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HORACE

Technology in the Essential School: Making Change in the Information Age

No matter how powerful, high tech alone can't make schools better. But if schools will first define the issues facing them, technology can prove a key strategy in achieving their goals.

BY KATHLEEN CUSHMAN

NINTH-GRADE HISTORY students in Tucson, Arizona take on the roles of citizens of the ancient Greek city-states competing for survival—huddled in teams as Macintosh computers calculate the economic and social consequences of every decision they make. From a battered classroom in rural New Hampshire, high school kids organize a three-day national student conference in Washington, D.C. on school change—logging on to an electronic network to attract peers from schools across the country. In a cafeteria in Louisville every day, kids at a special table collect their classmates' latest sports or academic prowess—on tapes and disks that will become a compact and permanent part of their records. And in teacher mailboxes in urban Chicago, new teaching ideas from all across the country regularly show up—downloaded from e-mail that links thousands of educators and researchers.

From video cameras to the CD-ROM database, from e-mail to the digital portfolio, technology is education's new darling, promising a rosy world of progress to schools and communities hungry for school improvement. But when Essential school people at these and other schools talked about technology in a range of recent interviews, they tempered their enthusiasm with cautious pragmatism. Rather than put the technological cart before the horse of classroom change, they warn, schools must first focus on what their core issues are—then use technology wisely in devising new approaches.

"When Essential schools plan backwards from their goals, they see technology as a tool, not an end," says David Niguidula, who has worked for several years with technological issues at the Coalition of Essential Schools. "Member schools are usually striving to break down the professional isolation of teachers, to reach and challenge kids at very different levels, to assess student progress in rich and concrete ways—all things that technology can greatly help achieve."

And although the flood of new-fangled systems and products often proves more daunting than dazzling to busy school people, Niguidula predicts that within a short time the technological marketplace will become as commonplace and easy to use as the television and telephone. "Ten years from now, for instance, students or teachers researching something electronically will have no more trouble than they do using a library now," he says. "In the meantime, you can do a lot already if you're willing to invest a little time and effort."

But how quickly should educators move to embrace new technology that often proves obsolete as soon as people pay for it? How can they create a synergy between technology and restructuring, using one to bolster and inspire the other? As

Essential schools pick their gingerly way through the technological jungle, how can they keep their sights focused on getting all students to use their minds well? Some answers may emerge through looking at several key areas of Essential School change and examining how technology can speed progress in each.

Student as Info-Age Worker

The Coalition's governing metaphor of "student as worker," which asks students to "learn how to learn" with their teachers as coaches, meshes well with the potential uses of technology. Once the school's door opens onto virtually unlimited access to information, a profound shift in pedagogy often seems necessary and logical. Electronic tools are ideally suited to individual and small-group work, whether that means discussions generated by role-playing computer software packages, a student's video documentary presented as a course-level exhibition, or a solo research project using on-line university library sources. And they can help with many of the problems associated with challenging students with widely different academic backgrounds.

"Technology has transformed our ability to work with heterogeneous groups," says Kathy Pelles, who directs New York City's School of the Future, where 370 students in grades 7 through 10 use an electronic library and writing lab, multimedia lab, telecommunications lab, optical data center, and various classroom computers. "In one Spanish class we can have kids at six different proficiency levels, having e-mail conversations at their own level with other kids from a school in Vermont." The teacher facilitates and monitors student work, Pelles says, but "often the kids know more about technology than the teachers, so they collaborate with and help other kids." Teachers pair up to work with a technology specialist, which tends to generate team strategies as they discover new areas to explore.

Small-group work also springs naturally from the use of computers and video technology. Four or five kids sharing a video camera can put together a project combining several media, for example. Or simulation software can generate realistic situations on one classroom computer, with teams of students working out solutions in smaller groups. "No amount of interactive technology can substitute for dynamic human interactivity," warns David Dockterman of Tom Snyder Productions, who has developed a number of classroom software programs that are geared to stimulate thoughtful discussions in the one-computer classroom. "But videos and computers can often spark that by setting up learning in a rich narrative context—which is how people learn things best."

