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ABSTRACT

This special report's feature article, "The Global Classroom," focuses on the ways the Internet makes the global classroom possible by allowing children to communicate with others around the world. To facilitate use of the Internet, the Northwest Regional Laboratory (NWREL) has plugged into the network and will be offering guidance for users and a "gopher" to find Internet resources. Several case studies are presented of children's use of the Internet in the northwestern United States. The enormous potential of computers for education is beginning to be realized in the area. Other articles in this issue include: (1) "K-12 Educators and Students Trade Information on Electronic Bulletin Boards" (derived from the "ERIC Review," Winter 1993); (2) "Linking N.W. Schools to the Internet" (Lee Sherman Caudell); (3) "Telecommunications Terminology" (derived from the "ERIC Review," Winter 1993); (4) "Learning Physics in Bits and Bytes"; and (5) "Out Front in the Outback" (Tony Kneidek). (SLD)

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The Global Classroom

by Lee Sherman Caudell

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THE GLOBAL CLASSROOM

SCHOOLS ALL OVER THE NORTHWEST ARE PLUGGING INTO THE INTERNET, A WORLDWIDE COMPUTER NETWORK THAT OPENS THE DOOR TO INTERNATIONAL COMMUNICATION AND COLLABORATION

By LEE SHERMAN CAUDELL

"Telecommunications offers wonderful possibilities for learning, for it opens up the world of people, places, and ideas to students."

—Gwen Solomon
Phi Delta Kappan, December 1992

The global classroom is coming. It won't be long till kids in Kalispell will be chatting with kids in Katmandu. Kids in Molalla will be sharing data with kids in Mozambique. Kids in Seattle will be collaborating with kids in Soweto.

In some Northwest schools, the global classroom already has arrived. Aaron DeBord, a seventh-grader at Portland's Sellwood Middle School, is nonchalant about his online Canadian and British acquaintances. A budding computer wizard, Aaron is a student in Eric Bergmark's advanced computer applications class, which brings kids in at a gallop and keeps them riveted, often into their lunch hour.

"They're realizing that all the information in the world is out there," says Bergmark. "They can go online and pull down high-level information to put into a report. They can interview experts. They can access university libraries. They can converse in foreign languages."

The global classroom is possible because of a vast, rapidly expanding network called the Internet, which links millions of computers around the globe. Because the Internet lets all kinds of computers, from Macintoshes to IBM PCs, "talk" to each other, anybody with a computer, a modem, a phone line, and a network connection can plug in. And once you're plugged in, the whole world sits down beside you. The "Net" lets you send and receive messages (email), participate in discussions (computer conferencing), and send or receive data (file transfer), all without picking up the phone, getting in the car, or posting a letter.

In the classroom, the Net has the power to transform the way kids learn and teachers teach.

"The teacher no longer is the font of all wisdom," says Bergmark. "This is a true opportunity to be the guide on the side instead of the sage on the stage."

Vice President Al Gore, long a champion of technology and the sponsor of the High Performance Computing Act of 1991, last month challenged the communications industry to connect every American classroom to the so-called "information superhighway" by the year 2000. But several Northwest states are already on their way to universal Internet connections for teachers and students. Oregon, Washington, and Alaska all have kicked off statewide plans to connect every school to the Internet. In Montana and Idaho, the state education departments are looking into full Internet access for schools, according to department officials. Statewide Net

SPECIAL REPORT: ONLINE FOR LEARNING

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connections in Idaho schools got a big boost in January when Governor Cecil Andrus called on the Legislature to spend $7 million to hook schools up. (See Page 6 for a rundown on Internet plans and progress in each of the five Northwest states.)

Recently equipped with a Unix computer—the "gateway" to the Internet—the Northwest Regional Educational Laboratory (NWREL) has plugged into the network through NorthWestNet, a regional network serving education, government, and business in Alaska, Idaho, Montana, North Dakota, Oregon, and Washington. The Northwest Lab, in collaboration with the nation's nine other regional educational laboratories, is working to give educators access to up-to-the-minute research through state and regional networks. With support from the U.S. Department of Education's Office of Educational Research and Improvement, NWREL soon will be able to make studies, reports, databases, and other materials from the labs and educational research centers available online to schools throughout the region. To make those materials easier to find, NWREL will offer an Internet "Gopher"—a quick, convenient method of using menus to browse through online resources. And in a pilot project with five schools around the region, the Laboratory's Northwest Consortium for Mathematics and Science Teaching (CMAST) is testing the potential of networking to provide useful math and science information online and to assist educators in their quest for better curriculum.

"The laboratories' role," says Jan Holznagel, director of NWREL's Technology Program, "is to make sure all schools have access to the information they can use."

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"Computer networks can transform common educational experiences such as class discussions, paper writing, and collaborations with colleagues into exciting and unique projects that involve the interaction of students and teachers from around the world."

