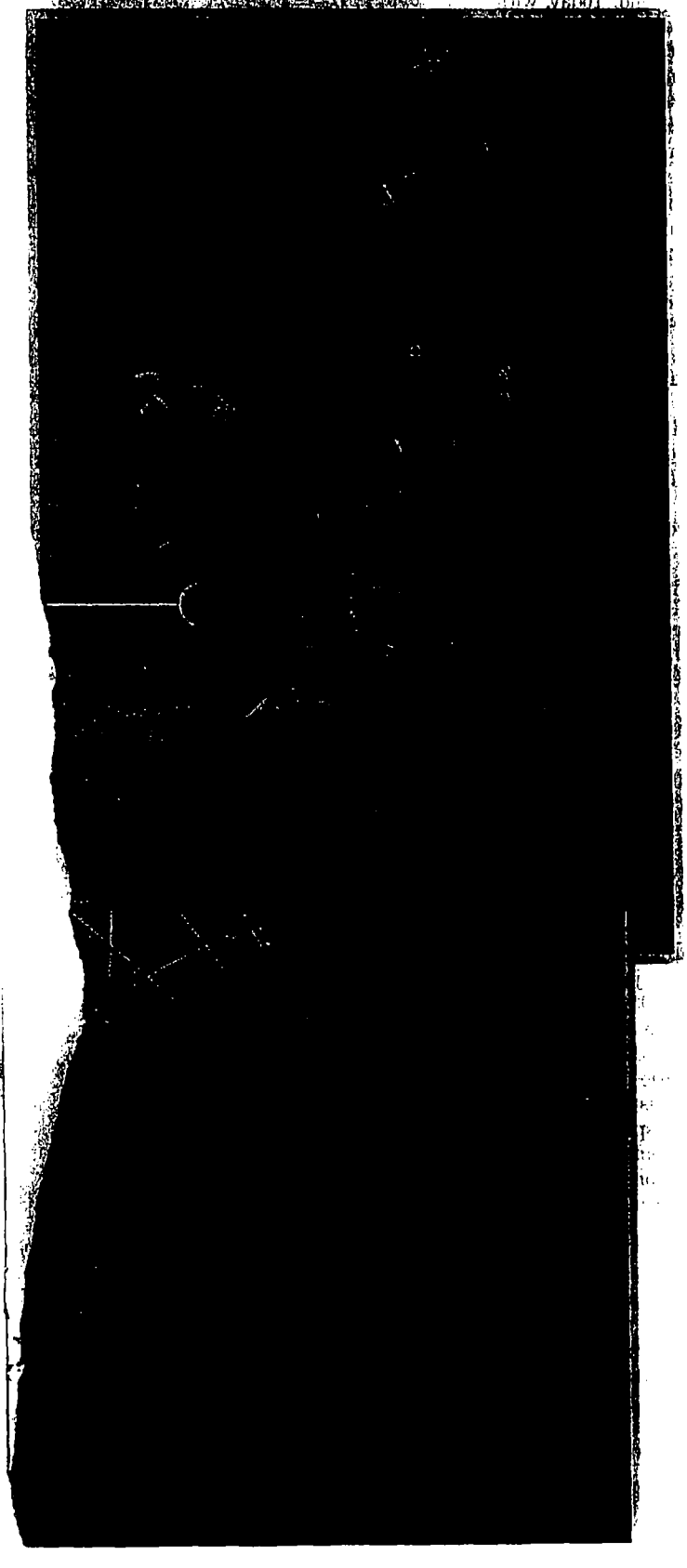
Some states have low raw scores and low scores for students from similar families, but show significant improvement. These states include North Carolina, Kentucky, West Virginia, Maryland, Rhode Island, Florida, and California. Utah has relatively high raw scores, but low scores for similar students and low improvement.

In interpreting why a state is high or low on the three measures, it is important to understand what the analysis identifies as the factors influential on each measure. High raw scores reflect mainly positive family characteristics. High scores for students from similar families can reflect the level and allocation of educational resources in the state, as well as reform efforts. The measure of improvement seems to reflect mainly educational reform efforts.