Merely to deal with the amount of information exploding into students' lives, Kathy Pelles observes, teaching tasks must aim to develop what School of the Future calls students' "GUMS skills"—getting, understanding, manipulating, and synthesizing information. "We asked kids to make hypermedia stacks about whether our school rule on offensive language violated their right to free speech, for example," she says. "It took time for them to figure out what to put into the stack, how to make comparisons and contrasts, how to present the material persuasively."

In fact, students working with computer hypercard stacks to select and organize information are often using their minds in quite different ways from their pencil-wielding predecessors, observes humanities teacher Kathy Juarez, who teaches at Piner High School in Santa Rosa, California. "It's important to acknowledge that technology can stretch our mental boundaries," she says. "We now have the power to do things we haven't even imagined before." Piner teachers believe that students must be trained to use technological tools to negotiate their future successfully; they are discussing a new list of desired high-tech skills that dovetail nicely, they say, with their Essential School goals.

On the other side of the coin, many worry that electronic short-cuts will seduce schools into shortchanging the three R's. But they can just as easily have the reverse effect—computer searches don't work, after all, if you can't spell the key words. In the high-tech library at Paul M. Hodgson Vocational-Technical High School in Newark, Delaware, for example, a frustrated senior boy combed an on-line catalog in vain for materials on "19th-centrey tools." Principal Steven Godowsky corrected the student's spelling, then made sure his English teacher followed up on the problem.

Teaching higher-order basics, too, becomes more important in the information age. "If ever there was a need for coaching students to use their minds well, it's now," says Piner's Kathy Juarez. "It's naive to think that even with technology kids are going to be able to make meaning of this incredible glut of information

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without learning to make connections between things, ask the right questions, make logical selections. But that's not to say it'll have to happen within the four walls of the classroom with 30 kids." Indeed, Piner students have liberal access not only to classroom computers but to the off-line adult world outside their school, where they work with mentors on a range of professional activities.

Curriculum Changes

Access to technology can change curriculum, too, in ways that reflect the Essential School emphasis on depth in student learning and a generalist's attitude on the part of teachers. At Catalina Foothills High School in Tucson, Arizona, science teacher Frank Draper uses sophisticated computer simulations to get students thinking about "system dynamics"—how decisions and actions affect the workings of entire systems from copper mining to flu epidemics. Working in teams at networked computer stations, students in one class compete for mining resources on an imaginary island, investigating nonrenewable resource management.

"The computer tells them what kind of soil sample their team 'discovers,'" Draper says. "Then they go get an actual sample from the classroom cupboards, analyze it chemically to determine its ore yield, and enter their results in. They can construct deals to trade land with other students, trying to run a profitable company while applying—and assessing—their knowledge of chemistry and economics." After a week of such grounding, students play out a number of "what if" scenarios using computer modeling, through a simulation program called STELLA.

At Chicago's Sullivan High School, where Socratic seminars drive the curriculum, students are using IBM's modern version of medieval illuminated books and manuscripts; by clicking on a word in the text they can access interviews, background materials, and various other related topics. It is a small step, David Niguidula points out, to "illuminating" their own texts similarly, opening up a new realm of academic discourse. At Hope High School in Providence, Rhode Island, Kay Scheidler's students have replaced their textbook with a Hypercard "corpus" of materials about United States history and literature. Not only can students access key primary sources, but they can add to the body of knowledge by making their own work available for reference by other students.

The study of foreign languages has long benefited from technology in the form of audiovisual aids, but here too the computer connection holds out new approaches. Using an