—*ERIC Review*, Winter 1993

Around the globe, the information superhighway is being paved with thousands of miles of phone lines, TV cable, satellite signals, and fiberoptic cable. Communications companies tell us that soon we will be working, shopping, playing, and socializing with our fingers on a keyboard and our eyes on a videoscreen. Some experts predict that ink-on-paper communications such as the *Northwest Report* you're holding in your hand will become obsolete. Instead, all such communications will take place online.

Today's students are tomorrow's superhighway travelers. Those who know how to gain access to the information highway will be positioned for leadership and success. Those who don't, won't.

"I believe very strongly that the students we're training today will be using computerized access to information for the rest of their lives—in the college environment and, ultimately, in their jobs," says Janet Murray, librarian at Portland's Wilson High School and a leader in K-12 networking. "If you think about the way we buy groceries or how we diagnose problems with automobiles, it's obvious that computerization is influencing every aspect of our lives."

To help make sure the United States stays out front in the information revolution, the Clinton Administration is leading the push for an advanced National Information Infrastructure, described as "a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips." In this vision, the best schools, teachers, and courses would be available to all students, regardless of geography, resources, or disability.

The leveling power of networking—its ability to erase the differences of location, gender, income, national origin, race, and physical prowess—makes it particularly attractive at a time when educators and policymakers everywhere are struggling with funding inequities and resegregation. On the Internet, a sixth-grade girl in the small Central Oregon town of Fossil could talk online to a European Nobel laureate, just as a 12th-grade boy in the affluent suburban enclave of Lake Oswego could. A poor child attending a rundown inner-city school on the West Coast could access the Library of Congress along with a wealthy child attending an elite prep school on the East Coast. A rural teacher in Montana could chat online with an urban teacher in Alaska. Or New York. Or France.

Whether this vision comes to pass for all Northwest schools will depend, first, on their physical access to the Internet—that is, Are they wired in?—and, second, on their practical access to the Internet—Are they trained to use it effectively?

RESOURCES

For the Internet novice, navigating the Net can be a lot like trying to find your way around an unfamiliar city without a map. You spend a lot of time wandering aimlessly, hoping to stumble on that art museum or famous restaurant you just *know* is out there somewhere. The Internet can be so confounding, in fact, that some users have called it "a savage interface."

The phenomenal growth of interest in the Internet has spawned a big collection of how-to books that guide users through the intricacies of global networking. Joni Rathbun, a teacher from Lincoln County, Oregon, has written *On Line: A Guide to Resources for Oregon Educators Online with COMPASS*, available through Oregon Ed-Net. Here are other titles:

- *The Internet Companion: A Beginner's Guide to Global Networking* by Tracy LaQuey (Addison-Wesley, 1993)
- *The Internet Complete Reference* by Harley Hahn and Rick Stout (Osborne/McGraw Hill, 1994)
- *The Internet Navigator: A New User's Guide to Network Exploration* by Paul A. Gilster (Wiley, 1993)
- *The Internet Passport: NorthWestNet's Guide to Our World Online* by NorthWestNet staff and Jonathan Kochmer (NorthWestNet, 1993)
- *The Whole Internet User's Guide and Catalog* by Ed Krol (O'Reilly & Associates, Inc., 1992)
- *Zen and the Art of the Internet: A Beginner's Guide* by Brendan Kehoe (Englewood Cliff, 1993)

Oregon is among the top six states leading the nation in providing wide networking access to schools, says Tom Cook of the Oregon Department of Education. Under the Oregon scheme, districts are working with their local ESDs to plan and pay for hookups to one of two central nodes installed by the education department with support from an $80,000 federal grant and a membership in the regional network NorthWestNet. Oregon counties already connected include Lane, Washington, Coos, Clackamas, Multnomah, Umatilla, and Linn-Benton, according to Cook. But he warns that unlike using dial-up networks such as COMPASS, administered by Oregon Ed-Net, getting full Internet access will require "a lot more administration" on the part of districts. He worries that Gore's call for universal school access to the information superhighway by 2000 might "set up a level of expectation that can't be met."

"There will be a lot of pressure applied by staff on their districts, and by districts on the states, and by states on the federal government to make this happen," says Cook. "There's just one tremendous amount of work still to do."

The statistics back up Cook's concerns. Nationwide, only 14 percent of public schools used networks in even one classroom in 1992, and only 22 percent possessed a modem—a vital piece of equipment for advanced computer networking—Vice President Gore said in a December speech in Washington, D.C. Gore promised, however, that schools won't be left behind in the nation's rush to get on the information superhighway. Several bills pending in Congress together would authorize $825 million to beef up school technology.

