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ABSTRACT

This packet includes reprints of articles and other information concerning the use of computer networks in small, rural schools. Computer networks can minimize isolation; develop stronger links to the community; access reference information from remote sources; and create professional and academic exchanges for teachers, administrators, and students. The five sections of the packet cover introduction to networking, funding, implementation of networking technology in the classroom, issues such as equitable access and staff development, and resources. Articles include: (1) "The Executive Educator's Complete Guide to the Internet" (Lars Kongshem); (2) "Restructuring for Learning with Technology: The Potential for Synergy" (Karen Sheingold); (3) "Plug into a Network" (Doug Vander Linden, Larry Clark); (4) "Network-Based Collaborations: How Universities Can Support K-12 Reform Efforts" (John Clement); (5) "Funding Electronic Classrooms" (Arlene Krebs); (6) "All about Grants: Where to Get Them, How to Get Them, and Profiles of Schools and Districts That Have Been Forever Changed--for the Better--after Getting Them" (Gwen Solomon); (6) "Education Online: Interactive K-12 Computing" (Edward J. Valauskas); (7) "Technology As a Vehicle for Transformation" (Lynn Murray and others); (8) "Developing a Telecommunications Curriculum for Students with Physical Disabilities" (Terry S. Gandell, Dorothy Laufer); (9) "Doing Science in the Electronic School District" (James D. Lehman and others); (10) "A Community of Learning" (Geriann Marie Walker); (11) "Education On-Line" (Yvonne Marie Andres); (12) "Telecommunications: Avoiding the Black Hole" (Margaret Riel); (13) "Linking Northwest Schools to the Internet" (Lee Sherman Caudell); (14) "Could Computer Use Be a Form of Tracking?" (Ike Coleman); (15) "Electronic Networking and the Construction of Professional Knowledge" (Gary D. Watts, Shari Castle); (16) "Blinded by Science" (Tom Snyder); (17) "Alternative Assessment: Putting Technology to the Test" (Isabelle Bruder); and (18) "Responsible Citizenship in the Electronic Community" (Sally Webster, Frank W. Connolly). The last section lists resources, including companies providing on-line services, information resources, funding organizations and ideas, books and articles on the Internet, and journals related to educational technology. (LP)

RURAL, SMALL SCHOOLS NETWORK

INFORMATION EXCHANGE

Number 16

ON-LINE LEARNING TECHNOLOGIES: NETWORKING IN THE CLASSROOM

The Regional Laboratory
for Educational Improvement of the Northeast & Islands

This publication is based on work sponsored wholly or in part by the U.S. Department of Education under contract number RP91002008. The content of the publication does not necessarily reflect the views of the department or any other agency of the U.S. Government.

The Regional Laboratory
for Educational Improvement of the Northeast & Islands

Summer 1994

Dear Rural, Small School Educator:

Imagine a school where students talk with geneticists, biologists, chemists, historians, or writers across the country – or the world – to find the most current knowledge on their science, social studies or English project. Imagine students developing effective communication and study skills by collaborating on research with peers and teachers via electronic mail or exploring sources of information on a database. These networking technology projects are a reality in many rural, urban, and suburban schools around the country.

These networks – often spoken of as "the information superhighway" or, in reference to education, as the creation of a "global village" – will affect the very nature of learning, teaching and knowledge. This Information Exchange Packet is compiled in response to the efforts to bring students, educators, and administrators online and to address ongoing restructuring endeavors in schools. The advantages to this kind of communication system, particularly in rural schools, include minimizing isolation, developing stronger links to the community, accessing reference information from remote sources, and creating professional and academic exchanges for teachers, administrators and students.

This packet, divided into five sections, covers practical and theoretical concerns in this area. The first section consists of introductory articles which give general explanations of networking. In the second section are articles on funding, perhaps the most important concern for rural and small schools. The third section describes classrooms and schools where networking technology is being implemented. Issues such as equitable access, ethical use, assessment, and staff development are examined in the fourth section. The last part of this package is a resource list of computers and education journals, informational organizations and online services available to schools.

With our packet we hope to convey the enormous potential in linking student to student, school to school, and to encourage educators to begin their investigation and implementation of successful and innovative technologies. We have included an evaluation card for your comments on this information packet and we also welcome your suggestions for future topics. Please note any ideas that you may have on this card or contact us at the Rural, Small Schools Network, 83 Boston Post Road, Sudbury, MA 01776, (508) 443-7991.

Sincerely,

John R. Sullivan, Jr., Ed.D.
Program Director
Rural, Small Schools Network

Ruth M. Bayer
Associate Program Director
Rural, Small Schools Network

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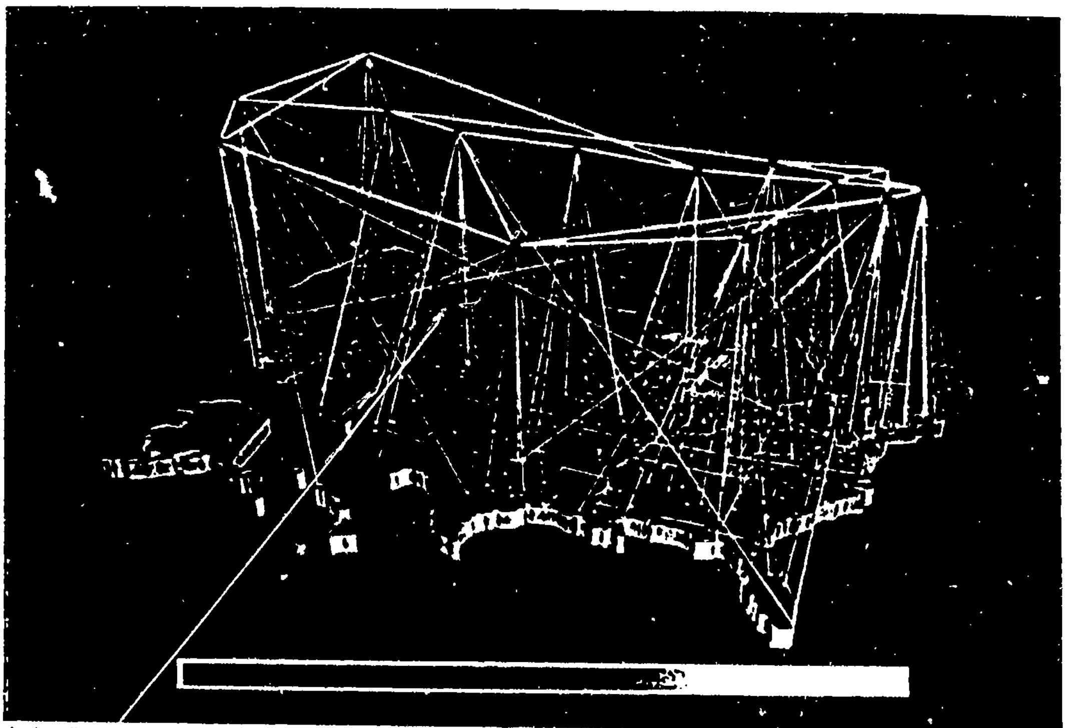
The Executive Educator's

Complete Guide To The Internet

By Lars Kongshem



A visualization study of the NSFNET—the Internet's National Science Foundation-funded research and education backbone network—done by the National Center for Supercomputing Applications shows traffic volume from low (purple) to high (white).

You've probably heard the buzz about the Internet: It's the hottest information and communications tool of the '90s; it's spawning the national information superhighway; and pioneering elementary and secondary schools across the country aren't waiting for the future—they're connecting to it now.

Last year, the Internet rose from obscurity to household word. Within the space of little more than 12 months, what had long been of interest mainly to scientists and university researchers was suddenly in the public spotlight, as newspapers, magazines, television news shows, Vice President Al Gore, even the Doonesbury comic strip sang its praises.

Today, more and more U.S. schoolchildren are using the Internet in their classrooms to corre-

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spond electronically with peers in distant countries and nearby towns, collaborate on projects across continents, query scientists for the latest discoveries, and retrieve text, data, and images from university and government host computers scattered across the globe.

Some critics question the wisdom of exposing students to uncensored information and opinions from all corners of the world, but savvy educators are learning ways to tap into the vast educational potential of the Internet while steering clear of danger areas that can land a school district in trouble. (See "Cybersex and Other Internet Hazards," page 64.)

What's more, administrators and teachers are taking advantage of this "mother of all computer networks" themselves, breaking free of geographic and professional isolation to discuss common concerns and develop joint curriculum projects with a worldwide community of like-minded colleagues. And they're finding that on-line resources for professional and personal development are just a few keystrokes away.

So just what exactly is the Internet? How do you get connected? And what can the Internet offer you and your schools? "*The Executive Educator's* Complete Guide to the Internet" will tell you what you need to know to get started.

From the Cold War to the classroom

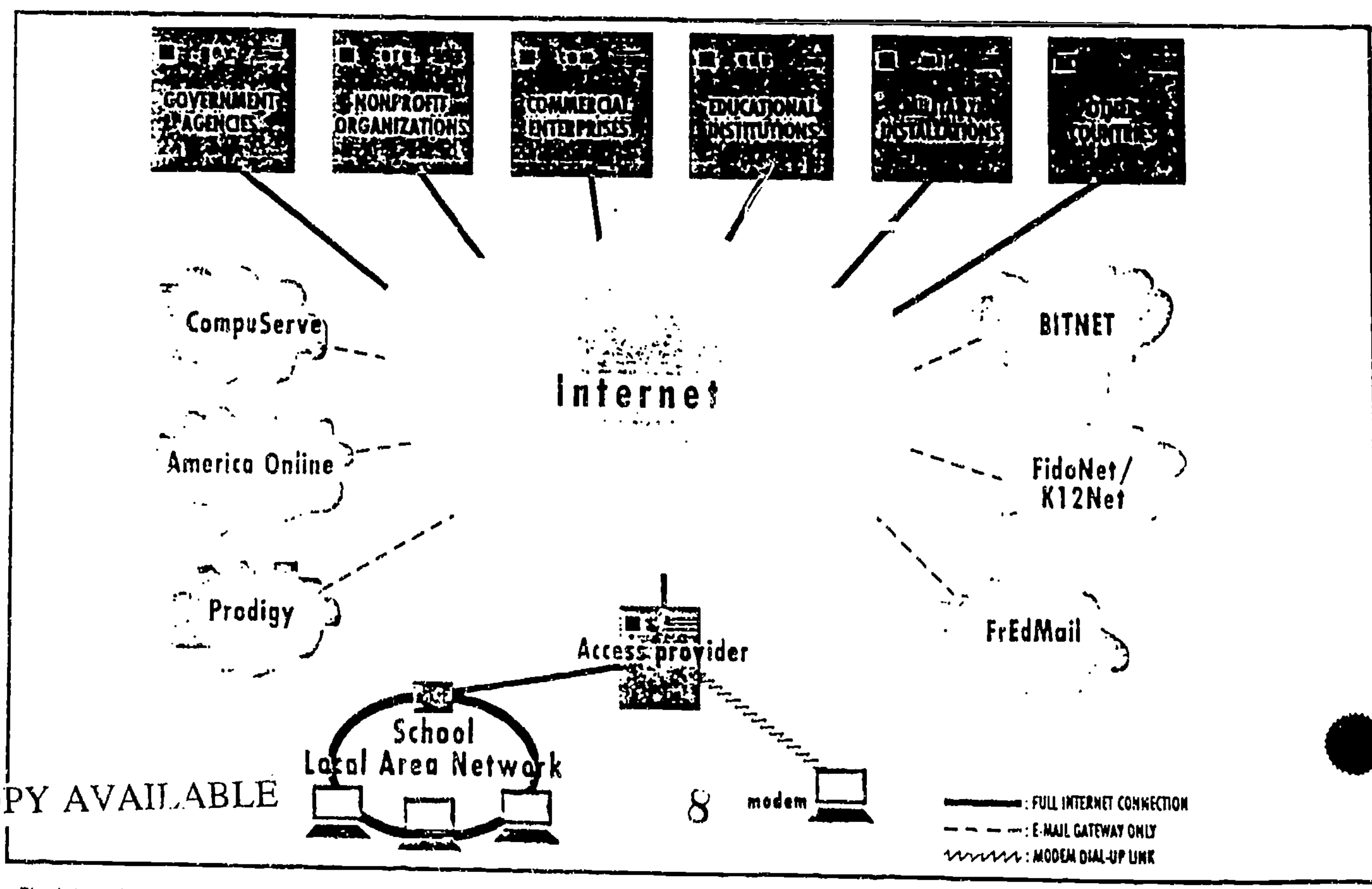
The Internet's roots go back a quarter century to a Pentagon research project to develop military computer networks sufficiently robust to survive World War III. Armed with this technology, the Internet has evolved into a global electronic village that celebrates open access to information and learning. Today, it's the world's largest public, cooperative, wide-area computer network. Though no one knows exactly how many people have Internet accounts, current estimates peg the number at close to 20 million users.

The phrase "a network of networks" is often used to describe the Internet. In fact, the Internet is not one physical entity; rather, it is a cooperative agreement among a multitude of government, public, and commercial computer networks to connect to each other in a standardized way so as to share resources and information.

The Internet works because all computers connected to it have agreed to speak the same language: Transmission Control Protocol/Internet Protocol, or TCP/IP for short. This cooperation has created a global web of computer networks that interconnects computers of all shapes and sizes, from Cray supercomputers and multiuser mainframes to desktop PCs and Macs.

Physical communication links among computers on the participating networks and among connected networks run the gamut from telephone lines and fiber-optic cable to radio and satellite transmissions. Yet to the user, the Internet appears as one gigantic, seamless, virtual network.

New networks are joining the Internet at the rate of one every 10 minutes, and for every network that joins, the usefulness of the Internet increases. In a single year—from October 1992 to October 1993—the Internet



BEST COPY AVAILABLE

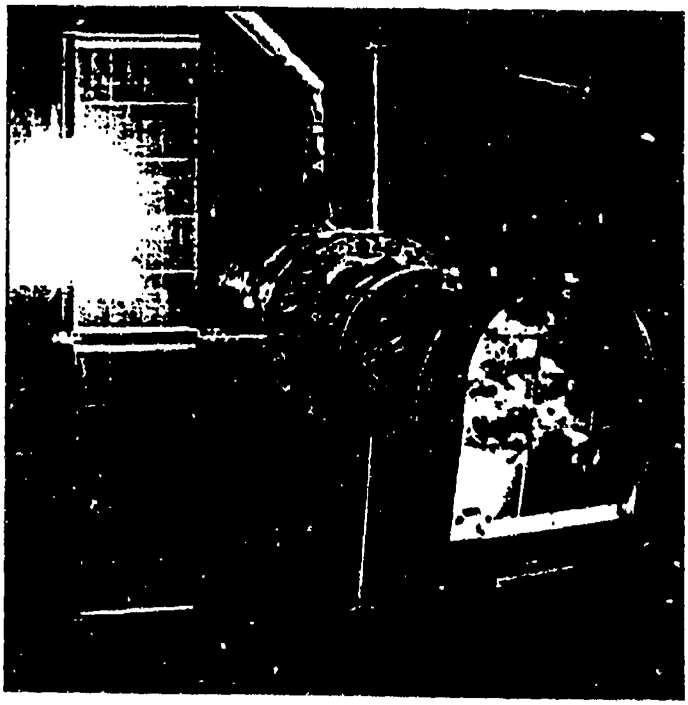
The Internet interconnects 2 million computers worldwide, and thousands of these computers provide free public access to a wealth of on-line resources and information. E-mail gateways to smaller non-profit and commercial computer networks allow users in 137 countries to exchange electronic mail.

doubled in size, to 16,500 networks connecting a total of 2 million computers in 62 countries.

The Internet has achieved critical mass: It has become the standard for public computer network communications by virtue of its sheer size. From the U.S. Department of Education in Washington to teachers and students in Texas; from reformers in Moscow to researchers in Antarctica, communicating using the Internet is becoming the norm.

Although the U.S. government subsidizes some of the Internet's major arteries for the research and education community, the Internet is not free: All participating networks pay for their own individual pieces of it. However, most of the Internet's costs are fixed—a situation ideally suited to schools. Once you've paid for the connection, it makes little difference whether it sits idle or whether your students spend all day retrieving information from a computer in Tokyo.

Last fall, the California Department of Education officially adopted the use of the Internet for statewide electronic communications and recommended that school districts and county offices of education follow suit: "Planning today to become part of [the Internet] will position schools and districts to take advantage of statewide, national, and global communications opportunities tomorrow," the department says.



Typical of the images you can access through the Internet is this view of the Hubble Space Telescope. Imax photo courtesy of NASA, the Smithsonian Institution, and Lockheed Corporation. To access: *ftp dftnic.gsfc.nasa.gov*

Getting your message across the Net

On the Net, as network gurus like to call the Internet, one of the most useful and least complicated things to do is send electronic mail. Unlike mail you send using the U.S. Postal Service ("snail mail," in the vernacular of the Net), Internet e-mail is delivered in seconds, even to other continents. It beats faxing, too, because you don't have to pay extra for long distance.

Internet e-mail addresses might look cryptic at first glance, yet they all follow the same simple structure: a user's log-in name, followed by the "@" sign, followed by the name of the host computer the user has an account on. The name is expressed in a string of "domains" separated by periods. (Domains are simply a hierarchical method of naming and categorizing host computers on the Internet.) For example, President Bill Clinton's e-mail address is *president@whitehouse.gov*—and yes, you can write to him.

E-mail is a very versatile medium—invaluable for instant personal correspondence, yet also capable of delivering other useful services that have immediate applications in the classroom.

One such use is the mailing list, also known as a "listserv." A mailing list allows any number of people who share an interest in a specific topic to participate in a discussion forum via e-mail. It works like this: When you send e-mail to the mailing list address, your message is broadcast automatically to everyone who has subscribed to the list. Replies can be made in public to the list, or in private by responding directly to the person who sent the message. Some mailing lists even distribute electronic newsletters.

Why use e-mail and mailing lists in schools? Research and anecdotal evidence have shown that students who write for an audience of their peers on the Net are more highly motivated and produce higher quality work than students whose writing assignments will be read only by their teacher.

"We have third-graders who are connecting with 8-year-olds in Guadalajara, Mexico, and eleventh-graders who are discussing gun control with students in Tokyo, Japan," says Leigh Zeitz (*zeitz@uni.edu*), instructional technology coordinator at the Malcolm Price Laboratory School in Cedar Falls, Iowa. (Zeitz's comments, and those of several other educators throughout this guide, came to *The Executive Educator* via Internet e-mail in response to a query posted on several mailing lists.)

The Internet abounds with collaborative K-12 projects, often based on mailing lists, that involve students in writing and sharing their work with other students worldwide—everything from simple pen-pal exchanges to multidisciplinary projects that involve science, geography, and different cultures. (For a list of ongoing projects and how to join them, see "Curriculum Projects on the Net," page 60.)

For teachers and administrators, e-mail and mailing lists provide the perfect medium for networking in the human sense, a way to discuss concerns and solutions to problems that are shared across district, state, and national boundaries.

Barry Rowe (*browe@ncsa.uiuc.edu*), who teaches chemistry and hypermedia at Champaign Centennial High School in Champaign, Ill., participates in Internet mailing lists to keep abreast of new developments in chemistry and teaching methods. "Our current discussion is on multiple-choice questions, and I am treated as an equal by the college teachers. This is very rewarding professionally," Rowe says.

Joyce M. Kendall (*j_kendall@nbnet.unb.edu*), a library media specialist at the Fall Mountain Regional High School in Alstead, N.H., subscribes to a school library media mailing list. "Now a lone librarian in a rural school district is no longer isolated," she says. "Within easy reach are hundreds of other school librarians with [whom] to communicate about what software has been the most trouble free, how other school districts handle specific policies, and so on. I cannot imagine life without the Internet—no way." (For a sampling of useful mailing lists and how to subscribe, see "The Global Water Cooler: Mailing Lists and Newsletters," below.)

Folks who subscribe to commercial and nonprofit networks that are not part of the Internet can in most cases exchange e-mail with Internet users, thanks to computerized gateways that automatically translate the incompatible message formats. This arrangement allows those who are not on the Internet to participate in mailing lists, too, uniting people in 137 countries in a global e-mail community (see diagram on page 56).

Mailing lists do have the potential to swamp your personal mailbox with a deluge of messages, and that places a practical limit on the number of lists you'll want to subscribe to; e-mail is not ideally suited to

THE GLOBAL WATER COOLER: MAILING LISTS AND NEWSLETTERS

To subscribe to one of the mailing lists below, follow the instructions provided, using your first and last name where indicated. You will receive a message in return that confirms your subscription; this message will also instruct you how to post messages to the list and how to end your subscription, so be sure to save this information for later reference. The procedure is the same for newsletters, with the exception that you may only receive—not post—messages.

K-12 school administration mailing list. The K12ADMIN list provides a discussion forum for K-12 school administrators—including superintendents, assistant superintendents, principals, vice principals, central and county office administrators, and others. Conversation focuses on topics of interest to school administrators, including school management, curriculum, services, operations, technology, and activities.

To subscribe, send e-mail to *listserv@suvm.syr.edu* with the command *subscribe k12admin firstname lastname* on the first line of the message. Leave the subject field blank.

Kidsphere—global computer networking mailing list. Discussions on the KIDSPHERE list concern global computer networking for children and their teachers—everything from efforts to get individual classes on-line to planning a grand scheme to link the whole world together. Topics of continuing interest include networks at the local, regional, and national level; interfaces and network services suitable for children; collaborative projects at the national and international level; and network access for the handicapped.

To subscribe, send e-mail to *kidsphere-request@vms.cis.pitt.edu* with the command *subscribe kidsphere firstname lastname* on the first line of the message. Leave the subject field blank.

Middle schools mailing list. The MIDDLE-L list is a discussion forum for anyone who is interested in middle schools and middle-level education—including administrators, teachers, school library media specialists, and parents.

To subscribe, send e-mail to *listserv@vmd.cso.uiuc.edu* with the command *subscribe middle-l firstname lastname* on the first line of the message. Leave the subject field blank.

School library media mailing list. The LM_NET list is a discussion forum for the school library media community. Conversation topics include the latest in school library media services, operations, and activities, as well as idea sharing, problem solving, and announcements of publications and conferences.

To subscribe, send e-mail to *listserv@suvm.syr.edu* with the command *subscribe lm_net firstname lastname* on the first line of the message. (Note the underscore in "lm_net.") Leave the subject field blank.

Consortium for School Networking mailing list. The COSNDISC list is a discussion forum to promote the use of the Internet and other computer networks as a resource for K-12 educators and students. Conversation concerns all aspects of school networking, including announcements and news, discussions, and calls for help or collaboration. This is a great place to learn from others who are using the Internet in schools.

To subscribe, send e-mail to *listproc@yukon.cren.org* with the command *subscribe cosndisc firstname lastname* on the first line of the message. Leave the subject field blank.

High-bandwidth K-12 Internet access mailing list. The SUPERK12 list seeks to promote the implementation and use of high-bandwidth (56K or T1) Internet connections and supercomputing resources in the K-12 environment. Want a T1 line to your school? Got one? Want to collaborate on projects with similarly equipped schools and national research laboratories that have supercomputing resources to spare? Get on this list.

To subscribe, send e-mail to *listserv@suvm.syr.edu* with the command *subscribe superk12 firstname lastname* on the first line of the message. Leave the subject field blank.

Education Policy Digest mailing list. The EDPOL-D moderated discussion forum from Scholastic, Inc., was created for administrators, teachers, parents, researchers, policymakers, and anyone else interested in the present and future of K-12 networking and technology. focuses on educational technology policy on all levels—federal, state, and local—without the techno-talk.

To subscribe, send e-mail to

dealing with a large volume of messages that are not directed at you personally.

One alternative to mailing lists that does not suffer from this limitation is a globally distributed bulletin board system called USENET, which more than 4 million people use to exchange information, opinions, and data. USENET subdivides discussion topics into more than 5,000 "newsgroups" that carry a total of 75 megabytes of traffic every day—yet because the messages are kept at central sites, they don't clutter up your mailbox.

To read and post messages on USENET, you use a newsreader—special software that allows you to sift quickly through messages and read only what you know will be of interest to you. You can even use so-called bozo filters to tune out people whose messages you're not interested in.

USENET carries an entire hierarchy of newsgroups devoted to K-12 educators and students. And with so many narrowly defined discussion areas, USENET is a great place for students and teachers alike to get information from experts on every imaginable topic.

The downside is that some of USENET's 5,000 newsgroups concern matters most people—parents in-

edpol-d-request@scholastic.com with the command *subscribe edpol-d firstname lastname* on the first line of the message. Leave the subject field blank.

Educational technology mailing list. The EDTECH list provides a moderated forum to discuss educational technology at all grade levels, including higher education. Topics include problems in using educational technology and how to solve them, new books and articles, course offerings in educational technology, notable and not-so-notable educational hardware and software, educational technology conferences, and research projects.

To subscribe, send e-mail to *listserv@msu.bitnet* with the command *subscribe edtech firstname lastname* on the first line of the message. Leave the subject field blank. (Note: This list is also available as the newsgroup *bit.listserv.edtech* on USENET.)

Internet news mailing list. What's happening on and about the Net? The NET-HAPPENINGS list, provided by InterNIC Information Services, distributes news and announcements about the Internet itself to the network community. This is not a discussion list.

To subscribe, send e-mail to *listserv@is.internic.net* with the command *subscribe net-happenings firstname lastname* on the first line of the message. Leave the subject field blank.

Daily Report Card newsletter. The Daily Report Card news service summarizes the local, regional, and national media coverage of news stories related to education reform and the six national education goals. It is published by the American Political Network and distributed at no charge to a national audience of leaders in government, business, media, and education.

To subscribe, send e-mail to *listserv@gwuvm.bitnet* with the command *subscribe rptcrd firstname lastname* on the first line of the message. Leave the subject field blank.

Edupage newsletter. Edupage is a twice-weekly summary of information technology news items. It is provided without charge as a service by EDUCOM—a consortium of leading colleges and universities seeking to transform education through the use of information technology.

To subscribe, send e-mail to *listproc@educom.edu* with the command *subscribe edupage firstname lastname* on the first line of the message. Leave the subject field blank.

Infobits newsletter. Infobits is a monthly electronic news service that provides a summary of information technology and instruction technology news items. It is distributed without charge by the Institute for Academic Technology—a partnership between the University of North Carolina at Chapel Hill and IBM Corp.

To subscribe, send e-mail to *listserv@gibbs.oit.unc.edu* with the command *subscribe infobits firstname lastname* on the first line of the message. Leave the subject field blank.

Alawon newsletter. The American Library Association's Washington Office Newsline is an irregular publication that covers federal policy and legislation on public information access and technology. It is available free of charge.

To subscribe, send e-mail to *listserv@uicvm.uic.edu* with the command *subscribe ala-wo firstname lastname* on the first line of the message. Leave the subject field blank.

White House news summaries. This interactive e-mail newsletter service provides daily summaries of White House press releases. If an item is of interest, you may e-mail a computerized request to receive the entire document that has been summarized. Provided free of charge by the U.S. Department of Agriculture Extension Service.

To subscribe, send e-mail to *almanac@esusda.gov* with the command *subscribe wh-summary* on the first line of the message. Leave the subject field blank.

Radio Free Europe/Radio Liberty Daily Report. This free newsletter service provides a summary of the latest news and political developments in Russia, Transcaucasia and Central Asia, and Central and Eastern Europe. It is published Monday through Friday (except German holidays) by the Radio Free Europe/Radio Liberty Research Institute.

To subscribe, send e-mail to *listserv@ubvm.cc.buffalo.edu* with the command *subscribe rferl-l firstname lastname* on the first line of the message. Leave the subject field blank.—L.K.

cluded—would consider highly inappropriate for children. One of the most popular newsgroups in the "alternative" hierarchy is devoted solely to digitized centerfold images, and in others you can find erotica, pro-drug sentiments, and other potential hot potatoes. For this reason, schools that have opted to offer USENET access to students invariably exclude a large number of newsgroups from the feed.

Virtual field trips

Imagine your students reaching out a long electronic arm across the Net to connect to distant computers and make use of free resources and information that have been made available there for public use. The capability to do what is called "interactive remote host access" is by far the Internet's greatest strength. For many, the real power of the Net becomes apparent the first time they log on to a computer located on another continent.

Remote log-in (known as telnet) and file transfer (known as FTP, for File Transfer Protocol) are the ba[illegible] connections the Internet supports. To use a resou[illegible] though, you first have to know it exists—not an easy task when new ones pop up every day. To remedy this problem, several network resource discovery tools have been developed over the last few years that make finding and using the right resource on the Net much easier.

The most popular tool is arguably Gopher, which uses menus to deliver information in a user-friendly fashion. Retrieving a file is no longer a nightmare of clunky FTP commands—you can just press a button on the keyboard. Moreover, Gopher provides a way to link many related resources that are scattered all over the Net and bring them all together in one place. You can even search menu items on all known Gopher servers on the Net to find what you're looking for.

CURRICULUM PROJECTS ON THE NET

This spring, three intrepid British travelers are setting out across the Arctic Ocean—from Siberia to Canada via the North Pole—bringing all necessary food and supplies with them. As the members of the Arctic Drift Stream Expedition traverse the 1,400 miles of water and ice, schoolchildren worldwide will be able to follow their progress and participate in the expedition's environmental mission—courtesy of an Internet curriculum project. Through the magic of global e-mail, children in participating schools will receive progress reports from the expedition members, as well as newspaper articles and photos in coded form. They will also discuss environmental issues raised by the expedition.

The Internet abounds with projects such as this. During World AIDS Day '94, schools from all districts in Florida exchanged awareness messages over the Internet. In December, NASA combined satellite television and the Internet for a mini-series about robot explorers in Antarctica, organizing interactive e-mail activities for students—who would send questions to scientists they had seen on the program—and making teacher guides available over the Internet.

Here is a sampling of ongoing projects—many of which have been organized and implemented by enthusiastic teachers in connected classrooms:

Academy One is a series of curriculum-based educational telecomputing projects sponsored by the National Public Telecomputing Network (NPTN). Projects include providing students with remote access to supercomputers; hosting global "teleolympics" in which students compete in track events in their own schoolyards, compare results on the Net, and give recognition to the international winners; having schools around the world share electronic editions of school newspapers, chronological accounts of a day in a student's life, or data gathered about local pollution; simulated space shuttle missions; "key-pal" exchanges; comparisons of holiday customs; and sonnet-writing contests. Teachers may join curriculum exchanges and other educator support projects.

Academy One is available through NPTN affiliate freenets: *telnet freenet-in-a.cwru.edu* to connect to the Cleveland Free-Net. Most Academy One projects can also accommodate schools that are limited to e-mail. Send e-mail to *aa005@nptn.org* for information.

Kidlink sponsors annual projects aimed at getting children ages 10 to 15 involved in a global dialogue. The current project, Kids-94, runs until May 7; in preceding years, roughly 10,000 children from 50 countries on all continents participated. The dialogue takes the form of an exchange of personal presentations and views on the desired future of the world. To begin, children are asked to give information about themselves, what they want to be when they grow up, how they want the world to be better, and what they can do to make this happen.

To learn about the projects, send e-mail to *listserv@vm1.nodak.edu* with the command *subscribe kidlink firstname lastname* on the first line of the message, using your own name and leaving the subject field blank; you will be added to the Kidlink news mailing list. For more information, send e-mail to *kidlink-info@vm1.nodak.edu* or use the Kidlink Gopher server: *gopher kids.duq.edu*

Newsday is a multicurricular project sponsored by the Global SchoolNet Foundation in which upper elementary through high school students produce local newspapers based on news dispatches from student correspondents in all participating schools. Students become news gatherers and reporters, editors, layout and graphics artists, and publishers. At the end of the project, participants exchange their finished product.

To join, send e-mail to *newsday@bonita.cerf.fred.org* for more information.

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By far the most impressive discovery tool is the World Wide Web (WWW, or simply the Web), which you can use to surf cyberspace from one information resource to another using hypertext and hypermedia links across the Net itself. As you arrive at new locations, the most advanced Web interfaces can present information from the remote resources using full-color graphics—even video and sound.

At the Woodside School District in Woodside, Calif., third through eighth-graders use these tools to access information on the Internet—from computers located in their classrooms.

"This has done incredible things for opening the world to our students," says Theresa A. Baker (*tbaker@mail.barrnet.net*), the district's technology director. "They have access to bodies of knowledge that no single teacher can provide, and they are finding out about different people and cultures in ways never before imagined."

In Fort Collins, Colo., the entire Poudre-R1 School District makes use of these resources. "Students of all ages—but primarily seventh though 12th-graders—use the system daily," says Greg Redder (*redder@colostate.edu*), who provides technical support and instructional help to the school district on behalf of Colorado State University. "For example, the campaign '92 documents available via Gopher and NASA Spacelink are very big attractions.

Sixteenth-century illuminated manuscript from the Vatican Library exhibit at the Library of Congress. To access: *gopher marvel.loc.gov*

World's Youth News is a news agency for students sponsored by Free-Net Finland. WYN collects and exchanges news written by and for children worldwide.

To join, send e-mail to *wyn@freenet.hut.fi* for further information.

Kids-WeatherNet is a weekly exchange of weather data among schools from the Czech Republic to Tasmania and from Alaska to Florida. The project runs each year from mid-August to June, and is open to all schools that wish to participate. Data are compiled weekly by students at Manzano Day School in Albuquerque, N.M., and distributed to all participants.

To join, send e-mail to *echo@triton.unm.edu* for more information.

MathMagic is a K-12 telecommunications project designed to motivate students to use computer technology while increasing problem-solving strategies and communications skills. Teams pair up over the Net to engage in dialogue aimed at solving word problems posted in four different grade categories.

For information about how to join, send e-mail to *mail-server@forum.swarthmore.edu* with the command *send mathmagic_info* on the first line of the message. You may also access information about the project through the following Gopher server: *gopher.forum.swarthmore.edu*

I*EARN is a worldwide K-12 network of students in 20 countries on all continents who work together on projects that make a meaningful difference for the Earth and its people. Subject areas include arts, literature, social studies, economics, politics, languages, environment, and science. Students use e-mail, on-line conferences, and video-telephones to communicate.

To join, send e-mail to *ed1@copenfund.igc.apc.org* for more information.

Global Schoolhouse Project is funded by the National Science Foundation to connect schools and students nationally and internationally using a variety of tools, including live videoconferencing over the Internet. Schools collaborate on research in space exploration, solid waste management, alternative energy sources, and weather and disaster preparedness. (Minimum requirements to do videoconferencing over the Internet are a 56K or T1 connection, Mac or PC with a video board, standard telephone connection and speakerphone for audio, and a video camera; Cornell University's CU-SeeMe videoconferencing software is used.)

To join, send e-mail to *gfutz@cerf.net* for more information.—L.K.

along with pen pals and connections to foreign Gopher servers."

(For a list of classroom-appropriate Internet resources. see "Internet Field Trips: Your Road Map to the Information Highway," page 67.)

The talk of the Net

Students can use the Internet for live interaction, too. Internet Relay Chat (IRC) is an application that amounts to a global CB network. Users pick a channel or start a new one and then "talk" by typing and responding to conversational messages that are immediately relayed across the network and flashed simultaneously on terminals in many different time zones. Imagine an international conference call without long-distance charges. During and immediately following California's January earthquake, IRC was buzzing with information and reports of the destruction.

A lot of the chatting is just gossip—and some of it is lewd and even obscene. But several curriculum projects have made good use of Internet Relay Chat as a structured and supervised activity that links together classrooms in different countries for exchanges of greetings and views.

A related phenomenon is the multiuser simulation environment, which adds simulated activities to the conversations. These are on-line role-playing games in which a large number of participants interact—using typed text—in an environment that has been programmed to simulate a fantasy world. Most are purely recreational, and many involve adventure themes spun off from the "Dungeons and Dragons" role-playing games or the "Star Trek" television and movie characters. These so-called multiuser dungeons (MUDs) are notoriously addictive.

But simulation environments can have educational applications, too: The Massachusetts Institute of Technology's Artificial Intelligence Lab runs MicroMUSE, a safe K-12 learning environment with an emphasis on scientific, cultural, and environmental concerns. The kids who use the system get to design some of the virtual landscapes it contains—one 9-year-old created a simulated Yellowstone National Park, complete with erupting geysers and a wandering moose.

What's more, kids learn valuable lessons in civics as they construct virtual communities on-line, says MicroMUSE's founder Barry Kort (*barry@kudzu.cnidr.org*), a consulting scientist at Bolt, Beranek, and Newman Labs in Cambridge, Mass.

"Cooperation and collaboration are valued behaviors in such communities," Kort says. "I have seen leadership skills emerge as the participants discovered the rewards of crafting a just society in which everyone is able to find a worthwhile and constructive role."

Internet on a shoestring

So how much does all this cost? The answer: It depends, but it might be less than you think. Internet access from commercial providers varies in cost according to how sophisticated a connection you want and how many users you want to serve. Geographic location is another variable—prices tend to be lower in metropolitan areas, where competition between local access providers is stronger.

The most basic and cost-effective type of Internet connection is what's known as dial-up: using a personal computer and modem to call and connect to a host computer that in turn is connected to the Internet. This type of connection requires the least in terms of hardware on the school's end because the PC is not actually on the Internet, it's just being used as a terminal; the Internet host computer is actually doing all the work. Even 15-year-old PC dinosaurs like Radio Shack's TRS-80 have gotten a new lease on life this way.

One dial-up account can serve a teacher, an adminis-

IS YOUR STATE HERE?

Education networks in the following states provide full access to the Internet:

- Arizona
- California
- Florida
- Indiana
- Massachusetts
- Michigan
- Minnesota
- Missouri
- Montana
- Nebraska
- New Hampshire
- New Mexico
- New York
- North Dakota
- Ohio
- Oregon
- Pennsylvania
- South Carolina
- South Dakota
- Texas
- Virginia

trator, or a classroom full of kids for as little as a flat fee of $30 per month, often with no surcharges for connect time. And in metropolitan areas, the access provider is usually only a local call away.