Tech Tips for School People

- Multi-line central school phone systems can foul up attempts to telecommunicate. A good solution is to install a few dedicated single lines exactly where you need them to use your modems.
- No matter how fast computers are, people still take time to learn new things. Allow for plenty of extra time—to get teachers and students up to speed, and for unexpected system crashes and other glitches.
- Small groups are better than large ones when you're working with technology. Rather than putting 40 teachers in a room to watch a professional development video, feed it on networked TVs into eight rooms where groups of five can respond and discuss it.
- When kids communicate with other schools through e-mail or bulletin boards, make sure they respond to messages. Interest in joint projects dies quickly without contact.
- One computer-savvy staffer can daily preview new material appearing on network bulletin boards, download or print whatever might interest teachers, and distribute it to teachers' mailboxes. Or keep a notebook in the teachers' lounge with the latest offerings.
- Offer teachers two types of computer training to suit different learning styles—a 30-hour course that takes them methodically from the start, and an intensive one-day workshop for those who like to experiment first and then ask questions of an expert.
- Local dealers or third-party vendors may agree to offer computer training at a reduced price. Other sources: computer-savvy university graduate students looking for an arena in which to collect data on educational computer use; local community or junior colleges, whose courses are often cheaper and more suited to school uses.
- You don't need much in the way of equipment to get started; a donated garden-variety PC and modem will suffice for telecommunicating. Some software companies (like Word Perfect) allow schools to install one copy on eight machines. And many businesses will donate old software they no longer have use for.
- Make use of parents' and kids' technological expertise. Get qualified mothers and fathers to offer training, individual coaching, or educational programs they might have written. And open your classroom computer labs to parents and students on weekends and evenings. Often kids will be adept at downloading and other procedures that initially baffle their teachers.
- The Internet offers vast access to bulletin boards, conferences, and databases, not all of which you'll be comfortable having students investigate. Find a way to log into KidsNet and stay there.

Opening Screen of the Digital Portfolio

Page 1 of 2: Goals — Student: Mary Sample — May 17, 1992

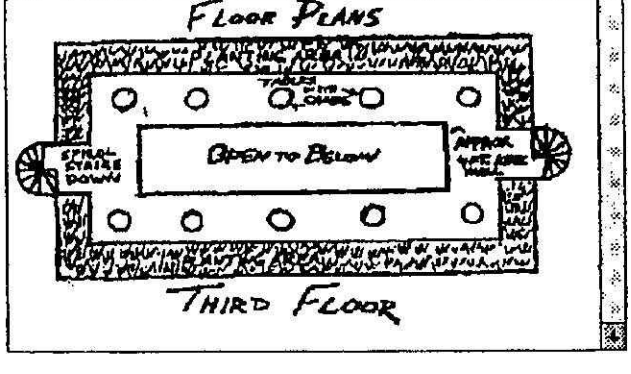
Communication and Math Skills	Algebra Exhibition	History Speech	Science Presentation	Writing Portfolio
Self-Sufficiency	Science in My House	Analysis of My Diet	Blueprints	Ethics in Science
Group Membership	Biology Team Investigation	Sophomore Debate	Mirey Brook	Kids' Conference
Application of Thinking/ Problem Solving	Recycling	Geometry in the World	New Car Ideas	Waterfront
Integration of Knowledge	Recycling	Is Your Water Safe?	Gödel, Escher, Bach	An Energy Strategy
Quit / Concepts	1989	1990	1991	1992

Looking at One Element of Student Work

Student: Mary Sample May 17, 1992

Title: Waterfront

The following figure shows floor plans for the Belvedere expansion project. The text can be seen by scrolling down on this bar to the right --->



Demonstrated Goals and Concepts

Geographic interaction between people and their surroundings

Reading and Observing

Visualizing space

Completion Date

February 12, 1992

Media

Quit | ◄ | Return | ► | Project | Skills | Assessment

The concept for the Digital Portfolio was developed by David Niguidula with the support of the IBM Corporation, as a computer-based tool for what the Exhibitions Project at the Coalition has termed "planning backwards." A first implementation was developed by Richard Bourgon at the Coalition of Essential Schools. Primary development of the current prototype was done by Michelle Riconscente of the Coalition staff using Toolbook software from Asymetrix. An earlier prototype, developed using Linkway Live! software from EduQuest, was created by Ms. Riconscente with further enhancements, including development of the interface and the use of multimedia, developed by Terry Waltman, Errol Rosser, and Jane Patla of EduQuest. Yolanda Jenkins has taken the lead for further development of the product at EduQuest. Revisions for the current version have come from suggestions at numerous conferences and from the students and staff at Eastern High School (Jefferson County, Kentucky) and Thayer High School (Winchester, New Hampshire).

unusually effective software program called Transparent Language, for instance, language students can read classic texts on screen, clicking on any word or phrase for instant elaboration of its grammar, syntax, and meaning. And a teacher at Byram Hills High School in Armonk, New York has her class conversing by e-mail with fellow students in France and Spain.