In Washington's Issaquah School District, a parent recently led an effort to bring state-of-the-art communications technology to the district, stretching resources by recruiting students to do much of the labor. Michael

Cynthia Denton, The Russell Country

Bookey of Digital Network Architects, a consultant who designs networks for large companies and small countries, was aghast at the technological void he found in the school district where his daughter was a seventh-grader in 1987.

"It was as if I discovered a primitive tribe in the North Cascades," Bookey says. "They didn't even have phones."

Working with a $3 million bond issue targeted at boosting the district's technological capabilities, Bookey and a volunteer crew of eight students and one teacher built an advanced computer network linking schools to each other and to the community and offering voice mail, email, and Internet access. Today, 125 students manage the network. Bookey calls the process an example of outcomes-based learning. "The students are learning mastery of technology by running one of the largest systems in the Northwest," he notes.

But hardware and lines by themselves won't create the global classroom. Without a road map, Internet neophytes can get lost quickly. Janet Murray at Wilson High School says Internet's complexity will challenge many teachers and students. "I see a great deal of focus on the engineering and stringing of wires," she says, but not enough attention on content, on training, and on making the Internet more user-friendly.

"What we see are some highly motivated folks who have connected to the Internet by conquering the intricacies of operating a Unix network," says Murray, "but those folks are not universally available in schools. There's a tremendous concern that the National Information Infrastructure will be a network of 'haves,' and there will be a significant number of schools excluded unless we figure out a way to make it readily accessible to normal bright folks, as opposed to Unix hackers."

A number of efforts are under way to help make the Internet more accessible to students and teachers. The 10 regional educational laboratories, for example, are pilot testing user-friendly interface software such as Panda and The Guide, as well as developing additional tools.

The labs also are collaborating to devise easy-to-use Gopher menus, and they are structuring laboratory databases for easy searching.

In Montana, the grass-roots network Big Sky Telegraph recently won an $880,000 grant from the Annenberg/CPB Math and Science Project and the US West Foundation to fund a large-scale networking training project, "Reach for the Sky." The two-and-a-half year project will train teams of rural teachers to use and design "telecurriculum" for math and science instruction, emphasizing collaborative student projects where students collect real data, work in groups to analyze data, share data with other groups nationally and internationally, and collaborate on written reports. The participating teachers then will mentor other teachers in networking strategies. The telecurricular materials will be available via the Internet to teachers nationwide through a national clearinghouse, which will be based at Big Sky and will offer online mentoring and skill development. The project builds upon and complements NWREL's SMART project (Science and Mathematics Academies for Rural Teachers) and Northwest CMAST's networking pilot projects.

"Students will be mirroring the types of activities that real mathematicians and scientists do—collect, share, and analyze data and collaborate in writing up reports based on the data," notes Cynthia Denton, project director.

Denton also runs a local bulletin board called The Russell Country, which gives users in the rural community of Hobson access to Native American art, agricultural conferences, regional products, and a variety of educational resources.

One easy way for educators to access the Internet without a lot of know-how is through K12Net, an international "network with training wheels," in the words of the network's cofounder, Janet Murray. Through K12Net (available on the Internet as a collection of Usenet newsgroups or on the worldwide FidoNet network), teachers and students can converse online with their counterparts in more than 20 countries and can choose among 37 subject areas, ranging from math to music, science to Spanish. Here are some examples of exchanges and projects that happen on K12Net as described in *Communications of the ACM* in August 1993:

- After a toilet-flushing experiment to study the effect of the earth's rotation, a student from New Zealand concluded that water drains clockwise in the southern hemisphere and counterclockwise in the northern hemisphere. An Australian student scoffed at the experiment ("What earth-shattering research!"), but a correspondent at the University of Colorado in Boulder described the Coriolis force in detail and told the student how to set up a scientifically verifiable experiment.
- High school physics students in Oregon, California, Nova Scotia, and Maryland attempted to replicate the ancient Greek astronomer Eratosthenes' experiment to calculate the size of the earth by measuring the length of a shadow cast by a stick at noon on three successive Mondays. The students posted their data and performed their calculations on the "Physics Challenge" channel. Their calculations were accurate to within 7 percent, according to Murray.
- Students participating in the Global Village News project contribute local news items and analyze them for local and regional differences in news reporting.
- "Math Magic" presents students in grades one through eight with challenging problems that can be solved with more than one strategy and may yield more than one solution. Kids post and compare their solutions on the network.
- Among Portland high schoolers, Murray says, the most popular K12Net opportunities are cross-cultural language exchanges. Students trade messages with German, French, Japanese, Spanish, and Russian students.

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"Generating the kind of student enthusiasm usually reserved for Nintendo games, global interaction in the virtual school arouses curiosity, bonds cultures, and invites new directions for education and, perhaps, for civilization as a whole."