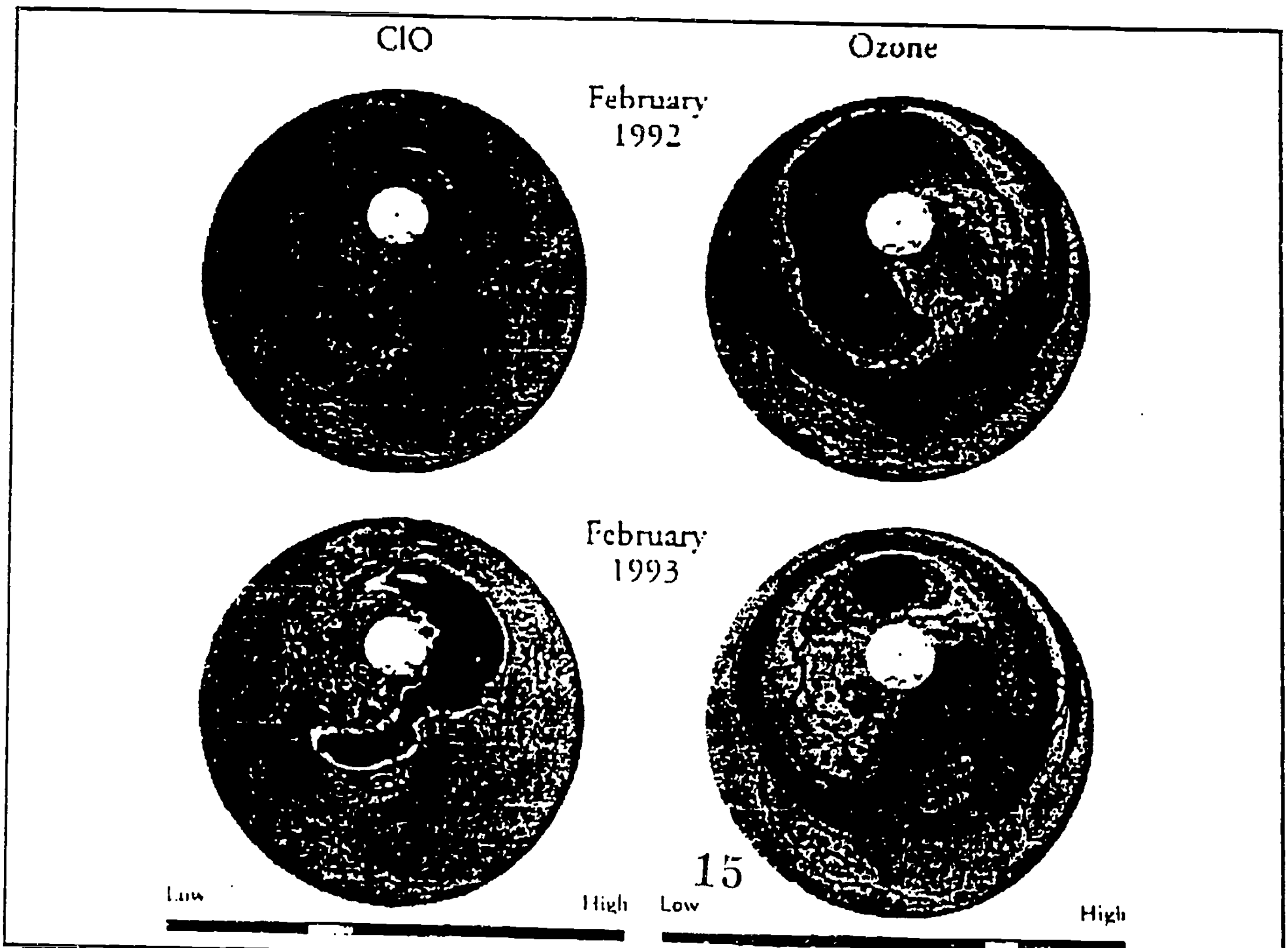
To find a commercial dial-up Internet access provider in your area, contact InterNIC Information Services at *info@internic.net* or (800) 444-4345. Or send e-mail to *info-deli-server@netcom.com* with the command *send pdial* in the subject field of the message; you will receive a list of dial-up access providers in the United States in return, courtesy of Peter Kaminski, proprietor of the Information Deli, an Internet consulting firm.

In many cases, schools can get dial-up Internet access free or for next to nothing through statewide education networks. According to the Educorp report *Networks Now: The 1993 Survey of How States Use Telecommunication Networks in Education*, full Internet access is available through education networks in 21 states (see box). Most other states either have an education network that is limited to Internet e-mail or are planning to implement an education network.

These state education networks currently provide Internet access to more than 109,000 K-12 users. Typically, staff and students with a computer and a modem can dial local or 800 numbers to connect to Internet hosts. Some state networks provide accounts only to teachers and administrators, but others also let students on-line.

"There's a danger that our society will become polarized between those [who] are information rich and those [who] are information poor, and I think the state has a role to play in preventing this," says Connie Stout (*cstout@tenet.edu*), who is the director of the Texas Education Network, or TENET.

To address the equity question, TENET provides full



Data from NASA's Upper Atmosphere Research Satellite shows how the ozone layer above Earth's northern hemisphere is being depleted as levels of chlorine monoxide in the atmosphere rise. Courtesy of the Jet Propulsion Laboratory's public information office. To access: *ftp pubinfo.jpl.nasa.gov*

Internet access for the nominal fee of $5 a year to more than 22,000 teachers, representing nearly every school in the state. Teachers may train students, who typically share one account per classroom.

Similarly, the California On-line Resources for Education (CORE) network makes Internet access available to more than 12,000 teachers and students in the state. Virginia's Public Education Network also dispenses accounts to both staff and students.

(For more information about the availability of education networks in your state, contact your state department of education or the Consortium for School Networking at *info@cosn.org* or 202/466-6296. To order a copy of the Educorp report, send an e-mail message to *dfrazier@cedar.cic.net* or call 703/345-1429.)

In many cases, too, universities will provide free dial-up accounts for teachers from local schools: Vanderbilt University, University of Kentucky, University of Maryland at College Park, Duquesne University in Pittsburgh, and El Paso Community College all provide such outreach programs.

Another free dial-up access option for students, teachers, and administrators is to get accounts on a local "freenet," provided there's one in the area. Freenets are community-supported networking projects that provide free accounts to the public—anyone who can connect with a computer and a modem. Freenets typically provide a wealth of community and local government information in addition to Internet access. (If you already have Internet access, you can telnet to a freenet to establish an account and use its resources.)

To find out if there's a freenet in your area, contact the National Public Telecomputing Network at *info@nptn.org* or (216) 247-5800.

Speed costs money—how fast do you want to go?

With a dial-up connection, your schools are driving the information highway via remote control; with a direct connection, they're right in the middle of Internet traffic. This has both benefits and drawbacks.

A direct connection to your schools allows your students to make more powerful use of the Internet, and it affords potentially greater control of content. With a di-

rect connection, users may also take advantage of friendly, point-and-click graphical interfaces to the Internet. The disadvantages are higher connection costs, a greater need for local technical expertise, and the necessity of more computing horsepower on the school's end.

The biggest cost variable is bandwidth—a measure of how fast the data flow through the connection. Bandwidth determines how many users can share a connection and what they can do with it.

The least expensive option involves using a high-speed modem—preferably 14,400 baud, or bits per second—to connect a PC or an entire local-area network of PCs to the Internet using an ordinary telephone line. This can be done using one of two similar methods: Serial Line Internet Protocol (SLIP), commonly used for connecting a single PC, or Point-to-Point Protocol (PPP), a more sophisticated method better suited to connecting local-area networks. Most dial-up access providers also offer these types of connections.

The next step up is a leased data line, dedicated to carrying the school's Internet traffic. Common speeds for dedicated lines are 56 KB (56,000 bits per second), T1 (1.54 million bits per second), and T3 (45 million bits per second)—the highest speed the Internet currently supports.

How much bandwidth is actually necessary for schools is a topic of hot debate. Faster connections allow a greater number of users to do more sophisticated things, such as videoconferencing, yet many argue the increased cost cannot be justified in terms of greater learning benefit.

Putting a school's local area network (with as many as 250 PCs) on the Internet using a SLIP PPP connection can cost as little as a flat fee of $250 per month plus a $750 startup fee. Hidden costs include hardware and software, technical support, and training. In comparison, a turnkey T1 connection that includes a leased line, installation, and 24-hour network information and support services can run as much as $55,000 per year plus line costs.

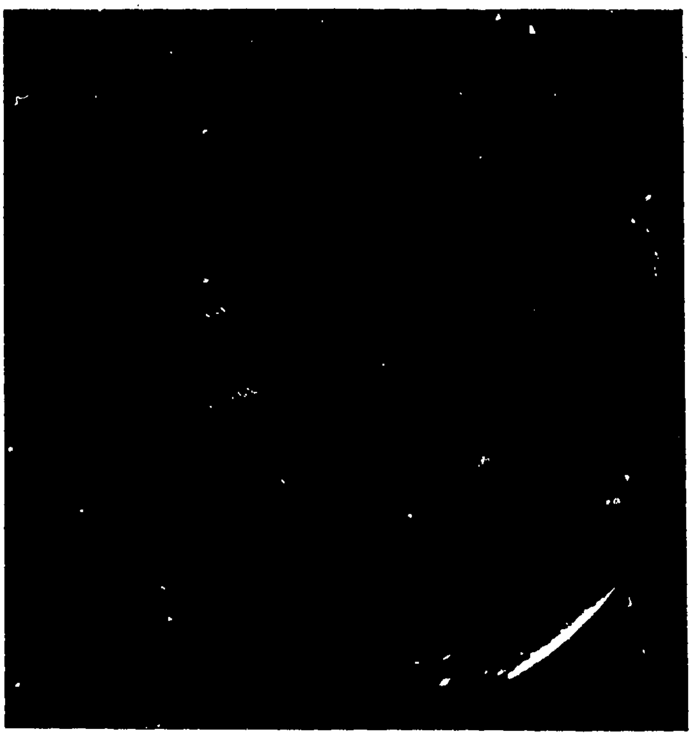
To locate a commercial dedicated-line Internet provider, contact the InterNIC (see above) or send e-mail (no message needed) to *dlist@ora.com* to receive an updated list of 38 U.S. providers, courtesy of computer book publisher O'Reilly and Associates.

In an effort to hold costs down, many school districts have formed partnerships with nearby universities or government laboratories that have Internet access to spare and are willing to siphon some of it off for little or no money. For example, the Florida Institute of Technology in Melbourne provides three local high schools with full Internet connections. Similarly, Gettysburg College in Pennsylvania connects Gettysburg Area High School via a T1 line and a Sun workstation; the Oak Ridge National Laboratories in east Tennessee make leased lines available to schools in the area; and the Oklahoma Geological Survey Observatory provides a dedicated line to Leonard School, which enrolls 125 K-8 students in rural Tulsa County.

Grants and demonstration programs are another way to pay for direct Internet connections. Thomas Jefferson High School for Science and Technology in Fairfax County, Va., for example, won its connection through SuperQuest, a national competition to get access to supercomputing resources.

Other grants also are available. For example, at press time, the U.S. Department of Commerce's National Telecommunications and Information Administration announced a $26 million matching grant program to help school districts and other nonprofits connect to the Internet and other networks. Contact the administration at (202) 482-2048 or *tiiap@ntia.doc.gov*; the application deadline is May 12, 1994.

And as the White House ponders sweeping changes in telecommunications regulations, many companies have discovered the public relations value in helping schools get Internet connections: Before calling off their proposed $33 billion merger in February, Bell Atlantic and TCI had announced plans to connect 26,000 elementary and secondary schools in areas served by the two companies. Although plans for that project might change as the two companies go their separate ways, Pacific Bell has made a similar proposal: to spend $100 million to connect 7,400 California schools, libraries, and community colleges with digital network lines that will allow Internet access and videoconferencing.



One thousand *Viking Orbiter* images were processed and combined to produce this composite photo of Mars, courtesy of the U.S. Geological Survey and NASA's Jet Propulsion Laboratory. To access: *ftp pubinfo.jpl.nasa.gov*

Why Johnny can hack—but not crack

You might think the potential for electronic high jinks would be considerable on the Internet. And in fact mischief does occur: In March, a college student was arrested by Secret Service agents for allegedly sending a death threat to President Clinton's e-mail address. But such incidents aren't common. With proper training,

kids generally conduct themselves responsibly—even, in many cases, policing each other's on-line speech and behavior.

"We've found that the community moderates itself," says Jack Crawford (*jack@rochgte.fidonet.org*), one of the founders of K12Net, a system of on-line conferences for students and teachers. "I used to lose sleep over this stuff, but I don't any more, because it takes care of itself. If someone gets out of line, everyone else will let him have it."

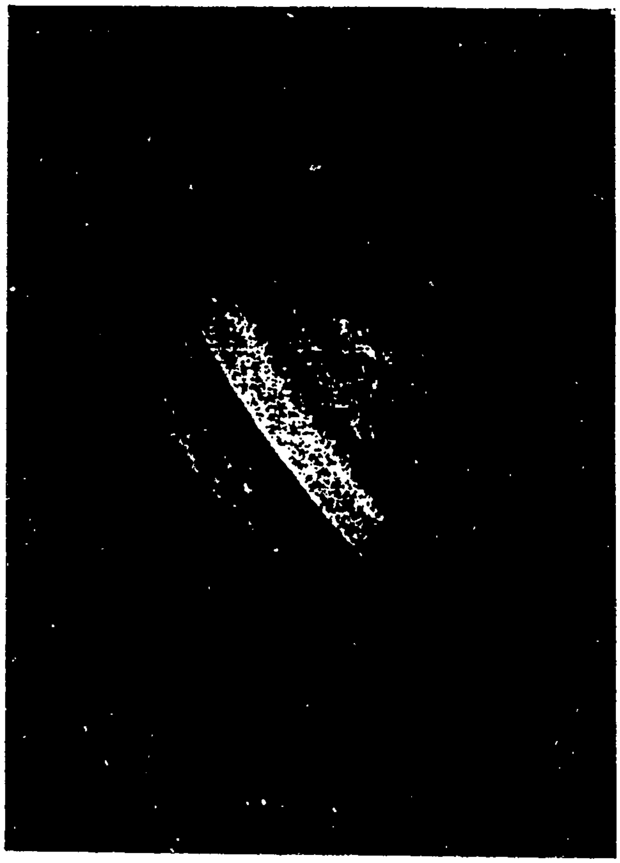
Robert D. Carlitz (*rdc@vms.cis.pitt.edu*), a professor of physics at the University of Pittsburgh who runs an unmoderated Internet mailing list for children, agrees that abusive or profane language is kept in check. In one incident, a student who had sent out an objectionable message immediately was inundated with reprimands from other students: "They sent messages saying, 'Hey, don't you know we're gonna lose our network access if you do that?'" Carlitz says.

Incidents of students who abuse a school's Internet connection to gain illegal access to other computers on the Net are few and far between. In the language of the Net, a person who does this is known as a "cracker"; in contrast, a "hacker" is someone who is very adept with computers. Should a break-in occur, you can get assistance from the Computer Emergency Response Team (*cert@cert.org*), based at Carnegie Mellon University.

"It took only a year for the first attempt," says Ron Tenison (*tenison@catseq.catlin.edu*), computer center director at Catlin Gabel School, a private K-12 school in Portland, Ore. "One of our students gave away a password, and someone else used the Internet connection to try to break in some other place. They were both picked up."

To prevent attempts at cracking, some schools don't allow staff members and students to access the school's Internet connection from home by means of a PC and modem. But such restrictions make it harder for teachers to find the time to become familiar and comfortable with the Net. And as K12Net's Crawford says, "You can't be visionary about something you don't understand."

Indeed, training for both teachers and students is essential, school networking experts agree. In a Ph.D. research study on the effects of Internet access for K-12 teachers, Florida Institute of Technology Network Administrator Mike Gallo (*gallo@zeno.fit.edu*) found teachers require ongoing Internet training, technical support, home Internet access, and time to learn and incorporate the Internet into their classes.



Voyager 2 took this picture of Saturn on July 21, 1981, when the spacecraft was 21 million miles from the planet. Courtesy of NASA's Jet Propulsion Laboratory. To access: *ftp pubinfo.jpl.nasa.gov*

No couch potatoes

Why Internet? Why not cable TV? Perhaps because the Internet obliterates the traditional mass media distinctions between producers and consumers of information. Anyone can provide information or a service to the Internet community—no marketing research committee gets to decide who or what. All it takes is a connection and a computer; even inexpensive desktop PCs and Macs can be set up as Gopher servers accessible to anyone anywhere on the Internet.

It's this essential two-way flow of information that sets the Internet apart—as a model for the information superhighway—from the passive consumerism of 500 cable TV channels. Even proprietary computer networks like CompuServe and America Online are designed primarily to deliver canned products to consumers for a profit.

Students in the Stark County School District in Canton, Ohio, know this well. Their StarkNet Gopher server not only allows them and their teachers to get to sources of information anywhere on the Internet, it also provides a means for them to make their work—creative writing, lesson plans, computer art and graphics, and sound files—available to other Internet users worldwide.

In the same way, the Columbia (Mo.) Public Schools make school board information, school lunch menus, and information about school athletic and fine arts events available on-line through the Gopher server they share with the City of Columbia, a local library, and the University of Missouri-Columbia—providing information to the local community and the world in one fell swoop.

In January, the Clinton Administration proposed to connect every classroom, library, hospital, and clinic to the planned National Information Infrastructure (of which the Internet is today's tangible reality) by the year 2000.

But why wait? The world already is a global village, and the Internet can make your students its citizens today. ◼

BEST COPY AVAILABLE

INTERNET FIELD TRIPS: YOUR ROAD MAP TO THE INFORMATION HIGHWAY

A comprehensive list of Internet travel destinations would fill a book, so we're presenting here only a sampling of interactive on-line resources of interest to educators and students. All resources on this list were available at press time, but keep in mind that services might change or disappear, and that host computers might be down temporarily.

To use the free resources on this list, you need access to a computer on the Internet that allows you to run the programs called telnet, Gopher, and FTP. (See the main article for a discussion about finding an Internet access provider.) Internet interfaces vary widely, yet these basic access methods are the Internet's common denominators. Instructions for accessing the resources are shown the way they would be typed at a Unix prompt: the name of the program followed by the name of the host computer you are accessing. (Unix is the most common operating system on computers connected to the Internet.) Other interfaces might require clicking on a program icon and entering the host name.

Here are some brief tips on using the programs:

Telnet connects you to a remote host computer as a terminal to run all kinds of programs. (If you don't have access to the World Wide Web or Internet Relay Chat on your local system, you can also use telnet to connect to public clients for these applications.) To terminate the connection prematurely, hit *Ctrl-]* and then type *quit*.

Gopher connects you to a menu-based information server running on a remote host computer. You can read and search for information and save files you've located. Use the up and down arrows to move the cursor, the right arrow to select a menu item, and the left arrow to retrace your steps. Menu items ending with "/" are directories, and those ending with "<?>" are searchable.

FTP allows you to retrieve files from a remote host computer. At the log-in prompt, type *anonymous*. At the password prompt, type your full e-mail address. To list files, type *dir*. In a directory listing, subdirectories are distinguished from files by a "d" at the beginning of each entry. To change to a subdirectory, type *cd <directory name>*. (Names of directories and files are case-sensitive. For example, "ReadMe.TXT" and "readme.txt" are not the same file.) In most cases, publicly available files reside in a directory called "pub." To move up one level in the directory structure, type *cdup*. If the file you want to retrieve is a software program or a graphic image file, type *binary*; if it is a text file, type *ascii* (this is the default). Then, to retrieve the file, type *get <filename>*. Type *quit* to terminate the connection. If you'd rather not have to use these clunky FTP commands, check out Colorado SuperNet's Gopher server, which allows you to use its menu-based interface to make FTP connections to virtually any host computer you specify. To access Colorado SuperNet: *gopher teal.csn.net*

Now, using these programs, here's a select list (in no particular order) of where you can go on the Internet and what'll you'll find when you get there. Bon voyage!

U.S. Dept. of Education

gopher gopher.ed.gov

Education research and statistics, funding opportunities, educational software, and information about the department and its programs.

Educational Resources Information Center (ERIC)

telnet sklib.usask.ca (log-in: sonia)

gopher ericir.syr.edu

The University of Saskatchewan allows Internet access to the searchable ERIC Current Index to Journals in Education and Resources in Education data base with records from 1983 to the present. The AskERIC Gopher provides information guides, searchable ERIC digests, listserv archives, education conference calendars, and more. (You may also send requests for information by e-mail to *askeric@ericir.syr.edu*)

Library of Congress

gopher marvel.loc.gov

Library of Congress card catalog, data base of pending and approved federal legislation, Supreme Court rulings, and on-line exhibits containing text and images—Vatican Library, Dead Sea Scrolls, Russian Archives, and 1492. Many additional federal and international resources.

Federal government information

gopher ace.esusda.gov

gopher esusda.gov

Public access to government information, including the Health Security Act of 1993, National Information Infrastructure documents, North American Free Trade Agreement, General Agreement on Tariffs and Trade, National Performance Review, White House information, U.S. Congress information including phone and fax numbers, 1995 proposed U.S. federal budget, Federal Emergency Management Administration, disaster relief information about the 1993 floods and the 1994 Northridge, Calif., earthquake, and more. Service provided by the U.S. Department of Agriculture Extension Service.

U.S. Congress

gopher gopher.senate.gov

gopher gopher.house.gov

Information about the U.S. Congress, U.S. senators and representatives, and committees. (These sites are new, and information is still being added.)

FedWorld

telnet fedworld.doc.gov

Access to more than 100 government data bases and computer bulletin boards and many sources of federal information.

Grants information

gopher bongo.cc.utexas.edu

Compilation of information about sources of fund-

ing. Includes searchable foundations data base, the Foundation Center, deadlines by agency, Catalog of Federal Domestic Assistance, Federal Information Exchange, National Institutes of Health, National Science Foundation, and more. Provided by the University of Texas at Austin. (Look in the World directory, then in Grants and Funding.)

NASA Spacelink

telnet spacelink.msfc.nasa.gov

Marshall Space Flight Center computer bulletin board for teachers and students. Provides information about NASA and space flight, shuttle schedules, space images, and more. Users may leave questions for NASA scientists.

NASA space images and info

gopher bozo.lpl.arizona.edu

ftp explorer.arc.nasa.gov

ftp pubinfo.jpl.nasa.gov

Space images from current and historical missions, animations, daily NASA news, mission information, curriculum materials, and education resources.

Smithsonian photos

ftp photo1.si.edu

A variety of Smithsonian photographs made available as electronic image files. Categories include air and space, art, people and places, science and nature, and technology and history. Provided by the Smithsonian Institution's Office of Printing and Photographic Services in Washington, D.C.

Newton (Argonne National Laboratory)

telnet newton.dep.anl.gov

U.S. Department of Energy computer bulletin board for teachers and students. "Ask a Scientist" service allows students and teachers to leave questions for scientists. Also features news about Argonne's educational and scientific programs; ideas for classroom demonstrations, activities, and field trips; discussions with teachers and scientists; calendar of events; publications; and more.

SpaceMet

telnet spacemet.phast.umass.edu

Computer bulletin board for teachers and students interested in space, science, teaching, and related subjects. Includes a data base of space information and on-line access to *USA Today*.

Classroom Earth

telnet classroom_earth.ciesin.org 2010 (include port number)

Environmental education bulletin board for educators and students that provides environmental information, resources, and conferencing.

EcoGopher

gopher ecosys.drdr.virginia.edu

Environmental resources, information, and news. Includes information about environmental organizations, project ideas, and an environmental library.

Global environmental information

gopher infoserver.ciesin.org

Environmental Internet Catalog contains weather and meteorology data, including current weather forecasts and current weather satellite images, as well as movies and images of the East Coast blizzard of 1993, the 1993 floods, hurricanes Andrew and Hugo, and software to play the movies on Macs and PCs. Many other resources. Provided by the Consortium for International Earth Science Information Network.

Weather forecasts

telnet downwind.sprl.umich.edu 3000 (include port number)

U.S. weather forecasts and climate data, current weather observations, ski conditions, long-range forecasts, earthquake reports, hurricane advisories, international weather data, and more. Provided by the University of Michigan Weather Underground.

Weather satellite images

gopher wx.atmos.uiuc.edu

gopher gopher.ssec.wisc.edu

Meteorological satellite images and weather maps, updated many times daily.

MicroMUSE

telnet michael.ai.mit.edu

K-12 multiuser system in which kids construct simulated learning environments in which to interact. Emphasis is on scientific, cultural, and environmental concerns. Provided by the Massachusetts Institute of Technology's Artificial Intelligence Lab.

Disabilities information

gopher.ucla.edu 4334 (include port number)

Includes full text of the Americans with Disabilities Act, related information, and links to other disability Gopher servers, including Deaf Gopher. From the UCLA Disabilities and Computing Program.

C-SPAN

gopher c-span.org

Information about the C-SPAN in the Classroom program, including program schedules and ways to use C-SPAN programming in the curriculum.

California Dept. of Education

gopher goldmine.cde.ca.gov

Information about school finance, curriculum, special education, charter schools, legislation, technology planning, and more.

California legislative information

gopher gopher.sen.ca.gov

Extensive information about California state senate and state assembly legislation and legislators.

California emergency information

telnet 134.186.127.1 5501 (include port number)

Disaster information and news, provided by the California governor's office of emergency services.

State of Texas information

telnet window.texas.gov

News and information about Texas state government, economic data, state and federal grants, and links to state computer bulletin boards. Provided by the Texas Comptroller of Public Accounts.

Library card catalogs

telnet pac.carl.org

telnet melvyl.ucop.edu

telnet nyplgate.nypl.org (log-in: nypl)

Access to library card catalogs of public libraries nationwide: the Colorado Alliance of Research Li-

braries; the University of California campus libraries; and the New York public libraries.

Teacher education Gopher

gopher state.virginia.edu

Discussion groups, teaching modules, research, electronic publications, and software archives related to teacher education. Established by the Society for Technology and Teacher Education, University of Virginia, and University of Houston to use the Internet to benefit teacher education programs around the world.

Academic Position Network

gopher wcni.cis.umn.edu 11111 (include port number)

On-line position announcement service based at the University of Minnesota. Includes faculty, administration, staff, graduate assistants, and fellowship positions, searchable by state or the entire United States.

On-line Career Center

gopher gopher.msen.com

On-line job bank includes announcements in all professions—including positions for superintendents, principals, and teachers.

Chronicle of Higher Education

gopher chronicle.merit.edu

Brief abstracts of news from the *Chronicle*, including job announcements.

Consortium for School Networking (CoSN)

gopher cosn.org

Information about CoSN; National Center for Technology Planning, a clearinghouse of school district technology plans; other information related to K-12 networking.

En route to Jupiter in 1990, the spacecraft Galileo passed the Earth and took this picture. To access: *ftp pubinfo.jpl.nasa.gov*

NYSERNet Empire Internet Schoolhouse

gopher nysernet.org

K-12 collection includes Internet project invitations, references and resources, career and guidance office with on-line admissions service for New York state colleges, grants information center, school reform and technology planning center, CNN Newsroom classroom guides, links to other school systems, and subject-oriented information.

K-12 student Gopher

gopher nuoca7.nuoca.ohio.gov

Suitable K-12 Internet resources without links to inappropriate sources of information. Federal government resources include Catalog of Federal Domestic Assistance, Clinton's Health Care Plan, Supreme Court Rulings, U.S. State Dept. travel advisories, and CIA World Factbook.

Florida Tech education Gopher

gopher sci-ed.fit.edu

Education resources by subject area, including space images from NASA, reference desk with Webster's Dictionary and Roget's Thesaurus, U.S. telephone area code and zipcode finders, world area codes, census information, geographic name server, libraries, and more.

Blacksburg Electronic Village

gopher morse.cns.vt.edu

Electronic Schoolhouse with K-12 education resources, including information and links to sources of information arranged by subject area.

Armadillo middle school Gopher

gopher chico.rice.edu 1170 (include port number)

Collection of K-12 Internet Acceptable Use Policies and information about Texas natural and cultural history. Created by teachers and students in the Houston School District.

Canada's SchoolNet

gopher ernest.carleton.ca 419 (include port number)

Collection of K-12 offerings for Canadian schools.

Schools you can visit on the Internet

gopher sparc3.sparcc.ohio.gov

gopher bigcat.missouri.edu

gopher bvsd.k12.co.us

gopher titania.ckp.edu

gopher lobo.rmhs.colorado.edu

gopher gopher.prs.k12.nj.us

gopher wealaka.okgeosurvey1.gov

gopher copernicus.bbn.com

Stark County School District, Canton, Ohio; Columbia (Mo.) Public Schools; Boulder Valley (Colo.) School District; Pittsburgh Public Schools; Poudre-R1 School District, Ft. Collins, Colo.; Princeton Regional School District; Leonard School, Tulsa County, Okla.; and the National School Network Testbed, a project of Bolt, Beranek, and Newman, Inc.

State education networks you can visit

gopher gopher.tenet.edu

telnet vdoe386.vak12ed.edu (log-in and password: guest)

telnet eis.calstate.edu (log in: ctp)

telnet psupen.psu.edu (user name: TX)

gopher informns.k12.mn.us

telnet k12.ucs.umass.edu (log-in: guest)

telnet bigsky.bigsky.dillon.mt.us (log in: bbs)

telnet sendit.nodak.edu (log in: bbs; password: sendit2me)

telnet gcedunet.peachnet.edu

Texas Education Network; Virginia Public Education Network; California On-line Resources for Education; Pennsylvania Department of Education Teacher

Pages; Internet for Minnesota Schools (formerly TIES-net); University of Massachusetts K-12 Info. System: Big Sky Telegraph, Montana; SENDIT, North Dakota; and GC Edunet, Georgia.

United Nations
gopher gopher.undp.org
Information about the U.N. and its agencies, current news and press releases, and General Assembly and Security Council resolutions.

World Bank
gopher ftp.worldbank.org
Public information service containing searchable documents and publications about World Bank activities in many countries.

World Health Organization
gopher gopher.who.ch
Press releases, and information about influenza, diabetes, and AIDS. Located in Switzerland.

Ex-USSR data base
telnet ukanaix.cc.ukans.edu (log-in: ex-ussr)
Information about former republics of the Soviet Union, including lists of top officials from Russia, Uzbekistan, Turkmenistan, Tajikistan, Tatarstan, Kazakhstan, Belarus, and Kyrgyzstan; e-mail addresses for a wide variety of institutions and organizations in the former USSR, including several K-12 schools; and discussions. Web interface.

Russia-America information
telnet solar.rtd.utk.edu (log-in: friends)
"Friends and Partners" service, jointly developed by citizens of Russia and the United States, serves as a repository for information about the two countries. Contains much useful K-12 information. Web interface.

Russian Freenet
telnet izhmark.udmurtia.su (log-in and password: guest)
Talk to Internauts in Russia.

University of Zagreb, Croatia
gopher diana.zems.etf.hr
News reports from Sarajevo and Bosnia, daily press bulletins from the Serb-Croat conflict, press releases from the Croatian Foreign Ministry, and U.S. Embassy daily bulletins. (Slow connection.)

Israel and Jewish information
gopher israel-info.gov.il
gopher jerusalem1.datasrv.co.il
gopher israel.nysernet.org 71 (include port number)
Information about Israel and Arab-Israeli relations, including maps and pictures, provided by the Ministry of Foreign Affairs in Jerusalem; electronic Jewish library, containing Holocaust archives and historical documents, provided by the Jerusalem One Network; Jewish networking information, including Holocaust information and pictures, provided by the New York-Israel Project.

National University of Singapore
gopher solomon.technet.sg
News and information about Singapore and the British Council.

French-speaking Gopher
gopher gopher.jussieu.fr
Links to French-speaking gopher servers across the world. On-line subway navigator lets you find a route in the subways of Lille, Lyon, Paris, and Munich in either French or English.

Japan Gopher
gopher gan.ncc.go.jp
Information about the culture, diplomacy, economy, events, food, geography, government, history, society, and universities of Japan—from the Japanese perspective. Provided by the National Cancer Center in Tokyo.

European Gopher servers
gopher gopher.sunet.se
Swedish gopher provides links to other gopher servers in European countries.

Wellington, New Zealand City Council
gopher gopher.wcc.govt.nz
Information about New Zealand and the town of Wellington.

World Wide Web demo
telnet ukanaix.cc.ukans.edu (log-in: www)
Open Web client with text-based interface for Internet users who do not have Web access on their local systems. Use up and down arrows to move between hypertext links, right arrow to activate a link, and left arrow to retrace your steps. You are not limited to the links that are shown; to create new hypertext links, hit *g* and enter a new Uniform Resource Locator name. You may wish to try the following useful URLs:
http://info.cern.ch/hypertext/DataSources/Yanoff.html
http://www.cen.uiuc.edu/~jj9544/index.html
http://galaxy.einet.net/gopher/gopher.html

Internet Relay Chat demo
telnet ircclient.itc.univie.ac.at 6668 (include port number)
Open IRC telnet client in Vienna, Austria, for Internet users who do not have IRC access on their local systems but want to try it out. Limited to 15 users at a time, so use sparingly. When you log in, you will be prompted for a nickname to identify you to other users on-line. Commands begin with a slash: Use */list* to see a listing of all available chat channels, use */join =name-of-channel* to join a channel, and */quit* to disconnect. Anything else you type on the command line will be broadcast. (Connection may be slow.)

Internet information
gopher internic.net
Information, registration, and directory services for the Internet community. Provided by InterNIC Information Services as a service of the National Science Foundation.

Internet training materials
gopher trainmat.ncl.ac.uk
A collection of network training materials and information.

Internet trainers and consultants
gopher gopher.fonorola.net
A directory of network trainers and consultants. Look under the Internet Business Journal.—L.K.

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Restructuring for Learning With Technology: The Potential for Synergy

The agendas of active learning, technology, and restructuring – each a powerful vehicle for changing learning and teaching in schools – need to be pursued concurrently to be maximally effective, Ms. Sheingold maintains.

BY KAREN SHEINGOLD

THE SUCCESSFUL transformation of student learning in the Nineties will require the bringing together of three agendas of reform: an emerging consensus about learning and teaching, a movement toward well-integrated uses of technology, and the push for restructuring. Each agenda alone presents possibilities for a very powerful redesign of education. Yet none has realized – or is likely to realize – its full potential in the absence of the other two.

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In the past, approaches that view students as active learners and that aim to help students understand academic content and be able to think were seen as important for only selected groups of students.[1] Today, these goals and approaches are urged as priorities for *all* students. The consensus emerging about these ambitious learning goals and methods — supported by a body of research on how people learn — both demands and makes credible a broader commitment to this approach than has thus far been attempted.

Similarly, past technologies have been promoted as "the answer" for education.[2] Today, these views are generally tempered by an understanding that it is not the features of the technology alone, but rather the ways in which those features are used in human environments, that shape its impact. At the same time, the technology itself has changed. Today's computer and video technologies are more powerful and versatile than the technologies that preceded them and are much more widely available in schools than were earlier technologies. Moreover, their pervasiveness in the world of adult work has given them a new legitimacy in school, and a growing cadre of teachers is learning how to use them well.

Indeed, reforms of many kinds have continually cycled through American education.[3] For example, recent reforms have called for "injections" of new kinds of curricula and teaching methods or for more stringent adherence to standards. Yet proponents of restructuring argue that, unless the system itself changes in fundamental and thoroughgoing ways, no reforms can be successful in the long run. Restructuring provides a framework for changing the system as a whole, thus creating an environment within which particular reforms can be carried out successfully.

Below, I further define these three agendas, lay out the opportunities and challenges each presents, and discuss how advancing each requires advancing the other two. I also describe some of the places where these agendas are beginning to come together and offer some recommendations about how the process might be speeded. Because of space limitations, I have neglected many relevant issues (e.g., assessment, accountability, incentives, and the uses of technology to promote restructuring independent of student learning). However, some of these considerations are discussed in the other two articles in this special section.

CONSENSUS ON LEARNING: THE OPPORTUNITY

Educators and policy makers nationwide recognize the critical need for students to learn how to think, to understand concepts and ideas, to apply what they learn, and to be able to pose questions and solve problems. Such goals, once pursued only in our best public and independent schools, are now deemed mandatory for all U.S. children. These goals represent standards that are not simply higher than current ones but qualitatively different. We are not seeking more of the same; we are pursuing much more complex and rigorous standards of academic accomplishment.

The realization that approaches to teaching and learning must be fundamentally altered comes from many quarters. The recent report of the National Governors' Association emphasizes that students must learn to use their minds well in school and points out that radical changes are required to overhaul the school curriculum. Textbooks and curriculum materials, the report points out, "focus largely on the mastery of discrete, low-level skills and isolated facts, and deny opportunities for students to master subject matter in depth, learn more complex problem-solving skills, or apply the skills they do learn."[4] Similarly, those who are working on a comprehensive redesign of school curricula, those who analyze how students are doing in particular subjects, and those who conduct national assessments have all come to similar conclusions about what our students ought to be learning and about the changes that must occur in how students learn.[5]

As educators and policy makers stress the urgency of pursuing these new goals for student accomplishment, they acknowledge that the goals rest on a

quite different model of what teaching and learning should be about.[6] Effective learning hinges on the active engagement of students in constructing their own knowledge and understanding. Such learning is not a solitary process; it occurs through interaction with and support from the world of people and objects and through the use of technologies of many kinds. In this model of learning, teaching involves less telling and more supporting, facilitating, and coaching of students. And learning itself becomes not the acquisition of a stable body of facts and truths, but rather a dynamic process of understanding knowledge and its human creation.

This set of assumptions goes by a variety of labels, among them *student-centered* and *constructivist*. I will refer to this approach as active learning/adventurous teaching, to acknowledge from the beginning that both learning and teaching are under revision.[7]

WHAT DOES IT TAKE?

What would it mean to create classrooms in which the goals of active learning/adventurous teaching are seriously pursued? Much research in recent decades has informed us about the kinds of classroom circumstances that help students to develop a deep understanding of academic content.[8] Students should engage in complex tasks — such as conducting a science experiment, composing a poem, or analyzing the causes of economic decline in their local community — that enable them to participate in the many processes that make up intellectual accomplishments. By and large, tasks should *not* have one right answer, and problems should *not* have only one route to a solution. To the greatest extent possible, students should engage in work that has an understandable, even compelling, purpose. Authentic and legitimate work, work that has real connection to the world outside school, is likely to be engaging and memorable precisely because it does matter.

Moreover, because students come to school with markedly different backgrounds, interests, and skills, learning must be individualized much more than the typical format of whole-group lessons will allow. This doesn't imply that students should spend all their time learning alone. To the contrary, small-group and collaborative learning can be effective methods for accommodating and addressing differences in students' understanding and skills, as well as for involving them in complex and challenging tasks. However, the lockstep approach to learning that is common in most schools (i.e., everyone in the same grade learning the same thing, at the same time, and in the same way) will fail for many students. Schools must find ways of diagnosing students' strengths and weaknesses and must devise programs that build on students' strengths, allow them to pursue existing interests and to cultivate new ones, and enable them to get help when they need it.

> ■BY AND LARGE, STUDENTS' TASKS SHOULD *NOT* HAVE ONE RIGHT ANSWER, AND PROBLEMS SHOULD *NOT* HAVE ONLY ONE ROUTE TO A SOLUTION. RATHER, STUDENTS SHOULD ENGAGE IN WORK THAT HAS AN UNDERSTANDABLE, EVEN COMPELLING, PURPOSE.

In addition, classrooms will have to become places where all students can be deeply engaged in learning subject matter. Learning to think and learning content are integrally related. Only through serious involvement with content can students be challenged to reason, question, integrate information from different sources, and devise their own interpretations. At the same time, such "higher-order" activities help students to understand and remember information and ideas.

THE CHALLENGE

The challenge presented by pursuing these kinds of goals and approaches is profound. Historically, such approaches have proved most difficult to implement and have succeeded only at the margins of the education establishment.

Creating schools in which students are engaged in learning and are learning to use their minds well means asking teachers to do something that is very hard to do. It requires them both to give up long-held beliefs about teaching and learning and to devise instruction that embodies the new goals and approaches. Indeed, as David Cohen eloquently argues, we know little about the instructional implications of the view of learning that pervades — implicitly if not always explicitly — current reform efforts.[9] Cohen's term, *adventurous teaching*, appropriately conveys what such teaching involves, as well as what is entailed in becoming such a teacher.

This approach also requires that schools and teachers make very hard choices about curriculum. If students are to be held accountable for understanding (not just memorizing), for applying knowledge (not just reciting it), for demonstrating their understanding through carrying out complex projects, and for doing their own research, then they must venture more deeply into a carefully chosen set of topics or concepts. Teachers and others will have to decide what curricular material deserves such focused effort — and what can be ignored.

Similarly, if the active learning/adventurous teaching approach is taken seriously, many organizational features of schools must be questioned. For example, 40-minute periods are too short to do justice to the kind of work students will be expected to do, and some of the information resources that students will need for their work may not be found within the school but will instead be available in the larger community or through telecommunications networks.