Supported by a grant from IBM, Thayer High School in Winchester, New Hampshire is on the way to digitizing virtually everything students do. In Dale Courtney's technical ed class, tenth-grader Dani Hopkins deftly manipulates the computer-assisted drafting tools she hopes could land her an architect's job some day. Next to her sits the school's acknowledged tech-head, Andrew Earley, who at sixteen can discourse knowledgeably with top IBM engineers when anything goes wrong in any of the school's complex systems.

Andy's case illustrates how technology can open up a curriculum both to cross disciplinary boundaries and to adjust to students' individual needs. "Andy was so uninterested in his regular courses that he had to go to summer school last year in algebra and English," says principal Dennis Littky. "Finally we decided to let him devise a program whereby he can demonstrate mastery in all our nineteen skill areas through independent work in technology." Andy often arrives at school at six in the morning and stays till late at night, Littky says, serving as the right-hand man of Thayer's director of technology, Elliot Washor.

In Tom McGuire's "networking" class, a dozen Thayer students meet daily to reflect on their own high school education and what it means. They visit younger students' classes to explain the school's new emphasis on mastering nineteen key skill areas (and new ways of demonstrating and documenting that mastery electronically). They survey student opinions on what qualities they will look for in a principal when Dennis Littky retires this year. And they use e-mail to exchange ideas about school change with other students around the country. In April the class will travel to Washington, D.C. for a national student conference which their technological wizardry has helped them organize from top to bottom.

"Technology is a hook," declares McGuire. "It draws kids into work they wouldn't otherwise be doing." Whether that involves collaborating with their peers nationwide on a scientific database documenting the extent of acid rain (as a National Geographic Society electronic network is doing) or functioning as respected participants in education reform, it has the same effect, he believes: to make their experience of learning more authentic and meaningful.

Assessment and Accountability

The acid test of a school's success comes when kids must demonstrate their intellectual progress and prowess; and new technologies offer a range of new assessment possibilities. By its nature much new technology is performance-oriented; so videotapes, audiotapes, and hypermedia add a dimension to student presentations and exhibitions. "It's a shame how many student papers are only seen by the student and her teacher," Kathy Juarez comments. "Using another form not only opens student work up to other viewers, but encourages us to broaden our assessments to include a range of student learning styles."

Just as important, the larger community—parents, experts, other teachers and students, employers, and colleges—can more easily witness and evaluate student work when it is made available in various digitized forms. With the help of an IBM grant, the Coalition is working with Thayer High School and Louisville's Eastern High School on developing the prototype of a "digital portfolio" that would document and assess student progress in an elegantly accessible form. The two efforts differ in interesting ways, but both result in a single disk or CD that can follow a student's progress—in still pictures, audio, video, or written text—through his or her entire school career.

At Thayer, the technology promises to remove the burden of multiple record-keeping from the school's attempt to assess student progress toward nineteen skills that must be demonstrated by graduation. "The logistics of documenting that is a nightmare," says Rick Durkee, who oversees the school's computer technology. "We had nineteen folders into which we would put any of the kids' work that met that competency. There was a lot of duplication, and a tremendous amount of sheer bulk of materials." Now students' digitized assignments can be placed in one or more skill folders by the team or the student herself; comments and evaluations from any number of sources go alongside, making clear what skill areas they demonstrate and how well they do it. (See sidebar, page 4.)