—Harry Noden and Barbara Moss
The Reading Teacher
October 1993

As educators steer their students onto the information superhighway, they face the danger of "letting the technological tail wag the pedagogical dog," in the words of Thomas Callister and Faith Dunn, writing in *Phi Delta Kappan* magazine in December 1992. Advanced technologies can dazzle well-intentioned users, the writers warn, blinding them to the learning goals that should drive all instruction.

"Machines are tools, valuable only when a human intelligence organizes their use in a productive way," the authors note. "In the classroom, that human is a teacher, who controls the nature of the environment and what happens there. Good classroom tools extend the teacher's power by creating a rich learning environment. If the teacher does not know what to make of the tool, or fears it, or misconstrues its uses, it will be used badly or not at all. If the teacher perceives the machine as a master, not as a servant, its potential will never be realized."


Janet Murray, Wilson High School

For a number of educators and students here in the Northwest, the enormous potential of computer networking for meeting curricular goals, encouraging creative thinking, and fostering collaborative learning already is being realized. In January, for example, two virtual wagontrains took off across K12Net carrying kids from 23 widely scattered classrooms on an online journey down the Oregon Trail. In this classroom-to-classroom project, developed by Joni Rathbun and Barb Fowler of Oceanlake Elementary School in Newport, Oregon, students from Idaho, Oregon, Washington, North Dakota, New York, Massachusetts, North Carolina, and Taiwan are traveling together from St. Joseph, Missouri, to the Willamette Valley, having taken on the identities of actual pioneer families. Along the way, the pioneers will record their experiences in journals, discuss the impact of pioneers on Native Americans, write letters to the folks back home, weigh the pros and cons of taking a shortcut in the face of dwindling supplies, deal with tragic deaths and serious illnesses, stop over at the Whitman mission, and debate the relative costs and dangers of taking the Columbia River versus the Barlow Trail to the Willamette Valley.

Students at Henkle Middle School in Washington's White Salmon Valley School District may soon follow the 1,100-mile Iditarod online, says district technology coordinator Jeannie Milnes. Each year, students schoolwide follow the progress of the annual Alaskan dogsled race, learning lessons in geography, science, math, reading, and writing along the way. In the past, local dogsled teams have visited the school, and students have had occasional phone access to a staff member's husband, who is an Iditarod participant. Now, with districtwide Internet access, Milnes is looking into giving the students real-time access to the race, including the ability to download (send via computer) photos of the mushers and dogs for students to use in reports. Milnes is also exploring another online opportunity for White Salmon students offered through the World Forum, a project of the Interactive Communications and Simula-

tions (ICS) program of the University of Michigan School of Education. Through telecommunications, participating students will be in contact with an international group of explorers and scientists who will cross the Arctic Ocean from Russia to Canada via the North Pole, traveling by dogsleds and specially designed canoe sleds.

At Sexton Mountain Elementary School in Oregon's Beaverton School District, fifth- and sixth-graders in Patrick Webb's class recently collaborated with students in West Virginia to study and compare the birth weights of newborns across two communities. Using actual birth-weight data collected from local hospitals, the students learned the mathematical concepts of mean and average. They practiced metric conversions. They created graphs and charts. And they discussed the relationship of birth weights to socioeconomic differences between the two communities.

With the power to shrink the world and expand it simultaneously, the information superhighway is the road to the future for today's students. Janet Murray's vision of that future—and of the Internet's role in it—transcends the discrete projects, individual children, and particular teachers that make up the global classroom.

"My dream," she says, "is that if we get kids in the United States talking to kids in Russia talking to kids in South Africa talking to kids in Taiwan, simply the existence of those personal connections or friendships will overcome some of the prejudice and the bigotry that confounds international politics today.

"That," she says, "is the big, ...listic dream."

K-12 EDUCATORS AND STUDENTS TRADE INFORMATION ON ELECTRONIC BULLETIN BOARDS

"And I said, with my net I can get them I bet.
I bet, with my net, I can get those Things yet!"

—The Cat in the Hat

Through computer networking, educators and students can communicate with colleagues around the state, around the nation, and around the planet on local "bulletin boards"—the electronic equivalent of cork boards, where users can post and read messages on a wide range of topics. More than 25,000 of these local bulletin boards cooperate to form a free global network, FidoNet, which provides local users with access to others around the globe. K12Net, a computer network for elementary and secondary teachers and students, uses FidoNet for its networking connections. FrEdMail, a network dedicated solely to K-12 education, is also based on connecting locally controlled bulletin boards operated at universities, district, or county education agencies, and even local schools.

Here's a quick look at these and other network services available to K-12 educators:

K12Net

Cofounded by librarian Janet Murray of Portland's Wilson High School, K12Net links 550 bulletin boards in more than 20 countries through "echo forums" in 37 curriculum areas. With just a local phone call, users can send messages that will be "echoed" to users around the globe. This way, educators and students interested in topics ranging from performing arts to Russian can communicate and work cooperatively with other interested individuals from Israel to New Zealand.