Clearly, there is no single way to embody these assumptions, approaches, and goals in a functioning school. There are teachers, principals, and reform groups (e.g., the Coalition of Essential Schools) already taking this task seriously. But the field is genuinely open for experimentation, discovery, and creation. Indeed, the

possibility of success hinges on such openness.

NEED FOR RESTRUCTURING AND TECHNOLOGY

What is required to advance such an ambitious agenda in the nation's schools? First, there must be a widespread public commitment from policy makers and educational leaders. More important than public statements and documents, however, is real commitment to creating the kind of school environments that will support innovations. (Jane David discusses such a school environment in her article in this special section.) In an innovative school, people are encouraged to take risks, to learn from one another (and from those outside the system), to work hard at changes that (whether they succeed or fail) can inform future plans and designs. The commitment to creating this kind of school environment is inherent in restructuring as it is currently defined. However, because active learning and adventurous teaching are so difficult to institute, schools and teachers will need to have available to them and make well-integrated use of any technologies that can help support and advance this agenda.

WELL-INTEGRATED USE OF TECHNOLOGY: THE OPPORTUNITY

While future technologies offer almost unimaginable possibilities to education, even those that are currently available have significant potential for supporting active learning and adventurous teaching. For example, computer software tools, such as word processors and graphing programs, can help organize and structure complex tasks for students. Video and videodisc technologies can provide visual examples of real-world phenomena, events, and stories that students can use for problem-finding and problem-solving activities. Computer networking and satellite communications technologies can help promote local and long-distance collaboration and communication among students and teachers and can help them become part of the larger world of scholars and scientists. Within classrooms and through networks, students can create and have access to databases that can enhance their research.

Multimedia technologies can provide much richer sets of materials for learning than are typically available in classrooms or school libraries today. These can contribute significantly to students' exploration and research. The production capabilities of computers and video cameras enable students to create attractive, professional-looking products of their own design, which can easily be shared or revised. In addition, the public nature of computer work in classrooms can help foster collaboration, discussion, and reflection. Some kinds of computer software can help students monitor and manipulate their own thought processes as well as demonstrate concepts that prove hard to grasp (e.g., what a median is). Other software allows students to simulate complex scientific, economic, or historical events and phenomena, thus exploring the variables and relationships that constitute these phenomena.

All of these uses can contribute to the kinds of classrooms we envision. Taken together, they can provide a resource-rich environment for our resource-poor and often crowded classrooms.

Some schools in this country have adopted these and other creative uses of technology that support students' engagement, active learning, and thinking. There are an increasing number of reports from the field about good projects, excited teachers and students, and creative uses of technology. Educational technology magazines regularly carry impressive stories about what teachers have accomplished with technology in their classrooms. Now the research evidence is beginning to accumulate that computer use in classrooms can support and help bring about active learning. (The article by Allan Collins in this special section provides details.)

In addition, a recent survey of a group of teachers selected because of their accomplishments in integrating technology into their teaching practice revealed that most of them believe that their practice itself has changed as a result of using computers.[10] They indicated that they are capable of presenting more complex material to students, that student work can proceed more independently and in ways that are better tailored to individual needs, and that they are acting more as coaches than as information providers. For some of these teachers, the process of integrating the technology did more than enable them to change things in their classrooms: it actually helped them to see that change was needed.

THE CHALLENGE

Despite the promise that new technologies offer to schools and despite the encouraging developments in some places, the full potential of the technologies is not being widely realized. The use of technology in schools has yet to be tied directly to agendas for improving learning on a large scale. Computer-based technology has been brought into schools during the past decade largely because the technology was seen as important in and of itself — because it was an increasingly central component of the world of adult work. Courses in programming and computer literacy in secondary schools and drill on basic skills in elementary schools have been the general rule.[11] Only recently have applications — word processors, database management systems, spreadsheets, and graphics programs — made their way into more than a few classrooms. And only recently have educators been attempting to integrate the use of computers into subject-matter teaching and learning. But technology is not likely to have a qualitative impact on education unless it is deeply integrated into the purposes and activities of the classroom.

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NEED FOR ACTIVE LEARNING AND RESTRUCTURING

If districts, schools, and teachers decided that the central (if not the sole) purpose of technology in the schools was to help achieve active learning and adventurous teaching, then technology would have a comprehensive, exciting, and forward-looking role in the schools. This purpose would bring focus and depth to the use of technology, would enable schools to take advantage of the expertise of teachers who are already using technology to further these goals, and would probably have a significant educational impact.

Giving technologies a serious educational mission in schools and districts is not sufficient, however. Once teachers begin to use technologies well to advance student learning, they often 1) need more time to learn about, obtain additional training in, and plan for the use of the technologies; 2) want students to have longer blocks of time in which to do their technology-based work; 3) want to integrate the curriculum and try team teaching; and 4) need greater access to technologies for themselves and their students. The barriers these teachers must overcome are precisely what teachers in restructuring districts have (or are supposed to have) the authority to change.[12]

It is very unlikely that the widespread and effective use of technologies to promote active learning can take place unless schools can reorganize their own structures, priorities, and spaces. As with active learning itself, seriously pushing the potential of technologies requires both a commitment to thoughtful innovation and a school community that supports such change. Restructuring can provide the context in which such innovation can take place.

RESTRUCTURING

Within the last decade there has been nearly universal agreement that our schools are not working for a large proportion of our students. The list of indicators is long, consistent, and depressing. Not only are students not learning the complex skills and knowledge that they need to function effectively and productively as citizens in our democratic and increasingly information-oriented society, but many are dropping out long before they complete high school. Others, although present, remain lethargic, uninterested, and unchallenged by a system that rewards obedience and passivity.

A first wave of school reform, based on the naive assumption that we needed only larger doses of the same sort of education — e.g., more requirements, a longer school day and year — has not produced significant positive results. A second wave, now proceeding, is founded on the more radical assumption that we need nothing less than a wholly reorganized system operating on a different set of expectations and incentives.

> ■ RATHER THAN TELLING SCHOOLS HOW TO DO WHAT THEY MUST DO, THE CENTRAL OFFICE CAN HELP THEM GET THINGS DONE.

WHAT IS RESTRUCTURING?

In practice the term *restructuring* means many things at the moment. It is applied to phenomena as diverse as giving teachers more authority for school management, reorganizing a school's daily schedule, developing performance-based assessments to measure student learning, and creating ungraded classrooms. It seems either that the term is ill-defined or that it refers to something so general that all of these phenomena qualify as part of it. Yet an attempt at definition is critical if restructuring is to mean, as it must, more than this year's special project.

The central idea underlying many restructuring efforts is that the system itself must be reorganized from top to bottom in order to achieve the kinds of learning and thinking outcomes now seen as necessary for students. An organizational structure must be created in which authority and responsibility are aligned — in which those who are charged with getting the job done, namely schools and teachers, have the authority and the support they need to do it. In the long run, this means that schools and districts must be accountable for achieving certain yet-to-be-defined outcomes, rather than for adhering to a set of procedural guidelines and regulations. Educators will have the responsibility for deciding how to reach these goals.[13]

Such an approach dictates a very different relationship between the central office and the schools, and many decisions must be pushed down to the school level. The central office can then play a more supportive role. Rather than telling schools how to do what they must do, the central office can help them get things done. In addition, community participation is seen as central to the setting of goals for the school system and, in some cases, to school-based decision making as well.

This systemic approach to reform, by itself, says nothing about how schools should operate or how teachers should do their work. It assumes that — given the authority, support, and incentives — school staffs can figure out how to achieve the desired outcomes. Through such a structure, it is hoped that people's best efforts and energies will be mobilized and will flourish. Over time, this outcomes-oriented system that respects teachers as professionals should lead to a much more productive education system.

CHALLENGE

The challenge of making the complex changes that are called for by restructuring is staggering. All participants in the system — superintendents, principals, teachers, students, parents, school board members, and community members —

must learn how to do their jobs differently. The allocation of resources must be reexamined, often by people who have not previously been involved in such matters.

What were once taken as "givens" are now being reconsidered. What constitutes a school (no longer simply a separate building) is being called into question, as educators discover the importance of creating small communities within which students can be known and valued as individuals. Within schools, schedules, grouping practices, teaching assignments, the use of space, curriculum, and assessment must all be rethought and redesigned. District and state regulations, formerly insurmountable obstacles to change, are being waived for schools that can justify the waiver as necessary for their programs.

NEED FOR ACTIVE LEARNING AND TECHNOLOGY

With all this activity in the interest of systemic change, by far the most serious challenge for restructuring efforts is actually changing what and how students learn in school. If this does not happen, then restructuring will have failed to achieve its central purpose.

Thus the ambitious goals for student accomplishment and radical approaches to reorganizing the educational enterprise must be met with equally ambitious and radical approaches to changing learning and teaching in the classroom. If we seek qualitative change, we must be willing to craft qualitatively different instructional practices and learning environments. The active learning/adventurous teaching approach can guide, inform, and be informed and expanded by the restructuring process.

Finally, if restructuring is to succeed on a large scale, it will need to take maximum advantage of the tools and techniques that can support the process. It is unlikely that the ambitious goals for learning and teaching can be met without widespread, creative, and well-integrated uses of technologies of many kinds.

EFFORTS AT SYNERGY

If my argument so far is correct, considerable synergy should result from the thoughtful bringing together of these three agendas. Each both requires and advances the other two. Restructuring provides the expectations and organizational conditions that foster and sustain genuine, well-supported, and long-lasting innovation; high standards for student accomplishment and an active learning/adventurous teaching approach (well-matched by newly designed assessments and accountability systems) define both purpose and direction for the innovations; and technologies act as both supports and catalysts for the redesign of learning and teaching (and of the reorganization effort).

To date, evidence of such synergy is slim indeed. But that is not surprising, given the recency of all three agendas and the challenges that each one poses in its own right. Yet these ideas are making their way into a number of public forums — although the active learning connection is often only implied or left out entirely. In the past few years, increasing numbers of national conferences of educators and researchers have included restructuring and technology on their agendas. The National Education Association and the American Federation of Teachers, in collaboration with major vendors, have each been involved for several years with technology projects in support of restructuring. The Coalition of Essential Schools has just begun an IBM-supported project to assist two of its member schools in developing computer-based "exhibitions" of student performance.

There are also individual schools and districts working on these issues. Everything is in its early stages; nonetheless, I have been able to gather three types of examples: technology schools in restructuring districts, a technology/active learning project in a restructuring district, and whole districts making technology an element in restructuring.

TECHNOLOGY SCHOOLS

In some restructuring districts (e.g., Dade County, Florida; New York City; St. Paul; and San Diego) technology schools are being created. New schools

offer unique possibilities because they can design themselves from the ground up. Technology schools are especially interesting because they can provide real examples of the integrated use of technologies in environments in which technological resources are plentiful and staff and students are interested in using them imaginatively.

In some districts, where new buildings are being designed for technology schools, there are exciting opportunities to think through the spatial implications of reorganized learning environments. For example, newly designed schools might have:

- teacher technology rooms, where teachers can have access to technology for their own work and for collaborative projects;
- spaces of different sizes and shapes for students' individual work, for small groups, and for large groups;
- special studios or spaces in which students can work on technology-intensive projects; and
- electronic displays of student work in classrooms and in public spaces.

There are two risks associated with the creation of technology schools, however. First, they may do on a districtwide level what computer labs do in some schools: relegate technology to the margins of the system. Thus integration would become harder to achieve. Second, technology schools may focus on technology per se but lack an educational vision.

One technology school that does have a broader educational vision is the School of the Future, now beginning its second year of operation in New York City's District 2. It came into being as a result of a grant from the U.S. Department of Education's Fund for Innovation. It is located in a district in which the superintendent has been supportive of schools that give students a variety of options for obtaining a good education. All students in the district may apply to these schools. The School of the Future started with 82 seventh-graders and plans to add a grade each year through high school.

Before the school opened, its director created a vision for the school as a place where technology would be used for learning. She hired six teachers, three of whom had technological expertise, and together they planned — and continue to plan — what kind of school it is going to be. They selected students who were interested in technology (though not necessarily experienced with it), who had stick-to-itiveness, and who wanted to work in groups. The ethnic composition of the student body was selected to match that of the district (30% Asian, 30% white, 20% Hispanic, 20% black). Academic achievement was considered only to ensure adequate diversity.

> TEACHERS WILL HAVE TO CONFRONT SQUARELY THE DIFFICULT PROBLEM OF CREATING A SCHOOL ENVIRONMENT THAT IS FUNDAMENTALLY DIFFERENT FROM THE ONE THAT THEY THEMSELVES HAVE EXPERIENCED.

The plan for the School of the Future emphasized students' use of technology for projects. To give them time to get deeply involved in their work, class periods would run 100 minutes in length. Teachers were to function as guides and coaches. Teachers spent a great deal of time over the summer planning the curriculum (English and social studies are integrated under the rubric of *humanities*), and they were able to do some of their work over the board of education's computer network.

The school has a networked computer lab, in which students take their technology class and learn basic applications (word processor, database, and spreadsheet). Once students master the basic applications, the technology class and lab are used for student projects. The school also has computers in the classrooms (six for every 28 students), a scanner, a laser printer, video production equipment, a CD-ROM drive, and even an electronic easel that the school found abandoned in the district office. Eventually, students will be able to borrow computers for home use.

Although these plans sound very different from those of most schools, the school is still bound by state and city requirements and examinations. It is approaching student assessment gingerly, planning first to work on alternative forms of assessing students in elective courses.

It is much too early to know how the School of the Future will work out, but the teachers have been given a great deal of authority to design and redesign the educational program of the school. They see themselves as learners and as creators, and they are taking an appropriately experimental approach to their new school.

Certainly, from the perspective of size, selectivity, and resources, this school is starting out with many advantages. Some obvious barriers do not exist; others have been made less formidable. While removing such impediments does not ensure success, it does give the teachers more time to focus on the central issues of learning and teaching. Teachers will have to confront squarely the difficult problem of creating a school environment that is fundamentally different from the one that they themselves have experienced. Clearly, the School of the Future represents fertile ground in which to grow a technology-infused, reorganized school that gives student learning high priority. What is not clear is how (or whether) what is learned in this school will affect other restructuring efforts in New York City.

TECHNOLOGY PROJECTS IN RESTRUCTURING DISTRICTS

All districts have computers and related technologies, some in large quantity. In most districts, one can find special technology projects, often carried out by schools in collaboration with universities or with hardware vendors. But there are few projects in restructuring schools and districts that are explicitly aimed at furthering *both* reorganization and active learning. Discover Rochester is one.

Discover Rochester is a research and demonstration project entering its third year in a middle school in Rochester,

New York. The project is a collaborative effort of the Rochester City School District, the University of Rochester, the Rochester Museum and Science Center, and the Center for Technology in Education at Bank Street College.

Rochester, an urban district with a large number of poor students, is undergoing major restructuring. As part of this effort, it has reorganized its middle schools into houses, which are further subdivided into grade-level clusters taught by teams of four teachers. The Discover Rochester project was carried out with a class of non-Regents eighth-graders in its first year; it has since expanded to include two classes in the fall and all eighth-graders in the cluster (approximately 100 students) in the spring of 1991.

The purpose of Discover Rochester is to help students develop the thinking and problem-solving skills necessary to direct their own learning and to communicate what they have learned. This interdisciplinary project incorporates subject-matter curriculum and focuses on the local community. Students find out about the Rochester environment from scientific, mathematical, historical, cultural, and literary perspectives. They work in groups to conduct research, and they communicate their understandings via a multimedia exhibit at the Rochester Museum and Science Center. The exhibit, known as Discover Rochester, was created on Macintosh computers and displays students' work through text, audio, graphics, music, and maps.

The project ties in very well with the district's pedagogical and organizational goals, which include the integration of technology into subject-matter teaching, interdisciplinary teaching, and schools as centers of inquiry that make use of community resources. Teachers agreed that students could devote one full day per week to the project, with each teacher giving up one period of instruction per week. The district allowed these teachers to waive accountability for their students' districtwide final examinations, thus freeing them from the need to cover the same amount of material in their regular courses. In addition, the district purchased the equipment needed for the project.

A one-semester pilot produced very encouraging results. Students were engaged by the project, came to school more often, and participated in class much more frequently than they had before. Some gave up free time (e.g., lunch) to work on the project. They produced work of much higher quality than they had before, and they learned to use the computers quite fluently -- despite having had little or no previous experience. Through the project, students spent a good deal of time off campus doing their school-based work, such as interviewing people and borrowing photos from a local museum.

The teachers also became very involved in the project. Previously inexperienced with computers, they learned a great deal about them and other technologies. More important, the project provided teachers with an opportunity to collaborate with one another and with project staff members. Despite many differences in style and pedagogy, the teachers worked together successfully. As they created connections between the Discover Rochester project and their own curricula, the project began to make its way into classrooms during regular class time. For example, in English classes students spent a week reviewing what they had written for the Discover Rochester exhibit and planning their revisions. Teachers also became aware that, when working with students on the computers, they needed to play a different kind of role -- more facilitative than directive -- and that this transition was a very difficult one to make. By the end of the year, however, the teachers were better able to play a facilitative role and were much more comfortable doing so.

It is also encouraging that new teachers have asked to be included in the project this year. The district views Discover Rochester as a lighthouse project.

Will the kind of synergy this project is creating lead to broader innovation of a similar kind in Rochester? Or will the project simply disappear once the research is complete? No one can say for certain. But if it continues to take hold and be successful in the eyes of the participants, it will put pressure on the system to move in the same direction. As more teachers become interested and involved, they will need more technology, and they will want to learn how to use it productively in their own subject-matter classes. Some are already making such requests.

But teachers do not now have the authority to make their own purchasing decisions or to allocate resources for their own training. Whether and how they will get the long-term support they need once the research project is completed is not clear.

A second way this project is putting pressure on the system has to do with scheduling. Because students devote a full day per week to this project and because all the computers are located in the science room, complex scheduling problems have resulted.

As the project grows, different arrangements of space and time will have to be developed. Clusters of teachers may decide that, rather than set aside one day a week for a special project, they want to make the projects a part of daily life. In this case, periods may have to be longer than 40 minutes. And students may need special space for project development.

Once some critical mass of teachers has become involved in using technology to promote students' active learning, those teachers should be able to generate both practical solutions and exciting ideas for organizing the school and for using its resources more effectively. Because it is taking place in a district bent on restructuring, Discover Rochester has the potential to spark further innovation. The new demands it creates should be seen as opportunities for inventing new forms of schooling within existing schools.

USING TECHNOLOGY IN DISTRICT RESTRUCTURING

While large districts have been slow to make technology a widespread and integral part of restructuring, there are two small districts that have made technology and an active learning/adventurous teaching approach central to their re-

structuring efforts: the Chittenden South School District in Vermont and Central Kitsap School District in the state of Washington.

Chittenden South. In Chittenden South, a rural Vermont district with 3,000 students, restructuring and technology have been proceeding on parallel tracks. The schools are involved in an effort to restructure around a set of "essential learning behaviors" for students, which are goals that a committee of teachers designed. The Chittenden South schools are to be places where learning, not teaching, is emphasized. At the same time, a very active technology program in the schools, run by a group of teachers and one administrator, has resulted in extensive use of computers and video technologies in the district.

The two strands of activity intersect in the process of planning a major addition for a K-8 school that is to house 1,000 students. A team of teachers has been chosen to plan and pilot the new program, scheduled to begin in the fall of 1991. These teachers will work with 100 students in groups that are multi-aged and ungraded. The roles for technologies in the new school were still being discussed as this article was written, but there is a commitment to having a large quantity of technology available in the new addition (including a student/computer ratio of 5:1). As seems to be the case in many other districts, the very physical reality of the new addition has created an opportunity to infuse technology throughout the system. What is more interesting, though, is the way in which technologies and learning agendas intersect with and affect one another.

On the other coast, in Washington's 11,000-student Central Kitsap School District, restructuring efforts are also under way. In the past few years, there has been a move toward site-based management. With fully half of the district's teachers involved, an overall plan for restructuring the district has been developed. The plan includes a significant commitment to technology, funded largely by a local bond issue.

How did technology get into the plan in the first place? The core group of leaders (mostly teachers) who thought about and planned the changes in the district were technology users themselves and strong advocates of both restructuring and technology. The plan is pedagogically eclectic, and it varies from school to school. However, there are plans for a networked system of computers for all schools within the next two years.

A central focus of the effort is on teacher training and support. There are many teachers in the district who are not experienced with technology. An elementary school that opened in 1989-90 had few computer-using teachers but had a computer for every two students (six per classroom, two computer labs, and a computer on each teacher's desk). The computers were networked and were used primarily as a delivery system for instructional programs. Over the course of the year the teachers became acquainted with the technology and made extensive and enthusiastic use of the electronic mail feature, which allowed them to "talk to" one another and to keep track of what was happening in the school. Interestingly, the teachers are now asking for more sophisticated, more interactive programs for their students.

In two other elementary schools, multimedia technologies will play a major role in the instructional program. For example, teachers in one of the schools will work in teams during a common planning time to organize the curriculum around themes. They will use technologies to create multimedia problem-solving stations devoted to each one of the themes. Groups of students will cycle through the stations, while teachers will be available as facilitators. Almost half of the teachers in this school are involved in this program, and they will train their colleagues.

Restructuring and technology continue to work together in Central Kitsap, with the extensive planning and training effort still in progress. What is most impressive at the outset is the dual commitment to working on these agendas together and to providing enough technology and support to enable teachers to become knowledgeable users. In this way, large numbers of teachers can experiment intelligently with technology and push the boundaries of change in the district.

RECOMMENDATIONS

These and other isolated examples aside, the integration of restructuring, active learning, and technology is not yet occurring on a large scale. Why not? All three developments are of relatively recent origin, and bringing them together is not easy. Perhaps over time these agendas will come together on their own — or, as Allan Collins argues in this special section, the increasing use of technology will naturally move schools in the direction of active learning. But the need is too urgent and the opportunities too

great simply to wait and hope. Thus I offer a few recommendations that may speed the process.

1. Bring technology and learning to the same "table" when restructuring is being planned. Today, these agendas are on separate tracks in most districts, and technology is not harnessed to restructuring. Thus, for example, teachers can decide on a set of learning goals for the district and not ask (or be asked) about how technology could advance or support these goals. At the same time, technology specialists can decide to spend money on technology that they believe will be useful and not ask (or be asked) how this purchase relates to the district's newly defined goals. Unless both agendas are made part of the larger restructuring efforts, the opportunity for synergy will be lost.

In any district, the chances are very high that there are teachers or computer coordinators who are expert at integrating technology into classroom learning. Such people should be sought out and included in the restructuring process; they have a great deal to contribute.

2. Reconsider how technology is organized in the district. Are there structural ways to bring technology closer to learning goals? Technology budgets and purchasing authority could be more decentralized, so that schools or groups of teachers wishing to invest in technology could do so. Or, if technology does remain the province of the central office, it could be linked directly to curriculum and instruction. Alternatively, a committee of teachers could be involved in making key decisions about spending on technology.

How funds for technology are spent and the process by which those decisions are made are critical issues. If technology is thought of as a tool for restructuring, then we must ask some hard questions and make some hard choices. For example, if a restructuring school has a significant amount to spend on computers, should the money be spent on: 1) a system to individualize students' schedules and activities by managing this information in ways that are easily accessible to students and teachers; 2) a teacher network in the school, with computers on each teacher's desk, so that teachers can communicate better and plan together more easily; 3) "loaner" machines that teachers who do not own computers can take home in order to become more adept with the technology; 4) a multimedia laboratory, with computers, videodiscs, CD-ROM players, and peripherals that can enable students and teachers to create their own presentations and products; or 5) more classroom machines, so that the technology can become better integrated with students' ongoing work?

Clearly, there is no one right answer. In fact, any of the above options could be the solution for a given school. But laying out and considering such alternatives in relation to local circumstances and local goals for restructuring, learning, and teaching should be central to the discussion.

In addition, technology demands much more than hardware, software, and technical support in schools and districts. It needs people who can help teachers integrate the technology into their practice. These may be computer coordinators, media specialists, other teachers, or outside consultants or groups that provide such services. But schools and districts need to cultivate their own people with such expertise as well. Once teachers have become competent with new technologies, plans for and discussions of how to use them are really discussions about learning and teaching and about how to tailor technologies to the needs of individual teachers and students. In-house support from colleagues will be of greatest long-term value.

3. Work toward a critical mass of equipment and expertise. Technology can support active learning and restructuring — but only if there is enough technology and enough expertise in its effective use for teaching and learning. Once a school or district has achieved a critical mass of teachers and administrators who understand how they can use technology to support active learning, these educators can think through and implement the structural, organizational, and curricular changes that they wish to make. Without such a critical mass, efforts at widespread technology-infused change will flounder.

What constitutes a critical mass of expertise in technology? There is little evidence on which to make a judgment. Nonetheless, I speculate that, if half the teachers in a school are comfortable with using technology in their teaching and do so with some regularity in a variety of curricular areas, there would be a sufficient critical mass of expertise. Teachers could then help one another with the use of technology and could think together about the kinds of innovations they wish to try.

As for the technology itself, critical mass is not defined solely by numbers of computers or of other machines, but also by their location, by who has access to them, and by what they can be used for. For example, even a large number of computers used simply to move students through a programmed set of drills for a given number of minutes per day will not be sufficient to support restructuring. Such rigid uses do not give students or teachers the opportunity to control technology or to discover and design ways to use it for active learning.

On the other hand, one could take the same number of computers, provide software and peripherals so that they could be used in multiple ways, and place some in classrooms, in project work spaces for students and teachers, and on the desks of interested teachers. This configuration would give students and teachers the critical mass of technology-based experience that they need to support active learning and adventurous teaching.

4. Use the media to convey new images and metaphors of schooling. If educators are successful in integrating these three agendas in the next decade, then we will have created schools in which students' achievements are both higher than and different from those of today's students. These schools will not look and feel like our traditional idea of "school." The differences may create considerable discomfort for those of us who have grown up in traditional schools — that is, for most of us. Whatever we believe schools should be like, the traditional images are very powerful teachers

standing in front of quiet children, students seated in straight rows, teachers telling things to students. The images derive power from their familiarity.

It is very important, then, to cultivate new images of schooling, so that the new can become familiar and comfortable. The media can effectively portray new images of schooling: small groups of students engaged in animated discussion about data that they inspect on a computer screen; a student interviewing a senior citizen in the local community about local history, while other students videotape the interview; or a teacher and a student discussing and evaluating the contents of the student's portfolio of work, which includes products in several different media.

National media, particularly television, can be powerful forces in creating these kinds of images for the public. And, in small ways, they have begun to do so. But the need for such new images far outstrips what has been done to date.

Local — and much less expensive — efforts may also be effective. For example, an elementary school in Maine bent on restructuring makes creative use of the talents of a retired citizen who volunteers his services as a video technician.[14] He visits classrooms, tapes children at work, and interviews them. He also tapes their performances, plays, readings, and artwork. His tapes are then broadcast on the local-access cable channel. Parents not only have the pleasure of seeing their children on television, but they also see some new images of what school can be — of what their children's school already is.

The agendas of active learning, technology, and restructuring — each a powerful vehicle for changing learning and teaching in schools — need to be pursued concurrently to be maximally effective. If we imagine all three coming together in schools and districts, the potential for synergy is very great indeed.

Technology tied to learning and teaching of the kinds I have described can work much more powerfully in schools than it typically does. It can be still more powerful if its use is encouraged and supported in environments in which change, reorganization, and reflective experiments are valued. The active learning/adventurous teaching approach can come into being on a large scale only when ambitious goals of the kind now being widely espoused for all students are taken seriously and when teachers are given support for taking risks to do their work more effectively.

> ■NATIONAL MEDIA, PARTICULARLY TELEVISION, CAN BE POWERFUL FORCES IN CREATING NEW IMAGES OF SCHOOLING FOR THE PUBLIC. AND THEY HAVE BEGUN TO DO SO. BUT THE NEED FOR NEW IMAGES OUTSTRIPS MEDIA EFFORTS TO DATE.

Finally, restructuring will not succeed unless its ambitious goals for student accomplishment and for radical approaches to reorganizing the educational enterprise are met with equally ambitious and radical approaches to altering learning and teaching in the classroom. The active learning/adventurous teaching approach is the one most consonant with the goals currently put forth. Moreover, putting interactive computer and video technologies into the service of these learning and teaching goals can provide substantial help in reaching them. Put more strongly, it is unlikely that these ambitious goals for learning and teaching can be met on a large scale *without* widespread, creative, and well-integrated uses of many technologies.

What I am urging here is an effort not simply at synergy, but at building coherence of educational goals, approaches, tools, and structures. Even if we achieve only a very rough approximation of that coherence, we can transform schooling. Therein lies great opportunity.

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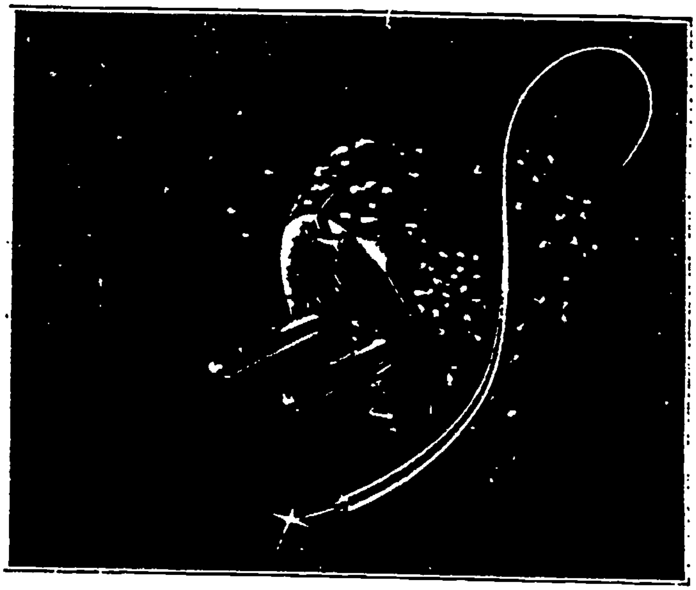
PLUG INTO A NETWORK

By Doug Vander Linden and Larry Clark

Here's what you need to know to get started building an information infrastructure for your schools



IF YOU WANT YOUR students to be able to tap into data on the nation's information highway, you need an information infrastructure in your school district. And the backbone of that infrastructure is a computer network.

That's what we've discovered in Unified School District 244 in Burlington, Kan. Located in the southeastern part of the state, our school district enrolls 1,000 students. We have a K-5 building with 500 students, a middle school with grades six, seven, and eight that has 250 students, and a 9-12 high school with 250 students.

Like many medium-sized school districts, we ventured into the information age one step at a time. But before long, we realized we needed to include computer networks in our technology planning. The computers in each of our buildings are now configured in networks, an arrangement that enhances both teaching and learning. Getting there has been a learning process for us, and we'd like to pass along what we've learned for the benefit of school districts like yours.

Three types of networks

In our planning, we considered not only what we wanted to do for students, but also what we wanted to accomplish for teachers and administrators. And that led us to networking. One consideration in selecting a network is the cost of software per user on the network. Consider, for example, a desktop-publishing program called The Writing Center, produced by The Learning Co. A stand-alone, single-user copy of the program costs $129.95. For a lab with 25 computers, then, it costs $3,248.75 to have legal copies for all the students to use at the same time.

Keep that price in mind as we discuss the three types of networks we looked at:

• **Device-sharing network.** In this kind of configuration, individual stand-alone computers are tied together, using a peripheral-sharing system. Apple built one of the basic systems into its Macintosh computers using the LocalTalk port. But if you don't have a Macintosh, or if you are using Apple IIe or IBM MS-DOS computers, you can use another electronic sharing device, such as the standard A-B-C-D switch box.

As their name suggests, the main reason to use device-sharing networks is to share peripherals, such as dot-matrix printers or laser printers. In some smaller device-sharing networks, you might even be able to share a modem.

• **Operating system-based network.** This kind of network still involves individual, stand-alone computers with hard drives. But the network is configured not only through physical connections, like Apple's LocalTalk or other network cabling; it is configured

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through the operating system software as well. For example, Apple's System 7 has the ability to share information on hard drives among the users on the network. Similarly, Windows NT from Microsoft is designed to allow users to share information based on the operating systems software within the computer. Another program, Novell Lite, also allows individual computers to be linked in a network without a separate, centralized computer acting as a file server.

The primary feature of an operating system-based network is to share data by allowing individual users to gain access to the data on other computers. For example, the superintendent might have a spreadsheet you need access to so you can fill in some information for budgeting. The superintendent can put the spreadsheet on his computer, and you can actually tap into that computer and get the file. When you're done, you can transfer the file back to the superintendent's computer or the superintendent can attach to your computer and get the file back.

The drawback is that the ability to share software on this kind of network is quite limited. If I have a copy of Microsoft Works on my computer and you want access to it, for example, I can't use it while you do. What's more, when you attach to my computer to use the program, you slow down the processing on my computer. The practical implication is that the software has to be located on both computers. You can share peripherals, such as printers and modems. But because you need to have the same software on each individual computer, your software cost will be high. Instead of purchasing individual copies, though, suppose you purchase a lab pack of software. A lab pack of The Writing Center, which includes five copies, costs $299.95, or a total of $1,499.75 for a lab with 25 computers—a savings of $1,749. (You can purchase lab packs for either a device-sharing network or an operating-system network.)

• **Client-server-based network.** In this configuration, which is the most common, each computer actually becomes a workstation connected to a dedicated computer, called the server, whose purpose is to provide the workstations with software and data—whether the data are for video, text, graphics, voice, or audio.

Again, the primary purpose of this kind of network is to allow computers to share and save data. But it's no longer necessary for you to use a program on my computer and slow my computer down. Instead, you go to the file server, get a copy of the program, and bring it to the memory of your computer. The server acts as the centralized computing power for the entire network.

What's more, the number of peripherals that can be used on the network increases dramatically—everything from printers and modems to scanners and fax machines. You might have what's called a CD-ROM server on the network. (This device allows multiple CD-ROM software programs to be made available across the network.) If you have a set of encyclopedias on one disk, students can gain access to it from anywhere in the building.

And as for software costs, take the same program, The Writing Center. A network package that can reach up to 50 users at once is just $799.95. For the cost of six single-user programs, in other words, you can reach 50 users at one time throughout the entire building.

KEEP YOUR NETWORK SAFE AND SOUND

Installing computer networks in your schools? These security considerations should enter into your plans. First, be sure you have a back-up system, and be sure to back up your files every night. Many school districts back up their files only once a week. But suppose your entire management system runs on the network and teachers enter grades and attendance every day. If the network goes down (and some day it will), the teachers have to go back and enter seven days worth of data. So we back up every day. And we have an uninterruptable power supply on our network that keeps the network up for 30 minutes if we lose power.

Next, you must have a disaster recovery plan. When we put in our first file server, we bought an identical one to be a back-up server for the whole district. If one of our network servers goes down, we can have it up and running again in two hours.

Your disaster recovery plan should also account for the possible loss of files due to theft, fire, or some other calamity. It's not enough simply to make back-up files of data if you store the back-ups in the same room as your file server. If someone breaks in, they can steal everything—back-up tapes and all. We keep all our back-ups in a different room than our file server is in, and we have a fire wall between the two rooms. That way, if there's a fire in the file server room, our back-up files will still be safe.

Another security consideration is protecting your data from viruses, which can enter the network when students use bulletin boards. To guard against viruses, we use a program from Intel called LAN Protect, an anti-virus program designed to sit on the file server. It monitors the server drive and the hard drives on each individual station, tracking all the files on both the workstations and the server itself. Several other network-based anti-virus programs are also available.

Finally, you have to protect your data from unauthorized access—students getting into the teacher's grade book, for example. We require teachers to have passwords and to change them periodically. (Teachers can also have unique passwords on e-mail and grading programs to provide an additional level of security.) We also use a number of software programs to provide security, including one called Intruder Detection, which is part of Novell's Netware system. It works like this: Say a student tries to log into the network, guessing at a teacher's user name or password. After three incorrect attempts, the program logs the student out and tells us the station where the attempt was made.—D.V.L. and L.C.

As of this year, every building in our school district has a client-server-based network. We have a 110-station network in our high school, working off a single file server. In our middle school, we have an 90-station network, and we have just put a 75-station network in our elementary school and a 10-station network in our central office.

Network protocols

What determines the speed and performance of your network is not only the speed of your server and workstations, but also which network protocol you select. To put it simply, the protocol determines how you tie computers together to form a network. Most of these protocols follow standards set by the IEEE (Institute of Electrical and Electronic Engineers), an international standards committee that has defined the specifications for network cabling and network cards.

You should be familiar with the following protocols:

• **Arcnet.** Although it is used in both business and education, Arcnet is not a standard recognized by IEEE. Network speed is measured in megabits per second, or MBS; with a speed ranging from 2.5 MBS up to 10 MBS, Arcnet can be relatively fast. It's also inexpensive: The cards cost approximately $100 each.

But be warned: Network technology is changing rapidly, and because Arcnet is not a standard, few new developments are being made for this protocol. So if you're looking for a network protocol that will grow and evolve, Arcnet—although it's a cheap performer—might not be your choice.

• **Ethernet.** Two major types of Ethernet networks are used in schools. The first, which was made popular by IBM, is called a baseband network. In a baseband network, the cabling goes from one computer directly to another and then to another; this configuration is commonly referred to as a bus. Baseband networks are relatively cheap, but they are slow and are limited to approximately 30 workstations per segment.

The second type of Ethernet network is called a 10 BASE-T network. In schools, these networks are typically designed in a star configuration using unshielded twisted-pair cable. These networks, which are now being used by corporate America and education, are capable of holding literally up to 1,000 stations. The IEEE standard for 10 BASE-T is 802.3.

In the 10 BASE-T environment, Ethernet has a speed of 10 MBS; the average cost per card is approximately $150. And with the 10 BASE-T network, you can have the entire Macintosh family and the entire MS-DOS family on the same network.

• **Token ring network.** Developed according to IBM standards, the token ring network has an IEEE standard number of 802.5. Again, there are two types, according to speed: The first speed is 4 MBS, with an average cost of $250 per card. The second speed is 16 MBS, at approximately $450 a card.

Two things to remember about the token ring network: First, you cannot put the entire Macintosh family on the network—only the Macintosh computers with a NuBus expansion slot.

Second, if you put a single 4-MBS card on a network that is made up of 16-MBS cards, you slow the speed of the entire network down to 4 MBS. The cards must be consistent. If you want a 16-MBS network, every card has to be a 16-MBS card.

• **Other protocols.** Additional protocols are either still in the development stage or have not yet come down enough in price to be affordable for most schools. One is FDDI (fiber distributed data interface), which is designed to give you a speed of 100 MBS on fiber optic cable. But FDDI cards are still in the $1,000-$2,000 price range.

Another product is Fast Ethernet, which is designed to provide 100 MBS performance in the 10 BASE-T environment—a tenfold increase in the speed. The cards cost approximately $695 each.

Another future protocol for the education environment is wireless communication. Wireless systems will still need to come down in price, improve in speed and performance, and overcome the limitations of school building structures to make inroads into schools, though.

Note the speed of the FDDI and Fast Ethernet protocols. If you want to put video on your network—and you probably will, eventually—you'll need more network speed than is currently available in the Arcnet, Ethernet, or token ring environments. Keep that in mind as you make technology purchasing decisions. For example, if you want to buy $150 Ethernet cards today, realizing that down the road you'll want to go to Fast Ethernet, make sure you tell the person providing your cable that you want it to comply with the Fast Ethernet standard. This would require purchasing Category 5 unshielded twisted-pair cable. That way, you can buy cable today for the cheaper Ethernet and then down the road move to Fast Ethernet and not have to recable an entire building.