At Eastern, computer wizard and science teacher Scott Horan signed up 20 students in a digital portfolio class to organize the entire project of documenting their schoolmates' work. "We treat it just like a yearbook—no teacher has any say as to what goes in," he says. "At the end of the year kids can take the disk home and put it on their mantel if they like—it's for them to display." Each student in Horan's class is the contact person for a dozen or more outside it, who have agreed to enter all their important accomplishments—from the big football game or school play to a recital, an exhibition, or a final paper—in digital form. The material is collected at lunchtime, when kids from the digital portfolio class sit at a special table; then they take the videos, audios, artwork, or text and translate it into the permanent record.

"We are not editors," Horan

declares. "We put in work warts and all. We want students to own this whole portfolio idea before we start using it to assess them." Nonetheless, the students themselves do notice and comment on the quality of their peers' work. "It's well known that kids respect other kids' opinions more than anyone else's," he says, "and next come employers and colleges. Teachers are the least respected audience."

Ultimately, Eastern will also use the digital portfolios as an assessment record, just as Thayer does—though Horan hopes kids will maintain a non-assessment portfolio as well. Because Kentucky's Education Reform Act already requires portfolio assessment in English and mathematics, with science and social studies soon to be added, Eastern is already knee-deep in file cabinets. A high-tech system, he expects, would solve this problem even as it presents its own storage challenges.

"One of the reasons this is taking so long is that you need a 2-gigabyte drive to save material on CD-ROM for 200 students," he says. "No student's portfolio is going to take up more than about 20 megabytes of memory. Still, that requires a massive storage capability—you're looking at a large tape backup drive system." Horan, who manages a computer store in Louisville himself, advises schools not to plan budgets for such projects based on what products currently cost. "The industry is growing and proliferating," he says. "Prices will come down."

Where to Go for Help: A Resource List for Technology and Learning

General guides to technology

Report of the Technology for Restructuring Institute, Toni M. Maddox, ed.; published by Center for Excellence in Education, Indiana University, 201 North Rose Ave., Bloomington, IN 47405. A guide in outline form which identifies key issues in school change (including authentic assessment, learning styles, outcome-based education, student as worker); lists references and resources in each area; and identifies software and communications networks that are being used successfully in schools.

We Teach with Technology: New Visions for Education, by Greg Kearsley, Beverly Hunter, and Mary Furlong (Franklin, Beedle & Associates, 8536 SW St. Helen's Drive, Suite D, Wilsonville, OR 97070; tel: 503-682-7668). A comprehensive introduction to the range of technologies available to classroom teachers; does not assume any background knowledge. Includes glossary, sample applications from schools across the country, and resource lists.

The Center for Children and Technology (formerly affiliated with the Bank Street College of Education and now part of Education Development Center) publishes technical reports and working papers on a wide range of issues relating to technology in schools. Their quarterly newsletter can be had by writing to 96 Morton St. 7th floor, New York, NY 10014 (tel: 212-875-4560).
Other publications from the center include:
Accomplished Teachers: Integrating Computers into Classroom Practice, by Karen Sheingold and Martha Hadley ($5). A descriptive report of a survey study of the uses of technology in the classroom, including changing uses as teachers become more experienced as well as barriers and incentives to these uses.

The Coalition of Essential Schools' Studies on Exhibitions series has three recent reports highlighting the uses of technology in achieving school reform. Each is available by sending $2.50 each Coalition of Essential Schools, Box 1969, Brown University, Providence, RI 02912.
Show, Don't Tell: Video and Accountability, by Elliot Washor (No. 10). Describes one school's attempts to use video in the classroom to improve accountability of teachers and their students.
The Digital Portfolio: A Richer Picture of Student Performance (No. 13), by David Niguidula. An example of a digital portfolio, including discussion of design and development issues.
Keeping Student Performance Central: The New York Assessment Collection, by David Allen and Joseph McDonald (No. 14). Describes a forthcoming digitized collection of real performance assessment in New York schools.

Center for Learning, Teaching and Technology, at Education Development Center (tel: 617-969-7100). Hooked into the ATLAS project, this center researches and disseminates examples of classroom uses of technology.

Institute for Research on Learning, 2550 Hanover St., Palo Alto, CA 94304 (tel: 415-496-7900). A think tank consulting to educators; publishes an array of materials including technology and education.