The measure of scores for students from similar families reflect the level of per-pupil spending and how it is utilized. States high on this measure usually have higher per-pupil expenditures, lower pupil-teacher ratios, more participation in public prekindergarten, lower teacher turnover, and teachers who report higher levels of resources needed for teaching. Appendix A (Figures A.16 to A.23) show the state ranks on these measures. These rankings are for the period from approximately 1984 to1994—the period when the NAEP test takers were in school. So state policies could have changed since then. For instance, Utah and California had the highest pupil-teacher ratios and lowest per-pupil spending in the nation in this period, and do poorly on scores for similar students. New Jersey and Connecticut have high spending and a lower pupil-teacher ratio and do relatively well on these scores. However, there are some anomalies that require more research. Rhode Island has high spending and a low pupil-teacher ratio, but poor scores for similar students. However, for some reason Rhode Island teachers report among the lowest level of resources. So there are still some missing factors that need further research to help explain state rankings.

We will be reporting an updated version of our analysis that include the 1998 4th- and 8th-grade reading tests in a few months.

CHOOLS



A technology revolution is about to sweep America's classrooms

In 1989, the schools in Union City, N.J., an impoverished Cuban enclave along the Hudson River across from Manhattan, were among the nation's worst. They received failing marks in 44 of the 52 categories New Jersey used to assess schools, and state officials warned they would seize control if Union City didn't shape up. The threat prompted many changes in Union City, including a technological transformation of its entire educational system. Aided by Bell Atlantic Corp., officials equipped the schools and students' homes with a network of computers, creating "one of the most, if not the most, wired urban school district in the U.S.," says Margaret Honey, director of the Center for Children & Technology in New York City.

But Union City did far more than simply buy computers. The school day was restructured into longer classes; teachers were given 40 hours of training a year, up from 8; the district's school budget more than doubled; and the traditional curriculum, emphasizing rote learning, was scrapped so students could work on joint projects such as researching a report on inventions. "The dynamics have changed tremendously," says Mary Ann Sakoutis, a 37-year veteran social studies teacher at Union City's Emerson High School, whose U.S. history students now spend much of their time on the Net researching such events as the Spanish-American War. "The kids are more involved, and I am no longer force-feeding them." It shows. Last year, Union City topped all New Jersey cities on state tests. The number of graduates accepted at top institutions such as Yale University and Massachusetts Institute of Technology has jumped from 8 in 1997, the last class taught the old-fashioned way, to 63 in 1999.

BLUEPRINT. True, Union City is hardly typical, now that it's on the cutting edge. Most of America's 53 million children in kindergarten through 12th grade still attend schools designed for the industrial, if not the agrarian, era. Everything from the school calendar, which still reflects the rhythms of farm life, to chalk-and-textbook instruction are better suited to preparing kids for the past than the future. But from Union City to the suburbs of Silicon Valley and the hollows of West Virginia, dozens of state-of-the-art schools have used technology as a catalyst to reinvent themselves in many ways, creating the blueprint for a new type of American school.

Call them schools for the New Economy. Over the next 5 to 10 years, the same technologies that have forced corporations to remake themselves for e-commerce hold the potential

By William C. Symonds

(CLOCKWISE FROM TOP LEFT) JOHN WILTSE; PORTER GIFFORD; DAVID ASCHKENAS; PORTER GIFFORD

to similarly transform U.S. education. With many of America's schools, especially in urban areas, failing to properly educate many of their students—and often literally falling apart—it's hard to believe such a grandiose vision could ever come to pass. But a decade or so ago, "we had the same controversy about whether the computer would transform work, and critics argued that all those investments were a waste," recalls Harvard Business School Professor Rosabeth Moss Kanter. Today, with the New Economy shredding old assumptions about productivity and growth, "it's hard to imagine anyone saying this," she says.