Additional considerations

After we decided on our network protocol (we chose a 10 BASE-T Ethernet environment), we still had to make some important decisions about network configuration and other matters.

The first question was which network software to use. Our choice was Novell Netware, which accommodates MS-DOS computers and, with a program called Netware for the Macintosh, also allows us to bring Macintosh computers onto the same file server. We have an IBM file server that runs all our MS-DOS and Macintosh computers on the same network.

Other products that are used in education include AppleShare Pro, which is designed primarily for Macintosh and Apple IIe computers; DigiCard, which many schools use for networking Apple IIs and MS-DOS computers; and SchoolMate, which is used to network Tandy-type computers.

Another consideration is hard disk size. The key advice: Buy as much as you can afford. We put 1.3 gigabytes in our 100-station file servers. We aren't close to using it all yet, but when you consider that one minute of video will take up several megabytes of hard disk space and software programs with Windows are growing larger and larger, then you know that the larger the

hard disk in the server, the longer it's going to last you down the road.

Still another thing to consider is where the students store their information. We originally thought they should store everything on floppy disk. But many kids can't remember to bring their lunch tickets to school, let alone their floppy disks. So we decided instead that all the students should store their information on the network. That accomplishes two things. First, wherever students go in the building, they can get into their files. Second, teachers can check and monitor students' work from anywhere on the network.

A final consideration is staff development and support. We plan for staff development in all of our technology applications, in the belief that you have to bring staff members along if you expect them to use technology in the classroom. We ask teachers to volunteer for some in-service sessions and provide stipends for others. We offer summer training, summer check-out of computers, and preservice training, as well as training during the school year. But support cannot stop with training: You have to have someone available to help people with problems when they occur—not a day later and certainly not a week later. We've hired a full-time person to help the district's technology director provide user support.

The payoff

What are the benefits of computer networks? For students, the real payoff is the information that is suddenly accessible to them through the CD-ROM server or the modem. Right now, our students can search encyclopedias on the network or reach out to a number of bulletin boards. And before long, way out on the plains of Kansas, our network will be able to tie to the Internet, and students will be able to work with a vast truckload of data on the information highway.

Another benefit for students: They get experience they can use in the world of work. Today, some 80 percent of all computers purchased are bought by businesses and put on networks. When students graduate and get jobs, they'll work on those networks, and we're preparing them to do that.

The networks also provide a wealth of individualized remedial and enrichment instruction for students and make possible valuable interdisciplinary activities. For example, social studies and English classes can team up on the network to work on joint projects.

For teachers, as for students, the real benefit is information accessibility. Imagine having more than one textbook at hand as you design lesson plans. Imagine having an on-line compact disc program that gives you an up-to-date map of Eastern Europe, instead of the old map of the Soviet Union in the social studies book.

Teachers also benefit enormously from the communications tools available through a network. Electronic mail can go a long way toward breaking down isolation and opening up communications among teachers. And the same cabling you put in for a 10 BASE-T network can be used to put in a telephone system as well.

Finally, teachers make use of the networks to monitor student performance—either on the integrated learning system or by looking at students' files on the network. And they can tap into the network to make use of instructional tools such as electronic grade books and quiz designers.

The networks have tremendous administrative advantages as well. In financial terms, a major benefit is encouraging full use of the computers you've already invested in. (The last thing your school board wants to do is buy a $2,000 paperweight.) In our high school, for example, 99 percent of the staff said use of technology and computers more than doubled in the first year after we installed the networks.

Record keeping is another example. Our state education department has estimated that tracking all the different kinds of information we'd like to track for each student would take a secretary for every teacher. But with a good district management system, we can do it with our existing staff—and pull together reports for administrators.

Right now, every secretary, guidance counselor, and principal in our school district uses a computer and is on a network. Talk about improved communications. During our first month using electronic mail, we sent 17,000 messages in one building alone—17,000 for some 35 or 40 staff members. We estimate that a third of those messages actually saved a piece of paper, which makes some 6,000 pieces of paper (and maybe a small tree).

Glimpses down the highway

Our EdTech 20/20 plan is a vision for the future. Our first goal is for all our students to be technology literate. We want them to be prepared to use technology in college, in trade school, or on the job. We want them to be life-long learners who are comfortable with change, because technology will continue to change.

Full integration of technology into the curriculum is another part of our plan. Our goal is to make technology applications a part of every subject, not just science and math, and we're helping teachers find ways to use technology applications in their classrooms.

We envision multimedia applications, using interactive CD-ROM to bring the curriculum alive and interest students in learning. We also are working toward two-way interactive video, and we're within 20 miles of getting on a fiber line. Once we've accomplished that and have set up a two-way interactive studio, we can link students to the rest of the world so they can take courses that are currently available only in larger school districts. The same technology will be a boon for staff development and a tool for the entire community.

Our next step is a wide-area network that will link all the buildings in the district. Once that's completed—within the next year—we'll be able to trade data from school to school, gather demographic information, and compile test data for mandated reports to the state.

Already, though, we believe the hard work and planning involved in selecting, installing, and maintaining our district's computer networks have more than paid off. In fact, at the risk of mixing our metaphors, we'd say that computer networks are both the heart and the backbone of any school technology plan.

SECTION II: FUNDING OF TECHNOLOGY IN SCHOOLS

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NETWORK-BASED COLLABORATIONS: HOW UNIVERSITIES CAN SUPPORT K–12 REFORM EFFORTS

MSELNET, KIDPLAN, the Geogame, the Induction Year project, Centennial space shuttle launch simulations, the School Renewal Network, the Virtual Worlds project—all are examples of network-based collaborative projects for K–12 teachers, curriculum specialists, and students. Most of these projects use the Internet, although a couple lack even an electronic mail gate to the national system. Let me tease you for now with just the names; later I'll give a brief description of each one.

Currently, there are many collaborations that use networking to support K–12 education and reform goals. There could be many more, however, and the ones that now exist should extend to more participants. A persistent problem for K–12 educators is lack of access to a national networking system. Many schools lack the bare essentials for computer-based communications: a computer with a modem and a telephone line that can be dedicated to such communications for at least part of the day. Even in settings that have these basic essentials, there are many dedicated educators who would love to use the resources but lack the know-how.

In several states (including California, Florida, New Mexico, New York, Texas, and Virginia), statewide network connection programs do exist. Elsewhere, infrastructure resources, training, and beginning-user help are clearly needed. But there are other vexing problems. For instance, an extensive network that connects, among others, the state mathematics and science supervisors of all the states and territories uses proprietary software and cannot provide even electronic mail connectivity to other networks. (Active efforts are under way to remedy this situation, and a mail gateway may exist by the time this is published.)

Other network systems are project specific, allowing only limited or no electronic mail outside project-oriented connections; at the end of the project, the account is closed and the connection ceases. Network-based communications can become a powerful engine to support K–12 reform, but first a critical mass of educators

By John Clement

John Clement directs EDUCOM's K–12 Networking Project. He will be reporting regularly on educational applications of networking and welcomes comments and ideas for items to include in this column. He can be reached at JRC@BITNIC or CLEMENT@EDUCOM.EDU.

must be connected with linkages that are permanent and generalized, rather than project specific.

Universities and colleges could play a significant part in helping collaborative projects become an engine to revitalize the schools. To begin with, institutions can get involved by supporting efforts to extend connectivity. Why do K–12 educators need networking? What would they use it for? The basic reasons are, of course, communicative: for personal growth and training, to expedite collaborative projects, to gain access to information and to curriculum resources, and to connect students with each other and with ongoing projects.

Donations of old equipment and software (some software companies are now offering license transfers to schools at no cost for academic purchase of upgraded software), as well as support for installing telephone lines, are needed in some local situations. In others, equipment is not the problem, but access, training, and user support are. Guest-account access may be a worthy temporary answer, but more important is helping a local system to develop its own training and support mechanisms over time. The key role that postsecondary institutions can play in this area is in providing, and supporting, the connection to the Internet.

Much of this communication and collaboration should occur among, and be instigated by, K–12 educators themselves. However, some very significant roles could be played by the university community; indeed, we can point to situations where they *are* being played. The vision of what universities and colleges can do to support K–12 network-based collaborations can extend well beyond connectivity.

A good example is in the development of K–12 curriculum approaches and materials. Many of the curricular experts now implementing new approaches are in postsecondary institutions. The approaches being advocated call for a more collaborative, project-oriented view of teaching and learning. But quite often, these experts don't have the combined knowledge of curriculum and of today's Internet, and we therefore run the risk of neglecting this potential avenue of communication in many curricular areas.

Or take the notion of significant scholarly and research collaborations that take place among teams of educators and students and disciplinary specialists in universities and research centers. Let's consider schooling as an integral part of the national enterprise and schoolpeople at all levels as a national resource. Shouldn't we be calling on them for their input on many projects?

During the 1980s, through the implementation of such projects as the National Geographic Society's Kids Network, Bob Tinker and his colleagues at the Technical Education Research Centers (TERC) pioneered the notion of putting serious research goals into the hands of student and teacher teams, integrated the results by use of telecommunications, and created collaborations with discipline experts. TERC's project areas, aimed at upper elementary grades, have included Acid Rain, What's in Our Water, Solar Energy, and What We Are Eating.

Now it is time to extend this idea to every curricular area at every educational level. Let's address topic areas and issues of national interest through collaborative project areas. Bob Tinker has thought of a student-run grid of seismic sensor stations. Here are some other ideas: a standing collaboration between teachers, students, and researchers on the genome and structure of the nematode *Caenorhabditis elegans*; periodic "market basket" grocery cost surveys; assessments of local unemployment or dropout rates; or access to prenatal care and "well baby" clinics. And how about field archaeology projects or a standing effort to monitor water quality or ground pollution or acid rain, run by a school on behalf of a state or federal environmental control agency?

The important features of such projects must be that they involve students, under teacher supervision in gathering real, useful data, [illegible] laboration with disciplinary r[illegible]h-ers on a standing (or at least [illegible] long-term, multiyear) basis. Discipline specialists would oversee quality control and provide mentoring and training when necessary. But leadership must be at least shared by K–12 [illegible] disciplinary community members. Finally, these efforts must be recognized as part of every teacher's job and each student's education, not as extra credit or as a club activity.

Let no one argue that students and teachers are incapable of such work. Projects such as these are important to the nation, not only as a source of needed data but also as the beginning of students' introduction into the "real world." One of the reasons that academic schoolwork is not taken seriously enough by our students is that it doesn't seem relevant to them.

If such projects are to be created, the roles that colleges and universities can play in K–12 educat[illegible]ll expand and so will the com[illegible]a-tion requirements. Postsecondary institutions can foster these collaborations directly by encouraging disciplinary departments to participate, by coordinating funding request preparation, and by supporting and rewarding faculty who participate. Collaborative, scholarly projects in the humanities and the arts and sciences can stimulate learning by offering long-term support for schools. Seminars, summer work opportunities, and sabbatical-year appointments can be created at both schools and colleges.

When your local school comes to ask about a guest account on the Internet, consider the opportunity you are being offered and the difference your support can make in revitalizing our K–12 schools.

The following are descriptions of the network-based collabo[illegible]ve projects mentioned at the be[illegible]g of this column:

MSELNET: Mathematical Sciences Education Leadership Network, a

collaborative effort between major mathematics associations and a division of the National Academy of Sciences. Established to connect the workers who implement the curriculum standards agreed to by the mathematics education community, including every state mathematics supervisor. Uses IBM's PSInet, a proprietary store-and-forward system currently without either Internet access or gateway capabilities.

KIDPLAN. Created by Odd de Presno of Norway, billed as "a global dialog for children from 10 to 15 years old." An ongoing version of a project that was originally called KIDS-91, which in May 1991 linked hundreds of children around the world. Uses the Internet.

Geogame. Developed by Tom Clauset of Winston-Salem, North Carolina, and aimed at middle and upper elementary school. School classes send in a description of their own site; the coordinator scrambles the information in each response and sends out the scrambles as puzzles for the groups to solve. Runs on FrEdmail and the Internet.

Induction Year project. Running over TENET (Texas Educational Network), this project provides training and support for first-year teachers in Texas. Runs on the Internet.

Centennial space shuttle launch simulations. These projects run in conjunction with NASA space shuttle launches. A full mock-up of a space shuttle is available at University School in Shaker Heights, Ohio. Student astronauts crew the mock-up for up to 24 hours along with a real space shuttle launch. Other schools throughout the United States and in other countries assume various roles in each simulated mission: secondary mission control, alternative landing sites, even the role of docking another shuttle. Runs on the Cleveland Free-Net, over the Internet.

School Renewal Network. A project of the National Education Association's National Center for Innovation, supporting more than twenty-five site-based management restructuring projects in schools around the country using a PSInet link.

Virtual Worlds project. Another periodic effort of the Cleveland Free-Net. After preliminary preparation, classes spend a school day exploring an assigned "virtual world": examining drone survey data, designing experiments, and reporting the results back to "mission control." ■

FUNDING ELEC
CLASSROOMS

BY ARLENE KREBS

As committed educators work to reform schools for the 21st century, they are joined by corporate and philanthropic leaders who understand the importance of their efforts and offer support for implementing technology in schools.

Funders recognize that every type of educational institution is involved in the effort—not only schools, but also museums, science/technology centers, libraries, and community agencies. Likewise, the work touches on every curriculum area, with math, sciences, technology, environmental studies, multiculturalism, and literacy in the spotlight of change.

Within those institutions and areas, funders recognize the benefits of integrating CD-ROMs, videodiscs, computers, multimedia, televisions, and telephones into new approaches to course content, activities, and assessment. They recognize, too, how electronic media are changing the ways we educate for a shared cultural heritage, organize schools, and interact with students and staff. They also recognize how parents, school districts, businesses, and community agencies are collaborating in new ways to transform traditional, hierarchical structures into democratic ones.

Many of the wealthiest foundations and corporate giving programs nave made a commitment to educational change, supporting local and national organizations that spearhead the school reform movement. These groups award grants that help educators, school leaders, parents, and communities work together, and they endorse imaginative grass-roots efforts.

Foundations such as Ford, MacArthur, and Pew support outreach through radio and television programs to inform parents and the community about local school restructuring efforts. Projects that have the potential to become financially self-sustaining and that can serve as models regionally and nationally receive high attention.

School reform is viewed as the primary way to implement the six national education goals endorsed at the National Education Summit of 1989. Those goals are reflected in the priorities among grant-givers: Emphasis on preschoolers speaks to the goal of all children entering school ready to learn; attention to the needs of at-risk youth aims to meet the goal of boosting the high school graduation rate to 90 percent; support for the continuing professional development of adults addresses the goal of lifelong learning; and emphasis on math

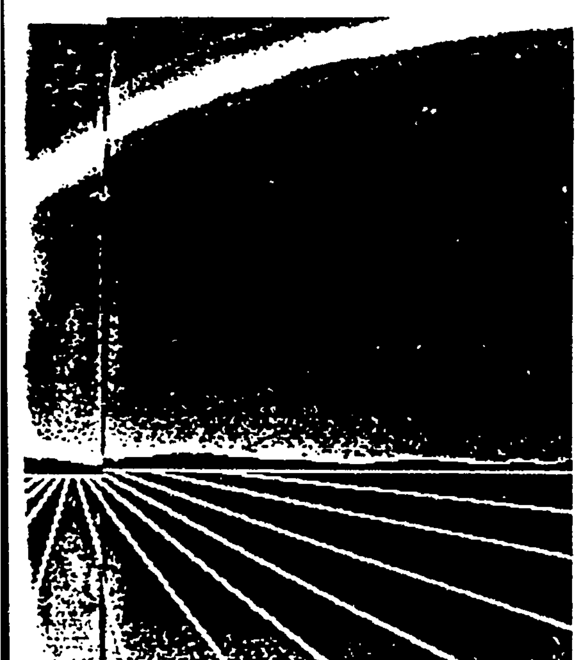
Arlene Krebs, author of The USDLA Funding Sourcebook for Distance Learning and Educational Technology, *is a 20-year educator and president of New Orbit Communications, a New York-based consulting firm specializing in educational media and telecommunications.*

Following are a few examples of such support:*

• **The Sloan Foundation** offers awards in its Independent Learning Outside the Classroom program, which looks for innovative approaches to math, science, and engineering studies—especially approaches that use multimedia and computer networks for self-education and that increase education and career opportunities for minorities and girls. Science museums and public libraries often serve as network hosts in these projects, providing families direct access to interactive learning materials and technical information.

Grants are awarded to science/technology centers, middle schools, and high schools.

• **Telephone companies** such



as Ameritech, NYNEX, BellSouth, Pacific Telesis, and GTE Telephone Operations actively support model demonstration projects that link homes, schools, libraries, and government agencies by way of telecommunications technologies.

These companies often supplement videoconferences and educational television programming—including new video-on-demand services—with teacher guides, student activities, and print and electronic resources. Computer networking and access to on-line data bases serve learners in rural, suburban, and urban areas.

The telephone companies have awarded grants to museums to archive materials on videodiscs and CD-ROMs and to museums and science/technology centers to create hands-on interactive exhibits. They have also supported mobile vans serving as learning-resource centers that travel to low-income and immigrant communities. Homework hot lines, an increasingly popular communications link between the family and the school, are also funded.

• **Apple Computer's K-12 Education Grants** program awards $4 million annually to projects that focus on the needs of at-risk students and on innovative multimedia curricula, especially in environmental studies and global interdependency. Recently funded projects create new learning environments by developing student-centered materials that link classroom learning and learning outside the classroom. For example, a grant to San Diego's Hoover High School helped ninth-grade students create oral, written, and visual histories of their community, using it as a "laboratory for learning." Each school is awarded equipment and $5,000 cash for other uses, such as purchasing software, training staff members, and attending conferences.

• **The National Foundation for the Improvement of Education (NFIE)**, created by the National Education Association in 1969, offers five grant programs. One, the Learning Tomorrow program, emphasizes creative approaches and critical thinking about technology, restructuring, and learning. In the first phase of this program, NFIE developed guides and scenarios describing what teaching and learning should look like in the schools of the future. These descriptions were formulated with advice from business and industry leaders, experts in technology, futurists, and educators.

Now in its grants phase, Learning Tomorrow operates regionally with support from local and regional foundations and corporations—especially the Regional Bell Operating Companies.

Recipients of grants in 1992 include the Garden City (Mich.) Public Schools for a project using lumaphones—telephones that can depict photos of callers on a screen—to connect stu-

CATEGORIES OF SCHOOL REFORM GRANTS

- school restructuring
- school and classroom management
- family/school partnerships
- school/community/business collaboratives
- national standards and assessment

CURRENT FUNDING PRIORITIES FOR CURRICULUM-FOCUSED GRANTS

- math and science education, assessment, and reform
- multicultural curricula using print, film, television, and multimedia
- foreign language and cultural studies
- environmental studies
- literacy projects
- supplementary educational materials
- data bases and on-line resources

EXAMPLES OF MEDIA SUPPORTED BY GRANTS

- interactive television
- homework hot lines, voice mail, and audioconferencing
- computer networks
- data bases
- television, film, and radio programming
- CD-ROM
- videodiscs
- multimedia
- facilities renovation
- telecommunications infrastructure
- equipment

* For more information, see *The USDLA Funding Sourcebook for Distance Learning and Educational Technologies*, by Arlene Krebs. This 272-page sourcebook, supported by a research grant from GTE Telephone Operations, lists funding agencies an[illegible]ant-writing tips and skills, as well as softw[illegible] to help format proposals and keep information current. Single copies are available for $39.50, plus $3.25 shipping and handling, from New Orbit Communications, 39 Plaza St., Brooklyn, N.Y. 11217, (718) 857-3717, fax (718) 857-6335. Copies are also available from USDLA, P.O. Box 5129, San Ramon, Calif. 94583, (800) 829-3400

News from the stars: Teachers get a briefing on the latest in satellite news-gathering technology through a GTE fellowship program.

dents in the United States, Germany, and Japan. A grant to the Austin (Texas) Independent School District supported development of K-12 curriculum units that use technology to encourage global understanding and world citizenship.

• **The Toshiba America Foundation,** created in 1990, gives high priority to math and science classroom projects initiated by middle school and high school teachers. Most grants target enhancement of the curriculum with hands-on learning experiences using computers and calculators, field trips for data collection, or visits to museums and science/technology centers. Toshiba emphasizes community-based programs and participation by girls and minorities.

Some of Toshiba's grants link children with parents in school "science day" projects, and some allow schools to participate in distance-learning "field trips," such as the Jason Project for science-focused undersea exploration. Still other grants support specialized activities and pilot projects for at-risk students, involving them in diverse science and math learning activities.

For example, a 1992 grant of $5,000 to Tuckers' Crossroads Elementary School in Lebanon, Tenn., supported a mobile mathematics lab that uses visual aids, manipulative materials, and real-world applications to further understanding of mathematics concepts for students in grades seven and eight.

Herman Farrer

APPLYING FOR A GRANT

Foundations rarely fund the purchase of equipment and technology per se. Instead, they fund projects whose content areas and activities match the foundation's priorities. Technology must be integral to the project's goals, rather than the goal in itself.

For direct grants of equipment and software—and sometimes cash—educators can turn to corporations and equipment manufacturers such as Apple Computer, Digital Equipment Corp., IBM, Panasonic, Sony, Tandy, and Texas Instruments.

In any case, it's important to research the interests of funding agencies and to contact their program officers before sending proposals.

Competition for equipment and money from both foundation and corporate sources is keen. Winning a grant usually requires much effort to develop links with the funding agencies and much time to prepare appropriate submissions.

Most funding agencies require first a brief (two or three-page) letter of inquiry. If the agency likes what it sees, it responds with application guidelines for a formal proposal. Grant-seekers can target their letters of inquiry to various agencies simultaneously. If more than one agency invites a full application, letting the agencies know that fact might well enhance your chances of gaining support from one of them.

Be certain to include professional training as part of the grant request. Teacher training accounts for nearly 50 percent of total funding in materials and media development grants. No matter what their priorities, funding agencies recognize that educators must be prepared effectively to transform classroom practices, content areas, and methods.

Funds are available for staff development workshops (in-service, after-school, and summer) and to adapt curricula to new interactive technologies. Grants to develop leadership skills for administrators, school board members, and staff members are also available.

The best grant proposals are those that encourage collaboration among institutions and within communities. Individual schools should involve other schools in their districts and establish links with local colleges and universities.

The following program development tips can lead to grant-winning and long-term success:

1. Generate partnerships and programs that can become economically self-sustaining.
2. Match curriculum and project objectives with appropriate media and transmission systems.
3. Where possible, involve groups of users, experts, and a consortium of sites, including libraries, community centers, homes, and museums.
4. Seek funding to extend the learning environment and to enhance participation through interactive technologies and multimedia.

Project assessment is crucial to funders and should be included in the program's proposed budget. For K-12 schools, the assessment phase of the project is a good place to build in collaboration with a local college or university, whose faculty can provide the necessary expertise for preparing criteria and reports. The educational research labs funded by the Department of Education's Office of Research and Improvement can often help with assessment.

Schools can also use education consultants who have broad experience in distance learning and educational technology. Because much of what is accomplished with technology in school restructuring strategies is not measurable by standardized test scores, educators and those who assist them must apply new techniques, new perspectives, new models, and even a new vocabulary to assess project results.

Funding agencies also are interested in disseminating information about the projects they fund, and they want to invest

carefully in projects that can serve as models and be replicated. Some foundations will help their grantees disseminate findings and activities nationwide.

Proposals should be written clearly and concisely and should be easy for readers to follow, complete with a cover page, project abstract, table of contents, and headers or footers on each page for easy reference. The budget need not be longer than a page or two. Supporting materials (letters of reference, recommendations, vitae) belong in the appendix.

One of the most important words of advice: re-apply. Only a small fraction of requests are funded, so it's essential to think of applying for grants as an ongoing process rather than an isolated occurrence. An agency that does not fund a proposal one year might look on the same proposal more favorably the next. By then, agency decision makers will know the applicant better and, if they [illegible] the project, might help r[illegible] the application.

New directions, new media, and new transmission systems have emerged as crucial to education. You must be imaginative and hard working to secure funding for the projects you have already initiated and for the possibilities and programs you only dream about. □

Where to get them, how to get them, and profiles of schools and districts that have been forever changed—for the better—after getting them

By Gwen Solomon

THE RECESSION HAS BEEN THE KNOCK-out punch to many school budgets that were already wobbly at the knees. As businesses fail and people lose jobs, local tax revenue—the primary source of many public school budgets—shrinks. As a result, schools aren't able to increase their annual budget, or worse, that budget gets even smaller. Many districts are fighting back by being extremely creative with their existing resources and personnel, implementing sound financial plans, and getting funds from outside sources.

One such outside source is a grant, which can, in some cases, provide hundreds of thousands of dollars to a school or district in one quick shot. While the money must be used for a specific purpose, a grant does help the school implement a new program without affecting the bottom line. It also gives educators the means to attain a particular educational goal and, in the process, wipe away some of those sinking feelings among staff associated with the recession and budget slashing.

Even more importantly, according to educators, simply the process of writing a grant proposal often has a greater effect than the money itself. The planning, research, and in-depth writing that is required in preparing a grant proposal provides a vision and long-term blueprint that the school might be able to implement later on—even if it doesn't win the grant.

Every educator should know a little bit about grant getting. Whether you write the grant itself, or ask someone to do it for you, knowing about grants is important. This article is *Electronic Learning*'s attempt to tell you everything you need to know about grants: where to get one, how to increase your chances of getting one, and why it's so important to at least try to get one—even if you don't succeed.

Grants for technology come in all shapes and forms: some grant-givers provide only equipment, others just money, and still others a combination of the two. The source may be the federal government, state, or local funding agencies, or private foundations. The amount may be in the thousands or in the millions. Whatever the case, the effect is the same: The funding is short lived, but the benefits are felt far into the future.

To show you first-hand some of those benefits, we highlight below a handful of schools and districts that recently applied for, and received, grants.

New Technology School

The McKinney Independent School District in McKinney, Texas, is planning a new technology-rich school and has hired new staff to design its overall program. As the sole recipient of the 1992 Department of Education Innovation in Education grant, McKinney was awarded almost $6 million dollars for a two-year period. With the money the district will create the Academic Competitiveness Through Technology (ACT) Academy, a K-12 school with demographics that will represent a cross-section of the district. Opening in September 1993, it will feature a world-class, technology-rich curriculum in English, mathematics, science, history and geography.

Interestingly, ACT Academy is not the brainstorm of a grant-writing team. The idea is an outgrowth of the district's long-range technology goals and plans. Critical to the creation of that plan was input and assistance from parents, businesses, and higher education, and the community at large. "That process" says Sue Gleghorn, assistant superintendent for instruction, "is more critical than the plan. It is designed so that the community will sustain the project after the federal grant ends."

To write the grant proposal, Gleghorn says, "We looked closely at our technology plan and extended it; we took a giant step forward to ask ourselves what school environment we would want as a final outcome. The result was the ACT Academy."

The academy will be housed in Greer Elementary School, currently a 400-student, K-3 campus that was built in the early 1930s. Almost $1.2 million of the grant will go to renovating and remodeling the building. The rest will support curriculum writing, staff development, and new staff.

While the curriculum will drive the technology, Gleghorn expects to use multimedia, telecommunications, and distance learning as integral components of the program. "We want to break the mold of conventional teaching strategies so that teachers can deliver instruction that results in superior academic achievement," Gleghorn says.

The ACT Academy will be a year-round school open from 7:00 a.m. to 10:00 p.m.; during after-school hours it will serve as a community learning center. Gleghorn envisions a 10 year old, a 16 year old, and a 35 year old working together on projects. In addition, teachers from the rest of the district can be trained there. All schools will be linked electronically.

Is $6 million the answer for every district? Gleghorn is certain that the money—and the long-range plan—will make a big difference in McKinney.

University Collaboration

A high school/university collaboration in Orem, Utah, is using technology instead of textbooks to teach mathematics. Thanks to a three-year, $749,000 Next Century Schools grant from RJR Nabisco, Orem High School will have a new integrated math, science, and English curriculum and a new homework assistance program.

Brigham Young University professor Edward Green began planning for this program 10 years ago when he started teaching Algebra without pay at Orem High. His overriding belief is that all students should take Algebra because, without it, students are often excluded from higher-level classes and college. A bit ahead of his time, he created new texts and designed instructional videos to assist him.

Today, Green and Orem's principal John Childs designed "The Computerized Classroom," which uses computers, video presentations, and mini-texts in a curriculum that integrates geometry and algebra II with Chemistry and English. They are developing materials such as newsprint textbooks, take-home videos of classroom instruction, and video/computer homework aids.

The grant allows them to produce and disseminate these materials and hire additional Orem teachers and BYU students and faculty to serve as consultants in the development, implementation, and replication of the program. Three quarters of the funding provides extra staff to allow them time to develop and create the instructional materials. The remaining funds are for computer hardware and other equipment. The key element, Green says, is the cooperation and team spirit the project generates. "It's amazing what you can get when people work together," Green says. "It's not just the product but a process that lasts."

Using CD-TV, regular compact disks, computers, monitors, and networks, the team has created instructional materials that present information to students in new ways. Much of it deals with real-world applications of mathematics. The next step is to incorporate telecommunications and distance learning via satellite dishes, to allow them to further reach out into the world.

The design team, using the grant money, is creating a system that will serve students in the district for many years. Green plans to offer the materials to other schools in the district.

Model Schools

The Alhambra Unified School District in Alhambra, Calif., is in the final year of a five-year state Model Technology Grant program. For each year of the funding Alhambra received $500,000. The money was used to create two model technology schools: Emory Park Elementary and Alhambra High. This year, the district received $300,000 ($292,000 in actual dollars after a recent cut) to maintain the program and disseminate the results, but the future is uncertain. While Gary Carnow, the district's coordinator of instructional technology, has leveraged the district's funding into additional grants and partnerships, and while the district and schools have been supportive, Carnow says: "This is a dry spell."

Carnow's goal when he came to the district in 1985 was to put a computer in every classroom and a computer lab in each school. He's 80 percent there but not likely to reach his goal in the very near future.

The five years of funding went primarily for staff development and equipment. At the elementary school, every teacher is knowledgeable about technology while at the high school 65-70 percent of the staff is technically competent. The equipment is well used and, Carnow says, "Technology now serves as a catalyst, making school more interesting to students and giving them new ways to explore." In addition, the two schools serve as training sites for teachers from the rest of the district and the surrounding area.

The original proposal, one of six that was eventually funded, was designed by district staff in conjunction with personnel from Pepperdine University. The key to winning, Carnow believes, was the proposal's philosophical vision. They focused on student-centered learning and proposed that technology could promote it.

In the first year, they enlisted the support of the elementary school staff and spent all of the resources on that school. Every staff member bought into the plan and by the third year, the staff even felt that it no longer needed a technology support person. Instead they asked to split the funds into small stipends for 10 teacher/facilitators and extra equipment. The high school began its program in the second year.

Each year, the district not only matched 10 percent of the grant funds but used Chapter 1 or Chapter 2 funds to buy more equipment. Other schools in the district solicited support from local businesses and parents and also wrote proposals for grants.

The result of the five-year grant: a lot of equipment, custom-designed materials, trained personnel, and an integrated technology program they probably can leverage into additional funds.

Strength in Diversity

In Abita Springs, Louisiana, teacher Kathleen Duplantier says of these tough economic times: "Louisiana will not notice as much as the rest of the U.S. because we've never really seen terrific economic times."

The Apple Crossroads grant for $115,000 worth of hardware and software that her school received helped by providing equipment and, more importantly, the motivation to expand instructional capabilities. Says Duplantier, "If you looked at the philosophy of the school today and the philosophy five years ago, I think you would see big changes, and some of those changes are because of the technology and the multicultural program that we put in place because of the grant."

While money isn't abundant, the area is rich in racial diversity. One program has students building HyperCard stacks about African-American, Choctaw, French, and Native American cultures. Each grade level is responsible for a culture; students conduct research to learn about a particular people's music, art, drama, and much more. Guests come in to tell stories and share information; students build stacks about the visitors and link this information to other stacks they created.

"We are in the process of some other technology changes too," Duplantier says. Many parents are buying home computers now, which is often a great financial sacrifice. In addition, when two new wings were built this past year, the district installed wiring for cable TV and networking. Technology, says Duplantier, has new importance in Abita Springs.

"What I feel we need now is not necessarily more hardware, although that would be nice, but training money, training time, and opportunities to broaden our teachers' perspectives about the possibilities of teaching with technology. It is very important to be sure that there is an exciting and meaningful curriculum that will be aided with the use of technology."

Distance Learning

In North Dakota, Donna Schwartz, superintendent of schools for the Diocese of Fargo, North Dakota, won a three-year U.S. Department of Education Eisenhower Math/Science grant. With the $330,000 that the diocese received, 13 schools purchased advanced and enrichment courses from satellite-based distance learning providers. Both students and teachers earn credit through downlinked classes in numerous subject areas. Even teachers from local public schools attend the telecourses.

Students are now taking advanced placement courses, as well as classes in marine science, physiology, and genetics—instruction which could not be provided any other way. Teachers are gaining new knowledge from staff development courses (not to mention college credit).

Schwartz appealed to a private foundation (which wishes to remain anonymous) for equipment and was thus able to outfit each school with satellite receivers, monitors, and telephones for the interactive courses. She's now writing a grant proposal for multimedia equipment.

When the funds run out, Schwartz believes the schools will pick up the costs themselves. "They want it badly enough, so they're finding ways," she says. Some schools have already formed planning committees and intend to request funds from local businesses and use matching funds from endowments to continue. "They've seen what a difference the technology can make."

For each grant winner, funding provided benefits that went far beyond the actual dollars. It encouraged staff to work together as a team, to create long-range plans, and to teach students in new ways. Perhaps most importantly, the grant money generated excitement among staff and students. What's the lesson for hopeful grant writers? The funding was merely the catalyst for change; the collaborative planning process made the biggest long-term difference. ■

Gwen Solomon is director of the School of the Future in New York City.

Grant Givers: What They Look for

There is no magic to writing a winning proposal, but there are steps you can take that will make grant readers take notice. *Electronic Learning* asked a panel of experts from funding agencies—federal, state, and foundation—to tell us what they look for in a winning proposal.

National Science Foundation. Beverly Hunter, program director for the National Science Foundation's Application of Advanced Technologies division, says that the NSF looks for bold statements about learning. Rather than having a focus on the technology itself or on making minor improvements to today's educational model, winning proposals stress educational ideas. "We look for conjectures on what is the nature of learning and teaching and how technology supports those ideas," Hunter says. "We want compelling possibilities because our job is to advance the state of the art and know how."

The National Science Foundation supports projects in many areas. Last year, Hunter's division received 200 preliminary proposals; of these, 60 were developed into formal proposals and 20 were funded. Grants ranged from $50,000 to several hundred thousand. Says Hunter, "Most people who are persistent eventually get funded."

Texas Education Agency. Many state education departments promote technology growth. In Texas, for example, the state technology allotment this year is $30 per student and—by state law—it will grow by $5 a year until it equals $50 per student per year. This amount, which totals $100 million, includes hardware, software, and training and will be awarded to schools under the Competitive Technology Demonstration Grants program.

The Texas Education Agency (TEA) both administers this program and provides technical support. While the funds are distributed equitably, districts must submit their five-year plan for technology to get these per capita funds. Says Geoffrey Fletcher, associate commissioner for technology, "We want to see a good plan that includes a solid vision, goals and objectives, a plan of action, and a realistic budget."

Private Foundation. The Minnesota-based McKnight Foundation donates $48 million each year to worthy causes, a small portion of which goes to education.

"There are four very clear criteria for winning a grant," says Michael O'Keefe, executive vice president. "First we determine that the project addresses a topic that is a priority for the foundation. Second, the applicants must demonstrate a clear understanding of the need or problem they want to solve, and it must be a critical issue. Third, there must be a powerful conviction that their strategy can solve the problem. And fourth, the applicants must convince us that they have the ability to accomplish what they propose."

U.S. Department of Education. "Read the request for proposals carefully and address all of the issues," is the advice from Seresa Simpson, program officer for the U.S. Department of Education's Fund for the Reform of Schools and Teaching (FIRST). Her department funds two grant programs. The Fund for Innovation in Education (FIE) awards grants in the areas of computers, technology, health, and innovation. And FIRST awards grants for schools and teachers, school development, and family partnerships. The amount of funding varies each year. In 1992, for example, FIE awarded $3.5 million to eight programs.

"Winning proposals," Simpson says, "support the purposes of the grant program, follow application directions, and meet the priorities of the competition." While each program has its own requirements, Education Department grants in general follow the criteria outlined in The Education Department General Administrative Regulations (EDGAR). Each proposal is reviewed by outside experts and recommendations are made to the Secretary of Education.

SECTION III: IDEAS FOR NETWORKING IN THE SCHOOL AND CLASSROOM

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mac monitor

by Edward J. Valauskas

Education Online: Interactive K-12 Computing

Imagine that I am a science teacher, managing a group of creative sixth grade students. I have watched them at lunch playing with sets of plastic dinosaurs, reconstructing ancient battles between Triceratops and Tyrannosaurus [1]. On their breaks, they access several compact discs on the classroom netwo·'k on dinosaurs, often visiting the Virtual Natural History Museum. Sometimes they roam on their computers through the halls of great dinosaur exhibits in museums in New York City, Chicago, Washington DC, London, Brussels, and Berlin. Just before afternoon class begins, and while they are on recess, I send out over the school network a deceptively simple assignment. A few of my students hanging out in the classroom, the lunchroom, and on the playground with their computers, pick up my assignment immediately [2]. On their computers, a QuickTime clip appears with me as the star. For a few irritating minutes, I hear my voice around the school hallways—at different decibel levels—asking my students the same question,"What happened to the dinosaurs?"

In our afternoon class, we work out a plan. Groups of five students will work as detective units on different parts of the assignment. One group will search the local library, and libraries on the network, to create a historical review of various theories on extinction. Another group will examine how museums have answered this question in their exhibits. A third team will search for experts in the field on the network and ask them directly for their opinions. A final dinosaur "squad" will synthesize all the reports and make a formal presentation in the school auditorium for me, their classmates, and any of their "witnesses" or "collaborators" from the network.

I have a few inklings over the next several weeks of the feverish activity of my charges. I find several complaints in my e-mail from a group of paleontologists at Berkeley, tired of being

I find several complaints in my e-mail...tired of being pinged electronically by a persistent sixth grader with the electronic handle of "Femur."

pinged electronically by a persistent sixth grader with the electronic handle of "Femur." A former colleague at the University of Chicago blind copies me on several large files that he sends to one of the groups. Another paleontologist in Denver lets me know that she has sent some students summary reports of her discoveries of dinosaurs above the Arctic Circle in Alaska. It seems my students have been burning up the network connections!

The leaders of the entire team ask me if one o'clock on the following Friday afternoon fits my schedule for a presentation. Surprised at their completion ahead of schedule, I agree to the date. Invitations go out over the school network. The school is abuzz with stories about the report—as I can tell by the volume of electronic notes going between students during classes. On the big day, with their computers hooked to the auditorium projection equipment, the show is ready to begin. I know that there are a few virtual visitors, by way of the network—Dave at the University in Chicago, Elly at the Geological Survey in Denver, and Steve in Cambridge.

The screen in the auditorium fills with a clip from Walt Disney's *Fantasia*, the famous dinosaur scene set to the music of Igor Stravinsky's "The Rite of Spring." It's followed by an interview with Michael Crichton, author of the fictional *Jurassic Park*. Next is a summary of formerly fashionable theories of extinction against a backdrop of Hollywood dinosaurs. The program continues for an hour and not a peep can be heard in the large room. At the end, I congratulate the team in their efforts, and their peers give them a standing ovation, punctuated with imitations of dinosaur sounds.