Communication tools and selected software

The ERIC Review: K-12 Computer Networking (Vol. 2, Issue 3, Winter 1993), U.S. Department of Education, Office of Educational Research and Improvement, Educational Resources Information Center. Free of charge. Call 1-800-538-3742. A comprehensive introduction to networking, including annotated resource lists of educational networks, government and private, and references.

Waters Grant System Dynamics Project, Orange Grove Middle School, 1911 East Orange Grove Rd, Tucson AZ 85718 (tel: 602-575-1243). Organization devising system dynamics applications in several Essential schools.

Creative Learning Exchange, 1 Keefe Rd., Acton, MA 01720 (tel: 508-287-0070). Organization promoting system dynamics applications.

Swarthmore Geometry Forum, c/o Annie Fetter, Swarthmore College, Swarthmore, PA 19081 (tel: 800-756-7823; e-mail annie@forum.swarthmore.edu).

Teachers' Idea & Information Exchange (TI&IE), P.O. Box 6229, Lincoln, NE 68506 (tel: 402-483-6957). Includes lesson plans and materials for sample data bases and teacher-created programs for use in the classroom. Requires Microsoft Works.

Technical and Educational Resource Consultancy (TERC), a Cambridge, MA group (617-547-0430) producing integrated curricula many of which make use of technology.

Tom Snyder Productions, 80 Coolidge Hill Rd., Watertown, MA 02172-2817 (tel: 1-800-342-0236). Produces simulations, projects, and texts for and about the one-computer classroom.

Transparent Language, 22 Proctor Hill Road, P.O. Box 575, Hollis, NH 03049 (tel:1-800-752-1767). Produces computer-based language learning.

Aside from acting as a superb organizing tool, what does the digital portfolio add to the quality of assessment practices? Among both teachers and students, its developers hope, it can raise awareness of what each task reveals about student learning. It can provide instantaneous comparisons of student work across the spectrum and at several points during the school career. And it can spark a useful dialogue between student and teacher as the work included undergoes revision along the way.

"My view is that teacher and student must go through a long-term negotiation aimed at raising the quality of the initial work," says Mark Gordon, a school librarian who recently moved from New York City's Central Park East Secondary School to Oceana High School in Pacifica, California. "The digital form is ideal for teacher input." For that matter, portfolios could also serve to evaluate teacher feedback, Gordon says, raising the quality of the entire learning dialogue.

Digital portfolios also could help drive meaningful student work well before the point of assessment, observes Judith Shlink, a teacher from Elmwood Junior-Senior High School in Elmwood, Illinois. "Individual assessment portfolios would make it easier to set the standards at the beginning of a course, then let students move on into independent work or the next class as soon as they demonstrate they've met them," she says. "We'd like to set up classes along a coaching model, moving through modules that create problems for kids to solve at their own pace."

If colleges were to accept a digital portfolio instead of a conventional transcript, its advocates say, a critical barrier to serious school change might at last be breached. Only half jokingly, one teacher at the Coalition's 1993 Fall Forum suggested that prestigious high schools not allow college recruiters to visit unless they could guarantee they had the equipment to read CD-ROM portfolios in their admissions offices. Employers, too, could review evidence of real student work digitally in a far more meaningful form than school records usually supply. And accreditation committees or state education departments could select random samples from districts to get a richer picture of school performance.

Breaking Staff Isolation

Aside from the many ways that technology can open up students' horizons to a world of learning, it has enormous power to break through the traditional isolation of classroom teachers. At Essential schools around the country, teachers are tapping into electronic communications networks to trade assignments, coordinate student projects, plan and attend workshops, get information, collaborate with other professionals, apply for jobs, and ask expert advice.

The Illinois Alliance of Essential Schools, for instance, has linked all its members into a powerful computer-conferencing project called PSInet (People Sharing Information Network). Over 4,000 calls came in last year to the project's toll-free number, as teachers and students communicated with each other, with school coaches, with the state board of education, with the University of Illinois, and with consultants and on-line technical experts. The network also serves as a gateway to the Internet, the worldwide electronic information highway offering virtually unlimited educational and research uses.