Of course, reinventing America's schools will involve far more than buying expensive gadgets. Just to keep classrooms staffed, the nation will have to hire and train 2.5 million new teachers over the coming decade. Given record low unemployment, recruiting quality replacements will require better-paid and better-trained teachers. And that's just the beginning. Schools increasingly will be ratcheting up standards for graduates. Thousands of school buildings will have to be repaired or replaced altogether. And radical structural reforms, including a healthy dose of competition from for-profit and charter schools, which are publicly funded but allowed to operate independently, will surely be shaking up resistant local bureaucracies across the country. Both Presidential candidates are running hard on promises to fix education. Al Gore would spend $115 billion over 10 years, more than twice the amount George W. Bush would, but both would give Washington a larger role.

Parents will be able to plug into their kids' lives as never before

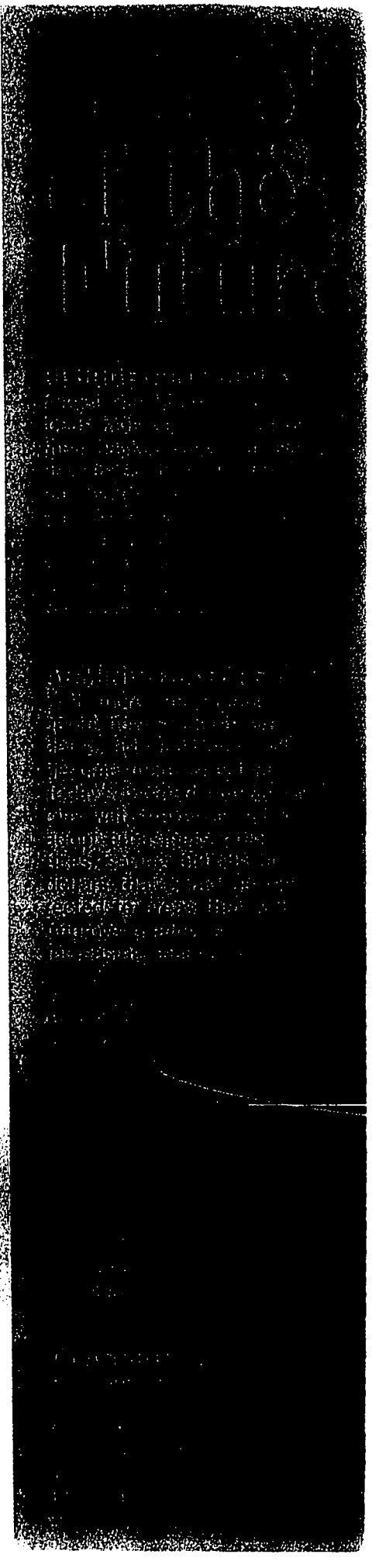
MOM'S WATCHING. Still, as Union City shows, technology can be a crucial tool to spur change. Just as the Net has allowed companies to tailor products for individuals, the Web can be harnessed to individualize instruction. Where e-mail has allowed people to work far more effectively with distant colleagues, so it can allow teachers to pool their knowledge online with colleagues around the country. Similarly, emerging technologies will allow parents to plug into their children's lives as never before, by exchanging e-mails with teachers and even watching Webcasts of their kids at school. And in the same way that e-business has slashed corporate overhead, technology can attack the administrative costs that now eat up so much of school spending.

The impact on the quality of public education could be profound. Today, with few exceptions, kids in wealthier neighborhoods tend to get the best education. But "the Internet will democratize education," predicts Jonathan Carson, CEO of the K-12 division of Learning Network, a unit of Pearson PLC, giving students even in poor communities access to the best libraries, to instructors from around the world, and to a far richer menu of courses, many of which will be delivered over the Web.

Technology could also help make education more relevant. Today's schools generally "do not prepare students to prosper in tomorrow's workplace," according to the CEO Forum on Education & Technology, a group of business executives and educators pushing for high-tech schools. But the new "digital learning environments" will be geared toward such vital New Economy skills as rapidly finding and assessing information and working in teams to solve problems.