When I return to my classroom, I check my electronic mail and find requests for copies of the students' report from Chicago, Denver, Cambridge, and other academic

...they have already loaded the file on the school server...so that anyone can FTP it.

locales. It seems they have been paid the highest possible compliment on the net. I am about to tell the class of their accolades, when they inform me that they have already loaded the file on the school server and posted instructions so that anyone can FTP it. It is amazing what a few computers and a simple question can do for a group of sixth grade dinosaur experts.

Does my fantasy sound too far-fetched? Are there ways now to allow this sort of constructive, as opposed to rote, learning? Here are a few examples, just so you believe me when I tell you that this is not as improbable as it sounds.

KIDSPHERE

One of the best resources available right now for students and teachers is KIDSPHERE. (KIDSPHERE used to go by the name KIDSNET, but recently was changed.) This is a list on the Internet designed exclusively to encourage the dynamic use of computers as a means to communicate—in ways impossible with any other educational tool. Founded in May, 1989, KIDSPHERE connects students to other students, teachers with colleagues, and opens opportunities for collaboration on a scale unknown in the history of education. The popularity of KIDSPHERE has led to several spinoffs, such as KIDS, a list for children to communicate just with other children, KIDS FROM KANATA, a Canadian project linking 3,000 students and 120 elementary schools that is just in its first phase, and KidzMail, a list for gifted students. What kind of projects appear on KIDSPHERE? Here are some recent examples.

PEN PALS

Perhaps the epitome of deadly education is foreign language learning, especially when it is practiced as exercises that engage students in unrealistic conversations, using lists of seemingly useless vocabulary, generating headaches pounding with verb tenses. A new way of learning the idiosyncrasies of a foreign language connects students in different countries over the nets, allowing the exchange of electronic mail in native tongues.

Kids in Minnesota practice their French with a class in Bologna (for whom French is also a second language). German students in Düsseldorf practice their English with counterparts in the United States. A student in Pisa describes, in an electronic letter, an annual tug-of-war over a trolley held on a city bridge every June. And for those without computers, notes are posted to encourage analog letters; a teacher in Slovakia asks for messages for her students to sharpen language skills and discuss issues of mutual interest, such as the environment.

VIRTUAL TRAVEL

With KIDSPHERE, students can ask questions of researchers in the Antarctic, explore the wilderness of northern Minnesota, check on the progress of the Iditarod Sled-Dog Race, or trek across Africa. Let me elaborate. An elementary school student in Washington State is intensely interested in penguins. With her computer, she discovers a physicist working at a research base on the southernmost continent. The physicist relays the questions to a biologist who in turn answers her questions on how penguins breathe underwater, how long they live, and how they reproduce.

Three groups of students explore the Boundary Water Canoe Area Wilderness north of Ely, Minnesota, communicating back to the network via cellular phones and Macintosh PowerBooks. Reports stream back on the weather, fauna, flora, and survival in the climatic extremes. Video cameras and faxes supplement the electronic reports with information on gear, food, games, and dog sledding.

A school near Cleveland coordinates reports from the Iditarod Race, which usually lasts 11 days. Reports on weather and standings provide students on KIDSPHERE with a real flavor for the experience without enduring freezing winds and deep snows. For those who have never understood wind chills and thermal shock, who have never seen a lake motionless and windswept as a sheet of ice, these trips via the computer provide a sampling of winter without risk and expense.

For those living in northern climes, it may be impossible to understand the extremes of the Sahara. With their computers and a satellite hookup, a group of students travelled on a 10,000-mile bicycle journey in Africa. Video footage, online reports, and a newsletter provide details about the expedition. Students have opportunities to ask questions of Africatrek's leader, and learn more about the geography and environment of Africa.

Their appetites whetted, a compact disc such as "Svinga" can provide even more information, in this case on the culture and life of Zimbabwe. Built with HyperCard, students can learn more about the history, economics, art, or animals of this country, fresh from the national encyclopedia. Explore a national park, learn native phrases, understand the value of local currency, all with the click of a mouse. In conjunction with KIDSPHERE expeditions, Svinga gives students a chance to explore to their imaginative limits right from their desktops [3].

ELECTRONIC SCIENCE

Environmental studies are an important part of the curriculum but often the focus on local problems prevents students from getting a larger, even global perspective. Many children are exposed to the concept of water pollution, acid rain, and deforestation, but have no idea that a given situation straddles national boundaries and even oceans. In one project, students collected samples of rain or snow and posted pH values to a bulletin board in Boston. In another networked experiment, fifth graders in Illinois analyzed samples of ground water collected by their cohorts and shipped in special kits. In exchange, fellow participants received a sample of Illinois groundwater, pH paper, and a color chart. Another fifth grade class polled their colleagues on environmental issues, asking students to rank air pollution, deforestation, extinction, water pollution, and waste disposal in terms of seriousness. Many experimenters received advice from scientists and teachers on procedures for their experiments, to ensure the validity of their results.

Other groups of students track migratory birds as they move north in the spring and south in the autumn from Canada and the United States to Central and South America. Children along migratory paths post the passage of different species electronically, allowing students to create electronic and paper maps in class on routes, distance travelled, and elapsed time from start to finish. To understand migration in the very real sense of actual movement—plotted on a chart, based on daily electronic communiqués—is a very different experience from a textbook discussion of avian navigation.

And there are answers for teachers seeking a new way of introducing an all too familiar topic, dinosaurs. Many children are paleontological experts, knowing the names and habits of herds of Mesozoic creatures with a depth that would rival the professionals. The names themselves become a secret language for students, because the alphabet soup of reptilian identities befuddles adults. Yet most of these young dinosaurian specialists do not understand the Greek and Latin prefixes and suffixes behind the names. A teacher in Menlo Park, CA, posted a note on KIDSPHERE asking for help with these prefixes and suffixes, to give her students an opportunity to invent their own new dinosaurs. Remembering a recent children's book on these extinct creatures with an exercise involving these Greek and Latin phrases, I pull it from the bookshelf, find in it a list of common suffixes and prefixes, and post my discovery to KIDSPHERE for all to enjoy [4].

Even adults can enjoy the serendipity of this list as a way to devise a new educational recipe! KIDSPHERE is not for children or teachers only; it is a way of learning different from any we have known—a license for education unlike anything I have ever seen [5].

AN EDUCATION REVIVAL

In 1989, the governors and the President of the United States agreed that education needed to be transformed radically to prepare for the new century. Those goals are impossible without funds; since 1980, two percent or less of the federal budget has been devoted to elementary and secondary education [6]. The lack of technology in schools is particularly noticeable in those struggling for funds for books, facilities, and salaries. For these institutions, it is merely a dream to imagine a classroom with even a single computer, a modem, and a dedicated phone line. Students and teachers lose opportunities, leading to a downward spiral in educational performance from kindergarten through high school. Can just a machine make a difference?

The evidence in support of technology exists in the Internet tools like KIDSPHERE. Children always answer that they plan careers as astronauts, paleontologists, physicians, and other scientists early in their academic careers. Then later, the routine and boredom of science and mathematics education drive them to video games, television, and sports. Access to resources like computers, decent science labs, and libraries with up-to-date collections can keep a few more students interested in science and math, well into high school and college.

Children along migratory paths post the passage of different species electronically...

Those of us who suffered a math teacher who could not add or a science instructor who could not boil water, remember the experience of our enthusiasm leaking away like gas from a rapidly deflating balloon. There are tools available to keep curiosity alive and well in students and to make teaching better than we ever thought possible. Who would have thought we would see a time when students scattered around the world could work together on a science project or a writing assignment? Or when verb tenses were perfected with pen pals thousands of miles apart?

The tools are available to improve education right now. It is only a matter of our commitment not only at a national level, but as individuals in schools, on networks, and within communities. We can make the adult population of the next century truly advanced, or remedial at reading, writing, math, and science levels akin to a century ago. With technology, the decision is truly up to us.

REFERENCES

[1] Portions of this column originally appeared as my keynote address at the Conference on Information Technology at the International School in Bangkok, Thailand on Feb. 18, 1993. My participation was sponsored by the East Asia Regional Council of Overseas Schools and the International School Bangkok. I am especially grateful to Rob and Linda Rubis of the International School Bangkok and Fred Brieve of the East Asia Regional Council for their assistance.

[2] These future student portable computers are known now as personal digital assistants (PDAs). See Donald T. Hawkins' TECHNOTRENDS column, "Have You Seen Your First PDA Yet?," in *ONLINE* 17, No. 2 (March 1993): pp. 81-83.

[3] For a review of Svinga, see Rebecca Jackson's analysis in the *Apple Library Users Group Newsletter* 9, No. 4 (Oct. 1991): pp. 58-60.

[4] See Jerry Booth, *The Big Beast Book: Dinosaurs and How They Got That Way*. Boston: Little, Brown, 1988, pp. 42-43. My hobby of collecting children's books on dinosaurs helped in this special case!

[5] To subscribe to KIDSPHERE, send a message to <kidsphere-request@vms.cis.pitt.edu> on the Internet or <kidsphere@pittvms> on BITNET. You'll be asked to write a short introduction about yourself for posting on KIDSPHERE.

[6] Committee for Education Funding. *Blueprint for a Better Tomorrow: A Plan for Federal Investment in Education*. Washington, DC, 1992, pp. 2-3.

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Technology as a Vehicle for Transformation

by Lynn Murray, Al Myers, Gary Howard, Bernard Caron, and Julie Longchamp-Fay

The accelerating rate of change and the knowledge explosion have made learning to learn the most important outcome of education for a 21st century democracy. Technology can provide a common ground where teachers and students can learn together—where young and old can share in the development of skills, discovery of knowledge, and even exploration of feelings about "not-knowing" and learning.

In 1991, at Williston Central School in Williston, Vermont, Swift House was created to pilot a transformed educational program. Approximately 900 students, ages 5 through 13, attend Williston, within a system of 10 "houses," or families, of learners. Each house encompasses a family composed of 85–100 students, 4 teachers, and associated support staff. Although all houses demonstrate aspects of the essential characteristics of the vision for a transformed school, the Swift House team has taken the lead in piloting the vision.

At Swift House, a part of the vision was to create a learning environment where students direct their own learning, becoming empowered learners able to continue learning throughout the 21st century. To achieve this vision, students need to focus on learning about the learning process itself and develop the skills of creative and critical thinking, problem solving, and self-assessment. They need to communicate, as well as develop the ability to seek, access, and apply knowledge. They need to use technology effectively. Finally, they need to cooperate and develop independence and confidence.

After two years of operation, the Swift House team has begun to consolidate and disseminate their experiences so that other teams within the school might join in the challenge of creating effective student-directed learning environments. The team identified three components central to

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transforming the learning environment: the changing role of the teacher, the learning process itself, and the role that technology might best play. With the assistance of a grant from the Vermont Institute for Science, Math and Technology (VISMT), the team (composed of teachers, a computer specialist, and the principal) developed a one-week technology lab experience for Williston teachers and students who wanted to explore these components and learn more about technology.

Changing Role of the Teacher

The role of the teacher needs to be conceived very differently from that of the teachers we all knew when we were in school. The Swift team coined the phrase "Lead Learner" in an attempt to capture the transformation from teacher as information giver to teacher as facilitator of learning. Lead Learners structure learning situations in which student-student and student-adult interactions allow students to take control and responsibility for their own learning. This approach dictates that the content of the learning emerges from interactions with students and their interests. Lead Learners are ready to learn right along with the students, investigating unexplored areas of interest; learning and experimenting with new research techniques, equipment, and materials; and constantly reflecting on what is learned and how. In short, learning is collaborative and ongoing.

Learning Process

The learning/thinking process has become a central focus of the curriculum—for both teachers and students. Traditional factual knowledge (content) is still important, but it is subservient to the learning process itself. Effective learners bring frameworks for understanding to new material. These frameworks clarify prior understandings and thus preserve meaning as teachers and students discover new ideas and concepts. By showing students how to be aware of their own learning styles and thinking processes and by making new learning strategies explicit, frameworks for incorporating new ideas become the focus of the classroom experience. This consciousness raises the level of effective learning, setting the stage for continued growth in the future.

Integration of Technology

The need to integrate technology into the learning process provided an ideal way to address our teachers' growth and practices related to their changing role and its relationship to the learning process. Independent of the "factual material" under consideration in creating projects and con-

ducting research, technology demands problem solving. When people use technology, they have to solve problems, such as creating files, dealing with the vagaries of a computer network, getting onto telecommunications applications, or organizing the pages of a multimedia project in a logical way. For example, multimedia applications, such as *Linkway* and *Hypercard*, allow learners to construct and reconstruct the "big picture" as they arrange, rearrange, and link pages and folders to other "big pictures." Such use of technology provides a strong visual communications tool for higher-order thinking. Technology provides teachers approaching their own transformation process with an effective medium for exploring their own practice.

Summer Lab

The Swift House team's technology lab hosted eight Learning Teams. Each team included one teacher and three students, ranging in age from 7 to 10 years. The eight teams participated in a week-long investigation of technology in relation to a focus topic—"Change." First, Swift House teachers modeled *Affinity charting*, a Total Quality tool, with which Learning Teams brainstormed on "Post-it" notes many ideas about "things that change." Each team then used a multivoting process to reach agreement on the specific topic they wished to concentrate on together. They moved on to *concept mapping*, with which the Learning Teams organized what they already knew and identified specific areas for further investigation. The Swift Team then demonstrated technology applications that would access information, organize it, and aid in its presentation to others. Teachers also read selected articles about metacognition and technology and reflected on the educational value of their experiences and ideas. During their work together, each Learning Team was charged with the task of developing a *multimedia presentation* on the theme of change. Teams developed presentations on such topics as the moon, the stars, dinosaurs, caterpillars, volcanoes, and nature. Throughout the week, teams reflected constantly on their learning-to-learn processes.

Learning to use technology provided an excellent opportunity for teachers to model learning for their students as they teamed with them to master the multimedia software programs. They made electronic folders; integrated artwork; captured video, photos, and audio; animated illustrations; embedded linked "buttons"; and integrated text—many for the first time. Teachers frequently found that students were more adept at the process, and they allowed students' discoveries to become learning opportunities for themselves, as well as the other students. This was easy to do, because most teachers started the week with the same level of knowledge

as the students. Teachers thus were compelled to approach the task in a collaborative mode with their students—providing ample opportunity to experience and reflect on the characteristics of the role of Lead Learner.

Teachers and students alike were unfamiliar with the presentation tool, *Linkway*, and the concept-mapping methods used to define and organize individual thought processes. The Learning Teams joined with Swift House teachers in creating a presentation to be proud of—working toward a common goal, troubleshooting computer availability and malfunctioning, sharing lead-learner roles depending on strengths and needs, and learning nuances of software by trial and error. Students were heard to chuckle, "Silly Mrs. Leonard!" when she lost her file, and to exclaim, "I showed Ms. Houskeeper how to animate her picture!" Teachers commented on the positive nature of the learning experience because of the "potential for so much more" in the future—sharing their new knowledge about technology and continuing to explore their role as Lead Learner and their ideas about learning.

The nature of technology itself, in any application, demands the development of problem-solving skills. Troubleshooting, discovering cause-effect relationships, understanding system operations, and finding appropriate resources (human or otherwise) are all a part of "making it work." The presence of technology in our daily environment necessitates learning systematic approaches and interrelationships.

The Swift House teachers, the teacher participants, and the young students all enjoyed the challenge of learning and leading at different times. Because the Lab operated at three different interlocking levels simultaneously, participants were highly enthusiastic, and interesting insights constantly emerged. Learning technological skills served to enhance and make explicit the reasoning and interaction processes used by both students and adults. Learning teams were interacting with technology, with an emerging knowledge base, and with each other.

No one had all the answers; but everyone had shared questions and a shared desire to discover knowledge and present it in an effective way. During daily reflection times, participants clarified their thinking about their own personal learning styles, their interaction patterns, and the possibilities for structuring learning experiences to provide maximum opportunity for problem solving, communication, cooperative skill development, and metacognition.

By the end of this intensive week, all participants had grown from these exploration and skill-building experiences. Both students and teachers

had an empowering experience with computers and multimedia, because they were able to immediately take control of their own learning and to develop and integrate new ideas into existing thought/knowledge frameworks. Adults were treated to the additional benefit of seeing the broad view. They discovered or reaffirmed their roles as Lead Learners—adults challenging themselves to go outside their comfort zone of working with the known, experiencing and modeling what students are expected to do every day in school. As teachers confronted the mysteries of the technology, they collaborated with their students in assimilating new information and skills, encouraging and sharing with each other in a relaxed and meaningful learning environment.

Participating teachers discovered that Lead Learning is total and unselfish involvement by all participants and includes shared goals, successes, and failures. It is more than the sum of cooperative learning and facilitating. Lead learning can take place without technology, but not without communication. Technology can offer learners the link into the understanding and sharing of the mindsets and knowledge base of each of the participants. The teachers' reflections and the students' responses to the projects clearly show the value of integrating adults and students into the learning process and the value of technology as a safe, dynamic meeting place for all learners.

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Developing a Telecommunications Curriculum for Students with Physical Disabilities

Terry S. Gandell • Dorothy Laufer

The use of telecommunications can facilitate integration into the community and the larger world.

Would you like your students to broaden their communication horizons? Are you interested in your students' being integrated more fully into the community? Have you experienced resistance to implementing new programs in your school?

If you answered "Yes" to any of these questions, you will be interested in learning of some of our experiences in developing a telecommunications curriculum for students ages 15 to 21 with physical disabilities. Telecommunications involves the use of a microcomputer and a modem, the hardware that connects two computers over a telephone line. Telecommunications makes it possible for two computers to talk to each other. From the home, office, or school, a person can get electronic mail, a variety of information, access to shopping and banking, and many other options by using telecommunications.

The Project

Both authors had used electronic mail personally and professionally for 8 years. Working with students with disabilities and observing current applications of electronic mail stimulated a desire to see this technology adapted for use by such students. The program we envisioned was a natural outgrowth of a pilot project called Blisscom. Blisscom, which is experimental software, has enabled persons with severe physical disabilities who use augmentative communication to send and receive Blissymbol messages over telephone lines. The success of this project highlighted the importance that telecommunications holds for people with disabilities. For us, witnessing the independence and communication of Blisscom users only reinforced the idea that computer technology is a door to many worlds.

We decided that a telecommunications curriculum could be developed as part of the regular school program. We wrote a curriculum proposal and submitted it to the principal, outlining goals, target population, curriculum, equipment needs, and staff requirements.

The response from the principal was positive. However, implementing the program was more of a political challenge than the staff had anticipated. The administrative team from the rehabilitation center where the educational program is housed was concerned that the curriculum would have major implications for their staffing, budget, and general policy, and were unable to get involved at this time. All staff members felt discouraged by this response, but with the support and encouragement of the school principal, the program was implemented.

Although we were unable to purchase the items requested (two telephone lines, one specially designated area in the school, two microcomputers, two modems, and adaptations for accessing the computer), we followed the original outline of the proposal as closely as possible. It was necessary to adapt the ideal to the reality of one modem, one shared telephone line, one shared microcomputer system, and two teachers for four periods per week.

The Students

The students who participated represented 1 of a total of 14 classes in the school. They were from 15 to 21 years of age and had varying degrees of physical disability ranging from mild cerebral palsy with the ability to walk, to severe quadriplegia with concomitant speech and cognitive disabilities. Some of the students required the use of special adaptive equipment such as a single switch to operate the computer. Their academic abilities ranged from grade two to grade nine, and they had all been exposed to and used computers for 5 years.

The Program

During the first three lessons, the different types of telecommunications systems were demonstrated. The four systems (see Table 1) included an internal mailbox program (Mailbox), a direct interactive communication system (Blisscom), a bulletin board system (Arctel), and a mainframe system (Compuserv). The class voted on which system they wanted to start with. Their choice of Blisscom seemed to reflect their desire to maintain communication with friends who had graduated and who depended on Blisscom for their telephone communication. This was in keeping with our global goal of maintaining a meaningful as well as functional program.

Over a period of 2 months (two 40-minute sessions per week), the students progressed from practicing individually to independent operation of Blisscom. Continued and frequent use of the system was not possible, because the computer was located in a locked room and was not accessible to a student who was unattended by a staff member. Easy access to the equipment would have been more likely to encourage and maintain consistent telecommunications.

Once the students mastered Blisscom, they gathered as a whole class for four lessons to explore Arctel, a bulletin board system. Although the list of objectives addressed electronic mail, bulletin boards, conferences, general board exploration, and telecommunications usage, the lessons focused on the electronic mail component as a starting point.

Adapting the System

Arctel is quite a complicated system to learn, and the procedures required adaptations to facilitate the students' learning and use of the system. For example, only first names were used to sign on, single letters were chosen as passwords, and stacking commands were taught. This reduced the amount of keyboarding strokes, thereby minimizing the need for physical movements. Despite these changes, not all of the students' needs for alternative means of physical access to the computer could be met. All but the essential commands needed for electronic mail were eliminated; specifically, the students were taught to ignore 8 of the 11 commands, which they did not require. A procedural manual was developed to reinforce these strategies.

Helping the Students Adapt

Through problem-solving and using the manual, the students developed skills that allowed them to use the system with less and less direction. These skills were developed through group discussions and on-line instruction in problem-solving. One simple technique that was effective in reducing students' anxieties, fears, stresses, disappointments, and frustrations with the systems was to defuse the situation by saying "SNAFU" (Situation Normal: All Fouled Up!). It certainly helped to remind the students that any time a person is working with technology there are bound to be problems. This nonthreatening attitude seemed to motivate the students to persevere. In only 3 months, they operated the electronic mail component of Arctel independently with only two 40-minute periods of instruction per week.

Table 1. Telecommunications Systems, Equipment, and Features

	Mailbox	Blisscom	Arctel	Compuserv
Equipment Needed				
Apple computer	✓	✓		
Any microcomputer			✓	✓
Modem		✓	✓	✓
Program diskette	✓	✓		
Communication software			✓	✓
Features				
Interactive		✓	✓	✓
Message storage/retrieval	✓	✓	✓	✓
On-line cost				✓
Single switch built in		✓		
Single switch available	✓		✓	✓

Adapting the Program

As the students progressed through the project, it became necessary to modify the list of objectives to add some that had not been anticipated. These additional objectives, directly related to telecommunications operation, related to the subskills involved in the operation of the system: problem-solving, organizing, planning, implementing, communicating, and writing.

Program Evaluation

Evaluation procedures concentrated on the acquisition of the skills directly related to the operation of the telecommunication system, rather than the subskills. The original list of 35 objectives (see Figure 1) was referenced in order to generate the progress report. Each item was recorded as either "not achieved," "achieved with assistance," or "achieved independently." "Not achieved" usually indicated that the objective was never introduced.

"I felt that thi was a wonderf thing to learn and I want to learn more.

Measurement and progress were recorded during informal group discussions, formal on-line periods, students' independent use of the system, and written tests. An exciting part of the evaluation was that it was a hands-on examination. For example, questions such as "How long have you been on-line?" and "How many messages do you have waiting?" required the student to use the telecommunications system in order to respond.

Goal attainment and student self-reports were considered integral in evaluating the program. All of the teachers

were pleased that the objectives were achieved in such a short time. Comments from the students such as the following reflected a positive response to the program:

> I felt that this was a wonderful thing to learn and I want to learn more.
>
> It's neat! I can stay friends with Frank when I leave school.
>
> At first I didn't understand it, but if you give the program a little more time you can get the hang of it.
>
> I imagine it will be put to good use by me when I am communicating to friends who have left school.

Conclusion

The students' enthusiasm for electronic mail is reflected in their comments. It is reasonable to assume that their enthusiasm will be just as great when they are introduced to other aspects of telecommunications. Students made appointments to use the system on a daily basis, and they regularly called teachers at home to discuss some of the "bugs" they had encountered.

Even at this embryonic stage of the telecommunications program, its influence on and place in the lives of students with physical disabilities has become a reality. The use of telecommunications can facilitate complete integration into the community and the larger world. Once the basic skills have been acquired with various systems, individuals with physical disabilities will have independent access to information, education, recreation, and vocational pursuits.

Although there are many steps to be covered before telecommunications is fully integrated into the curriculum, we are encouraged by the implications this technology has for students with special needs. Clearly, telecommunications can be an integral component of the educational curriculum in the same way that reading, writing, and mathematics are. It is our hope that schools and governments will support and promote the development and implementation of telecommunications programs.

Figure 1. Sample Objectives

General

The student will be able to

1. Demonstrate understanding of the concept of telecommunications.
2. List three or more uses for telecommunications.
3. Use two different types of modem software.
4. Retrieve information on line.

Specific The student will be able to	Mailbox	Blisscom	Arctel	Compuserv
1. Boot the system.				
2. Recognize a successful connection.				
3. Register and sign on the system.				
4. Determine whether or not he or she has any messages.				
5. Edit a message.				
6. Reply to a message.				
7. Print a message.				
8. Access a bulletin board.				
9. Solve a problem while on line.				
10. Reference manual when needed.				

Addendum

It has been 2 years since the implementation of this project. Many more students have begun to use telecommunications. All of the original participants have now graduated. We had hopes that the telecommunications program would be a useful tool for students not only in school but also after leaving school. This has certainly been the case! Students who were not as motivated to use telecommunications in school now use it enthusiastically and frequently at home. It moved from being a basic skill acquisition program to a necessary tool.

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Doing Science in the Electronic School District

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Abstract Computer networking is opening new avenues for the conduct of education in the classroom. No longer is the classroom bound by its physical walls. Using computer networking, teachers and students can access resources and communicate with peers as never before possible. In Indiana, a project called the Electronic School District has been exploring the potential of a wide area network linking K-12 schools and universities since 1987. Centered around a network called STEPS, Student and Teachers Electronic Productivity System, the project has spawned efforts of particular interest to science educators. One of these, peer-mentor networking, uses the computer network to support communication among teachers and students. Using electronic mail, network participants can exchange ideas with one another, as well as communicate with people around the world over the Bitnet international network. In addition, computer conferences on a variety of science-related topics have been established that provide both resources and a forum for the exchange of views. Another effort called STEPS to Better Science is exploring the classroom use of microcomputer-based laboratories for data acquisition. Via the network, data from different sites throughout the state can be exchanged. The emergence of computer networks like STEPS is providing new opportunities for science education by bringing resources into the classroom, reducing teacher isolation, and providing opportunities for addressing science problems beyond the scope of the classroom's walls.

The Electronic School District (ESD) is a joint study project presently underway in Indiana. Launched in 1987, the goal of the ESD project is to investigate the benefits to K-12 schools of a wide area computer network linking schools, universities in the state, and the Indiana Department of Education. The partners in this venture include Purdue and

Indiana Universities, the Indiana Department of Education, IBM Corporation, and pilot school systems throughout the state.

The result of this cooperative effort has been the development of a wide area computer network called STEPS—Student and Teachers Electronic Productivity System. The STEPS network serves as the hub for a variety of innovative projects beneficial to the entire state of Indiana and capable of serving as a model for other states and regions across the nation and throughout the world. It represents one of a growing number of computer networks that seek to serve K-12 education (McAnge, 1990). This paper will focus on the applications of the STEPS network that deal with the enhancement of science education in the participating schools.

Background

The STEPS network is anchored by an IBM 4381 mainframe computer located on the Indiana University campus. Personnel in the University Computing Services of Indiana University are responsible for maintenance and operation of the network. As originally configured, IBM System 36 minicomputers served as regional hubs tying together clusters of microcomputers within the state. However, this configuration proved to be problematic, and the minicomputers are no longer part of the network.

The five participating pilot schools in the ESD project each have laboratories of IBM PS/2 personal computers connected on local area networks (LANs) that bridge into the STEPS network. Schools that do not have direct connections to the STEPS network can access it using modem-equipped personal computers on a dial-up basis. About 2000 users, both teachers and students, now connect into the STEPS network on a regular basis.

The broad objectives of the ESD project are to (a) investigate the utility and effectiveness of various computer network applications for use by students and teachers, (b) develop and evaluate network tools for distance course delivery, (c) develop and evaluate applications that increase the productivity of school administrators, (d) promote infusion of computer networking technologies in K-12 schools, and (e) evaluate communication protocols and network topologies for interconnecting student and teacher workstations in a wide area network. Guided by these objectives, a number of research projects utilizing the network have been initiated by faculty at Purdue and Indiana Universities. The research component of the ESD project is directed by the Purdue University School of Education. This paper will focus on two projects that directly contribute to the enhancement of science education in the schools participating in the ESD project: Peer-Mentor Networking, a project involving student and teacher communication; and STEPS to Better Science, an effort involving both network connectivity and the use of microcomputer-based laboratories.

Peer-Mentor Networking

Peer-Mentor Networking involves the use of the STEPS computer network for communication among schools, and between schools and universities. Teachers can interact with other teachers as well as with university professors in their specialty areas. Likewise, students can interact with students at other schools, as well as with university students and faculty. The basic notion is to use computer telecommunications to decrease teacher isolation and increase the opportunities for interaction among teachers and students.

The Peer-Mentor Networking system rests on two communications platforms—electronic mail (e-mail) and computer conferencing. E-mail provides for one-to-one, one-to-many, and many-to-one communication. Computer conferencing provides a mechanism for the exchange of ideas and information on a variety of topics of special interest to STEPS users. Both e-mail and computer conferencing are enhanced by file transfer capability which allows users to upload and download information of interest.

On the STEPS network, e-mail is supported by IBM's PROFS software. This multipurpose program for the mainframe environment provides the capability for many personal productivity functions including scheduling and document preparation. However, only its e-mail function is extensively used on STEPS. In addition to contacting one another, teachers and students have access to experts over the network. For example, students involved in Project SITE/INSITE, a telecommunications in education effort, are using STEPS e-mail to send science questions to pharmaceutical researchers in area companies.

In addition to contacting other members of the STEPS network, users can also connect with individuals outside of STEPS over the Bitnet network. Bitnet is an international network linking many universities and research institutions. The STEPS computer is a node on the Bitnet network; thus, users can send e-mail to and receive e-mail from any other node on Bitnet.

The access to Bitnet greatly enhances the opportunities for interaction available to STEPS users. International pen-pal projects are already underway. Students are exchanging information with peers in Europe. In addition, a large number of listservers are available on Bitnet. Listservers are electronic bulletin boards residing on various computers on Bitnet. When a user subscribes to a listserver, any e-mail that is sent to it is automatically posted to all of the subscribers. Thus, an exchange of ideas from individuals all across the world is facilitated. A number of listservers are available that concern topics of special interest to science educators. Physics and environmental science listservers, for example, are being accessed by teachers on the STEPS network. Several listservers have been automatically linked into computer conferences on STEPS to permit easier access.

Computer conferences, like e-mail, provide an avenue for communication among users. However, computer conferences more closely resemble electronic bulletin boards. They are public forums on topics of special interest. A number of conferences on a variety of topics, many of which relate to science and science education, have been established. Within each conference, sub-topics are established, and individual contributions are listed under each sub-topic. Contributions can include resource information, as well as questions and comments from individual users of the system.

In the STEPS system, computer conferences operate within a software program called Grouptalk CONVENE. This program controls the creation and management of the conferences. Conference moderators can establish topics and organize conferences as they see fit. Individuals accessing a conference can browse the topics and read the contributions. In addition, on most topics, individual users are free to make their own contributions. Contributions may reference other contributions so that conversation threads can be traced forward or backward. All of the contributions are maintained within the system for ready access. Individuals interested in particular conferences or topics can subscribe to them. New conference contributions are then automatically posted to the subscribers' mailboxes.

As of this writing, a number of science-oriented conferences have been established encompassing such topics as weather, geoscience, physics, chemistry, biology, and microcomputer-based laboratories. There is also a conference for mathematics teachers, as well as a general teacher conference. Within each conference, topics of interest to teachers in

the field have been established. The weather conference, for example, includes data from Hurricane Hugo and facts about weather records from throughout the world. Teachers have also uploaded a long list of weather-related lesson plans. The recently added biology conference includes a section devoted to the Indianapolis Zoo. Users may download animal fact sheets prepared by the zoo's education staff or post questions to the staff. The following section gives a detailed description of the physics conference.

Conference Close-Up: The STEPS Physics Conference

The physics conference, like other conferences on the STEPS network, is intended to promote a dialogue among interested users. Its primary aim is to provide a resource and communications avenue for physics teachers. Physics teachers are typically among the most isolated members of the teaching profession. Many schools have only one physics teacher; consequently, that teacher feels isolated from his or her peers. The physics conference on STEPS provides a vehicle for physics teachers to stay in touch, share classroom problems and techniques, and stimulate one another's thinking.

As currently configured, the STEPS physics conference contains the following ten major topics:

(1) School concerns--concerns about the curriculum and pedagogy;
(2) Class demonstrations--favorite in-class demonstration of physics principles;
(3) Physics labs--favorite laboratory activities;
(4) Operation Physics--a section devoted to this national program that seeks to strengthen physics instruction at the lower and middle grades;
(5) High tech--a discussion of the use of computers and other technology in physics teaching;
(6) Current affairs--news about research and funding opportunities;
(7) Coming events--a listing of upcoming events of interest to physics teachers;
(8) Bio sketches--biographical sketches of conference participants;
(9) User comments--a forum for the exchange of ideas among participants; and
(10) PHYS-L--a posting of messages from this physics Bitnet listserver.

All of the topics in the conference have experienced some activity. Several favorite demonstrations and laboratory activities have been posted by teachers. However, the user comments topic clearly is the most active part of the conference. Dozens of physics teachers from around the state have obtained STEPS IDs and participated in the conference. This opportunity for interaction with other physics educators has proved to be the greatest attraction.

Last year one of the physics teachers who uses the conference posted the following problem for all to consider: "A wooden cylinder has a small lead weight glued to one end and is floating in water. Is the glue joint under tension or compression?" What followed was a spirited debate. Different users proposed different explanations; calls were made for clarification of the exact nature of the problem; and the discussion carried on. This example illustrates what computer conferencing is all about. For a physics teacher, this problem represented an interesting challenge and a focal point for discussion with colleagues. Without the computer conference, few of the teachers who became involved would have had anyone with whom to discuss it. Computer conferencing essentially reduces teacher isolation.

STEPS to Better Science Project

Another major effort related to science education in the ESD is the STEPS to Better Science project. This project involves the use of microcomputer-based laboratories in support of science education as well as the use of the STEPS network.

The microcomputer-based laboratory (MBL) is a system that uses the microcomputer for student-directed acquisition, display, and analysis of laboratory data. Using MBLs, students can explore, measure, and learn from the physical world that surrounds them and connect their understandings to a more formal scientific framework. With MBLs, students can acquire a better understanding of the scientific principles that underlie their experiences, a sound physical intuition, and competence in the use and interpretation of graphs (Mokros & Tinker, 1987; Thornton, 1987).

The STEPS to Better Science project uses one of the newest MBLs in the marketplace —IBM's Personal Science Laboratory (PSL). The PSL consists of a base unit with its own microprocessor that attaches to a microcomputer via the serial port. Various modules can be plugged into the base unit for data collection. The PSL currently supports modules for temperature, light, pH, and motion and mechanics. The hardware is controlled by a sophisticated piece of software called the PSL Explorer. It supports the creation and/or selection of experiments, real-time graphing of the data, and numerous options for manipulation and/or analysis of the data (Campbell & Lehman, 1991).

During the summer of 1990 teams of science teachers from the schools participating in the ESD project were trained in the use of STEPS and the PSL. Each school site received a PSL unit equipped with temperature, light, pH, and motion modules. Subsequently, these teams developed lesson applications of STEPS and the PSL for use in the science classrooms of their schools. Some of these applications include measurement of acid rain, the effects of pH on plant growth, Galileo's inclined plane experiment, and others. During the 1990-91 academic year, these lessons involving the use of the PSL were incorporated into the science classes in the schools.

Throughout the project, the STEPS network continues to be used as a communications vehicle. Teachers in the project work with other teachers in the same content areas to exchange ideas. In addition, some experiments involving shared data across the sites will be attempted. The acid rain experiment is one example. The rainwater pH data from the various state school sites will be posted to an MBL conference set up on STEPS so that students can collect and analyze the results from experiments at different sites. Another planned group experiment is a repeat of Eratosthenes' measurement of the earth's circumference based upon the shadows cast at noon on a particular day by identical sticks at two different locations. This activity has been described by James Levin and his colleagues at the University of Illinois (Levin, Rogers, Waugh, & Smith, 1989).

The use of the PSL is designed to promote students' abilities to do "real" science. The PSL provides a vehicle whereby students may easily collect information about the world and rapidly see the data expressed in graphical form. The use of STEPS is designed to broaden the students' views, to take them beyond the confines of their own communities to a consideration of problems in science that can affect us all.

Summary

Computer telecommunications is opening new avenues for teaching and learning in science. In the electronic school district, teachers and students can use e-mail to

communicate with others across the state and around the nation. Computer conferencing offers a means of sharing resources and reducing isolation. The sharing of experimental data gives students the opportunity to consider problems in science beyond the local scope. In the electronic school district, we can bring the global village into the classroom for the benefit of all.

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A Community of Learning

Geriann Marie Walker

Foreward

Elmira High School serves the small town of Veneta (3,300), the adjacent unincorporated community of Elmira (1,500) and the outlying communities of Noti (400) and Walton (300), total population 5,500. Veneta-Elmira is 15 miles from Eugene-Springfield, a metropolitan area of about 175,000. Eugene is home to the University of Oregon and major industries, and is separated from Veneta-Elmira by a wildlife refuge and a large reservoir.

Set in the foothills of Oregon's coast range, these small outlying rural communities accommodate an eclectic mix of lifestyles, avocations, and tastes. Although they increasingly serve as bedroom communities for Eugene-Springfield, their roots are still in the declining timber industry and in agriculture. The area has become an important part of Oregon's burgeoning wine industry, a variety of artisans and craftspersons do their work in this scenic and relatively inexpensive hinterland, and Veneta's biggest claim to fame is the Oregon Country Fair, the largest annual countercultural gathering in the country, if not the world. It is a place undergoing change as the tentacles of Eugene-Springfield reach farther west and highway improvements make the area more accessible and attractive to those with the money to build and commute.

Nonetheless, a cow pasture still lines the quarter-mile drive leading to the school, set against a backdrop of tall firs and rolling hills. Students participate in 4-H, raising pigs and sheep to earn money for school clothes and cars. This morning a local elementary school principal brought in extra buses and warned parents not to let their children walk to school because a cougar has been spotted in the neighborhood and killed a family dog, and as I drove to work today I saw a pair of bald eagles.

I went to Boston in the summer of 1989 to participate in the first teacher training workshop for LabNet. With only one year of teaching experience, I brought little more to the workshop than an insatiable appetite for new ideas and a bullheaded youthful spirit. I was taken by the idea of self-directed students working on projects with a community of peers linked by telecommunication, and I was excited by the potential for teachers to share and learn from each other using this same tool.

Now, nearly four years later, it is evident that LabNet has been the single most important influence on my career. Furthermore, my experiences with telecommunication and Project Enhanced Science Learning (PESL) have not only impacted my students, my colleagues, and my administrators, but the entire school community. As I reflect on the influence that LabNet has had on all of us, it is apparent that the two components of LabNet—telecommunication and PESL—although inextricably linked, have affected me and these different groups in different ways.

Thinking back to that initial workshop, I recall hearing someone with whom I was very impressed say that he had a class where students did nothing but physics projects. There was no other curriculum; the students chose their own areas of inquiry and developed their own methods of investigation. When I got home in the fall I asked my principal if I could offer such a course the following year, where students would do projects in any field of science, including social science, as long as they employed a scientific method of investigation. To my delight, my principal said yes.