K12Net is open to anyone with access to a local bulletin board. Access to K12Net is through FidoNet, a free, general-interest computer network that joins bulletin boards in more than 50 countries. While it is possible to send email from FidoNet to the Internet (and vice versa), FidoNet reaches many places where the Internet does not. There is no charge for using the network; a computer, modem, and telephone connection to a local bulletin board are all that you need.

To find the telephone numbers of active bulletin boards in your region, call a local computer store or your public library.

FrEdMail

Launched in 1986, FrEdMail (Free Educational Electronic Mail Network) links more than 150 electronic bulletin boards (called electronic mail centers) operated by individuals and institutions. Each bulletin board represents a "node" on the system and delivers Internet email to as many as 300 teachers and students.

In 1991, more than 5,000 teachers and their students participated in such FrEdMail projects as "Acid Rain," for which students from around the country collected rain samples, plotted national data, and shared research, conclusions, and essays on the causes and effects of acid rain, and "Experts Speak," which involved one group of students assuming the personalities of various historical figures and another group interviewing them to determine their identities.

Usenet

Usenet is a large, global network originally created to connect computers using the Unix operating system. One of the major activities on Usenet is Netnews, a system of discussion groups that allows users to discuss topics as diverse as genetic engineering and windsurfing. Between 1984 and 1989, Usenet grew from 2,000 connected sites and 150 newsgroups to 15,000 sites and one-half million users. Usenet can be accessed through many Internet, campus, and local bulletin board systems. Usenet's widespread availability and range of options make it highly relevant for educators and students. A word of caution, however: Educators should monitor their students' access because some newsgroups are not suitable for minors.

KIDSPHERE

Formerly called KIDSNET, KIDSPHERE is an international discussion group for teachers and others interested in networking for children and education. Participants discuss general questions about computer networking, user interfaces, and specific projects that link teachers and students using the Internet.

Primary source: ERIC Review, *U.S. Department of Education, OERI, Educational Resources Information Center, Volume 2, Issue 3, Winter 1993.*

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 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.

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 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.

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.

Source: ERIC Review, *U.S. Department of Education, OERI, Educational Resources Information Center. Winter 1993.*

Learning Physics In Bits and Bytes

At Catlin Gabel School, a private school in Portland, physics teacher Lowell Herr is using state-of-the-art technology to teach principles such as motion, forces, sound, light, and magnetism. Students generate raw data and instant visual representations through real-time computer experiments. Funding to equip the laboratories has come from the M.J. Murdock Charitable Trust, Tektronix, and the Oregon Community Foundation.

A "sysop" (system operator) for two K-12 bulletin boards, Herr also conducts yearly summer workshops on computerized physics labs for teachers from around the country. Below, Herr talks with *Northwest Report* editor Lee Sherman Caudell about using computers and networking for instruction and professional development.

Q: Will you describe how you're using computers to teach physics?

Herr: We're using them primarily for data collection—what we call real-time data collection with motion detectors, force probes, light probes, magnetic fields, smart pulleys, and things like that. We're actually collecting data for events that happen so fast, you can't do it any other way. And in some cases, we can see the information plotted right on the screen while, let's say, a student is moving around in a classroom. Or we're pushing and pulling on a force probe, and we can see that plotted real-time. In others, the information comes in very, very fast. We can't even plot it out fast enough, but we can record the data and then we go back and look at that data and put it into spreadsheets and analyze it and develop mathematical equations. We also do curve fitting. So you can do things like free-fall and accelerating beaded chains, things like that you just couldn't do a couple of years ago.

Q: How did you teach those kinds of concepts before you had this capability?

Herr: We couldn't do it. I had no way to capture the data. For example, I can take a force probe now and push and pull where the force changes, but if you look at a high school physics text, or even an introductory college physics text, the force problems are always based on constant force. You don't have problems where the force is changing. In nature, it's rare that a force stays constant. With computers, we can have gliders colliding with other gliders, and we can actually plot out and look at that changing force. We can examine what happened. And we can find slopes of lines which we used to do in a laborious fashion. I can integrate, take areas under a curve. We used to cut out pieces of paper and mass them on balances and compare them with known masses of known value. Really antiquated methods—you know, counting squares under a curve on graph paper. Now I just do that with moving a cursor right over the screen and selecting my points and there it is.

Q: What is the system you use, and how long have you been using it?