Make no mistake: Tremendous obstacles must be overcome before technology can deliver on such high-flown promises. Yes, educators have moved with surprising speed to join the high-tech revolution. Some 95% of public schools are wired to the Internet, vs. 35% in 1994 (chart, page 126). And the computer-to-student ratio has doubled since 1996. But the ratio is still just 1 to 5. The average school spends $133 a year per student on technology, less than 2% of the $360 billion annual public education budget—hardly enough to make a huge difference. The average student uses a computer less than an hour a day in school. "We're still in the dabbling phase," asserts America Online Inc. CEO Stephen M. Case, whose new AOL@School aims to guide teachers through the explosion of digital content. "Teachers have added the Internet like they're adding salt to a dish."

Indeed, training teachers to use the



new technology is one key problem. Only 30% of teachers require students to use the Internet to do research, and just 16% use it for lesson planning, according to a recent report by the CEO Forum. And schools devote just 8% of tech spending to training teachers how to navigate with the new tools. Even Bob Chase, head of the National Education Assn., the largest teacher's union, estimates that just a third of all teachers are well-prepared to use technology effectively. Warns IBM CEO Louis V. Gerstner Jr., who sees education as a huge growth opportunity for his company: If we "simply parachute computers and broadband into the schools and then walk away, there would be no real progress."

Special Report

DEARTH OF RESEARCH. And even if all the hurdles can be jumped, some critics question whether high tech is the best answer for America's schools. "Boosters have been claiming technology will make learning fast, fun, and easy" for decades, says William L. Rukeyser, chief coordinator of Learning in the Real World, a group of education-technology critics in Woodland, Calif. Yet so far, argues Stanford University education professor Larry Cuban, "there is no substantial body of evidence that computers have transformed teaching or learning."

One worry is about the learning process itself, particularly among young children. "Sitting still and looking at a screen is not a very effective way of learning" in elementary school, says Joan Almon, coordinator of the Alliance for Childhood, a group of critics based in College Park, Md. And although Edison Schools, a for-profit education company, gives every student in its 133 schools a computer beginning in third grade, Chief Information Officer Donald Sunderland agrees that "reading, writing, and arithmetic can't be turned entirely over to a machine. We're considering deemphasizing computers in kindergarten through second grade."

The fact is, little research has been done on the effects of computers on learning, so most educators are only guessing. One 1998 study by Harold Wenglinsky of Educational Testing Service found that "drill and kill" programs, those repetitive drills used for decades, lowered math scores. In contrast, students who used the computer for more sophisticated math games and simulations registered solid improvements. But the studies are few. "If this were a new drug, you'd have a fairly hefty percentage of the costs spent on research and development," says Rukeyser. "But that has not happened with education technology." Indeed, less than 0.5% of K-12 spending has gone into research.

Still, the vast majority of the education Establishment—from the teachers' unions to administrators to the Education Dept.—is jumping on the bandwagon, if for no other reason than the sweeping impact technology has already had on society. And action is urgent. A decade after the nation set ambitious education goals, only 40% of high school seniors are proficient in reading. Seniors rank below most other indus-