The Coalition's National ReLearning Faculty maintain close e-mail connections with each other and CES's central offices in Providence, Rhode Island through a simple and powerful server called CES Online. Some 300 people currently use the network, which is available through an e-mail system that has Internet access. Several dozen Coalition teachers are also communicating electronically with colleagues in Harvard University's Project Zero and in the Foxfire project, through a server established under the auspices of NCREST, Columbia University's center for school restructuring. And dozens of interest groups are talking via local electronic bulletin boards in networks like K12Net, the National Science Foundation's FrEdMail, the National Education Association's School Renewal Network, and AT&T's Long Distance Learning Network.

An interesting example of electronic teacher talk is the Swarthmore Geometry Project, an Internet "hub" with seven news groups devoted to discussing geometry from the school level right up through world-class theoreticians. Math teachers can download articles and book reviews, public-domain software and demonstrations of popular geometry programs, and much more; and they can share assignments and seek advice on teaching dilemmas. "We had one instance where an internationally known Princeton mathematician queried a high school geometry class on their solution to a geometry problem," says project coordinator Annie Fetter. "This is a simple and nonthreatening way to cross the thick black line between university and high school." Citing a Roper poll that found 95 percent of biology teachers felt isolated from their professional colleagues, the biotechnology firm Genentech also recently launched a national computer network to link them with each other and with working scientists.

Enriching professional development programs at schools around the country is the aim of Thayer High School's monthly hour-long interactive television workshop, "Here, Thayer, and Everywhere," which is produced by teachers, parents, and students from a crowded control room that abuts the school's small library. The program goes out to anyone who has satellite access, and scores of schools tune in to watch (or tape for later use) video examples of authentic assessment, heterogeneous grouping, changing

math teaching practices, and a range of Essential School ideas. The program, which reaches groups in 42 states, builds in time for small group discussion and invites call-in questions by phone or fax; it is followed immediately by a related program called MathWatch, which is designed specifically for math educators.

The Implications

As the technological choices get bigger, broader, more mind-boggling, and more user-friendly, how likely is it that Essential schools can and will do much about it? A new poll by Quality Education Data shows the percentage of districts planning to spend more on computer hardware and software in the coming year is at its highest level in five years. But even teachers who already feel comfortable with computers and whose schools enjoy a significant technological presence experience real barriers to integrating computers into their teaching, according to recent research from the Center for Technology in Education.

Those barriers have much in common, moreover, with the typical sticking points around Essential School change in general: time to prepare new kinds of lessons; time for the classes themselves to experience meaningful work; people to coach students in using new tools and practices; and financial support from the school and district, both for professional development and for buying high-tech materials. On-site support from colleagues and visits to exemplary schools proved a key element for successful teachers in the Center's study; so was the teachers' willingness to learn and change, which for some took some time to develop. Even with the best of intentions, meaningful change in this area will take at least five years, the study concludes; and it will depend on teachers having ample computers, support, and time, as well as a school structure and culture that encourages professional experimentation.

Many schools have jump-started their ventures into technology by making partnerships with the private sector; whether for purely civic-minded or for practical marketing purposes, companies from IBM and AT&T to Microsoft and Apple have sunk substantial money and equipment into public education. But there's a danger in relying on grants or corporate initiatives for what districts should consider as basic as chalkboards and file cabinets, David Niguidula warns. "Technology acquisition, maintenance, and training should show up as a consistent and substantial line-item in school budgets," he asserts. As for the discouraging rate at which new systems become obsolete, he says, if schools tailor their purchases to students' learning needs, then new high-tech purchases (like new textbooks) should only happen when those learning needs require them.

Finally, as Deborah Meier has pointed out, no amount of technology can substitute for the essential ingredient of teaching and learning: wisdom. Indeed, the very notion of what it means to be educated may shift in an era when "memory" applies more readily to machines than to human beings. In this view, only by grounding themselves in a commitment to deeper, more meaningful student engagement will school people succeed in keeping their balance as the information age careens around the corner into the next millennium. ❑

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