Getting Started

The primary challenge upon returning from that initial LabNet teacher training workshop was to obtain the necessary equipment in order to get on line on the LabNetwork. In my building, however, where funds have always been closely guarded, obtaining the necessary equipment—a computer, phone line, and modem— meant launching a political campaign to convince my principal, superintendent, and school board that LabNet was a program worth investing in. The plan to offer a course where students could participate in original scientific research while linked with a nationwide community of peers doing the same was a definite selling point. There was something appealing

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in the idea that our school would be part of a national program that would put us in touch with other schools, other scientists, other teachers—with a community of interested parties that did not exist in Elmira. (Even though we're near Eugene and the University of Oregon, with an excellent library, research facilities, and scientific experts, many of our kids think of Eugene as another town, a place that they don't think of when they think of home.)

At this time, my district had a superintendent who was perceived as being difficult to work with. Nevertheless, I asked for what I needed: a dedicated phone line in my classroom for telecommunication. He said yes! He not only said yes, but he showed a lot of interest in LabNet. My principal was also supportive, and used funds from her discretionary account to purchase a modem.

Involving the school board in supporting LabNet was the most enjoyable part of this political campaign. They were familiar with the work I had done with microcomputer-based laboratories during my first year of teaching and they were interested in continuing to update the district science program. When I asked for support for LabNet, they saw this as another opportunity to foster a program that the community could take pride in. After all, this was a national, federally-funded science education program; it would put Elmira on the map!

Each year I have given the school board and superintendent an update on LabNet. I have demonstrated the ways that I have used LabNet in my classroom, explained that LabNet has provided financial support for our school's program (a small matching grant of $200 and a Big Idea mini-grant of $4,200), and my students have made presentations on their use of the network for their projects. These presentations, which often lead to articles in the local newspaper, have resulted in long-lasting support for LabNet. Although the superintendent who got me my first phone line is gone, we've had two superintendents since then, and both have been enthusiastic. My first principal is also gone, but my new principal is just as supportive; when asked to write about the star programs at our school this fall, he chose to write about LabNet. I don't think that this enthusiasm comes just from me or my contact with these people. They see something inherently important in linking our rural school with a broader community devoted to improving science education.

Students on the Network

It took me until the winter of 1990 to get on line (about 6 months after I returned from the first LabNet workshop). The following year I began the projects class, and those students used the network to research their projects and solicit feedback on their experiments. They would write messages and I would log on, send them, and download any responses. I had a student who wanted to see if electricity could be generated from the temperature difference between ocean water and subsurface rocks on the shore. I suggested that he ask a physicist at MIT, who I knew was on the LabNetwork, for some help in setting up his experiment. He engaged in a dialogue with this professor and received some good feedback on the work that he was doing. This student took first place in the Engineering Division at a statewide science fair later that spring. His project also won a significant award from the Marine Corps, a scholarship to Pacific University (the host of this science fair), and he took first place at our county science fair. Every judge who interviewed him wanted to know more about LabNet and how he had used telecommunication as a resource in doing his project work. Since then, every project that students have completed as part of the projects class has involved telecommunication (either as a major tool in the research or as a resource for information and feedback), and nearly all projects have won awards at science fairs or competitions.

However, not all students' attempts at using the network have been so successful. There have been instances where student requests for help have been ignored. Also, some students have had a difficult time articulating their needs, making it difficult to respond to their messages. One student, putting a message on the network, asked for help in designing a project to compare open and closed ecosystems. She never received a response. It has been my experience that student messages are more apt to yield a response if they include specific questions that LabNetwork users can address, rather than requests for help or information regarding a broad topic. For example, last year one of my projects students wanted to conduct a survey of student attitudes about sports. She placed a request on the network asking teachers to distribute the survey in their schools and return the completed forms. Several teachers responded and she was able to gather data from high schools in each quadrant of the country.

The students in my projects class are not the only ones who use LabNet. I have conducted short-term projects in physical science classes where students have exchanged messages and ideas with kids doing the same project in another LabNet classroom. One of the more exciting examples of this is the Descent of a Ball activity where students must create a structure from paper and tape that will delay the descent of a ball dropped from a height of one meter. A couple of years ago my physics students exchanged messages describ-

ing their structures with students in Manassas, Virginia. The task of describing their structures verbally, without the aid of diagrams, was quite a challenge, as was the interpretation of the descriptions they received from our partner class.

My physics students use the network for ideas and feedback when they do independent projects during the spring. They recently posted messages regarding their projects for the third quarter. This morning we received replies for projects on holography, bridge building, radon measurement, and the strength of chicken egg shells. My chemistry students have used the network to share information about soil and water studies that they have conducted in their community and the surrounding area. Although their soil and water study was conducted last spring, they recently received a request for their results from students in Georgia who were in need of some comparative data.

It has been my experience that students seem to care more about the way that they report their projects when using LabNet. They edit their messages carefully and rewrite them—something they don't always do with the writing that they turn in to me. If they are working in groups, they all seem to want to have a say in what their message contains; it is not acceptable to let just one person do the writing. Students delight in sharing personal information about themselves and their school. They look forward to getting responses to their messages, and are disappointed if there aren't any. (I didn't even have to announce that the physics students had received responses to their messages this morning: They were crowded around the bulletin board where the messages were posted before class had even started!)

When telecommunication is involved, they feel part of something whose significance transcends the classroom. They are engaged in their own process of communicating with others and evaluating their work. The key is that it is their own. Students aren't just turning in a project for a grade or for me to read. It is something that is theirs and that they are sharing with a community of which they are a part. This evokes a different type of enthusiasm for the work they are doing; it validates their work and gives them a reason to respect it. They are learning to learn from others, just as real scientists do, just as we all do outside of the classroom.

LabNet has allowed our school to become a place where students do award-winning science projects and where any student taking science can be part of a telecommunication network. Student experiences with PESL and LabNet have fostered a genuine school-wide interest in the science program. Our school newspaper now routinely reports on projects that students are doing in my classes, something that rarely happened before. Physics projects are proudly displayed at a spring festival, and class projects and activities are often the feature of a student-produced weekly school news video that is broadcast in each classroom via Channel One.

A Teacher on the Network

Like my students, I also use the LabNetwork to get ideas and feedback. I've obtained many ideas for projects, activities, labs, and demonstrations from teachers on the network. As a new physics teacher with a degree in chemistry but only one college physics course to my name, I find this resource invaluable. Last week, I received a lab on friction from a teacher in Texas. Now I can use my computer force probes for something other than dynamics experiments. I also got the idea for my second quarter physics project, the King of the Hill Contest, from a LabNet teacher. (In this project students must devise cars powered by mousetraps and rubber bands that are capable of crossing over a hill and preventing their opponent's car from doing so from the opposite direction.) Furthermore, it was a LabNet teacher who suggested that I look to local businesses to help fund student project work. (I have been raising about $400 a year by following this teacher's advice.) And like my students, who feel that their work is validated when they are able to share it on the network, I feel validated when I can share my ideas with others who support the work I do.

The support that I get from teachers on the LabNetwork, teachers who share my enthusiasm for PESL, is different from the support that I get from colleagues in my department. While my colleagues do like to share ideas, they have seemed unwilling or unable to adopt PESL methods or to make use of the LabNetwork. When I received a small grant from LabNet to train them in telecommunication and to develop curricula, they were initially enthusiastic. However, their enthusiasm faded and their follow-through with the project was marginal. They did use the network themselves for a while, but their students never did the projects they had developed and never used the network.

Unlike me, my colleagues did not get hooked on telecommunication or PESL. The technical side of things was difficult for them. Neither of them had used computers very much before, and they weren't familiar with Appleworks or the telecommunication program we were using. The technology did not seem user-friendly to them, and I'm not certain that they were convinced that students would benefit from this type of classroom experience. In addition, they viewed the

process of engaging in a project with students and using the network as a big deal, something they had never done before, and I believe that they may have been intimidated by this or uncomfortable with the process of navigating through uncharted waters.

My colleagues did not have the experience of working with the LabNet community during workshops and training sessions. They were communicating with strangers; there were no familiar names and no faces to associate with any of the messages that they received. My experience has been that this type of connection with others on LabNet has kept me on line, motivated me to respond to messages, and encouraged me to feel free to post comments of my own. Those of us who have participated in LabNet workshops have continued to build upon the relationships that were forged during these summer trainings. For us, using the network means continuing to work with people whom we trust, people with whom one easily can take risks. The familiarity that we share has allowed us to expose our areas of expertise, as well as our weaknesses. There is a niche for everyone: the "techies," the philosophers, the pedagogues, and the pragmatists. It is unfortunate that my colleagues were unable to find their niche within this community.

But if I'm honest, I must admit that, like my colleagues, I have failed to take full advantage of the opportunities that LabNet presents. I really could use the network more. I could log on more frequently, and I could make more of an effort to respond to other peoples' messages and questions. (Although I do quite a bit of this type of thing already, messages often sit on my desk a week or two before I manage to send a reply).

I also could train more students to use the network (right now I have only one student who checks the network each week). Most importantly, I could incorporate telecommunication into more of the activities that take place in my classroom, and I could have students post more messages about the work they are doing. I still feel like telecommunication is something that I do more than my students do. It doesn't play a central role in my classroom. Projects do play a central role, and I often incorporate telecommunication into the process. However, I feel I have only begun to explore the many ways in which the network might be used with students.

Reflections

My comments above beg the question, Why is it that I don't do these things? I know that I have hesitated to have students use the network because I can't guarantee that there will be an audience for their inquiries. I can't guarantee that there will be a response to their message. Indeed, at times my students have been rather disappointed to find that their messages we[nt] unanswered. Last spring when my chemistry students were doing studies of soil, water, and acid rain in our area, they posted results and descriptions of their work on the network. They requested feedback from other classrooms and asked other teachers if they would like to share similar data and information. There were no responses to any of these messages. Not only were there no responses after nearly a month of posting reports, but a week or so after our project was finished, I spotted a message on LabNet by a teacher asking if anyone was interested in doing a project on acid rain! This teacher was a regular network user; I was astonished that he had not noticed any of the postings from my students. Not receiving any recognition for the work they were doing really took the wind out of their sails. After a while, they were wondering why they should even bother continuing to share their acid rain information on the network. Students want to be acknowledged w[hen t]hey make the effort to use the network, and whe[n th]is acknowledgment comes only from me and not from others in the LabNet community, they feel short-changed. In these cases, the feelings of validation, of belonging to a larger community, are replaced by familiar feelings of being invisible a[nd] unimportant.

Furthermore, students do not naturally or spontaneously use the network. Using telecommunication remains a conspicuous event. Students write messages most often because I have assigned that task as part of their project work. Because students don't telecommunicate regularly, and because using a computer and modem is not part of their daily routine, putting messages on the network and articulating ideas for presentation to others stands apart from other routine classroom activities. With the limitation of having only two computer-modem work stations, I find it necessary to have students write their messages on paper. Once the messages are collected, I type them up myself and log on and send them. Thus students don't have much concrete experience with telecommunicating, and although they can understand the concept of the network and have even seen me demonstrate use of the network (something I have done using an overhead projector display interfaced with the computer), LabNet is still an entity with which they have only indirect contact.

Obviously there are some problems with LabNet and with telecommunication in general. Use of a telecommunication network would be much easier if co[m]puter-modem communications were more familiar [to] students and teachers, if it were second nature to everyone, and the equipment were abundant and readily

available. But psychological barriers to network use are at least as significant as any barriers due to technology, resources, or training. Why is it that very few LabNet teachers have engaged in collaborative projects where students share information over the network? Why is it that new network users often fade away and do not become permanent members of the LabNet community? Why is it that students and teachers sometimes receive no response to their network messages? What are the effects of using telecommunication and PESL on student learning? Are there other successful networks with similar objectives that could be used as a model for LabNet? These are questions that the LabNet community struggles with. We have a wonderful tool at our disposal, one that we believe enriches the educational experience. Much of the potential, however, remains untapped.

LabNet's potential for overcoming the boundaries of place is especially important for rural teachers. I am the only physics teacher in my district, the only chemistry teacher in my district, and the only teacher in my department who is using a project approach to teaching science. In other words, I am isolated. I'm physically isolated from other teachers in my subject area and other teachers who share my commitment to PESL. LabNet lessens this isolation. It doesn't overcome it completely, however, as I am still separated from my LabNet colleagues by many miles. But it provides a tool for traversing those miles and gives me access to a community that has made a meaningful difference in my professional development.

Though LabNet's promise has yet to be fully realized, it has provided teachers and students with invaluable experiences in PESL and telecommunication. The beauty of the project lies in its structure. Not only has LabNet linked teachers electronically, it has linked them in an effort to explore a new method of teaching science. To do PESL, you need ideas and resources for projects. Telecommunication provides that. You need to trust that students will be able to come up with good ideas, good ways to solve problems and to meet challenges. You have to believe that things will work when the teacher becomes a facilitator rather than an authority: on the same level with students and learning along with them. This can only happen if you are a part of a community of people sharing the same teaching values and believing that learning through projects is valid and important. LabNet makes this happen.

EDUCATION ON-LINE

By Yvonne Marie Andrés

Dabbling in the Internet, calling up FrEdMail—your colleagues across the nation are learning the power of telecomputing

MANY TEACHERS AND STUDENTS ARE DIScovering that electronic communications can provide a dynamic link between themselves and their counterparts throughout the world. In fact, an estimated 50,000 teachers worldwide are using the Internet, the vast international network of electronic networks. Using these networks, teachers and students are tapping the computerized libraries of universities and other research centers; they are exchanging E-mail, reading news bulletins, and joining "chat" groups on many topics.

To many teachers, however, the Internet poses daunting challenges because of its very size, the difficulty of wending your way through it, the variety of computer systems that operate on it, and its lack of discrimination. Simply put, on the Internet it's hard to find the good and screen out the bad.

Many schools are turning to another electronic network for similar services that are more precisely tailored to the needs and capabilities of K-12 education. These schools have hooked up to the FrEdMail (Free Educational Electronic Mail) Network, a low-cost telecommunications network that helps teachers and students participate in a wide variety of learning experiences and communication.*

FrEdMail is a chain of computer bulletin boards dedicated to K-12 education; it gives schools the ability to exchange messages, documents, and even video images. Access to the network can be remarkably inexpensive—requiring little more than a basic computer, a modem, and local telephone service.

FrEdMail grew out of a cooperative project by a group of San Diego-area school districts that began in 1986. From those roots, the FrEdMail Network has expanded to more than 200 electronic bulletin boards. The FrEdMail Foundation was incorporated as a not-for-profit educational consortium in 1990.

The bulletin boards—the "nodes" of the network—reside in computers at universities, district and county offices of education, individual schools, and classrooms scattered across the United States and in Australia, Canada, the United Kingdom, and Ireland. Individuals at each site maintain the bulletin boards. Participants can communicate with their local node using an Apple IIe or IIgs, Macintosh, or IBM-type microcomputer. The local bulletin boards pass along messages to larger computers at regional nodes, which in turn route messages to the intended recipients. Last year, approximately 10,000 teachers and students used FrEdMail for learning projects.

The network also has opened a "gateway" connection to a much larger network, the California Education and Research Federation Network (CERFnet), at the San Diego Supercomputer Center at the University of California at San Diego. CERFnet in turn connects FrEdMail to NSFnet, the National Science Foundation network serving the scientific community, and the Internet. These connections allow members of NSFnet and other networks to serve as regional FrEdMail hosts, poten-

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* For further information on the FrEdMail or SCHLnet services, contact FrEdMail Foundation, P.O. Box 243, Bonita, Calif. 91908; (619) 475-4852. E-mail: arogers@bonita.cerf.fred.org.

tially allowing more than 3,000 school districts around the United States to be on the network and giving local teachers and their students E-mail access to the Internet—at little or no cost. (E-mail access to the Internet is available already through such services as CompuServ and America Online.)

What it offers

The resources FrEdMail offers include well-organized data bases on a variety of subjects—information on grant and funding sources; vast collections of scientific, mathematical, geographical, historical, and literary documents; solutions to technical problems; experts in various fields who are willing to provide assistance; and teachers interested in trading ideas. The network does not limit users to E-mail and text files; graphics, sound bites, and video clips can also be exchanged.

Teachers have found that using the network can motivate students to become better learners and writers. Teachers themselves can discuss experiences, teaching materials, and curriculum ideas with colleagues and can obtain information about workshops, job opportunities, legislation affecting education, and other current topics.

For many educators, in fact, FrEdMail has served as the training wheels for telecommunications—a low-cost, accessible, effective avenue for technology novices to gain their first experience with the incredible power of telecomputing technologies. Unlike most of the commercial or academic networks on the Internet, FrEdMail is easy for teachers and students to use.

Ease of use is a crucial feature for the many schools that lack technical expertise. A school's system operator, who tends the computer that is the school's connection to FrEdMail, typically is a classroom teacher who had no special technical skills before taking a 15-hour training course. The system operator does, however, need the interest and enthusiasm to become an advocate who trains other teachers, provides technical help, and recruits other participants.

Each school district that serves as a node can tailor its use of the network to its local needs. Some districts emphasize using the bulletin boards for instructional or administrative purposes at the district level—connecting students at different schools, for example. Other sites have students use the network for schoolwide projects or at home. By setting up and maintaining the node, the school or district essentially can offer a subsidized service to students who could not otherwise afford telecomputing. Schools quickly realize that the network is more useful when it has more participants, so each site has a vested interest in actively recruiting new participants and training teachers.

The FrEdMail Foundation supports the network by loading it with learning projects and classroom activities. The foundation also hosts dozens of electronic conferences for teachers and students that are focused on various curriculum areas and specific projects. (The network may be used only for educational purposes.)

Using the network, students have studied Soviet and American cooperation in space, acid rain, and literature—just to name a few of many projects. In the acid rain project, students measure the acidity of rain sam-

ples from their own community, exchange data with classes across the United States and Canada, plot the national data, and exchange their conclusions and essays on the causes and effects of acid rain.

Another project, the Global Authors' Literary Anthology, compiles student essays on monthly themes, such as personal memoirs, liberty and patriotism, holiday menus and recipes, and mathematical puzzles. Selected works by students—original articles, editorials, essays, interviews, one-act plays, and art—appear in an electronic anthology published every semester.

In another project, called Experts Speak, students in one group assume the personalities of various historical figures, and a group from another school interviews them electronically to determine their identities. Other projects involve cultural exchanges, statistical data collection and analysis, scientific experiments and observation, and map and globe skills. Potential projects are limited only by the ingenuity of the teachers and students on the network.

A new project, called the Global Schoolhouse, combines problem-solving skills, environmental issues, global consciousness, and modern information technologies to accomplish a common goal. Four classrooms—in California, Tennessee, Virginia, and London, England—are investigating the environmental problems created by water run-off. The classrooms communicate with each other using FrEdMail, the Internet, and video teleconferences over the Internet using Cornell University's CU-SeeMe software on Apple Macintosh computers. (The software is available free on the university's electronic bulletin board; to use it, computers must be equipped with a "video spigot" board, which costs about $300.)

Spreading the news

Another feature of electronic networks is their ability to let users exchange news and host discussion forums on any topic. Last fall, the foundation started the SCHLnet newsgroup service, a system to help teachers with specific interests build collaborative learning projects across the nation or around the world. SCHLnet, which is modeled after the USENET discussion groups on the Internet, can sift through thousands of messages and select only those on topics chosen by the user.

Unlike USENET, though, SCHLnet is aimed specifically at K-12 teachers and their students. Although freedom of expression on USENET generally allows material that is controversial, offensive, or even pornographic, SCHLnet actively moderates many electronic discussions and monitors the rest to ensure professional standards of expression and etiquette. (SCHLnet covers the costs of managing and moderating the network by charging fees based on the size of a school or district network or the number of users. Annual fees for the largest districts are no more than $700; fees for small districts are substantially less.)

Using the standard USENET message format, SCHLnet can deliver messages directly to a school network file server. From there, a school or district bulletin board or wide or local-area network can distribute messages to teachers and students. In this way, SCHLnet will give schools an interactive market for ideas, resources, opportunities, and information—without the extraneous and sometimes offensive distractions found on other newsgroup services.

FrEdMail's projects and discussion forums—and the new links to the Internet—bring the information age directly to schools that otherwise might have to wait years for the infrastructure to reach them. Now any school district can use the network to involve teachers and students in the broader world of learning. ■

HOW TO USE FREDMAIL

Not only is FrEdMail a valuable resource for educators, it is easy to use, too. Here's how: First, turn on your computer and modem and start your communications program (this is the program that sends and receives data over the modem; any of the common versions will do). Type in the telephone number of the closest FrEdMail bulletin board. If your school district is a "node" on the network (or if you are near one), you are fortunate—it's a local telephone call. Otherwise, to save money you might want to dial up FrEdMail during low-rate hours.

When you hear the "connect" sound, press the Return key to activate the FrEdMail bulletin board. The bulletin board asks for your user name and password, which you were assigned when you subscribed to FrEdMail.

Now the network's main menu appears on your screen; it gives you a series of menu-driven choices. The main menu also signals if you have received any E-mail messages since your last visit. If so, you can enter E-mail to read them and reply. If a message is lengthy or important, you can save it on your own computer's memory disk to read later. Similarly, you can reply to messages on-line or send a message you've composed earlier. Messages normally stay at the node computer until after midnight, when telephone rates are lowest; then the network distributes them, through regional hubs, to their destinations.

After leaving E-mail, you might select one of FrEdMail's news groups on a subject of interest. You can choose to read about new ideas for science projects, for example, or the daily lesson plan from the Cable News Network based on the day's headlines. Other news groups carry information on curriculum development, professional meetings, and other topics. You can contribute to the discussion by sending the news group a bulletin.

Next, you might check the features section, which stores a wide range of how-to and reference articles. In addition, your school or district can set up a local bulletin board to display announcements or information or to serve as an archive of school improvement plans or the minutes of school board meetings.

When you're done, simply exit back to the main menu and press "g" for "good-bye." If you have a problem or query, leave a message for the system operator on your way out.—Y.M.A.

Telecommunications: Avoiding the Black Hole

by Margaret Riel

Will electronic networks infuse your classroom with new learning opportunity, or merely pul away your time and energy? Your planning will make the difference.

Our project provided a vehicle for practicing thinking skills... Through messages from their peers around the world, students learned to distinguish facts from opinions and became alert for signs of bias and prejudice within their own work and the writing of others.
—Ron Oastler, Lord Strathcona Public School, Kingston, Ontario, Canada

The enjoyable part was watching them take control of their own learning and education. As they worked on their projects on global peace, Gulf region politics, community profiles, textile industry, drug abuse, and self-reflective essays...found that I, too, was touched by the magic of being able to 'talk' with my peers in distant places.
—William Burrall, Moundsville Junior High School, Moundsville, West Virginia, USA

Through contact with schools throughout the U.S., Canada and Saudi Arabia, students learned metric conversions and money exchange rates and had a meaningful lesson on time zones.... My students wrote, rewrote, proof-read and rewrote. Because their writing was important to them, this process was meaningful. Complaints were at a minimum and their writing was at a premium, and learning was interesting and fun for them as well as for me! I wish it could always be this way.
—Sharon Kubenka, Ingram School, Ingram, Texas, USA

These comments by teachers voice the excitement of both students and teachers as they participate in distant learning facilitated by computers and phone lines. But this excitement can be deceiving: it makes distant learning seem as easy as dialing a phone number. Even the most informal educational activity on a network represents many hours of planning and organization.

When computer networking projects are well planned, the results are extremely impressive, as indicated by these comments. However, computer networking can also be a "black hole" into which one of most valuable and limited educational resource vanishes leaving no discernible trace. That resource is teacher planning time. Teachers can spend countless hours either searching for projects that are appropriate for their students or in trying to organize projects of their own.

How can teachers avoid the black hole of networking and achieve the promise that advocates of computer networking describe with such missionary zeal? There are many answers to this question but I would like to offer four general recommendations.

Avoid pen-pal-only projects.

With the conviction that comes from personal experience, I would recommend teachers avoid any attempts to match their class of students one-to-one with students at a distance for the task of exchanging friendly letters. The cost in terms of teacher planning time and student learning time in establishing and maintaining the electronic coordination is far greater than any educational gain that occurs. For teachers who feel that this form of direct communication has a place in the classroom, I recommend that they give their students class time to write letters to their distant friends, cousins or grandparents. Letter writing encourages writing fluency and can be personally rewarding for some students, but because it is essentially a private channel of communication, it is difficult to use as a vehicle for classroom instruction. Messages that are sent to the whole class on topics related to classroom learning will be of much more ed cational value.

Network with more than one—or even two—other classrooms.

I say this with full knowledge of the time takes to find even one reliable partner for . electronic exchange. Here is my reason f this advice. The projects that are planned a likely to take a great deal of work and orgar zation. Even if teacher commitment remai high, teachers work in settings that are high unpredictable. A sudden shift in the scho population might result in change in a teac ing assignment. An opportunity may arise th necessitates a change of schools. comput equipment might be reassigned or break dow The additional schools will enrich the acti ties by providing a range of perspectives. Th will also provide the added insurance that project will not fall victim to the deafeni sounds of electronic silence. Ideally, work wi five to 10 classes on a networking project. V have found in years of matching schools in Learning Circles on the AT&T Learning Ne work that this range provides the maximu diversity at a size that is still small enough f an intimate level of exchange.

Have a well-defined group project with a beginning and ending date and a written product.

Computer networks designed so that bu people can share their general concerns oft fall silent. Scheduling is one of the bigge problems for organizing activities across clas rooms. A beginning and ending date with e plicit description of the type of information be exchanged is critical to the success of t project. When students work towards a wr ten summary of the work or an anthology the shared writing they have a goal that giv meaning to the exchanges. This final public tion phase helps students reflect on their shar work and learn to present the most importa ideas in a written format.

Make your network projects part of a larger framework of classroom activities.

An effective way to integrate networking with classroom instruction is to select a part of the instructional unit that can be enriched by information from different locations. However, it is unlikely that others classes will be ready and waiting to work on issues in your curriculum without some reciprocal arrangement. If you expect other classrooms to enrich your students work, remember to extend a similar offer in return.

This reciprocal teaching and learning approach characterizes Learning Circle interactions on the AT&T Learning Network. Classes are matched together based on a choice of similar curricular themes into groups called Learning Circles. Each of the classes in a Circle is invited to sponsor a group project drawn from their curriculum. The whole class works on their sponsored project incorporating the information received from distant classrooms. Students are grouped into teams to collect and send information to distant classes for their projects. Here are some examples of the way teachers have extended student learning using telecommunications.

A New York teacher was doing a science unit on nuclear energy. One part of the project involved studying the risks associated with nuclear energy. Her students asked their Learning Circle partners (students from three U.S. cities and two international cities) to share information about the location of their nearest nuclear power plant and to describe local community debates over its location and safe operation.

A teacher in Australia was teaching a unit on a local aboriginal tribe. A part of his lesson plan involved having students read legends from this tribe. This classroom activity was extended by sponsoring a Learning Circle project that involved the sharing of local legends from indigenous people from each of the seven states or countries represented in the Learning Circle.

Students in a German class were exploring alternative programs for the conservation of energy, particularly the effectiveness of recycling programs. They sent a survey to their U.S., French, and Canadian partners asking them if or how they sort household trash, where trash is taken, and what recycling programs, if any, were in place in their communities.

A class in Louisiana was studying the Civil War. Their project involved composing a set of letters that might have been written at the time of the Civil War. Students from states that fought in the Civil War were asked to send two letters that fighting soldiers in their location might have written home to their families Students who lived in places not directly involved in fighting the Civil War were asked to write two letters that people in their community might have sent to a friend or relative involved in the war.

Each of these projects exemplifies the following three criteria that teachers on the AT&T Learning Network are asked to consider as they select projects to sponsor in their Learning Circles.

1. The networking project should take advantage of the cultural or regional diversity represented by the network partners. When students are working with students from across the nation and/or around the world, the increase in the communication costs needs to be offset by the educational gain that comes from these cross-cultural exchanges. If project responses from students in one location are virtually identical to those from the other locations, the participants are not taking full advantage of this educational tool. Having students investigate their own location, environment, history, social problems, or cultural attitudes in relationship to others is a very effective way for students to learn about themselves as well as about people in distant locations.

2. The request for information from distant classes should be reasonable in scope. A teacher cannot expect teachers at a distance to become completely involved in their instructional units. Each teacher has specific teaching constraints. But a reasonable request, a small part of the whole classroom activity, is an excellent way to extend the learning in new ways. Students' requests for surveys, local information, observations, opinions, descriptions, or student essays can be accomplished either as a class or homework assignment without placing a heavy strain on the required curriculum. The teacher originating the project might be spending a month or more on the theme or lesson. But the distant teachers should be able to organize a response to enrich this lesson in one or two class periods.

3. The information collected should be of interest to a wide audience of students, teachers, parents, and others. When students are engaged in activities that adults value, students take care and pride in their work. After the information is received, students and teachers work together to collect, organize, and present the information in a final project summary. This report can be shared with those who participated in the project and with others who may be interested in the students' work. When distant students have invested their time in helping on a project, they are excited to see the outcome and learn fro[m one] another. If their parents or community l[eaders] read their work with genuine interest, students come to see their work as important and are motivated to work hard.

From promise to practice.

Computer networking is an exciting new tool for extending classroom learning into the community and utilizing peers around the world as teachers for one another The cost of telecomputing is very reasonable if it is used in ways that result in real gains in student learning.

Students are not the only learners in this new distant forum. When teachers work together to help each other extend classroom learning they benefit personally and professionally from these partnerships. Recognition for well-designed network lessons motivates teacher creativity. This type of collaborative work among teachers provides them a channel for the discussion of many issues related to school reform without leaving the classroom.

The infusion of new ideas and strat[egies] from across a shrinking world is the pr[omise] of new communication technologies. Fulfilling the promise will require careful planning of this new educational context. The technical connections are a necessary but far from sufficient part of the process. The cost/benefit ratio is complex. The goal is to create an educational program using computer telecommunications that maximizes the educational benefit while minimizing cost in terms of our limited educational resources: teacher planning time, student class time, and school funds. Good education is never free. But a range of different partnerships among software developers, communication providers, and schools are currently making it possible for teachers and students to connect their classrooms with new worlds of learning.

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For more information about the A[T&T] Learning Network, call 800/367-7225, e[xten]sion 4158, or write to: AT&T Learning Network, P. O. Box 6391, Parsippany, NJ 07054.

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Linking N.W. Schools To the Internet

Many Northwest schools now have or soon will have convenient access to the worldwide computer network through state education agencies

By Lee Sherman Caudell

Nationwide. about 60 percent of states now operate a statewide computer or telecommunications network. Many of these networks offer schools economical access to the "mother of all networks," the Internet. In four of the five Northwest states, the education department or another state education agency has established a statewide telecommunications system, and many school districts are plugging into the Internet through these systems. In addition, there are several substate or subregional systems, and many local bulletin board systems operated by teachers or other community members. NWREL will use the existing networks to provide access for school personnel to education information, and to enhance the capability of Laboratory staff to have close contact with teachers and others. Here's a look at what's happening in each state.

Oregon: With an $80,000 grant from the U.S. Department of Education, the Oregon Department of Education has launched an ambitious plan to make Internet available to all schools through NorthWestNet. The grant funded the installation of two nodes, one in Washington County and one in Lane County, and an Internet subscription for all public K-12 staff and students. All of Oregon's education service districts ultimately will be connected to one node or the other, and will share the cost of hookup with local districts. A number of districts already are plugged in, according to Tom Cook of the state education department. In Lane County, for example, 4,000 staff and students already are active Internet users. District personnel from around the state are helping to set direction and policy, tackle technical questions, and develop training and materials. And the education department is providing workshops to help schools get started on the Internet. "Interest is growing by leaps and bounds," says Cook. "I'm averaging five or six calls a day from people who have read something or heard something and want more information."

Oregon educators can also plug into the Internet through Oregon ED-NET. Created by the Legislature and seeded with lottery money, Oregon ED-NET provides an electronic information service called COMPASS, which includes access to the Internet. There are 1,500 to 2,000 subscribers on the network, many of them students or educators, according to ED-NET's Nancy Jesuale. For schools in remote or rural areas lacking leased lines, COMPASS offers easy, inexpensive dial-up access to the Internet for a yearly subscription fee of $75 per person. "Compass has local dial-up in 22 cities in Oregon, such as John Day, Burns, Pendleton, and The Dalles," says Jesuale.

Washington: Washington's statewide network, WEdNet (Washington Educational Network), is operated by the Washington School Information Processing Cooperative (WSIPC), an independent cooperative providing computer services to its 275 member districts. Originally formed by the state's education service districts to transmit administrative data to and from the Office of State Superintendent of Public Instruction, WEdNet is extending its reach into classrooms locally and internationally by connecting schools to the Internet via ESDs. A recent $4.7 million legislative allocation for technical restructuring in Washington schools is helping support the cost of the connection. About 30 districts are currently connected, according to Dennis Lampson of WSIPC. Dennis Small of the Office of Public Instruction predicts it will be three to five years before all or most of the state's 296 districts are linked to the network. Meanwhile, the state office is "working to give people a reason to be online," says Small, by offering Internet workshops for teachers.

"BIG SKY TELEGRAPH IS AVAILABLE TO ANYONE, ANYWHERE, ANYTIME."

Frank Odasz, Big Sky Telegraph

Another service available to Washington educators is Learning Link, an interactive educational telecommunications system serving teachers and students, operated by Seattle's public broadcasting station KCTS. In Washington and British Columbia, 125 school districts have access to Learning Link, according to Art Johnson of KCTS. Learning Link offers email, online discussion groups, daily lesson plans to *CNN Newsroom*, curriculum information, databases, and Internet access, among other services.

Washington schools also participate in a number of smaller networks around the state.

Alaska: The state recently launched a new plan to give all Alaska schools access to the information superhighway. The University of Alaska Computer Network (UACN), which links universities statewide, has agreed to expand network access to the K-12 community through the Department of Education. Right now, the department is paying $25,000 annually for unlimited network IDs for schools, according to Lois Stiegemeier. But next year, participating districts will begin sharing the cost, paying $400 to $500 to use the network, which picks up Internet through the Seattle-based regional network NorthWestNet. A lot of districts are "raring to go" on the Internet, Stiegemeier says. But she cautions that inadequate training may stymie some of the enthusiasm. "We're not providing any training here at the department," she says. "The districts will have to provide the handholding and the training." Stiegemeier says the department will encourage educators to take online courses in navigating the Internet offered by the University of Alaska Southeast in Juneau.

Montana: All Montana schools have free access to electronic bulletin boards, databases, email, and public conferences through the Montana Educational Telecommunications Network (METNET). Supported by the state Office of Public Instruction, METNET consists of 17 sites across the state, of which nine are school districts serving a specific set of schools. Schools have access through local lines or toll-free dial-up. Created in 1992, the network uses Fido software, transferring messages around the state through the central site at the Office of Public Instruction, which coordinates message traffic. Internet access provided by NorthWestNet through a gateway at Big Sky Telegraph (described below) provides email only, but the education department is looking into getting full Internet access. "We'd like to do it, depending on the cost and legislative support," says Bob Morris of the Office of Public Instruction.

Big Sky Telegraph is run from Western Montana College in Dillon through the Montana University System Educational Network (MUSENET). Primarily serving rural schools, Big Sky is available to "anyone, anywhere, anytime," says the network's founder Frank Odasz. Big Sky was created to tie together the state's 110 one-room schools and link them to resources around the state. For $50, subscribers get access to Big Sky, including Internet email. In just a few weeks, Big Sky will offer the full range of Internet services—bulletin boards, file transfer, telnetting, and email—to educators and other subscribers, thanks to a $38,000 grant from US West Communications. Another grant to Big Sky, $880,000 from Annenberg/CPB and the US West Foundation, is funding a project to design math and science "telecurriculum" for rural schools (see the story beginning on Page 1).

Another Montana network, EDUNET, provides distance-learning courses to 30 rural schools via email, file transfer, and interactive testing.

Idaho: The state is served by Idaho Public Television (formerly the Idaho Education and Public Broadcasting System), one of the original PBS stations that formed a Learning Link co-op. Learning Link, an 800-number service provided to every Idaho school through the Idaho Board of Education and Idaho Public Television, gives schools access to electronic bulletin boards, databases, and Internet email. But many of the state's 13,000 teachers lack the equipment and/or expertise for using the network. Just under 15 percent of Idaho's teachers currently use electronic communications, according to Bob Pyle of Idaho Public Television. The 100 newsgroups offered through the network are monitored "to keep them clean," says Pyle, who points out that pornography or off-color messages are inevitable on a network open to millions of users.

Although no statewide plan exists to hook schools directly into the Internet, Rich Mincer of the state Department of Education says the agency is looking into the question. The likelihood that Idaho's schools soon will be widely wired for networking got a big boost in January when Governor Cecil Andrus proposed spending $7 million to connect schools to the information superhighway.

SECTION IV: ISSUES IN TECHNOLOGY AND EDUCATION

Reprinted with permission from Ike Coleman. Article appeared in Education Week, April 17, 1991.

Could Computer Use Be a Form of Tracking?

By Ike Coleman

At a local high school the other day, I watched as a friend of mine who teaches there unpacked a brand new CD-ROM drive to add to the Macintosh SE and laser printer she already has in her classroom. I couldn't help but notice that the drive, like the other pieces of the Macintosh equipment, was by district policy reserved for use by the gifted and talented program. And I know that almost all the students who make up the gifted and talented program are the children of parents who are fairly affluent, many of them faculty members at nearby Clemson University, where I work. By district policy, then, the sons and daughters of the significant population of poorer parents in the area are not to have access to the best of the school's equipment. My friend, like many of the best teachers, ducks policy. "Have you ever seen a student who isn't gifted?" someone once asked her. "Never," she said. Even so, even with the best of intentions on the part of teachers, the district policy is an obstacle.

tions. Recently, I walked through another teacher's "basic" class (read "children of poorer parents") to a small room in the back, where the teacher and a few Advanced Placement students were producing a school publication on one of the district's Macintoshes. The "basic" students, waiting patiently for the teacher, had probably never used the computer, and knew they never would.

Like tracking, computer use divides along socioeconomic lines. But, because mastering the machines has become essential to success in the world beyond school, computers complicate the question of which kids will eventually make it. Though the issue is more complex than we'd like to believe, we can tell ourselves that with perseverance any student can do well in school. At least the tools for success—books, pens, and paper—are cheap. But we can't even make the pretense about computers: Poor people cannot afford them.

On the other hand, many students grow up with computers at home, computers they use for everything from electronic games, to word processing, to computer-based telecommunications. Just as children surrounded by books at home are at an advantage when they come to school, the students with computers at home obviously have an advantage over students whose parents can't afford the machines.

The issue of how computers are used at school, then, is pressing. But according to the Laboratory of Comparative Human Cognition in a 1989 article in the *Harvard Educational Review*—and as expected, given schools' tendency to track students along socioeconomic lines—poorer students are allowed neither the quantity nor the quality of access to computers as are more affluent students. Surprisingly, the relative prosperity of the district makes little difference: Poor students in wealthy districts get little access to the machines, just as they would in poor districts with fewer computers.

But even when poor kids are given access to the machines, the *ways* they are allowed to use them differ radically from their use by more affluent students. While advanced students use desktop-publishing software to produce literary publications, for instance, in low-track and remedial classes, populated mostly by poorer students, kids who use computers use them largely for so-called "skill and drill."