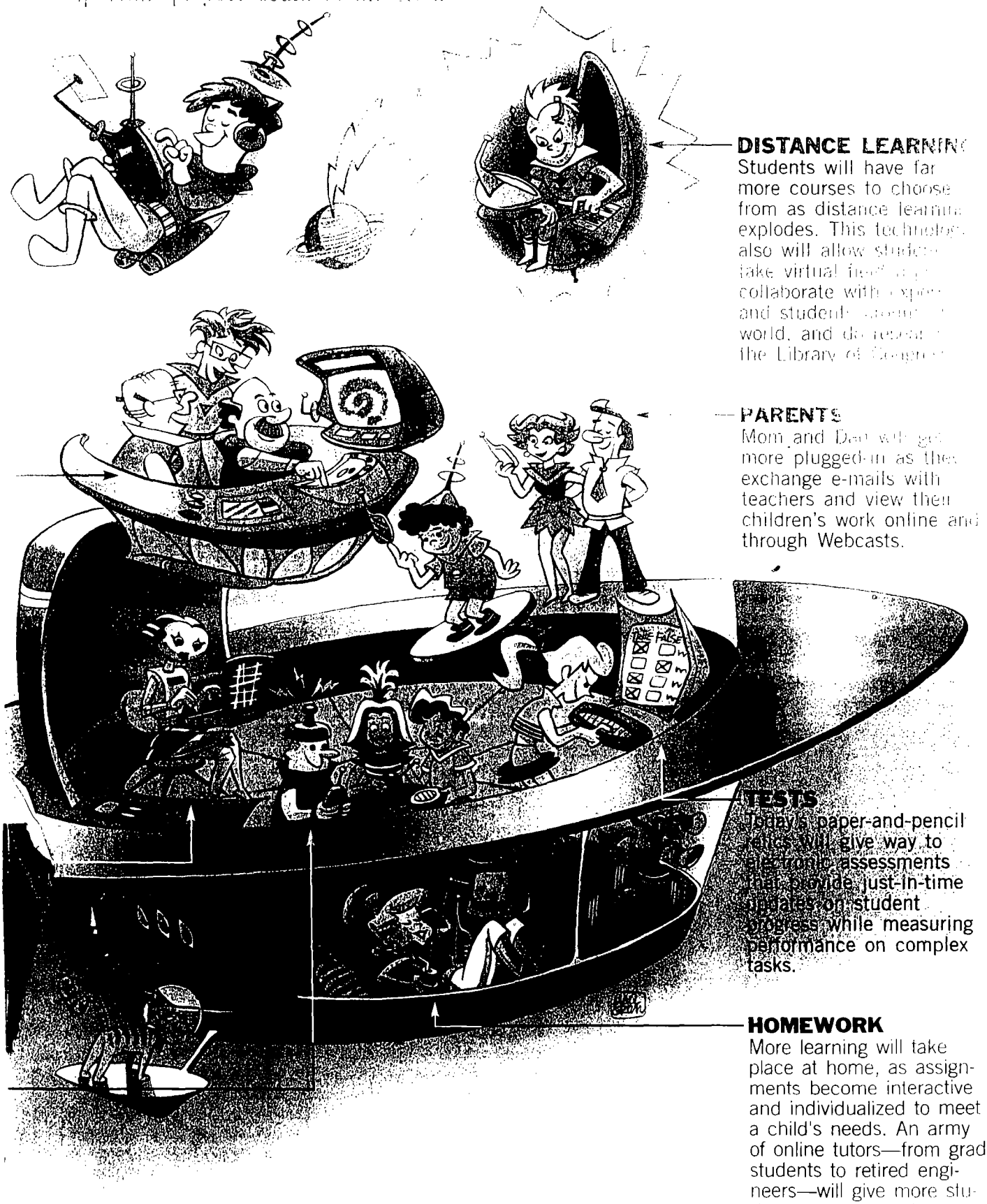
The Explosion in e-Learning

Dozens of new companies are springing up to serve the emerging K-12 market for digital learning. Investors have poured nearly $1 billion into these companies since the beginning of 1999, estimates Merrill Lynch. Among the new players:

COMPANY	FOUNDED	HEADQUARTERS	INVESTORS	COMMENTS
APEX LEARNING	1997	Bellevue, Wash.	Founded by Paul Allen. Other investors include Warburg Pincus, Edison Schools	Provides advanced placement courses over the Net. Targeting the 40% of high schools that don't offer such courses. Also offers online professional development for teachers
CLASSROOM CONNECT	1994	Brisbane, Calif.	More than $70 million from Intel, AT&T, U.S. Trust, and others	Offers online curriculum, including virtual adventures known as "quests" in which teams of scientists go to locales like the Galapagos Islands; classes follow the team online and ask questions. Says it has reached 3.7 million students in 50,000 schools
LIGHTSPAN	[illegible]	[illegible]	[illegible]	[illegible]
NETSCHOOLS	[illegible]	[illegible]	[illegible]	[illegible]
ZAPME!	1997	San Ramon, Calif.	Public, with market value of some $80 million. Private investors include Dell, Sylvan Learning Systems	Installs mid-computer labs, with Net access, in public schools in exchange for showing students on-screen ads. Though controversial among groups opposed to school commercialism, has installed labs in 2,200 schools and has a waiting list of 2,000 schools

DATA: BUSINESS WEEK, MERRILL LYNCH & CO.