Herr: It's called Microcomputer Based Laboratories (MBL), and I started working with this at Tufts University in 1987. Twenty

TONY KNEIDEK

Catlin Gabel physics teacher Lowell Herr confers with a student about an experiment

of us piloted some of the very first force probes and motion detectors with Ron Thornton, a physics teacher at Tufts, and David Sokoloff, a physics prof at the University of Oregon. That was really crude material. And then they invited us back again to do more work in '88.

Q: I assume you're hooked into the Internet with this?

Herr: Yes.

Q: Are you doing collaborative projects with other schools?

Herr. I have done some. Last fall, two teachers up here in Oregon combined with a teacher in Southern California to measure the circumference of the earth. We did that through networking. I communicate with about three or four hundred teachers, college teachers mainly, on Internet and we discuss a variety of physics questions. So if I have a problem that comes up in my classroom, I just walk over to the terminal, dial up, and I have access to three to four hundred teachers.

Q: Is it a bulletin board?

Herr: It's what's called a listserv. It's a bit like a bulletin board. When I type a message, it goes out to everyone who's signed up. It's called Phys-L.

Q: It's specifically for physics teachers?

Herr: Yes, it's specific for physics. And then there's a Phys-Share. I belong to two of them. One of them has its origins in Pennsylvania, and the other one is housed in Florida.

Q: Can you give an example of something that you would discuss with people on the network?

Herr: I recall I was working on an experiment on a linear air track, and I wanted a glider with

a magnet on it to float by a very strong magnet, so as the glider went by, the glider would slow down, but then as it passed, it would be kicked out again and it would speed up. And I wanted to graph this motion out. And I was having trouble setting this up so that I could get it to work. So I described the question on Phys-L, put it out one afternoon. Answers as to how to set this up started coming back that afternoon almost immediately. I tried some of those and they didn't work. Then, next morning I came in, logged on again, and there one fellow had the answer that worked.

Q: What would you have done in the past if you hadn't had that resource?

Herr: If I had a physics question, I would call a couple of professors at Reed [College] that I know. And you feel that in a way you're infringing on their time. Many times they would be in class, and I would have to leave a message. And I only could do that because I know them. Now I have access to all these people.

Q: So the network is a resource for you as well as for your students?

Herr: That's right. Many times, when an answer comes back that I think is appropriate, I forward it to my students so they all get that answer directly. They have the Internet address of that physics teacher, so if they have a follow-up question, they can send a letter directly to that individual and ask more questions.

Q: Do students actually take advantage of that?

Herr: To some degree, yes. I'm also involved in a project called Student Watershed Research Project. We're examining the Tualatin River Basin where the teachers and students go out into the field and gather water samples and then they come back and do a lot of chemistry on that water sample, enter it into a database, and then that's uploaded onto a server that I run here in the back room. And there's an "Ask an Expert" resource where the students can ask experts questions. There's a group of people who have pledged to check in to the network regularly and answer student questions.

Q: Technology advocates argue that one of the advantages of computer networking is that it promotes cooperative learning and student initiative and changes the role of the teacher to more of a mentor than a lecturer. Do you find that that's true?

Herr: I'm not sure if it's really made that change yet. Where I see the advantages here with the computers and the network is that they have dramatically changed the kinds of labs that we do. Students are in contact with other students to a degree, but there's not very many high schools that are on the Internet yet. I have a network of about 20 to 40 teachers that I network with. And we communicate with each other, sharing new ideas in teaching, sharing labs. I have some dreams that I'm hoping to bring off within a year where we actually have an Internet site here for teachers to telnet into and get access to labs that we're developing for a summer workshop. We're hoping to get funding from the Murdock Trust to do that. We have a grant in to them now that will allow us to make that possible.

Q: Looking down the road, do you see the possibility that your students may be networking with students in other countries?

Herr: Yeah, very possibly. I just came back from a physics meeting, and while I was gone, one of the assignments my kids had was to develop a physics newspaper. I have a friend in New York state whose students do this. We're going to ftp [file transfer protocol] this material, back to his school. And then his students can take this information, integrate it into their paper, and his kids are going to add articles, and they'll then ftp that material back out to us. We want to put together a joint newspaper taking the best from both schools. We would like to have other schools join in so the students will share information back and forth. And we can send this, including the pictures. This fellow is in an experimental program with IBM where his school and an adjacent school are connected up with fiberoptics and the students are actually working at the two different schools on the same spreadsheet. They'll see the same spreadsheet and they're sending video back and forth that they actually can see.

Q: Simultaneously?

Herr: Simultaneous, that's right. Real live connections. And he wanted us to be the other site, so we could work together across the country. We have the fiberoptics into our building to do it, but he doesn't know if IBM has the fiberoptics from Yorktown into Portland. That's what we need—the fiberoptics across the country, or to send it by satellite. But that's something that's coming. He said sending files like this will be a piece of cake.

Q: One criticism of computer use in schools is that sometimes educators let the technology drive the curriculum instead of vice versa. How do you ensure that you're using technology to meet curriculum goals?