In his book *Insult to Intelligence*, Frank Smith has made the case against skill-and-drill computer work far more completely and eloquently than I can. "Drill and kill," as it's justifiably nicknamed, whether on worksheet or computer screen, teaches little that it's supposed to teach. A computerized vocabulary test, for instance, may or may not prepare students for

Has Computer Use Become a New Form of Tracking?

Continued from Page 32

standardized tests by which the school and district will be judged, but it has almost no relationship to real language use. As theorists of language and learning from James Britton on have known, students doing such work learn nearly nothing that will transfer to the real spoken and written language of their lives.

What skill-and-drill software does teach is more frightening than what it doesn't. Students performing exercises involving isolated skills are not the masters but the slaves of the computers. I've often seen students with programs that tell them things like: "John, you're a genius. Now try the next question." With such software students learn, for one thing, to be obedient to a machine, a machine that, like something out of *1984* impersonates a human being. But even without the bells and whistles, students who do computer multiple-choice exercises for countless hours of their school lives learn not to be critical thinkers. They learn not to wonder why the world of the computer screen has no relationship to their world.

That for poorer students skill and drill is often the only exposure to computer technology should disturb us deeply. As *Technology and the American Transition*, a report by the U.S. Office of Technology Assessment, points out, business will adjust to the workforce it has available. If a segment of the working population has not learned the flexibility and creative thinking necessary for the ideal economy of the very near future, business will just have to make do with what it has, creating tracks for the workforce available. People who grew up poor and were badly served by schools will find jobs that ask for little talent and offer little reward. I can't help imagining that such jobs might well involve obedience to machines—one skill the workers will have learned well.

Kids, in short, who had no chance to use current technology for their own purposes at school will likely not have the chance at work. They'll have low-paying jobs, and they'll be unable to afford to expose *their* children to technology in constructive ways. Thus, schools are probably helping to cement in place an underclass, subservient to technology instead of mastering it.

> That for poorer students 'skill and drill' is often the only exposure to computer technology should disturb us deeply.

But if we want to, we can give *all* students access to powerful technology that is not expensive. Several interactive educational networks, such as BreadNet, a network for teachers and students sponsored by the Bread Loaf School of English, require only the cheapest machines (I use a $500 clone). And though on-line time is not free, teachers who have been given the time and the support necessary to learn to use networks wisely themselves can give their students inexpensive experiences, rich in reading, writing, and thought.

BreadNet supports, for students and teachers, what is called asynchronous computer conferencing, which simply means that a number of sites send writing to a central "conference" to be read by all members of the conference at their convenience. Unlike electronic pen-pal systems, such conferences allow a great deal of collaboration, among classes and groups within classes, before writing is sent—and a great deal of communication, oral and written, for the amount of writing actually transmitted.

In one short-term conference on BreadNet, called "World Class," students and teachers in all parts of the globe—from Wilsall, Mont., to London, to Lima—described for others on the network environmental problems in their country and region, and then discussed global problems and possible solutions. In addition, students composed questions for U.S. Senator Albert Gore's senior legislative assistant on global environmental issues, Rick Adcock, and sent those questions to the computer conference. Mr. Adcock answered the questions on tape, and his answers were transcribed and posted on the network.

Here is a description of local problems from Randy Boyd, Chad Hall, and Greg Johnson, students in Wheelwright, Ky., a town in one of the poorer regions of the United States: "Much of our water is being destroyed or harmed by people and major corporations here in Kentucky. The problem is a difficult one because the pollution comes from several sources. Because of all the mining that takes place here, when we have hard rains, we also have mud slides, like those that occur in California. . . . Other substances washed into the creeks with the[illegible] The sediment has lots of organic and inorganic matter in it, along with pesticides and other pollutants. Probably the most harmful is acid from pit and strip mines. . . ."

These students are communicating knowledge to a wide and diverse audience, and in the process are probably synthesizing information they had not fully formulated for themselves before. In addition, they are learning infinitely more about the basic skills than basic-skills programs teach. And they are learning computer technology—very cheaply.

Most importantly, from their work on "World Class," students from all tracks and all socioeconomic backgrounds learned that their learning and their writing could not only affect their lives, but also had the potential to change the world. After intensive reading and writing about global environmental problems, students in many schools began to take action, starting recycling centers and lobbying at the local level.

This is only one example of the kind of learning students can do cheaply with the power of tech[illegible]ogy. Every district in the U[illegible] States could probably afford to make work like this available to all students. And students who have learned to be the masters of computers, to use them for their own purposes, will not only be better prepared to enter the Information Age, they will have the power to make the world more humane.

But if we don't treat them humanely, if we prevent a segment of the population from exposure to technology for such uses, that power will be lost, for this generation and for generations to come. ■

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Electronic N
The Constr
Professional

Professional development that changes the local culture is critical to the transformation of schools, Mr. Watts and Ms. Castle aver, and one highly successful tool for such professional development is dialogic networking.

BY GARY D. WATTS AND SHARI CASTLE

There is something new here, something not at all prominent in early research on the diffusion and adoption of innovations: the belief that teachers have minds. It is as though, in the *Wizard of Oz*, the Scarecrow knew all along that he had a mind, while the Wizard came late to this conclusion. Well, the Wizards of Research know now that teachers have minds, and that teachers are pretty confident of that as well.[1]

IN THE LATE 1960s the U.S. Department of Defense, through its Advanced Research Projects Agency (ARPA), established the first large-scale computer network. That network, known as ARPANET, was designed to link computer scientists at universities and other research institutions to distant computers to which they

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would otherwise not have access.[2] One minor feature of the network was a facility known as electronic mail (E-mail).

Electronic mail soon became one of the most popular features of ARPANET. While some network administrators objected to electronic mail because they did not see it as a vital use of computer time, the demand for improved E-mail carried the day. Scientists used ARPANET to exchange ideas casually. Graduate students discussed problems and shared skills. Project heads coordinated activities and communicated with funding agencies. A network of collaborators formed without regard for physical location.

In an article in *Scientific American*, Lee Sproull and Sara Kiesler assessed the impact of this new way of communicating: "Managers are often attracted to networks by the promise of faster communication and greater efficiency. In our view, the real potential of network communication has less to do with such matters than with influencing the overall work environment and the capabilities of employees."[3] Based on our experience, we heartily agree. The development by the National Education Association (NEA) of the School Renewal Network over the past four years has confirmed the profound potential of this technology to reduce teacher isolation by building communities of learners without regard to location. Networks designed for such a purpose are capable of providing significant opportunities for professional development, new learning, the dissemination of research, and the transformation of schools.

FORM FOLLOWS FUNCTION

Networks can be thought of as analogous to highways. While everyone understands generic references to highways, most people also perceive the distinctions between limited-access interstates, state highways, and "blue highways." In the world of electronic networking, however, few understand the distinctions between different types of networks.

To oversimplify, networks can serve three distinct functions.

- Most networks are "resource networks." They exist to provide data and information to a user who reads the information from data files maintained by the network.
- Some networks provide the capacity to send messages to other users. This E-mail function greatly enhances communication by eliminating the barriers of time and distance.
- A few networks are designed to allow a community of users to carry on a discussion or participate in a conference with all the other members of the community. Users of these dialogic networks read, contribute to, and follow strands of conversation on individual topics. As with E-mail, the barriers of time and distance are eliminated.

Our focus in this article is on dialogic networks – specifically those designed for use by adults in educational environments. These networks have the power to change not only the user but the environment in which the user works.

FROM REFORM TO TRANSFORMATION

The traditional approach to school change involves top-down initiatives in which needs are assessed, one option is selected, teachers are told to implement it, and the effectiveness of the implementation is evaluated at the end. While the aim is to transform the system, the actual results usually fall far short of the mark. One reason for such failures is that local practitioners and stakeholders are seldom involved in all phases of the process, from initial vision to evaluation.[4]

The National Education Association (NEA) initiated a different model in 1985, when it established the Mastery in Learning Project. The effort was conceived as a bottom-up, grassroots, faculty-driven initiative. A great deal of effort was put into a needs assessment followed by the use of research to develop locally appropriate options. Twenty-six schools were selected from a very competitive list of applicants.

When the NEA National Center for Innovation was created in 1989, the size and scope of the effort expanded significantly. The National Center now encompasses the Mastery in Learning Project, the Learning Labs Initiative, the Mastery in Learning Consortium, the Teacher Education Initiative, and the Excellence in Action programs. There are more than a hundred project sites, including schools, school clusters, districts, and teacher preparation institutions.

Over the past six years, we have observed and studied the change process in the Mastery in Learning and National Center sites. Schools involved in these projects have documented a progression – not necessarily linear, neat, or discrete – from teaching as a "craft" to teaching as an art or science, from teacher development to student empowerment. A "theory of action" for school transformation has emerged.[5]

This progression toward school transformation often starts with individual affirmation. As teachers discover the power of their talents, strengths, and voices within and beyond the classroom, they begin acknowledging to themselves and others that they are important professionals who can make a difference in their schools. As they begin to share their knowledge and experiences with others, a sense of faculty-ness emerges. Educators begin to believe that their schools can change and that they, as faculties, are responsible for and capable of accomplishing that change. Teachers begin to see that it is possible to look to research for options and that it is okay to take risks. As faculty-ness grows, a culture conducive to change is born. "We've always done it that way" is no longer a sufficient reason to continue doing it that way. The faculty begins to "challenge the regularities."[6]

Many of the National Center's projects have moved along this continuum, changing the day-to-day lives of adults in the schools. Few have significantly transformed the day-to-day lives of students – yet. We now see that teacher development is a critical precursor to meaningful change in schools. But it is not an end in itself. True school transformation will be measured not by how involved teachers are in decision making but by how teachers, empowered as professional decision makers, are able to empower their students as learners.

It is our observation that education reformers cannot skip the phases of individual affirmation and the development of faculty-ness and go directly to testing the options. To do so dooms a reform to becoming another top-down mandate of limited duration because the implementers – the teachers – have little ownership and few of the necessary skills for change. Teachers merely close their classroom doors – and their minds – to the innovation.

NETWORKING TO SUPPORT SCHOOL RENEWAL

One of the tools we developed to support all phases of the change process is the NEA School Renewal Network. This dialogic network electronically links all the National Center's project sites. The results are powerful.

The Mastery in Learning Project was unique in that sustained attention was given to decision making supported by a knowledge base – including theory, research, good ideas, and the wisdom of practice. Our original (and limited) intention was to provide access to this knowledge base through the project office. In response to queries from the participating schools, we packaged research, model programs, bibliographies, and lists of other schools with similar questions and mailed them – using the U.S. postal service.

Problems exist, however, in using research in school settings and in sharing the largely uncodified wisdom of practice.[7] Even with the project staff providing resources and assistance, particular obstacles persisted once the mail from the project office arrived at the school. Some faculties experienced difficulties applying generalized findings to their particular situations. Others found that research in their particular areas of inquiry was scarce. A lack of skill in interpreting or conducting research became apparent in some schools. For example, teachers often had difficulty making sense of conflicting findings in the research, and they often felt that the research did not adequately address the complexities of schoolwide restructuring. Finally, lack of time for reviewing and summarizing a body of research was consistently a problem.[8] In studying the project schools, Joanne Schnesk and Gary Rackliffe found that teachers used their experience to mediate between generalized findings and specific situations, yet neither the wisdom of teaching experience nor the process of applying research had been codified.[9]

Teachers generally lack opportunities to share their thinking and to construct new knowledge about their teaching practice.[10] Children learn vocabulary best in the context of ordinary communication and have many opportunities to do so, but teachers have been building their teaching knowledge in isolation. We saw that sustained interaction among practitioners across a broad geographical area was needed so they could share practical wisdom; interaction between researchers and practitioners was needed to make the knowledge base useful in diverse settings. Only with such communication could research and practice be integrated for the purpose of transforming schools.[11]

Because of the geographical dispersion of the schools in the project and the NEA's successful experience with a remote bulletin board service, electronic networking seemed the logical way to facilitate the crucial interaction. In 1988 we began to examine available software

> Networking has influenced the environment in many of the participating schools and is supporting school renewal.

and struggled over the practicalities of using phone lines to connect our sites. The problem of phone lines cannot be understated (and deserves separate and special attention elsewhere). We had greater problems securing school phone lines that were available to teachers than we did securing computers. In addition, facing the problem of who would pay the long-distance charges convinced us that the best software would make the network as inexpensive to the user as possible.

We selected IBM's PSInet (People Sharing Information Network) software because it uses a batch processing system and does not depend on "real time" phone connections. All reading and composing of papers and maintenance of files is done with the "phone on the hook." PSInet allows the user to transmit automatically at any time of day or night. While the batch processing method saves phone costs, it does require compatible computers equipped with hard disks.

Another feature of PSInet that influenced our selection is that it permits both messages and conferences. The users of the School Renewal Network continually design and redesign the conference structure in response to real needs and situations. The current conference structure includes 10 topics deemed critical to school restructuring: thinking, instructional strategies, school/classroom organization, curriculum, positive school climate, at-risk students, parent/community involvement, networking/technology, restructuring, and student assessment. There are several subtopics under each category and, within each subtopic, hundreds of strands of dialogue on various issues, problems, and ideas.

A year into the development of the School Renewal Network, we added 10 prominent researchers to the dialogue. One researcher was assigned to each conference on the network. This innovation has been extremely significant. Although both the researchers and the practitioners had misgivings about this step, the linking of research to practice has become much more natural, flowing from the needs of the users without the trappings of status and hierarchy. Put a researcher on a podium delivering a packaged address, and the teachers soon tune out mentally. Make a researcher a peer participant on a network, and both the researcher and the teachers grow from the interchange.[12]

We have found that it is possible to alter the culture of schooling by promoting nonlinear, multidirectional interactions among stakeholders in reform. These "virtual" communities of collaboration capitalize on the "distributed expertise" of the participants. Explorations of research, reflective dialogues on professional issues, and the sharing of experience are now everyday events on the School Renewal Network. Networking has influenced the environment in many of the participating schools and is supporting school renewal. It is clear from the following posted messages that the network is fostering individual affirmation, a sense of faculty-ness, and informed decision making.

> The [School Renewal Network] conference really got me reconnected to

my life's work in education. My energy and enthusiasm for all aspects of the job are far beyond what they were. I really believe that school renewal is a result, at least in part, of personal renewal.

* * *

I can't help but realize how far we've come. We were a good school when we began, but, with the support of all of you, we have fine-tuned curricula, honed teaching strategies, and transformed our school into a much more child-centered place. Best of all, I think we're better educators. We use research, self-evaluate our own teaching and school practices, and work hard to make school a fun, exciting, and safe place for kids to be.

ENGAGING TEACHERS IN NETWORK PARTICIPATION

After four years of experience with the School Renewal Network, we find that six conditions are necessary to encourage and facilitate dialogic networking.

1. *The network must encourage the development of affinity groups.* Teacher isolation has been the prevalent culture in schools. The creation of faculty-ness has not been a priority of teacher preparation or supervision. Therefore, teachers are not accustomed to engaging in reflective dialogue with peers. With the addition of the beginner's discomfort with new technology, it is little wonder that teachers do not drift naturally into in-depth discussions with strangers via computer networks. Support and trust have to be built if reflective dialogue is to occur. Once a supportive climate is established, participants begin to challenge one another to ask bigger and harder questions.

Our experience with bulletin board networks generally shows that bulletin boards are dominated by small cliques of "techy" users and are intimidating to the average teacher. Inexperienced network users tend to call in only a few times and then lurk in the background. We noticed the same pattern during the early phases of the School Renewal Network. Only when they felt part of the community did teachers become active participants. Creating that sense of community is extremely difficult on a large, impersonal network. The best solution is to form smaller affinity groups. Small, personalized groups are more likely to find a common, manageable focus for in-depth dialogue.

2. *"High touch" must be emphasized as much as "high tech."* In *The Third Wave*, Alvin Toffler warned that mechanization needs to be balanced with personalization.[13] We find this to be true. While not always practical to arrange, we discovered that face-to-face meetings of site coordinators were one of the most powerful stimulators of community building and dialogue. A network researcher came up with the idea of sharing photographs to build and maintain connections. Occasional phone calls and hand-written notes further contribute to the humanization of the technology.

3. *Qualified facilitators must be available.* We find that three kinds of network facilitation are needed. First, technical assistance is essential to help beginning users get started, learn the software, and deal with the numerous small problems that frustrate novices. Our goal is to bring teachers without technological experience onto the network. A friendly voice on the other end of the telephone line will help assuage fears, solve problems, and dispel discomfort. The more technical assistance available, particularly at the beginning, the better.

Second, conversational facilitation is needed to help participants talk across role groups, frame issues, follow up on unanswered questions, summarize discussions, engage reluctant contributors, develop conventions (general rules for common use), and deepen the dialogue. For example, inexperienced network users tend to send requests for information that are cryptic and nonspecific in scope: "We are concerned about instructional grouping in our school. Please give us all the information you have on grouping." Because responding to such a request is so difficult, the sender receives few, if any, responses.

Conversational facilitation is particularly important in a dialogic network because the network's strength rests in the regular, reflective contributions of each participant. The conversational facilitator needs interpersonal and group development skills, rather than technical knowledge. On the School Renewal Network, different individuals provide tech-

nical assistance and conversational facilitation.

Third, local outreach is needed to involve colleagues at the site level. The challenge is to move dialogue back and forth between the network and a significant number of school faculty members, so that the information truly affects site-based restructuring. Structures and processes must be developed for training, disseminating information, reading, discussing, and contributing to the network. The greatest danger is that one teacher will become the "computer person" and that other faculty members will fail to become involved in the dialogue.

If the local facilitator can empower faculty members to discuss and use network information, then results related to the network's purpose and the school's restructuring agenda occur. If a local facilitator just gets information without engaging others in discussing or using it, then little or nothing happens.

The difficulty of involving a significant number of people is compounded when access to the network is limited by the number of computers available. When only one computer workstation is available for an entire faculty (as is the case with most sites on the School Renewal Network), local outreach is critical.

4. *The structure of the network must be empowering*. The structure of the network and its database must be developed on principles that empower the users. First, the network must be easy to use. Second, the focus of the network topics must be clear. Third, all users should be considered equal in terms of their contributions to the dialogue, their access to information, and their input into network development. We do not use position titles such as professor, principal, supervisor, or teacher. Participants on the School Renewal Network often mention the importance of talking with another person who is equally committed to school transformation rather than to someone with a certain position or title.

5. *The network must take advantage of the principle of distributed expertise.* As one participant said, "None of us is as smart as all of us." The involvement of multiple stakeholders allows numerous perspectives and knowledge bases to influence restructuring. On the School Renewal Network, the inclusion of both researchers and practitioners has enriched and strengthened the dialogue. All participants share as peers, so appreciation grows for the particular knowledge and experience of each individual. Users communicate across the worlds of research and practice to learn with and from one another. Practitioners learn about the use of research and its adaptation to local contexts. As practitioners describe how they apply research, the wisdom of practice gets recorded. Researchers learn about the myriad factors that discourage the use of research in schools. They also gain insight into the learning and teaching issues that confront teachers regularly but have not been addressed by research.

6. *Access to the network must be maximized.* Many factors affect the degree of participation in the network. A sense of purpose, a belief in the network's relevance, and a willingness to take risks are important predispositions for active participation. Perhaps most crucial, however, are the location of the hardware and the amount of time available for networking. The closer the computer is to the user's daily pathways, the more it will be used. Fear of theft caused some sites to lock the computer away where it could not be used easily. In other sites, some teachers had to walk 10 minutes from one end of the building to the other. Having the computer in or near the faculty room proved one of the most successful arrangements, because everybody goes there.

Time for additional tasks in schools is a problem, and few teachers have the luxury of casual time to experiment with and learn about networking. It is essential, therefore, to develop creative ways of making time available for all teachers to use the network. In several schools, a committee or small group shared responsibility for training, workstation maintenance, and local outreach. In other schools, small groups took responsibility for monitoring and participating in particular conferences. Access to home computers also increased participation.

> It is essential to develop creative ways of making time available for all teachers to use the network.

EXPECT THE OBVIOUS

Network developers should expect to experience three phenomena. While they seem obvious, anticipating and planning for these givens greatly facilitate dialogic networking.

Networks are developmental. They grow and change as facilitators and users acquire sophistication. During the first year, the users focused on technical issues, learning the software, writing private messages, and sending public requests of a very general nature ("Tell me everything you know about . . ."). During the second year, participants turned their attention to building relationships ("high touch") and developing interactions. Requests became more specific, with rich contextual details included. The number of responses surpassed the number of requests.[14] In our third year we focused on increasing the length of the conversations and broadening their substantive and reflective content.[15] During the fourth year, we have been working on developing smaller focus groups for school-based action research projects.

Planning from the start for formative assessment over time will enhance the network's growth and quality. Using the "action research" spiral of continuous insight and action ensures development in concert with the network's purpose and the participants' needs.

Users have different styles. As in any other arena, people have different skills, concerns, and styles. For example, we observed that some users focus on resources, while others focus on dialogue. Some have a facilitative style, while others are more confrontational. Some are analytical; others are more emotive. We see differences in preference for theoretical versus practical discussions. Some participants act as leaders, while others follow. Some are self-starters; others

need nudging. Some try to solve technical problems themselves, while others call for help. Styles of network use are greatly influenced by whether one views the network primarily as an information source or as a problem-solving tool. Flexibility, sensitivity, and personalization are needed to involve everyone fully.

Users have different levels of technical experience. People with technical experience and expertise are at least partially motivated by their interest in the technology. However, the majority of teachers are nontechnical users who must be motivated by the nontechnical aspects of networking, such as access to research and the sharing of experience. For network participation, we believe that neutrality toward technology is sufficient: "I'm not afraid of the technology, but I don't have to love it — I just have to use it." The focus should be on carrying on a dialogue with peers, not on using technology.

POSITIVE OUTCOMES

Our four-year experiment with the NEA School Renewal Network has produced several positive outcomes.

• *Increased teacher professionalism.* If research is to be applied in schools, teachers must develop and trust in their own voices. One teacher said she thought she had nothing to say, only to become a major participant in a discussion of interdisciplinary team-teaching. Teachers on the School Renewal Network moved from isolation in classrooms to collegiality with other networkers to collaboration on issues of substance.

• *Increased dialogue between researchers and practitioners.* While practitioners developed their voices, researchers refined theirs. A shared language began to evolve. The researchers report learning about the realities of schools and, consequently, reframing research questions. A synergistic knowledge base, greater than the sum of its parts and valuable to both groups, has been the result.

• *Greater possibility of substantive change through the use of information.* The School Renewal Network is not a resource network, but a dialogic network. When information is adapted to fit the user's school context and is internalized through dialogue and reflection, school restructuring is much more likely to occur than when resources are simply called up in isolation.

• *Breaking down of institutional and hierarchical barriers.* The participants in the School Renewal Network now talk as peers. They report increased comfort and a blurring of the distinctions between researchers, administrators, and teachers. Participants have gradually taken on new roles. For example, some teachers are becoming action researchers in their schools.

• *Eliminating barriers of time and place.* The School Renewal Network covers more than a hundred sites in extremely diverse settings. Dialogue is continuous and recorded. One can participate daily or weekly and still be a full partner. The time spent playing "telephone tag" is significantly reduced.

A SUCCESSFUL change process moves through teacher development to student empowerment. Therefore, professional development that changes the local culture is critical to the transformation of schools. One highly successful tool for such professional development is dialogic networking. An enthusiastic network participant summarizes the powerful effects of the School Renewal Network:

> Network teachers are onto something big — something unique, in my experience. They have learned and are practicing the art and science of deliberation, of consensus building, of discussion of ideas and concepts. They possess and are continuing to develop the power of a profession, power that can be put to good use as they continue to learn and to teach. They are putting intellectual, emotional, and physical energies into transforming schools into exciting places for adults and young people. They are linking with good people, good ideas, good activities, important controversies, perplexing issues. They are creating contexts for themselves and for their clients that overcome the constraints of business as usual.
>
> The network schools are becoming places in which *everyone* is expected to grow and learn. And the learning, whether for children or youths or adults, is not conventional. Teachers are learning from one another. They are offering to share what they know with one another and are willing to accept feedback — positive and not so positive — in the spirit of professional colleagueship. Teachers are experimenting with the new — not totally discarding the tried and true but seriously questioning the persistent dilemmas inherent in being a teacher.

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BLINDED BY SCIENCE

By Tom Snyder

Computer marketers have latched on to the progressive agenda of teaching and—if we're not careful—have the potential to devalue education

NO MATTER WHAT WE DO, A HUGE INFUSION of technology is coming to education. It doesn't matter if it works or not, whether we make mistakes or not. It's coming because so much money is behind it. And because that infusion of technology is inevitable, it would be nice to start adding some new perspectives about technology in the schools.

It's just possible our decisions about technology in schools are not being guided by the instincts of our best teachers. In fact, it's hip sometimes to try to get rid of that pesky teacher—that egomaniacal, full-frontal teacher who stands up there and exploits everyone by imposing the tyranny of his personal point of view on a whole class full of children.

Right now, we run the risk of being blinded by science. Without teachers driving this whole technology revolution, we're in trouble. And that's what I want to talk to you about. How we can make sure teachers' instincts are fully integrated into our decisions about technology in schools.

I think most educators have an image of themselves as being progressive. Trouble is, I also think we're coming to the end of a progressive era. I've sensed this for a while now, beginning when I minored in education back in 1970, and then when I went on to graduate school in the mid-70s, and then when I was teaching at the Harvard School of Education in the '80s and '90s. Believe it or not, I see a real trend away from the progressive era.

One of the problems with progressive education is that it's not what everyone wants it to be. Even sloppy liberals like me get a little bit embarrassed when we think about some of the language of progressive education. Progressive education has essentially failed us, and that's hard for a liberal to say.

Certainly, conservative education failed us at the end of the 19th century. Consequently, John Dewey came along and said we must have active learners, and we must have less frontal teaching. But, by and large, the progressive agenda has been pretty much of a disaster.

Unfortunately, classroom computers came along in the early '80s, just at the time when progressive educators were scratching their heads and saying, "Is this really working?" Computer marketers have latched on to the progressive agenda of teaching. Technology in schools today exists on the last gasp of progressive education.

What do I mean by the progressive era and teachers? Well, a researcher named Allison Davis went around the United States and England and asked teachers to identify the primary influences on how they think about teaching. A huge majority identified one man—Jean Piaget.

According to Davis, that's because in every school of education, when you're studying to become a teacher, you learn about Piaget. He's been phenomenally important to the way we think about education in this country. He was from Switzerland. He was a quirky, kindly, sweet, old fellow, who by the end of his career had an incredible impact on all of us.

When Davis asked these teachers what Piaget's beliefs were, most teachers said something like this: "Oh, he's the guy who poured the water from one container to another." I've based my whole career on that. But other than pouring water back and forth, Piaget did something else that left an indelible mark. Some of the terminology most essential to progressive education grew out of Piaget's work.

Take the term "active learners," for example—that's

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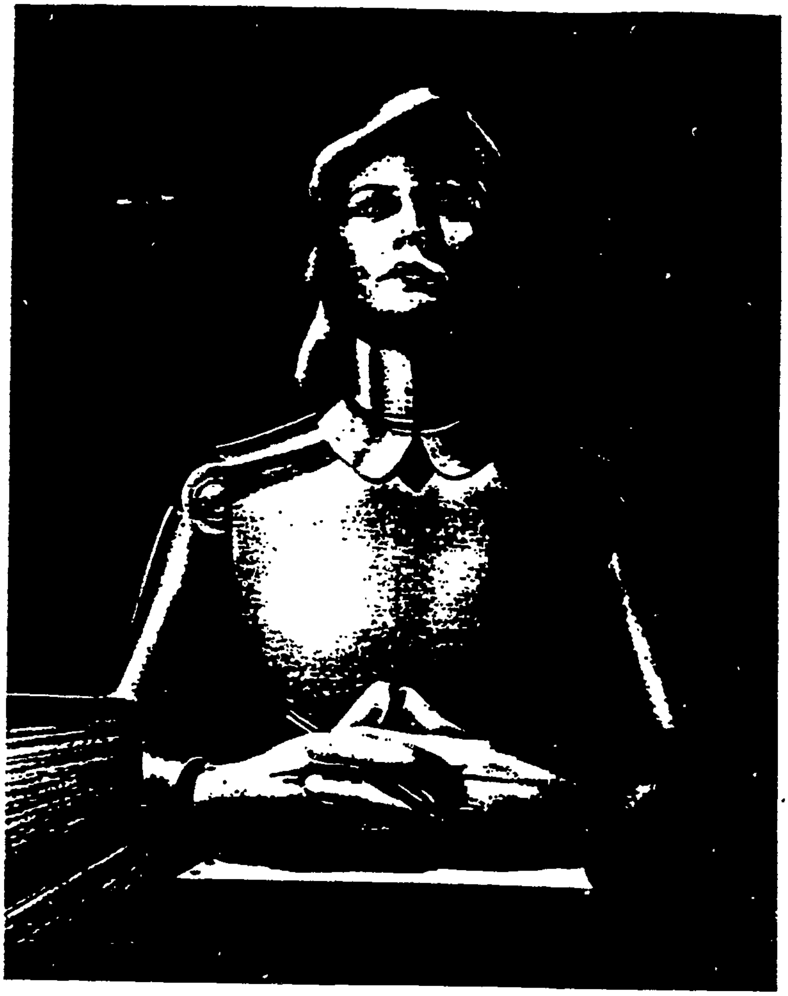
straight out of Piaget and John Dewey. Kids should be active learners. They should move. They should do things. They should push buttons. They should explore on their own. (Hence the term "discovery learning.") They pop out of the womb ready to learn all by themselves. Student-centered learning, then, becomes important.



Or consider Piaget's distrust—if not disapproval—of the role language plays in teaching. Language, he said, confuses things. If you ask children to tell you what they know, they might not be able to tell you in words. They could show their knowledge better, the reasoning goes, using manipulative materials. So language plays a lesser—and somewhat more suspect—role in learning.

Then take the idea that tasks should be "developmentally appropriate," or appropriate to the child's level of intellectual development. The classic activity from Piaget—familiar to virtually all teachers—involves pouring a certain amount of water from a narrow container into a wider one. Of course, the level of the water is lower in the wider container than it was in the narrow container. Then the teacher asks the child, "Is this more water, less water, or the same amount of water?" Kids up to a certain age—somewhere between 5 and 6—will say it's less water, even though they just saw you pour all of the water from one container to the other. To use Piaget's nomenclature, kids at this age don't understand the idea of conservation of volume.

This is important not because the specific skill is important but because Piaget was showing that children have certain developmental levels, and if you force them to go beyond these levels, you are violating an important principle about how kids learn. You have to know how a child's mind works—then you have to make sure you are giving manipulative experiences that are appropriate to that child's level of development. You can't teach beyond that level; you have to wait until children reach the age at which they're capable of understanding the concepts you're trying to teach. Then they're off.

If Piaget were alive today, he would be thrilled with the computer—the ultimate Piagetian machine. The computer slides that next manipulative experience in front the student just when the student is ready for it. And as soon as the child is developmentally ready to do the next thing, in it comes, thanks to a mouse or some other interface device. You can manipulate blue cubes on top of red cubes without moving the yellow cube more than three spaces. You can be working independently while the computer's tracking you and setting out what you should do next. (With some so-called integrated learning systems, you can log on at age 3 and log off at 18.) The computer always gives you just the right problem—just at the time you need it.

Which is part of the problem. In a funny way, the progressive education movement has devalued teaching. And the computer, appropriating the same language and the same ideas, has the tendency to do the same thing—if we're not careful.

A guide to the buzzwords

Let me give you some examples of the ways in which the progressive movement's key phrases have become today's buzzwords for computers in the classroom. Such buzzwords sound fine, of course, and normally we are willing to go along with them and accept their use. Computer vendors surf on this specious level all the time; it's that easy.

• **Frontal teaching.** Now that's a term I kid about, but you hear it frequently at computer conferences: "We've got to reinvent the school and get rid of that frontal teaching."

We all know where the term comes from, of course—from the traditional autocratic teacher who would get up in front of the classroom and lecture and have no relationship with the students. The progressive agenda opposed that kind of teaching.

In fact, there's a myth abroad that says we should hate or distrust any kind of lecturing because it is autocratic and doesn't let children do their own thing. Put

Illustration by Craig Calsbeek, The Stock Illustration Source.

Linear thinking isn't boring—any more than a Shakespeare play or a Beethoven symphony is boring

another way, lecturing has become anathema (to some) because it isn't student-centered. But consider this: When John Scully came to Apple Computer in 1990, he wasn't a computer expert. He'd worked at Coca-Cola and had a marketing background. Suddenly, he had to learn about physics and electronics and new forms of data and communication—things you'd have to take a graduate course to learn. And he had to learn all this in about six months.

Shortly after Scully started at Apple, *The Wall Street Journal* asked him, "How did you learn so much about technology so quickly?" The interviewers asked that question with sort of a knowing grin, expecting that the answer would be something about hypermedia, which we hear so much about today and which was already doable on Apple and IBM computers.

But Scully didn't use hypermedia, with its high-tech ability to jump around from film to photographs to books. Instead, he rented videotapes from a service that offered great lectures from the great lecturers in the world. Scully sat down at home and watched these videotaped lectures because he had to learn fast and he had to learn well and he wanted to be inspired. And one of the things about great lecturers is that they love their subjects. They insist on communicating their ideas because their subjects are of passionate interest to them.

Apple's developer conferences—at which participants have to learn a lot of technical things about new marketing opportunities quickly—work the same way. Apple does use computers at these sessions. But the computer is used as a demonstration tool for a lecturer who loves the topic. Everyone else sits by taking notes, and no one feels devalued or abused. Except for when the company is teaching its developers about CD ROM updates, Apple never uses a bit of interactive technology in its corporate classrooms.

• **Linear thinking.** That's another term taken from Piaget. In the computer world, "linear" implies not branching, which is not entirely desirable because computers can be highly nonlinear in the way they work. At a branch in a computer circuit, for example, you can make one choice to go one way and another choice to go another—that's what the computer does well.

Branching is at the heart of hypertext. In hypertext, you create your own path through a book. Instead of starting at the beginning and working your way methodically through to the end, you create your own knowledge and your own understanding based on the way you learn and what you need and what you think. Hypertext, the book of the future, is totally interactive in this way.

After reading a book on hypertext from a prominent author, I wrote the man a letter and said, "Dear ______ (ignore his name), I've read your book. Very confused. Don't understand any of it. Of course, I did start on the last page. And then I read a page somewhere in the middle because I just felt like it. And then I started at the beginning. But my attention span was too short, and I kind of jumped forward."

Or consider my experience preparing to teach a class on technology with a colleague at Harvard. The course wasn't coming together—we couldn't organize what we were going to teach—when another colleague suggested, "Because this course is about technology, why don't you do your whole course in hypertext?"

The idea was compelling, because at that point we had 3,000 index cards all over my kitchen floor listing all the points we wanted to make. My colleague kept saying to me, "We have to figure out what we're going to say—and how we're going to present it." Now a wave of relief and laziness passed over us: With hypertext, we could take those 3,000 index cards, hook them up in hypertext, and let the students navigate through all these points of view at will. So we started doing just that—only to realize we had totally abdicated our responsibility. We had to sit down and figure out what we were trying to say in the course. It was hard work, but we had to do it.

Sometimes when I look at hypertext reports students have put together, I see something similar: a complete lack of commitment on the child's part—or on the teacher's part—to say something, to make a commitment to an ugly, linear point of view.

But linear thinking isn't boring—any more than a Shakespeare play or a Beethoven symphony is boring. Linear thinking can have all kinds of contusions and paths in it. Linear thinking is something we should value.

• **Computer equity.** That's a term people talked about a lot in the 1980s. What are we going to do about the fact that rich white kids are going to own all the technology and are going to have an advantage, especially in schools?

But that's not what's happening. Instead, poor black kids are getting the largest amount of time-on-task on computers. That's because big Chapter 1 programs in desperate inner-city schools have brought in integrated learning systems to solve their problems.

Twenty years from now, when an employer interviews an applicant from an inner-city school, that employer's going to say, "Oh, you were taught on the computer," and maybe hire that student for a job on the production line. But if that employer is talking to a kid who grew up in the suburbs, he's going to say, "Oh, you were taught by a teacher," and hire that student for a management position. It is almost a kind of reverse equity. We have decided to solve the problem of bad teachers—or not enough teachers—with computers.

But the solution to bad teachers is not computers; it's good teachers. And the solution to not enough teachers is not computers: it's more teachers. It's that simple.

What's missing in such an approach is talk about the social nature of learning, talk about narrative and context

Talk about talk

Back in 1980, I had my first TRS-80 computer (with all of 4K memory), which I used in class not for instruction but to help me keep things straight. We were doing group activities in that class—old-fashioned paper-and-pencil simulations of kids running factories or doing archeological digs or searching for oil or sailing across the ocean—and I started using the computer as a secretary.

It was great. I had a paperless desk, and I did all my writing on the computer—reports home to parents, curriculum ideas, and the like. It was like having a teacher's aide to whom I could say, "Take a letter," or "Get me that report on Timmy right now."

One day, we had an important visitor who had come to observe my class and sat in the back of the room. We were doing a simulation that was going extremely well, I thought, with groups of kids each running their own factory. The computer was keeping track of how many energy units they had and how much money they had and what technology they were using. As the teacher, I was enormously proud, because the kids were talking with each other about kilocalories and British thermal units and so on. What's more, when the period ended, they were actually talking to each other about the problem and planning what they were going to do and how they were going to call each other that night.

In short, the computer had helped me create a dynamic experience I couldn't have created on my own. The activity was too time-consuming, and paper and pencil couldn't handle it.

But the man in the back of the room—yes, he was from Harvard—had read one issue of *Creative Computing* and all of Seymour Papert's book, *Mindstorms*. And at the end of the class, he came up and told me the class was a disaster. (As John Holt, the education philosopher, said, every teacher lives in constant fear that the administration will find out what's really going on in your classroom.) I felt terrible. And when I asked him why he thought the class was a disaster, he said, "Because you're pushing all the buttons and the kids aren't pushing any." At that moment I realized: He must have read *Mindstorms*, because Seymour Papert always said we must put computer power into the kids' hands, get the kids pushing the buttons.

The defensive part of me wanted to shake him and say, "Didn't you see what was happening in that class? We had some serious learning. There was social interaction between the kids. Language was being exchanged." But for him, the more important thing was that the kids weren't pushing the buttons. That is not going to be a useful guideline for us as we make decisions over the next decade about technology in schools.

What's missing in such an approach is talk about talk: talk about the social nature of learning, talk about narrative and context, talk about all those things that graduate schools of education are finally beginning to take seriously with the work of people such as Howard Gardner and Jerome Bruner. It's no longer a question of a couple mystics out there talking about this. Today, we're beginning to pay more attention to the science of language and the science of the social side of teaching.

Let me give an example that debunks the old Piagetian world. Piaget's experiment with pouring water from one container to another is one of those classic metaphors that helps keep the progressive movement alive. But most of us are a bit suspicious when we hear about that experiment. We think, that's something my 3-year-old would understand. But if you check the data, you'll find that yes, this same experiment has been done over and over in very controlled circumstances and using very controlled language to make sure no false variables sneak in.

But then a researcher did what's called the "cracked beaker experiment." It was a stroke of genius. Trained as a classic Piagetian, this woman knew how to do the original experiment, and she knew that, out of 100 6-year-olds, only 10 percent understand the principle of conservation of volume. But her experiment is different.

She tells the children, "I'm going to do a little experiment with this beaker that's got some water in it." And while she's describing this fun thing they're going to do and swirling the water around in the beaker, she says, "Oh my, look at that. The beaker's cracked. I don't think this experiment is going to work with a cracked beaker. Let me get another one." So she gets a second beaker, one that's wider than the first one, and she pours the water from the cracked beaker into the wider one. And of course, the water rises to a different level.