[illegible] to neighborhood schools, as there are [illegible] a decade from now [illegible] take full advantage of emerging e-learning technologies, it could change much of what will happen in these schools. Here's a look at how some of the most important players could be affected:



DISTANCE LEARNING
Students will have far more courses to choose from as distance learning explodes. This technology also will allow students to take virtual field trips, collaborate with experts and students around the world, and do research in the Library of Congress.

PARENTS
Mom and Dad will get more plugged-in as they exchange e-mails with teachers and view their children's work online and through Webcasts.

TESTS
Today's paper-and-pencil tests will give way to electronic assessments that provide just-in-time updates on student progress while measuring performance on complex tasks.

HOMEWORK
More learning will take place at home, as assignments become interactive and individualized to meet a child's needs. An army of online tutors—from grad students to retired engineers—will give more students one-on-one help.

THE COMPUTERS AT ROOSEVELT-EDISON SCHOOL, LINKED TO THOSE IN STUDENTS' HOMES, HAVE BOOSTED FAMILY INVOLVEMENT

trial countries in math and science. "We need a leap forward comparable to the G.I. Bill," which gave World War II veterans a college education, asserts Senator Bob Kerry (D-Neb.), chair of the Congress-appointed Web-Based Education Commission.

It's no surprise that high-tech corporations are cheering educators on. Annual school technology spending has tripled, to $6.2 billion since 1992 and is expected to at least double again within four years. To tap the vast new market, IBM has marshaled top research scientists into its Reinventing Education project. Intel Corp. and Microsoft Corp. are teaming up to train 100,000 U.S. teachers—and 400,000 worldwide—on how to use technology. Intel alone plans to spend some $100 million on the project.

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The lure of riches has also spawned a host of startups, attracting nearly $1 billion in venture capital since early 1999, figures Merrill Lynch & Co. analyst Michael T. Moe (table, page 120). To push the high-tech agenda, Apple Computer Inc., America Online Inc., and more than 20 other companies formed the CEO Forum on Education & Technology in Washington, D.C. In part, these companies are banking on a revolution in computing technology, from broadband to voice recognition and the wireless Web. Before the decade is out, "every student will have multiple devices to access the Net anytime, anywhere," predicts Toby Richards, director of education for Microsoft. And many of the new devices—from eBooks to Palm-like portables—will be cheaper and easier to use than today's PCs.

In turn, ubiquitous access to the Net could spark the greatest revolution in education since the Gutenberg press mass-produced books, argues futurist David Thornburg. The old classroom standby—the textbook—will morph into a digital version that can be constantly updated. It will be supplemented by oceans of content. "The biggest change is that information now comes from the entire world" rather than being [illegible] what's in the school library," says Linda Roberts, head of education technology at the U.S. Education Dept.

Consider [illegible] the [illegible] at Hundred [illegible] tiny school library, where some books dated from the 1930s, says Andrea [illegible] who graduated from Hundred in June. But in 1998, Hundred hired NetSchools to give every student a rugged laptop with wireless Net access. Before, "these students could have been victims of the Digital Divide," says Superintendent Martha Dean, who won government grants to pay for most of the $450,000 cost of the NetSchools program. "Now they've got access to up-to-date information anytime." For example, agricultural students use their laptops for everything from "managing the school's commercial greenhouse to studying the latest university research on plant and animal diseases," says teacher Virgil Wilkins. And it's paying off. Last spring, students at Hundred "scored higher and ranked above the national mean in every subject" on the SAT-9 national skills tests, says Dean.