Herr: I know what I want to do in a physics course. Anytime I take anything out of the program, it's not supplanted because there's some new technology. It has to have good pedagogical reasons for being put back into the curriculum. There's a lot of evidence that the work I'm doing with the MBL has good pedagogical reasons for being introduced. It helps students overcome misconceptions they bring to the classroom. And that's why I'm doing it.

Q: One misgiving some people have about the Internet is that there is some material on it that wouldn't be appropriate for kids to have access to. Do you worry about that? How do you deal with that?

Herr: We block that from coming into our school. The problem is, you can't block the kids from telnetting out to other institutions who don't have that same kind of ethic and the kids can get access to, say, the porno humor that's out there. It's a problem.

Out Front In the Outback

Students in remote Saco, Montana, are on the cutting edge of the information revolution with access to the latest telecommunications technology

By Tony Kneidek

Don't look for students in Saco, Montana, to be fumbling around with scads of notebooks or reams of paper as they make their way through the halls of their K-12 school buildings.

What the district's 148 students are more likely to be toting are disk-carrying cases to keep track of the class work, correspondence, assignments, and other information they generate on one of the scores of computers in the rural district. "There is a greater number of students at Saco carrying disks than notebooks," says Superintendent Carl Knudsen. "Our system is used extensively."

That system boasts about as many computers as students in the remote northern Montana district, where bus routes range from 96 to 132 miles a day to get children to school. And the system has grown by megabytes in the past six years. But how does a community of 200 people located in northern Montana's "mosquito-infested flats between Malta and Glasgow" develop a state-of-the-art computer network that has been recognized as one of the most innovative classroom technology systems nationwide?

First, says Knudsen, you develop a districtwide focus on computers for student learning and build support among board members and school staff. "In Saco," he says, "the school board and staff are committed to providing opportunities for students so they can succeed in any area they pursue. This gives them those opportunities."

But commitment alone will not get the job done, and the money for such a sophisticated system is not easy to come by. The next step, Knudsen says, is to apply for grants to purchase and update computer/technology systems. "In the last six years, we've gotten more than $1 million in grants," Knudsen says, adding that he and others were working on another three-year, $375,000 grant proposal to further enhance computer technology.

The focus of all the efforts, Knudsen adds, must remain on student achievement. And he is firmly convinced that the computer technology in his district has enhanced student learning, increased student enthusiasm about school, and laid the foundation for postsecondary education and lifelong learning after high school graduation.

In the last five years, Knudsen notes, composite ACT scores for seniors have increased from 16.6 to 19.6. Similarly, PSAT scores for juniors have gone from 14 to 19. The increases correspond to the implementation of the computer technology program in the schools. "Just four years ago," Knudsen notes, "the staff and school board adopted a goal to have keyboard literacy by the sixth grade. Now, we've moved that to the second grade. We think that the excitement for technology and for students to succeed has increased student focus on school and life after school. This has helped students become more focused sooner on their school careers."

The technology also has opened avenues for students to participate in other activities in the school and community. For example, students raise money by teaching community education classes in computer use. They also researched and wrote grant proposals that resulted in $6,000 in awards for a student youth center in town, then used a computer program to redesign the old vacant building that serves as the youth center. Other spin-offs of the project include student-led construction teams, student-inspired interior designs, and student-scrounged furnishings.

"This technology has helped students to improve not only their own education, but their school and community as well," Knudsen says. "The greatest benefit of all this technology is the students' ability to take advantage of it and use it."

Students, too, recognize that their school is unique in its technology offerings. Those who go on to higher education often report that colleges and universities have less sophisticated systems than the Saco district. "It's a great opportunity for us at Saco," says Shyla Taylor, a senior at the high school. "Access to all this technology puts us ahead of other high schools and many colleges."

Taylor, president of the Montana Chapter of the Technology Student Association, also works with elementary students to hone their computer skills. Such activities helped Taylor clarify her career goals. "I didn't really know what I wanted to do when I started my junior year," Taylor says. "But by working with kids and technology, it became clear to me." Next year, Taylor will attend Montana State University in Bozeman and major in elementary education with a minor in technology.

Saco's use of computers and technology stretches beyond the classroom and the local community as well. "We have more than 100 computers networked and all of our students are on email," Knudsen says. "We even have some students who are interacting with students in other parts of the country."

In Saco schools, all classrooms have at least two computers, and elementary classrooms are equipped with two IBMs, two Apples, and a Macintosh, Knudsen says. This year, the district has installed its fourth computer laboratory for student use. The school libraries also are networked so that students can determine from their classroom or lab workstations if a book is on file, available, or checked out.

