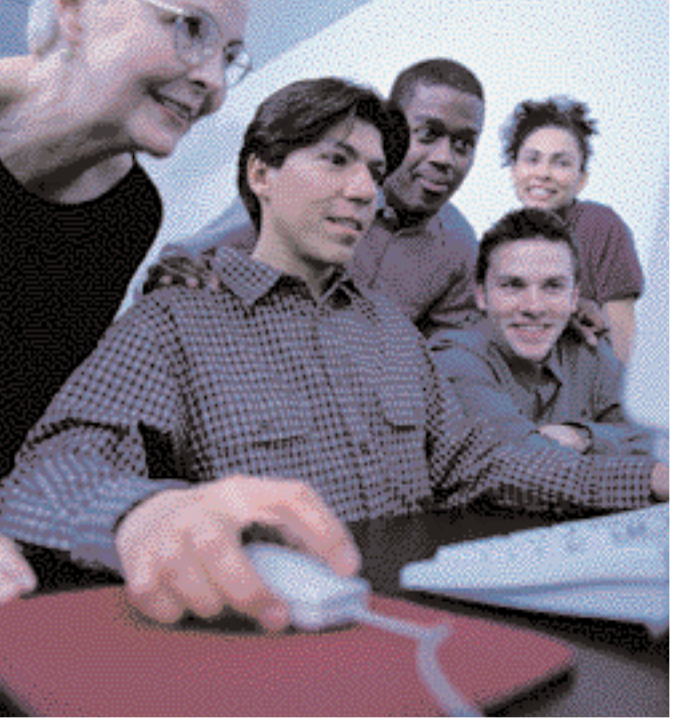

THE DIGITAL CALIFORNIA PROJECT

AN INVITATION TO DREAM

DCP Infrastructure

County, district and school networks access the DCP by establishing high-speed local connections to the nearest node.

DCP Infrastructure

Regional hubs throughout the state, as well as primary and secondary access nodes in each county, form the DCP backbone.

DCP Infrastructure

The DCP connects schools with both the commercial Internet and the high-speed Internet2 consortium of U.S. universities, colleges and R&D partners around the globe.

DCP Infrastructure

By building on the advanced higher-education networks of CalREN-2 and 4CNet, the DCP connects the K–20 community for next-generation collaborations.

High-performance Capabilities

- Bandwidths that are hundreds of times faster than current Internet connections allow the delivery of high-quality, realistic video and audio over the network.
- Videoconferencing, in which participants at several locations are able to see and hear one another in real time, is possible using camera-equipped computers and the high-bandwidth network.
- Collaboration is facilitated through the ability to share documents and to edit, touch and manipulate objects remotely, in real-time, from multiple sites.
- Dramatic improvements in capacity and new Quality of Service safeguards make the transfer of large quantities of data more efficient and reliable.

Dear Citizens of California,

California's schools, colleges, and universities have entered a new era of resource sharing and working together. This document describes how the state's students will benefit from access to a new statewide educational network created by the Digital California Project (DCP). The DCP offers a remarkable new set of technological resources for teaching and learning in California. The DCP combines and strengthens the broadband networks that link the University of California, the California State University and California Community Colleges to the more than 8,500 K–12 schools in the state. This high performance, broadband network will put a wide range of educational resources instantaneously at the fingertips of students and educators. These tools will assist all students in achieving the high standards set for them by the California State Board of Education.

The DCP: An Invitation to Dream describes a vision of how education can be improved and enhanced through the use of DCP's technology resources. The companies that have contributed to the creation of this publication have pledged to support the DCP. Our contributions to this document are tangible proof of that commitment. We congratulate the State of California for its efforts to bring high performance networked resources to students and teachers.

This document is intended to serve as an invitation to Californians to participate in creating technology-rich learning and teaching environments for all. The educational experiences described in it are only a few of the many that the DCP will facilitate. We invite you to read this, think about it and help make it a reality in every California community. Contact your local county office of education or school district and find out how the DCP is being deployed to help your students learn in this new millennium.

Sincerely,

Sue Collins
Apex Learning

David Dwyer
Apple Computer

Jenny House
Classroom Connect

Michael Jay
Branium Technologies

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Bigchalk.com

Lee Wilson
Chancery

Welcome to the Digital California Project

What is the Digital California Project (DCP)?

The Digital California Project: K–12 Statewide Network (DCP) is an initiative proposed by Gov. Gray Davis to provide $31.6 million annually, funded by the State of California, to build and maintain a cohesive and seamless statewide, advanced services network backbone that reaches into each of the state's 58 counties for use by California's K–12 students, teachers and administrators.

What are the goals of the DCP?

DCP has five major goals:

1. To provide a statewide network communications infrastructure for the K–20 systems in California;
2. To facilitate access to rich content resources for teaching and learning in K–12;
3. To create an environment that facilitates collaboration between California's K–12 and higher education communities;
4. To provide a conduit for educators to access Information Age tools and enhance the skills required to use technology effectively in the classroom; and
5. To provide an ongoing mechanism and the technical support required to sustain a cohesive and reliable K–20 statewide education network.