VIRTUAL HIGH. Being wired also makes possible all sorts of collaborations among educators. Virtual High School, the nation's largest Web-based school, based in Concord, Mass., recruits top high school teachers to offer courses over the Net. In return for their services, each participating school can enroll up to 20 students for each course a teacher at that school contributes. Hudson High outside Boston signed up in 1998. The school has only 900 students, but through VHS it has added 200 courses, from anatomy to the history of the Vietnam War. "Students have to be self-motivated to succeed," cautions Peggy Collins, who combines her regular job of teaching physics at Hudson with teaching astronomy through VHS. But it's a gold mine for bright students such as Nick Servio, who graduated from Hudson last spring with an interest in marine biology. He was able to take an evolution seminar with a Cleveland-based teacher who had been to the Galapagos Islands three times. VHS expects to sign up more than 4,000 students in 30 states this fall, up from about 300 three years ago.

Can schools embrace the Net without embracing all its ads?

Distance learning will also help cash-strapped schools fill in some holes. Up to 40% of public schools can't afford to set up advanced-placement courses, so Bellevue (Wash.)-based Apex Learning Inc. sells virtual AP classes to 165 schools. And when

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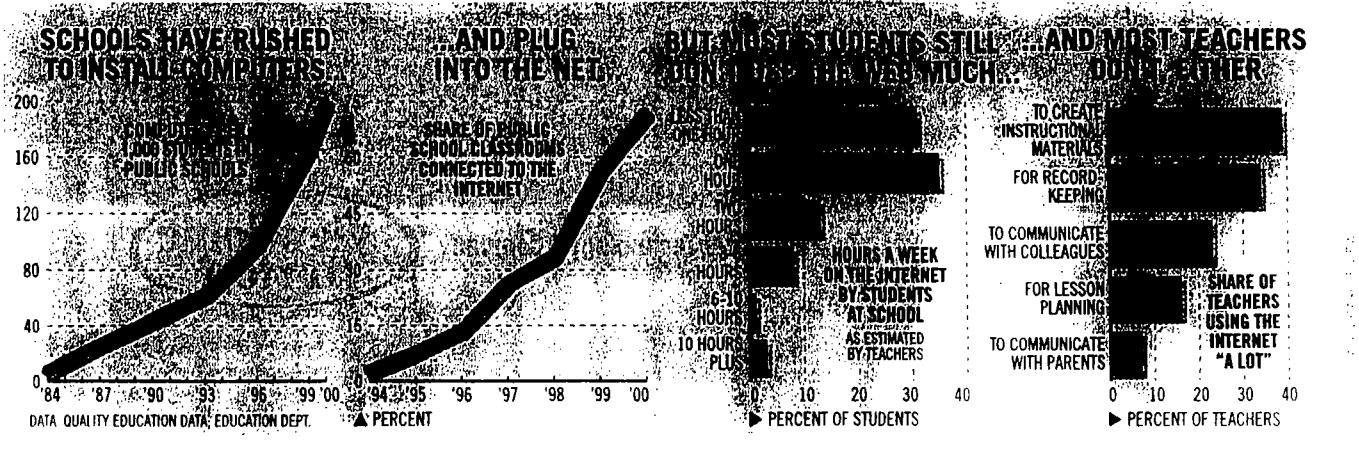
Teachers can share best practices, regardless of how far apart they are

"ALMOST LIKE A FAMILY." The real question, though, is whether students learn anything more than they do with paper and pencils. So far, computers have hardly produced a huge national payoff, in part because they're used so sparingly—and often as a stand-alone—in many schools. But in places where educators use technology to change the way they teach, they're discovering how it can help to engage students from even the poorest families, where motivation tends to be lower. At the Accelerated Learning Laboratory, a public school in Worcester, Mass., kindergartners use a state-of-the-art television studio to help produce programs seen by parents and peers alike. Principal Carol A. Schilinsky says

in the region's coal country. Then, Dotson got involved in an IBM-supported project to develop lessons online with 11 other English teachers from around the state. She drafted a three-week literature unit, online colleagues suggested changes, and then they tested the plan before submitting it to a jury of master teachers. The final product was posted on the Web, where it and others like it are expected to be used by thousands of teachers statewide this year. "Now, I have access to the best practices of other teachers," says Dotson. "And I have grown enormously."