"It's not going to work, because now there's a different amount of water," she says. And most of the 6-year-olds say, "No, it's the same amount of water."

Then this researcher and her graduate students ran another experiment that I find delightful. They thought, "Maybe our findings had something to do with cracks." So instead, they designed the "naughty puppet experiment." It's basically the same, but instead of the crack, there's a naughty puppet who says, "No, you can't use that beaker. I hate that beaker. You've got to use my favorite one." And the results are the same.

What Piaget's original experiment did is systematically remove language and context to make the experiment fair and scientific. It was very fair, very scientific, but it was drained of story, context, narrative—the human component. The kids were trying to outsmart that experiment. When the Piagetian experimenter asked if the amount of water was the same in both containers, the kids were thinking, "Gee, that's a stupid question. Maybe they want me to say it's a different amount of water."

Context, it turns out, is not such a small factor.

Complaining about computers is about as smart today as complaining about the printing press would have been in the 1500s

Jerome Bruner, the man who has turned me around more than anyone else, goes so far as to theorize that parts of our brain are hard-wired to make sense of the world through narrative. Indeed, he goes so far as to say that humankind probably wouldn't have survived when the world started getting complicated five or six thousand years ago if we didn't have the ability to make sense of the world through narrative structures.

Anyone who works with children recognizes that. With children, you explain a list of stuff, and they only remember some of it. But read them a story about a monster with red socks and then read it again later and change the color of the socks, and the children will correct you. This narrative sense is an ignored part of what makes us great and human and smart; stripping our world of its social context and its story context is a fundamental mistake.

At times, though, the world of hypertext seems almost antinarrative. You click on Martin Luther King, and you hear the beginning of a speech that can make you cry because it's so beautiful. Then the speech ends, and you're back at the menu. And you say, "Wait a minute—don't stop me in the middle of nowhere. What about Selma? Fit this in for me. I'm only a kid (or only an adult). I need context."

The computer is threatening to be like MTV with no beginning, middle, or end. All the simple logic is breaking down.

A must-do list

Complaining about computers is about as smart today as complaining about the printing press would have been in the 1500s. It's not useful. Computers are an absolutely enormous revolution. How do we make that revolution work for us? I'd like to suggest a list of three absolute musts.

I'm not being facetious or speaking metaphorically. It would be great to give every child a laptop word-processor. But that's not going to happen: we simply don't have enough money. Let's say we've earmarked a couple of billion dollars for technology, though. Here's what I would do with it:

• First, every single disabled child in the country would have full-time access to a computer at school. A computer can be arms, legs, mouth, ears, or eyes to a disabled child. It is the most heartbreaking, moving, and magical thing to see what a microprocessor with an interface can do for a child who's otherwise totally physically or emotionally disenfranchised. We have enough computers right now to give one to every disabled student in our schools and let all these students feel great about themselves. It's almost embarrassing that we haven't done so already.

• Next—on a somewhat more mundane level—I'd argue that we should use computers as tools. Science labs have been buying microscopes and lab balances that cost a thousand bucks each for 50 years so they can do experiments that require interpretation and data. But computers are a vital tool in science and engineering as well, and every kid in every science course ought to have access to them. It's not that expensive to put computers in school science labs. We've been making that kind of expenditure for years, and we know how to do it. It fits in the infrastructure of schools.

• Finally, and most controversially, we have to put a computer on every teacher's desk. I said that once in Tennessee to a group of administrators, and a guy came up to me afterwards and said, "We don't talk like that around here." But putting a computer on every teacher's desk is essential, because we have to find out how technology is going to work in schools. And the way we're going to find out is through the teachers.

If you simply take an innovation and plunk it down in an institution—be it a hospital, a government, or a school—the innovation won't take hold. Instead, you have to go in like an anthropologist or a sociologist and understand how the institution really works. And we have done precious little of that in education. The RAND Corp. did a study in 1978 trying to figure out why some teaching machines—like language labs—that were tested in Texas back in the '60s were no longer used. Test scores rose every place these devices were used. They were cost-effective, too, and administrators loved them. But they disappeared.

Why? A no-brainer, said RAND, which gave two reasons. First, any time you inject an innovation into a school without taking into account the complex social nature and workings of the institution, that innovation will fail. Period. Every time.

And second, whenever you try to introduce a new technology—like a stirrup or a plow—into an existing institution, you'll fail unless that technology directly benefits one or more adults who are central to the institution. It's not enough to improve people or make them more efficient. They've got to like the new technology better than what they had before; it's got to feel better to them in some way.

We skipped that point when we first started introducing computers into schools. We might think we've done that, but we haven't. We keep thinking, "Yes, we're making tools for teachers." But we don't really make tools for teachers; in fact, we've figured out a way to keep the teacher pretty much out of the loop.

We can get technology to fit in schools, of course. But we have to think about putting people's magical or spiritual or personal instincts into play so the technology will have a place there. To do that, you have to get the technology into the hands of your teachers, and you have to say, "Here, It's yours. You can use it to write letters to your old boyfriends if you want. It's yours. We are trusting you just the way we trust middle managers and executives and every other working person in this country with the technology." ■

ALTERNATIVE ASSESSMENT

PUTTING TECHNOLOGY TO THE TEST

BY ISABELLE BRUDER

WHICH OF THE FOLLOWING BEST measures what a student has learned?
a.) standardized or multiple choice tests
b.) portfolios of the student's best work
c.) performance-based assessments
d.) all of the above

If you picked *d.) all of the above*, you're among a growing number of educators who recognize that as school reforms change curriculum and instruction, how we assess teaching and learning must change as well.

For decades, schools and communities in this country have relied upon standardized tests to measure how efficiently a teacher teaches or how adequately a student learns, usually without considering whether or not the student could apply what was learned beyond taking the test. In fact, even though individual teachers for years have evaluated students using a variety of methods, formal assessment has barely changed.

Until now. Today many people agree with alternative assessment expert Grant Wiggins who says, "the proof of a person's capacity is found in their ability to perform or produce, not in their ability to answer on cue."

In changing from an industrial to an Information Age nation, we have moved from placing disproportionate

◀ **At Brooklyn (N.Y.) Technical High School, videotapes of science project presentations give teachers a closer look at how students explain their knowledge to others**

PHOTO ANDREW LEVINE

value on rote memorization of decontextualized facts to highly valuing the ability to solve complex problems through critical thinking and communications skills.

Arnold Packer of Johns Hopkins University directed the U.S. Labor Secretary's Commission on Achieving Necessary Skills (SCANS), which issued a report that calls for students to be able to perform a number of "workplace skills" and to "solve life's problems." He sees little connection between traditional standardized tests and real life skills.

"Tests were driving schools to teach to the answers of multiple choice questions," says Packer. "The world is more complicated than that; it requires a different kind of thinking. The problems the world will serve up to you don't look at all like the problems on a multiple choice test."

Technology's Potential

The problems the world will serve up to our students will also most likely involve technology. So it would follow that technology could play a major role in alternative assessments in schools. However, exactly what technology can do for assessments is not yet clear.

There are a number of immediate and existing applications for technology in assessment—such as computer-adaptive tests like those given by Educational Testing Services, Princeton, N.J. So far these are basically the same tests administered by pencil and paper put into a new computer wrapping. The difference is that the computer-based test responds to the individual's learning speed and style, moving on to more or less difficult questions as indicated by the student's previous responses.

But the skills tested remain the same. And as Marc Tucker, co-director of the New Standards Project which calls for national education standards and assessments, recently cautioned: "We don't need to create a more sophisticated way of measuring the current levels of failure."

Technology can certainly minimize the labor-intensive tasks associated with assessment (namely, paperwork), says Grant Wiggins, but the process still requires human judgment. "The jargon aside," he says, "what matters is that you want to know if people can use their knowledge intelligently. To find that out you have to get them to produce or perform with it."

Performance-Based Assessment

In fact, performance-based assessment, in conjunction with existing testing methods, is becoming increasingly popular strategy for evaluating student learning. In the assessment, a student performs a task that requires in-depth understanding of a skill and is evaluated by how effectively he or she communicates that understanding to others. [For a glossary of assessment terms, see box this page.]

Educators are exploring how technology can be used in evaluating student performances. There are a number of ideas on the table. Wiggins describes what he envisions as "an example of low technology" for performance assessments: a teacher using a bar code reader on a scoring sheet, walking around the classroom coding in assessments of student work as it occurs. "It's a natural," he says.

In fact, this technology isn't just an item on Wiggins' wish list: It already exists. It's called *Learner Profile—The Observational Assessment Tool.* Released in December by Wings for Learning/Sunburst, of Scotts Valley, Calif., the Mac-based system costs less than $1,000 and includes software, bar code reader, 16K credit card-sized scanning device, and a disk-drivelike computer attachment in which teachers download the scanner data.

Teachers walk around their classrooms and scan bar codes that relate to their observations of the student's work, such as "mastered" or "developing" for a given skill. Teachers can customize bar codes to reflect the learning objectives they have planned for a lesson. Once they've downloaded student data, the program's relational data base lets teachers create a variety of reports that do everything from listing the names of all students who have not yet mastered a particular skill to viewing group data using graphs and charts.

Marge Cappo, president of Wings for Learning, says that "a lot of the ways we assess are ways that are easy to test. Technology can bring in more sophisticated assessments of skills and

(Continued on page 26)

◀ **Jan Hawkins: "This culture is wedded to numbers as a gauge of how we do. It's such an emotionally charged indicator. We all remember our SAT scores."**

(Continued from page 23)

make it easier to do. Most of our assessments up to this point concentrate only on [finished] product; this lets you look more at the process."

Many people point to computer simulations—where students are thrust into real world kinds of environments—as another way to assess how students apply their knowledge. Simulations have "some [assessment] value," reports Jan Hawkins, director of the Center for Children and Technology (CCT) at Bank Street College in New York City. "But it's not clear yet to anybody what the key parts of the process are for a practical portfolio." Most simulations enable teachers to see a final product, and do not provide a detailed record of the student's decision-making process along the way. Giving teachers that kind of information would be clearly valuable in a performance-based assessment environment.

One of the most obvious technologies for performance-based assessment is video. For example, at Brooklyn Technical High School in New York City, science students work in groups to design a product, then give 10-minute presentations about the product design to an audience of their peers, other teachers, and outside observers, many of them experts in various science-related fields. So when a group presents their design of a car wash, they have to explain to a physicist in the audience why they decided to use a pulley system instead of gears.

Videotaping plays two distinct roles in the evaluation process. First, the teacher videotapes a series of interviews with students while they are planning and creating their product to allow evaluators a closer look "at how the kids are explaining their knowledge to other people," says Hawkins who, with CCT, has been working with the Brooklyn program. Then, the presentation is taped to provide a record of the performance and serve later on as a basis for evaluation for the teacher and a self-assessment tool for the students.

Issues of Equity

One of the big advantages of using video in assessments is that the technology is readily available to most schools. That access, says Dennie Palmer Wolf, is a critical issue in ensuring equity in assessment. Wolf is the executive director of PACE (Performance Assessment Collaboratives for Education), a Harvard program that's setting up portfolio-based projects at middle schools in six cities.

Designers of alternative assessment strategies and products, she says, should use technologies that are readily available to schools, like slide projectors and VCRs. "If we require laserdiscs or CD-ROM," she points out, "we'll end up hitting only privileged kids."

In fact, equity was one of the primary goals of setting up standardized tests in the first place, as Jan Hawkins points out. "It's really important not to trash the multiple choice test. It had a very democratic goal: It allowed students from different places to compete in the same way. It was trying to make equity possible," she says.

CCT has been working with science and math classes in New York City to find out where technology can make contributions to assessment. "One of the things that always comes up in our teachers' groups," says Hawkins, "is they don't want [to assess] just final product, because it's not fair to compare our [city] kids to wealthy kids in

The Roles of Different Media in Assessment

It's next to impossible, not to mention extremely costly, to objectively score everything a student does. That's why the Center for Technology in Education at Bank Street College, N.Y., suggests instituting a testing system that measures a broad range of student abilities, using different tools to measure different skills. Each medium listed here (excerpted from CTE's technical report #12) can be used to assess different abilities as part of an overall assessment strategy. To order the report, contact the Bank Street bookstore at (212) 678-1654.

Computers

The strength of the computer is its ability to track the process of learning and thinking and to interact with students. This gives it a variety of ways to tap into aspects of students' abilities that other media cannot. Computers can record:

- how students learn with feedback
- students' thinking processes
- student's abilities to deal with realistic situations and problems.

Video

Video can record ongoing activities and explanations in rich detail. This makes it possible to record:

- how students explain ideas and answer questions that challenge their understanding
- how well a student listens
- how well students cooperate in a joint task
- how students carry out tasks and perform experiments.

Pencil and paper

Paper and pencil are currently used to measure students' knowledge of facts, concepts, and procedures, their ability to solve problems, and their ability to comprehend text. Paper and pencil can also be used to record:

- how students compose texts and documents of different kinds
- how students critique different documents or performances.

PHOTO BY ANDREW LEVINE

Dennie Palmer Wolf: Technologies used in assessment should already be in schools. "If we require CD-ROMs, we'll end up only hitting the rich kids."

suburban schools."

But, the fact that technology can help students create different kinds of products that reflect different kinds of abilities holds "enormous promise for equitably promoting" a student's display of knowledge, says Wolf.

Frank Betts, who directs technology projects for the Association for Supervision and Curriculum Development (ASCD), agrees. He says that "one of the distinct purposes of assessment is to encourage the myriad talents kids possess. Few children," he adds, "very few human beings, in fact, do all things well. So finding the talent and letting kids express it and feel good about themselves" is an important component of assessment. And it's one that technology can address.

For instance, rather than being limited to pencil and paper presentations, students can use multimedia tools to create an entire presentation that exhibits their understanding of the topic in a number of ways. But, Wolf points out, since the students are generally much more adept at technology manipulation than teachers, the teachers might be impressed more by the technological display than by the student's knowledge.

Measuring the knowledge a student displays rather than how he or she displays it is a "complicated issue, and the presence of technology in assessment is going to push it to the front," Wolf says. Districts might need "to start organizing technology S.W.A.T. teams or start rotating teachers who can go around and help each other learn how to use the technologies."

Portfolios

Perhaps one of the earliest and most obvious uses of technology for assessments has been with writing portfolios. In fact, portfolio-based projects have come to represent alternative assessment in many schools. Many of those schools, however, do not manage the portfolios with technology, and technology can ease the physical burden of storing massive amounts of information, says Dennie Palmer Wolf.

National Computer Systems (NCS), the largest provider of standardized test scoring hardware and forms for K-12, sees a role for new technologies in portfolio management. "We are adding electronic imaging to our instructional management system," says NCS vice president of education, Robert Bowan. "Teachers can use it to build portfolios by capturing student work in whatever format it's produced—handwritten, computer-generated, video, or audio." Bowan says the imaging system will also be used in national programs, such as NAEP tests, to help store everything from written essays to traditional bubble test answers.

In addition to storing portfolios, technology can also help in transferring materials from one school to another. "I don't think we can start to make decisions about kids' lives based on portfolios unless we have stable and transportable storage of those portfo-

1992 National Studies on Testing and Assessment

Alternative assessment is on a lot of people's minds these days. Just look at a few of the recently released national studies.

Testing in American Schools: Asking the Right Questions, Office of Technology Assessment, U.S. Congress. Two contractor reports done for this OTA project are directly related to technology and assessment. They are: "Computers in Educational Assessment: An Opportunity to Restructure Educational Practice," from the Institute for Computer Uses in Education; and "Applications in Educational Assessment: Future Technologies," from the Center for Children and Technology, Bank Street College. For information on these reports, contact the National Technical Information Service at (703) 487-4650. The complete report, Testing in American Schools, is available from: New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 ($14).

The Influence of Testing on Teaching Math and Science in Grades 4-12, National Science Foundation and the Center for the Study of Testing, Evaluation, and Educational Policy. This report concludes, in part, that both standardized and textbook tests emphasize and mutually reinforce low-level thinking and knowledge, especially in classrooms with high minority enrollment. The Executive Summary is free, and the full report costs $31. Write: NSF Study/CSTEEP, 323 Campion Hall, Boston College, Chestnut Hill, MA 02167.

From Gatekeeper to Gateway: Transforming Testing in America, the National Commission on Testing and Public Policy. A summary of findings on the problems of testing and restructuring recommendations, one of which says testing programs should be redirected from over-reliance on multiple choice tests toward alternative forms of assessment. Contact: The National Commission on Testing and Public Policy, McGuinn 529, Boston College, Chestnut Hill, MA 02167 ($6).

Learning a Living: Blueprint for High Performance, the Secretary's Commission on Achieving Necessary Skills, U.S. Dept. of Labor. A SCANS report for America 2000 sets forth "workplace competencies" needed for high performance in the nation, focusing on reinventing schools, restructuring assessment, fostering work-based learning, and reorganizing the workplace by the year 2000. Full report ($8) available from: Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.

Raising Standards for American Education, National Council on Education Standards and Testing. The council recommends the development of national education standards with a linked voluntary system of assessments, including alternative assessments. The report is available ($5.50) from: Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325.

PHOTO BY BOB ADLER

lios," Wolf says. "The reality is that kids are moving around with their parents."

In the Littleton, Colo., Public Schools there is a districtwide move to performance-based assessment, and technology "plays a huge role in keeping track of portfolio data," according to Elliot Asp, the district's curriculum and assessment specialist. The assessment includes video portfolio projects in areas such as public speaking. These video portfolios not only assess student progress, but show the community what the school is accomplishing.

At the O'Farrell Community School in San Diego, Calif., an innovative restructuring effort includes creating an electronic folder for each student in the school. Throughout the year, the portfolio amasses a diverse picture of the student's progress.

For example, Jeanette Barrozo, an eighth grader, has in her electronic portfolio: a *HyperCard* stack called "Presenting My Life"; another *HyperCard* stack featuring a problem-solving simulation about money; a log of her *Oregon Trail* journey; four separate documents investigating essential questions in the thematic units she's studying; and a poster she created about keeping the school clean.

"We wanted students to see the ease of using electronic media to keep track of their work," says O'Farrell teacher George Muñoz. "Last year, we took a year's worth of work, put it into *HyperCard* format, then gave a presentation to a panel of our teachers. It's how we assess."

◄ Arnold Packer: "The problems the world serves up don't look like the problems on a multiple choice test. We need assessment for a thinking curriculum."

Professional Development

Changing educators' views of assessment, and helping them use assessment to promote learning, "is essentially a professional development issue," says Jay McTighe of the Maryland Assessment Consortium.

In Maryland, a statewide technology-based staff development project, combined with state changes in testing, "got everyone's attention" says McTighe. Much of that attention was focused on the inevitable crossover from staff development to assessment.

The project includes a multimedia data base that offers to teachers research on teaching and learning, organized by subject area, levels, and specific techniques, such as cooperative learning. The framework is also linked to METNET, a statewide online system with room for teacher discussions, e-mail, and announcements.

Although this framework is technology-based for staff development, McTighe points to plans "down the road" to include performance assessment tasks on the data base that teachers can use. Videotaped examples of teachers using performance assessment might also be included.

In Connecticut, where performance-based assessments have been used for a decade, "you can't avoid the teacher redevelopment issue," says Joan Boykoff Baron, coordinator of the state's common core of learning assessment program. Baron emphasizes that "if you don't change how teachers are teaching, it won't work to change the way they assess. The logic is easy, but the implementation is very hard."

To make it easier, teachers in Connecticut are involved in developing, administering, and scoring assessments. "You have to engage teachers every step of the way," Baron says.

National Attention

The alternative assessment movement has gained momentum in recent years, and Arnold Packer believes this is in part because education recognizes that teachers, students, and communities only pay attention to what is assessed and recorded.

"But the assessment [should] become part of the process," Packer says. "In any natural learning, feedback is constant—whether sailing, playing the violin, or using software—if you make a mistake you find out about it quickly. It's assessment for a thinking curriculum, and in the last few years it's gotten more and more attention."

National attention notwithstanding, alternative assessment is not guaranteed a place in schools. Jan Hawkins reminds us that "this culture is wedded to numbers as a gauge of how we do. It's such an emotionally charged indicator; we all remember our SAT scores. But what does it mean?"

Using new methods to assess student learning "means destabilizing that connection of how we know what we know," she says. "We're asking people to disconnect from a deeply held belief about what's an adequate indicator."

In addition, integrating technology into alternative assessment, says Hawkins, will require "a major rethink all over schools about what assessment is and what it should do in relation to instruction." But it's important that educators start rethinking. "The big picture is that technology can make some pretty interesting contributions." ■

—Primary research by Judy Schuster

If You Think Traditional Testing Is Cheap ...

Skeptics of alternative assessment say it costs too much, but traditional testing ain't exactly cheap. The Office of Technology Assessment estimates standardized testing in a large urban district in 1990-91 cost $6 per student per test to administer. That figure doesn't include $13 per student in teacher time spent giving the test and $100 per pupil for teacher prep time. If you're looking to fund alternative assessment, one grant source is the Toyota USA Foundation, 19001 S. Western Ave., Torrance, CA 90509.

Grant information provided by: ITS, Inc., 313 Pioneer Circle, Woodstock, GA 30188; (404) 924-3317. ITS publishes Grant Writer's Assistant software, which contains an expandable data base of funding resources.

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RESPONSIBLE CITIZENSHIP IN THE ELECTRONIC COMMUNITY

By Sally Webster and Frank W. Connolly

SOME OF THE FUNDAMENTAL VALUES OF EDUCATION ARE AT RISK AS WE INTEGRATE COMPUTERS INTO OUR SCHOOLS AND COLLEGES

Education and computers... one of the most static institutions and one that represents a dynamic technology. The former is steeped in tradition and slow to accept change. The latter is so fluid as to have few standards, much less traditions. As computers permeate more areas of our life, including education, some proclaim that education will be radically changed.

The environment of a classroom is dynamic; it changes as technology brings new tools and techniques to teaching and learning. But the basic values on which education is based must remain constant. Some peripheral values may change because our requirements or needs change. For example, working independently has, over time, become entrenched in our educational system. Today, collaboration and group activity are more important in research, manufacturing, and services. Computers and networks facilitate such collaborative activities, nurturing a change in values that is already under way.

Some of the fundamental values of education are at risk as we integrate computers into our schools and colleges. In drafting the Bill of Rights and Responsibilities for Electronic Learners, we have tried to identify those values and ensure that they not get lost. The values to be protected include:

- equality of access to resources
- active, responsible citizenship
- control over personal information

- freedom of speech
- respect for the work of others
- responsibility to conserve and protect limited resources

EQUALITY OF ACCESS

Within schools and colleges, all students and teachers ideally have full access to resources that enhance teaching and learning. School districts and institutions are already committed to giving students and faculty open and equal access to institutional libraries. As more information is held in electronic form on fileservers on or off the campus, students and faculty need the same kind of access to it as to information committed to paper, film, and tape (cf. Article I, Sec. 1).

We teach students to read and then how to use a library. If we had not learned to use libraries, there would be little demand on them. In the same way, we must teach students to use information held in computers. Enabling access requires training learners, not just installing hardware (cf. Article I, Sec. 2).

Equal access to resources applies not only to individuals but also to entire school districts, individual schools, and colleges. Technology can help education to lessen inequalities by giving both individuals and institutions with limited finances access to and use of resources without having to replicate them. We share limited resources through interlibrary loan programs; we should do no less with information stored in computers.

Providing equal access does not mean giving everybody the same equipment, software, or time. Although we try to ensure equal access to information resources for students and faculty within individual institutions, we recognize that institutions have unique missions and financial constraints. Institutions already allocate their other resources (e.g., library materials, laboratory equipment) according to their missions and finances. Institutions have the right to allocate access to information resources, so long as the allocation scheme recognizes the right of individual access in the same way as other allocation schemes do (cf. Article III, Sec. 3).

ACTIVE, RESPONSIBLE CITIZENSHIP

Teaching good citizenship is a common objective at all levels of education. Not only do we talk about it, but also we model the appropriate behavior and expect students to behave in similar ways. We expect members of a community to recognize the role they play—at times contributing to the common good, at times drawing on the contributions of others, at times working to advance the community by enforcing norms, and at times sharing information with the community. Citizens of electronic communities must be informed and active as well.

Whereas institutions are responsible for providing equal access and training, individuals in the electronic community are personally responsible for actively making use of

By their nature, information resources invite active participation and a commitment to learn and explore.

both access and training to further their own educational objectives (cf. Article II, Sec. 1). By their nature, information resources invite active participation and a commitment to learn and explore. Information resources foster active, lifelong learning, especially as information resources become available to all citizens.

Control over Personal Information

In modern society, much information is collected about each of us: SAT scores, income levels, race, grades, subscriptions, library records. Society recognizes that individuals should be informed about personal information held by an institution and should have at least some control over the ways the information is disseminated. These rights are embodied in the Privacy Act of 1977 and the Buckley Amendment limiting access to students' records, among others. Extending that kind of control over personal information stored in computers is easy to understand, because the only difference is in the medium used to store it (cf. Article I, Sec. 2).

Educational institutions collect and retain many kinds of information about their students and employees. With the right to collect and archive such information (cf. Article III, Sec. 1) comes the responsibility to appropriately control its dissemination. As institutional members of the electronic community, they must put into place the policies and procedures that protect information stored electronically (cf. Article IV, Secs. 2 & 3) and ensure that individual privacy of and control over personal information are a practical reality. Institutions must also secure personal information by instituting security measures that protect the information they have collected.

Freedom of Speech

Academic freedom is a long-standing tradition in education, based in part on the guarantee of free speech in the U.S. Bill of Rights. Insofar as free speech is protected at any institution in the electronic community, these guarantees should extend to expression using an electronic medium (cf. Article I, Sec. 4). We should not discriminate between regular communication and the new forms in the electronic community simply because the medium of exchange is different.

As with all rights, the right to free speech is not absolute. Freedom of speech in any medium does not imply the right to slander or harass other members of the community. The introduction of computers changes only the medium. Computers may spread inappropriate messages more rapidly or widely, but the fundamental principles and guidelines for institutional action ought to be the same as for abusive messages delivered in traditional ways. Citizens should respect the privacy of others, respect diversity, and generally behave ethically toward others (cf. Article II, Sec. 4).

We should not discriminate between regular communication and the new forms in the electronic community simply because the medium of exchange is different.

Respect for Work of Others

Intellectual property committed to electronic media is protected in the same ways as other intellectual property is protected. Citizens of the electronic community whose intellectual works are committed to or stored on file servers, in electronic mail messages, or on bulletin boards have the same ownership rights to those works as if they had been committed to the traditional media (cf. Article I, Sec. 5). By law, a work is protected by copyright as soon as it is committed to a medium, including an electronic one.

It isn't enough to agree in principle that creators of intellectual property have ownership rights to it. Users of electronic intellectual works must actively honor that right by giving credit to the creators when credit is due (cf. Article II, Sec. 2). When a work is in the form of books and articles, we have no trouble understanding plagiarism. We enforce the letter and spirit of copyright by punishing those who plagiarize. Electronic intellectual works deserve the same respect and are covered by the same traditions.

Another fundamental value of education is that works should be honest and accurate. As educators, we are committed to the value of protecting the integrity of data and information. Works stored in computers are so easily changed or interchanged with other information that citizens of the electronic community must be vigilant, lest the information we all depend on be manipulated or corrupted to the point that it is useless (cf. Article II, Sec. 3).

Responsibility to Conserve and Protect Resources

When many people must share scarce or expensive resources, there is value in using them responsibly, in conserving them. In times of limited budgets, more resources become shared—projectors, laboratory equipment, demonstration materials . . . and information resources (cf. Article II, Sec. 5). Responsible sharing of scarce resources requires us to put limits on the amount of time they can be used. In the same way, members of the electronic community of learners must recognize their responsibility to the community and not squander precious disk space, central processing unit cycles, or other information resources.

The Bill as a Guideline

Computers will continue to change the way we teach, learn, and conduct research. Even though technology enables change, however, it ought not be the driving force. The expanding role of and our dependence on computers need to occur within the traditions and values of education. Both the change and the values it threatens must be examined so as to protect the critical values of education. The Bill of Rights and Responsibilities for Electronic Learners constitutes a guideline for considering the place of computers in educational institutions. Because each school, district, and college is unique, the results of this analysis may be different for each. The important point is to ensure that the values underlying education in general and individual institutions in particular are furthered by the increased adoption of technology. ■

SECTION V: RESOURCES IN NETWORKING TECHNOLOGY

RESOURCES FOR
ON-LINE LEARNING TECHNOLOGIES: NETWORKING IN THE CLASSROOM

COMPANIES PROVIDING ON-LINE SERVICES FOR EDUCATION

America On-Line
Provides E-mail, encyclopedia services, education programs, weather, world news, business information, live conferencing, and product and technical information.
8619 Westwood Center Drive
Vienna, VA 22184
(800) 827-6364

AT&T Long Distance Learning Network
A curriculum-based program through "learning circles" of classrooms that exchange and discuss work and publish reports of their work. Cultural and international issues, science, math, and literature.
P.O. Box 6391
Parsippany, NJ 07054
(800) 242-6005

Bolt, Beranek and Newman, Inc.
Martin Huntley
National School Network Testbed
A research and development resource in which participating schools and organizations are provided with training and support in using the network resources to bring educational benefit to teachers and students.
150 Cambridge Park Drive
Cambridge, MA 02140
(617) 873-3000

FrEdMail
FrEdMail Foundation
An electronic network designed especially for classroom-based collaborative projects, linking kids from one place with kids in another place.
P.O. Box 243
Bonita, CA 91908-0243
(619) 475-4852

GTE Education Services, Inc.
Provides network access with electronic data collection; specialized databases on special education, human services, early childhood, and reference/research material.
West Airfield Drive
P.O. Box 619810
D/FW Airport, TX 75261-9810
(800) 927-3000

IGC Networks
EcoNet, LaborNet, ConflictNet, and PeaceNet offer discussions on peace, the environment, human rights, and social justice issues.
Institute for Global Communications
18 DeBoom Street
San Francisco, CA 94107
(415) 442-0220

K12net
Inexpensive school-based electronic Bulletin Board System connected to schools world-wide.
Wayne-Finger Lakes Teacher Resource Center
703 E. Maple Avenue
10 Eisenhower Hall
Newark, NY 14513-1863
(315) 331-1584

National Geographic Kids Network
A K-12 network for investigations of the environment. Students conduct experiments in their local environments, upload their data and then read, interpret, and analyze maps, charts and data from other classrooms.
National Geographic Society
Educational Services
P.O. Box 96892
Washington, DC 20090
(800) 368-2728

PRODIGY
(not available for Macintosh users)
Access to Bulletin Boards, Classroom-to-Classroom projects, Reference materials, monthly "Nova" and "National Geographic" featuring topics in science geography.
Prodigy Interactive Personal Service
445 Hamilton
White Plains, NY 10601
(800) 776-3449

Scholastic Network
Provides K12 resources such as authors online, teacher-to-teacher math exchange, science research online, human rights watch, worldwide current events exchanges between students, bilingual/ESL teacher exchanges.
Scholastic, Inc.
555 Broadway
New York, NY 10012
(800) 246-2986

SPECIAL EDUCATION AND TECHNOLOGY RESOURCES

Alliance for Technology Access
Forty-five technology resource and demonstration centers offer funding referrals and training opportunities.
1128 Solano Avenue
Albany, CA 94706
(510) 528-0747 (voice)

National Information Center for Children and Youth with Disabilities
Provides free information and referrals.
P.O. Box 1492
Washington, DC 20013
(800) 999-5599 (voice)
(703) 893-8614 (text)

National Institute on Deafness and Other Communication Disorders Clearinghouse
NIDCD provides free literature searches and publications.
P.O. Box 37777
Washington, DC 20013-7777
(800) 241-1044 (voice)
(800) 241-1055 (text)

National Institute on Disability and Rehabilitation Research
NIDRR offers information, referrals, access to databases, including ABLEDATA on assistive technology and its applications.
c/o Macro International Inc.
8455 Colesville Road, Suite 935
Silver Springs, MD 20910-3319
(800) 227-0216 or (301) 588-9284 (voice and text)

Telecommunications for the Deaf
This clearinghouse supplies free database searches and printed information and sells videotapes and in-person training.
8719 Colesville Road, Suite 300
Silver Springs, MD 20910
(301) 589-3786 (voice)
(301) 589-3006 (text)

FUNDING ORGANIZATIONS AND IDEAS

For Rural Schools

Annenberg/CPB Science and Math Project
Program to support rural teachers' math and science teaching efforts.
Scott Roberts, Project Officer
The Annenberg/CPB Project
901 E Street
Washington, DC 20004
(202) 879-9641

General

A+ America
Companies sponsored by A+ America have redeemable proofs of purchase on their products which can be converted to A+ points for the purchase of technology equipment for schools.
139 Billerica Road
Chelmsford, MA 01824
(508) 256-9469

BOOKS AND ARTICLES ON THE INTERNET

Ethical Uses of Information Technologies in Education, by Jay P. Sivin and Ellen P. Bialo (1992) Washington, D.C.: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. To order, write: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Washington, DC 20531, or call 800-851-3420.

Global Quest: The Internet in the Classroom: Internet Background Information, by the Imaging Technology Branch of the NASA Ames Research Center, 1993, and Distributed by NASA'S Central Operation of Resource for Educators, Lorain County JVS, 15181 Route 58 South, Oberlin, Ohio, 44704, 216-774-1051. This text is directly from the Internet and comes with a video. This is a very concise and detailed resource on networking and includes a list of resources for educators.

Incomplete Guide to the Internet and Other Telecommunications Opportunities Especially for Teachers and Students K-12, NCSA Education Group, 1993. For a hardcopy contact: Chuck Farmer NCSA Education Group, 605 E. Springfield Avenue, Champaign, Ill, 61820.

A Teacher's Guide to Fellowships and Awards, by Karen O'Connor is a guide to fellowships, funding, and award programs throughout the country including information on several programs that are technology-related. For $2.00, order from: State House Bookstore Room 116, State House, Boston, MA 02133

Telecommunications and K-12 Educators: Findings from a National Survey, by Margaret Honey and Andres Henriquez, Center for Technology in Education, Bank Street College of Education, 1993.

"Telecommunications," in *Bread Loaf News* from Middlebury College, Fall/Winter, 1992. Bread Loaf Office, Middlebury College, Middlebury, Vermont 05753-6115.

The Technology Age Classroom by Terence R. Cannings and LeRoy Finkel, Wilsonville, Oregon: Franklin, Beedle, and Associates, 1993.

TERC's Global Laboratory Project
A worldwide network of student scientists studying the environment. Students share the data they collect, develop research plans, conduct collaborative research and publish the results. Access is through EcoNet network.
2067 Massachusetts Avenue
Cambridge, MA 02140
(617) 547-0430

World Classroom
Worldwide network for information in most content areas and teachers can select from wide variety of online projects.
Global Learning Corporation
P.O. Box 201361
Arlington, Tex 76006
(800) 866-4452

TEACHERS AND ADMINISTRATORS ONLINE

BreadNet/International Telecomputing Consortium
Nonprofit corporation helping teachers and students use new information technologies.
1250 24th Street, N.W., Suite 600
Washington, DC 20037
(202) 466-0533
or email: info@itc.org

ATLIS (America Tomorrow Leadership Information Service)
for NASSP members
A network dedicated to education, training, and workforce development with calendar listings, list of services and resources, list of employment opportunities, database on topics related to schools, and bulletin board electronic mail.
(800) 456-8881

INFORMATION RESOURCES

Center for Children and Technology
Informative articles on technology implementation in schools.
96 Morton Street
New York, NY 10014
(212) 807-4200

Consortium for School Networking (COSN)
For information on state and regional networks and the Internet. Organization overseeing the work of National Research and Education Network(NREN) which provides access to electronic information resources for government, industry and the education community.
P.O. Box 65193
Washington, DC 20035
(202) 466-6296

Educational Technology Center
Informative articles on educational technology.
Harvard Graduate School of Education
Nichols House, Appian Way
Cambridge, MA 02138
(617) 495-9373

International Council for Computers in Education
1787 Agate Street
University of Oregon
Eugene, OR 97403
(503) 686-4414

Internet Society
The international society of Internet cooperation and coordination.
1895 Preston White Drive, Suite 100
Reston, VA 22091
(703) 620-8990

MCET (Massachusetts Corporation for Educational Telecommunications)
Direct resource for Massachusetts.
38 Sidney Street
Cambridge, MA 02139
(617) 621-0290

ALTERNATIVE ASSESSMENT AND TECHNOLOGY

Northwest Regional Educational Laboratory
A Database and Catalog of Alternative Assessments for MS-DOS a nd Macintosh sytems
Marketing Office
101 SW Main Street, Suite 500
Portland, OR 97204-3297

National Center for Research on Evaluation, Standards and Student Testing (CRESST)
Alternative Assessement in Practice Database
on disk in Macintosh Hypercard
CRESST UCLA Graduate School of Education
405 Hilgard Avenue
Los Angeles, CA 90024-1522
(These databases can be downloaded from both organizations at no cost on Gopher:
NWERL's Filemaker Pro version at gopher.nwrel.org
CRESST's HyperCard version at gopher.cse.ucla.edu)

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TELECOMMUNICATIONS TERMINOLOGY

Bulletin board. A computerized forum that allows network users to ask questions, offer ideas, and receive feedback from other network users. Often organized around a topic of common interest.

Conferencing. Online "meeting" of a designated group of people to discuss a topic of common interest.

Database. A collection of information organized to allow users to search and retrieve contents that interest them.

Download. To use telecommunications software and a modem to copy a file of information through a network for use at a local computer.

Electronic mail (email). Messages sent through a communications network from one computer user or group to another.

File server. A computer used primarily to store files and provide network users with access to those files.

FTP (file transfer protocol). A protocol allowing a user linked to one Internet host to access and transfer files from another host over a network.

Gateway. A computer that connects two or more networks using different protocols or allows incompatible applications to communicate. Also used in a general sense to refer to providing direct access to other remote networks or services.

Gopher. Client/server software developed at the University of Minnesota to provide flexible access to resources such as databases available via the Internet.

Internet. The international network of networks based on the TCP/IP protocol.

Local area network (LAN). A group of computers linked together within a limited physical space, usually to share printers, software, and the like.

Modem. A device that enables computers to communicate over telephone lines.

Network. A group of computers that can communicate electronically.

Node. A single computer within a network.

NREN (National Research and Education Network). A proposed "electronic information highway" or national networking infrastructure that will support communication across the scientific, government, defense, business, academic, library, and K-12 communities.

Protocol. The rules governing network interaction; used to determine where, when, how, and in what format information is transmitted.

Telnet. An Internet protocol enabling a user at one site to gain access to the commands and programs of a host at another site; also refers to the program that allows this remote login.

Upload. To use telecommunications software and a modem to transfer files from a local computer through a network to another computer.

Wide area network (WAN). A long-distance computer network that enables computers not physically linked to communicate with each other through telecommunications.

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Journals Related to Technology in Education

This list is not exhaustive. Libraries will have current subscription addresses.

Computers and Composition
Computers and Education
Computer Education
Computing Teacher
Computers in Schools
Educational Technology
EduCom Review
Edutopia: Newsletter of the George Lucas Educational Foundation
Electronic Learning
Electronic School
Journal of Computer-Based Instruction
Journal of Computers in Mathematics and Science Teaching
Journal of Educational Computing Research
Technological Horizons in Education Journal (T.H.E. Journal)
Technology and Learning
The Writing Notebook Journal