What will the DCP K–12 statewide network look like?

DCP builds on work of the Corporation for Education Network Initiatives in California (CENIC). CENIC's higher education advanced services network, CalREN-2, currently connects more than 40 research and higher education institutions throughout California, including the California Institute of Technology, California State University campuses, Stanford University, University of California, and University of Southern California. Moreover, DCP leverages investments in the inter-connected California State University wide-area network, 4CNet, as well as existing network infrastructures supported by county Offices of Education and local school districts. DCP provides more robust networking capabilities than the commercial Internet and is interconnected with both the commercial Internet and the expanded universe of Internet2—a university-led consortium that shares a high speed network for collaboration and research aimed at building advanced technologies and applications for tomorrow's Internet.

Specifically, the DCP network plan extends the CalREN-2/4CNet infrastructure backbone into all 58 counties in the state by providing regional DCP hub sites strategically located throughout California, as well as primary and secondary access nodes in each county. These county-based access nodes will be positioned to take full advantage of existing county, district and school networks, as well as the telecommunications infrastructure at school sites.

Why do we need an advanced K–12 network?

While today's Internet is widely viewed as an effective means to provide information and a limited array of services to K–12 educators and students, it is insufficient to facilitate the comprehensive sharing of multimedia resources and the delivery of high bandwidth programs and services. DCP represents the first cohesive effort to address the need for connectivity among all segments of education statewide with the advanced networking services necessary to access the rich resources most useful in an educational setting. Furthermore, by leveraging the high performance, advanced services networks of CalREN-2 and 4CNet, DCP will extend the reach of these networks into the K–12 education community throughout the state, facilitating collaboration between the K–12 community and higher education.

What is the timeline for DCP implementation?

The first stage of the network build-out (Round 1), involving installation of the first set of hub and node sites, is underway with approximately half the node sites being installed by December 31, 2001. Round 1 is scheduled for completion by June 30, 2002. The second stage of the network build-out (Round 2) is currently being planned.

Where can I learn more about the DCP?

You can learn more about the DCP at www.cenic.org and about Internet2 at www.Internet2.edu.

To download a pdf version of this publication, visit www.cenic.org/vision.pdf.

DigitalCaliforniaProject
AN INVITATION TO DREAM

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A Look Inside

Technology in the service of better education for all students in California is about to take a significant step forward, with help from the Digital California Project (DCP). The DCP's aim is to create a high-speed infrastructure that links K–12 schools, districts and counties—to one another, to California's higher education community, and to a worldwide, next-generation network known as Internet2.

Some of the elements of the DCP are ones that schools have experienced before. Like the current Internet, it will allow students to communicate with and learn from peers, experts and resources all across the globe. And like the multimedia tools that have been made possible by computers, CD-ROMs and other digital breakthroughs in recent years, it will offer students access to realistic video, sound and interactive elements that can be used to engage and learn.

However, as these two uses of technology—connectivity and multimedia—come together smoothly for the first time, an entirely new world opens up for students, teachers, administrators and community members. The high-performance network offers unprecedented access to a new generation of rich digital resources—and challenges the way we envision the school experience.

Looking Ahead

What might K–12 education, empowered by this new form of connectivity, look like in the next few years? This is the question that we—a group of educational technologists affiliated with software, hardware and online content companies—set out to address in the publication you are now reading. Invited by the Governor's office to provide input, we decided to do so in the form of a vision document for others to respond to and build upon. In addition to drawing on our own experiences, we interviewed a number of innovative educators, from both the K–12 and higher education worlds, about their hopes and ideas. We asked them to reflect on some of the best uses of technology in California schools today, and to dream about what new doors might be opened with access to next-generation Internet capabilities.

As you will see in the pages that follow, we focused our questions on four challenges facing California schools today: How do we help all students meet high academic standards? How do we ensure that students are prepared with lifelong skills that will allow them to be successful learners and leaders in the decades to come? What can we do to recruit and prepare a new generation of teachers and help all educators keep up with a rapidly-changing world? And how can new technology-empowered tools help manage the data analysis and communication challenges that are central to school accountability? In the final pages of this booklet, we also examine pitfalls to avoid and new challenges to anticipate along the way, with some thoughts about possible solutions.

The collective vision we describe here is not ultimately about technology; it is about people—about students, teachers, administrators and community members working together in supportive environments that nurture learning. When used creatively and appropriately, the new technology will be in the background, enabling not driving. It will be harnessed to make a dramatic difference in many areas of education, and bypassed in others, where a "low tech" approach remains preferable.

Nothing in this publication is meant to be a formula or an all-encompassing list of uses. Instead, we offer some scenarios for you to think about, react to, argue with, or build upon. We hope our dreams stir your dreams. We hope we can all build a better future together.