Students also have computer access to the Western Library Network, which links them to materials in libraries throughout the Western United States. *National Geographic*, articles from the *Readers' Guide to Periodical Literature*, and other publications, articles, and research also are available from individual workstations. Students also can learn about colleges, universities, and vocational schools with the assistance of the ACT Discover Guidance software. The program includes interest inventories that help students identify strengths early on and prepare them for future education or training.

All classrooms also are equipped with a telephone and 27-inch television monitor that allows teachers to retrieve information available on 14 VCRs and

laser players in the library. Telecommunications also are common in Saco schools. Students in first through sixth grades can take Spanish lessons transmitted from Northern Arizona University in Flagstaff. Middle and high school students have a choice of Spanish, French, Russian, or Japanese offered through Star Schools, an interactive telecommunications program originating in Spokane, Washington. In addition, *Discover* and *CNN Newsroom* are available via the Saco schools through satellite dishes. (The district will demonstrate its technological offerings April 20-22 at the tech prep conference in Seattle.)

Implementation of state-of-the-art technology did not occur overnight in Saco. The district started with a computer grading and attendance system. "We provided a lot of training and, ultimately, a computer in every classroom so teachers could access them," Knudsen says. "They began by doing grades and attendance from their rooms."

Teachers attended six days of training in the first year. "Initially, we provided the extra training and we provided encouragement," Knudsen says. "For the foot-draggers, we pushed and pulled. Finally, after three years, we said, 'We will be doing this. It's time to get on the train or be left in the station.' Everyone now is on the train."

But the need for training does not end once the technology system is in place. In Saco, substitutes cover teachers' classrooms during ongoing training. "We have training sessions routinely once a month to upgrade skills on software," Knudsen says.

Saco schools must prepare dents to work in a world that is undergoing rapid technological changes. About 95 percent of Saco's graduates go on to college or vocational school, and about 80 percent of those complete their postsecondary education or training. Most do not return to live in Saco. "We're quite sparse and rural," Knudsen says. "There's not a lot of opportunity for students to come back unless they're taking over a family business or working on the farm."

Seven years ago, the school board, administration, and staff at Saco decided to "get into the computer age." Now, Knudsen says, it's important to bring the computer age to the rest of the community. "We're in the process of securing some laptops so students and parents can access our system from home. They'll be able to use our library, do regional searches throughout Northwest libraries, and get other information. Access is a real important part of the system we've built here."

Saco School District's technology program is not exactly a well-kept secret. It has been recognized as an outstanding program by the state of Montana and was one of just six schools in the nation recognized for its innovative use of technology in the classroom by *Redbook* magazine. Representatives from more than 70 other schools have visited Saco to glean information about the computer technology program there.

The district also is the telecommunications center for the Hi-Line Educational Administrative Region in Montana, and hosts the EDUNET Interactive Educational Telecommunications system, as well as a local node for the Montana Educational Telecommunications Network (METNET) and email. NWREL is assisting Saco School District with bridging the EDUNET and METNET systems.

This spring, Saco schools will serve as a demonstration site for FOCUS, a fiberoptic system that unites schools. Knudsen anticipates that up to 50 schools will participate in the demonstration.

DWIGHT FREEMAN

Shyla Taylor, a senior at Saco High School, works with second-graders Zack Mandeville and Kaylee Weyrauch on the IBM Network using the program "Patterns and Blocks."

FLASHBACK

Educational Technology—Managers of statewide and other K-12 educational networks in the Northwest recently met at NWREL to discuss educational telecommunications applications in the region. Topics included paths of Internet connectivity, regional directory design, plans for state and regional Gophers, pilot tests for user interfaces, and strategies for data transmission, collection, and analysis among schools, districts, and states. Pictured are: (back row, from left) Don Holznagel, NWREL; Tony Naughtin, NorthWestNet; Bob Morris, METNET, Montana; Frank Odasz, Big Sky Telegraph, Montana; Bob Pyle, Idaho Public Television; Don Laurance, Washington OSPI; (front row, from left) Nancy Jesuale, Oregon ED-NET; Cynthia Denton, The Russell Country Bulletin Board System, Montana; and Tom Cook, Oregon Department of Education.

Early Childhood—Betty Keltner (left) of Civitan International, University of Alabama, Birmingham, and Kendra Hughes of Albina Head Start in Portland met at NWREL in January as part of a site visit for the Albina Head Start/Portland Public Schools Transition Project. Portland is one of 32 sites nationwide participating in the National Head Start Transition Project.

Rural Education—Jose Garcia, migrant education coordinator for the Oregon Department of Education (DOE), and Roberta Hutton, assistant superintendent of the Division of School Improvement at the Oregon DOE, recently participated in a joint meeting of NWREL's Rural Education Advisory Committee and the Rural Curriculum Study Committee. Topics under consideration included state standardization and curriculum renewal strategies for small, rural schools.

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