Think about the possibility of reviving education's often sclerotic bureaucracies. Most school administrators manage



TEACHING TEACHERS: YOU CAN'T SIMPLY PARACHUTE COMPUTERS INTO THE SCHOOLS AND THEN WALK AWAY," WARNS IBM'S GERSTNER

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with scant data about what goes on in their classrooms. But that's changing, too. IBM has zeroed in on this market, in particular. In 1996, IBM began helping Florida's Broward County computerize its school administration. At the time, administrators still manually reviewed tests scores of all 250,000 students. They were always months behind, and even then they could do only crude analysis. But since IBM installed a data warehouse, "we get just-in-time data about how the kids are performing," says former Broward County Associate Superintendent Carmen V. Russo, who recently became the chief of Baltimore City Schools. "Problems show up sooner, and we address them sooner." Such intervention was one factor that helped to remove all 25 county schools on Florida's list of failing schools within three years, she says.

POCKETS OF SUCCESS. Even critics acknowledge that the best high-tech schools have achieved some remarkable results. Perhaps most impressive is West Virginia, which in 1990 launched a statewide effort to use technology to improve its struggling schools. Computers were gradually integrated into classes, beginning with the earliest grades, while teachers received extensive training. The result? "Over seven years, they made more gains than any other Southern state," says Dale Mann, a professor at Columbia University's Teachers College who led a 1999 study of the West Virginia effort. West Virginia jumped to 11th, from 33rd, on national achievement tests, even as the state remained mired near the bottom economically.

But while the U.S. has pockets of tech education excellence, "the real challenge is how to extend these state-of-the-art approaches to every school," says John Anderson, vice-chairman of New American Schools, a school-reform group in Washington, D.C. Problem No. 1: money. A 1997 Presidential report called for devoting 5% of K-12 spending to technology. That would require nearly tripling current spending, to some $18 billion annually. It would also require a major shift in spending priorities at a time when many schools still have crumbling infrastructures. Many model schools have skirted difficult choices by finding new revenue. For example, Virginia's Mantua Elementary School went high tech after a financial settlement from a nearby oil spill.

Critics worry that more schools may turn to advertising as a way to. ZapMe! Corp., in San Ramon, Calif., offers schools free computer labs, complete with satellite Net access, in return for showing ads on the computers. ZapMe! has labs in 2,200 schools, up from 200 in 1999, and a waiting list of 2,000 more. "They're turning schools into advertising delivery factories," fumes Gary Ruskin, head of Commercial Alert, which opposes commercialism in schools. ZapMe! CEO Rick Inatome responds that "when you go to the Net, you get banner ads anyway."

Over time, technology itself could help ease the cost issue. It's not just ever-plunging hardware costs. At present, nearly all of the nation's 16,400 school districts rely on archaic, paper-intensive systems to buy supplies. "They're in the Flintstone Age," says Amar Singh of Simplexis, a company founded by former GOP Presidential candidate Lamar Alexander to tackle the problem of streamlining purchasing. Singh figures schools could cut the cost of supplies by 10%—$8 billion a year—by automating the order process and pooling purchases.

Other barriers, such as inadequately trained teachers, will be harder to overcome. Colleges, which must turn out more than 2 million new teachers in the coming decade, need to be reinvented "to place technology at the center of new-teacher training," says Forum Executive Director Ken Kay. Big cultural shifts are also needed. Today's pencil-and-paper tests should be replaced with computer-based assessments that do a better job of measuring student performance on complex tasks. The school calendar, designed to make sure that students were available to help out with farm chores, needs to be lengthened to meet the demands of the New Economy.

For all the obstacles, "we've just begun to use these [digital] tools" to transform education," says Apple Computer Inc. CEO Steve Jobs, whose company has long been the leading supplier of computers to schools. Says Stanford's Smith: "We're going to see radical changes in American education for the first time in over a century." The question isn't so much whether computers can help to improve education. Rather, it's how long U.S. children must wait before their schools leave the Industrial Age to join the New Economy.

For in-depth interviews with Intel CEO Craig Barrett, AOL's Steve Case, IBM's Lou Gerstner, Vice-President Al Gore, and Apple Computer's Steve Jobs, see the Sept. 25 issue online at www.businessweek.com