Helping All Students Meet High Standards

With the Public Schools Accountability Act, signed into law in 1999, California set out "to ensure that each child…receives a high quality education consistent with all statewide content and performance standards." These standards, which parallel ones established throughout the country, are just the beginning. It is now up to schools to help every student meet and exceed the ambitious new goals that have been set for them—regardless of socioeconomic background, learning style, or languages spoken at home.

How can the next generation of high-performance, network-delivered technology help?

Multifaceted Learning

Successful teachers generally use a wide variety of approaches and materials to meet the diverse learning needs of their students. One middle-grade student, for example, might come to an understanding of graphing equations by using pencil and paper to plot data points from a real-world experiment. Another might need to experiment with a computerized graphing tool, manipulating the graph's shape and observing how the accompanying equation changes. Still other students will have "aha" experiences only after watching narrated videos illustrating real-world applications of equations.

An example of a program that has been using technology for several years to help facilitate such a multifaceted approach is the TEAMS Distance Learning (DL) project from the Los Angeles County Office of Education (LACOE). TEAMS DL features televised and videotaped shows, in several subject areas, for both professional development and student use. To reinforce the concepts introduced in the videos, students work with manipulatives, engage in group problem-solving activities, and visit a Web site featuring brainteasers, resource links and interactive activities.

LACOE has recently begun adapting TEAMS DL lessons to take advantage of DCP capabilities. Program manager Marilynn Fong sees tremendous potential in merging the video and Web materials into a single digital product that will allow participants to flexibly navigate between video and interactive activities, treating them as a virtual "think lab." Although LACOE has no immediate plans to incorporate videoconferencing into TEAMS DL, one can imagine ways in which it could play an important role in the future. For example, the TEAMS videos now encourage classes to pause the action at a number of points in order to try out various problem-solving challenges. With live broadcasts and DCP technology, it would be possible for a moderator to lead a discussion with participating classes, zooming in on different classrooms so students could demonstrate their solutions for others to see.

Virtual Labs and Classes

Ron Bergmann, program director for the California State University Virtual Learning Lab Project, is equally enthusiastic about the possibilities offered by high-bandwidth connectivity. Although the virtual lab project currently focuses on college-level French and Japanese instruction, Bergmann hopes eventually to apply this approach to K–12 education and to a broad range of disciplines. "The bandwidth is important," he says, "to allow schools to pool resources and collaborate. Since we don't always have enough students in any one location to hold a class, we want to simulate the language labs that can be offered on-site and make them accessible to students from many different places."

The labs he refers to typically involve student workstations and a console that allows the professor to send assignments to groups of students, check in on them and post any group's work for others to see. In the virtual configuration, students can be grouped with peers on other campuses, using microphones and headsets to converse. In the future, Bergman imagines realistic video being added to teach such things as American Sign Language; to provide a variety of illustrative clips to reinforce lessons; and to allow students to interact with native speakers in other countries.

K–12 schools with limited people resources and dispersed students are equally aware of the value of virtual courses. In the Denair School District in California's Central Valley, for example, District Superintendent Edward Parraz explains that, "Because our high school is rural, with only 430 students, we have found it challenging to respond to mandates requiring us to offer AP courses. We want to give these sorts of opportunities to our students but that requires partnering with online providers."

One of those providers is the University of California's College Prep program (UCCP), designed to offer preparatory courses to California high school students who otherwise would not have the opportu-

nity. Director Elaine Wheeler says that future courses will be designed to take advantage of DCP capabilities. We can expect, for example, that an upcoming AP class on environmental science might use video and high-quality animation to show how volcanoes and other natural phenomena work. "The bandwidth will also enable more sophisticated simulations than were possible before," Wheeler adds, "allowing students to alter a number of variables and observe how things change."

Denair's technology director, Mark Ranes, hopes that next-generation virtual classes will help reduce the isolation some students feel when involved in distance learning. Video-based interaction, the ability to work simultaneously on shared documents, and other real-time collaborations with remote peers will help build important connections. Another enhancement that Wheeler expects will do a lot to increase students' sense of involvement is the use of a 3-D virtual environment in which student "avatars" navigate from one room to another, using virtual lockers and interacting with classmates and teachers in realistic ways.

Mentors and Consultants

Whether students are participating in virtual classes or one-time events online, the new technology offers an unprecedented opportunity to bring outside experts to the classroom. An engineer might visit virtually and show how his or her team uses surveying tools and geometry skills on a road construction project. Or students might connect with a biology professor who demonstrates the use of an electron microscope to answer their scientific questions.

Virtual collaborations of this sort can make a tremendous difference for students with special needs. In Sacramento County, for example, an expert from UC Davis Medical Center's Mind Institute is using videoconferencing to help teachers understand how to work effectively with students who have neurodevelopmental disabilities.

In another example, San Joaquin county teachers are collaborating over the Internet with a company that specializes in auditory problems. Recordings of student responses to assigned tasks are sent to the specialists who then develop new lessons, customized to the needs of each learner. With higher bandwidth connections in place, one can expect such collaborations to become more commonplace, involving not only voice recordings but the chance for specialists to observe, speak with and evaluate students over the network.

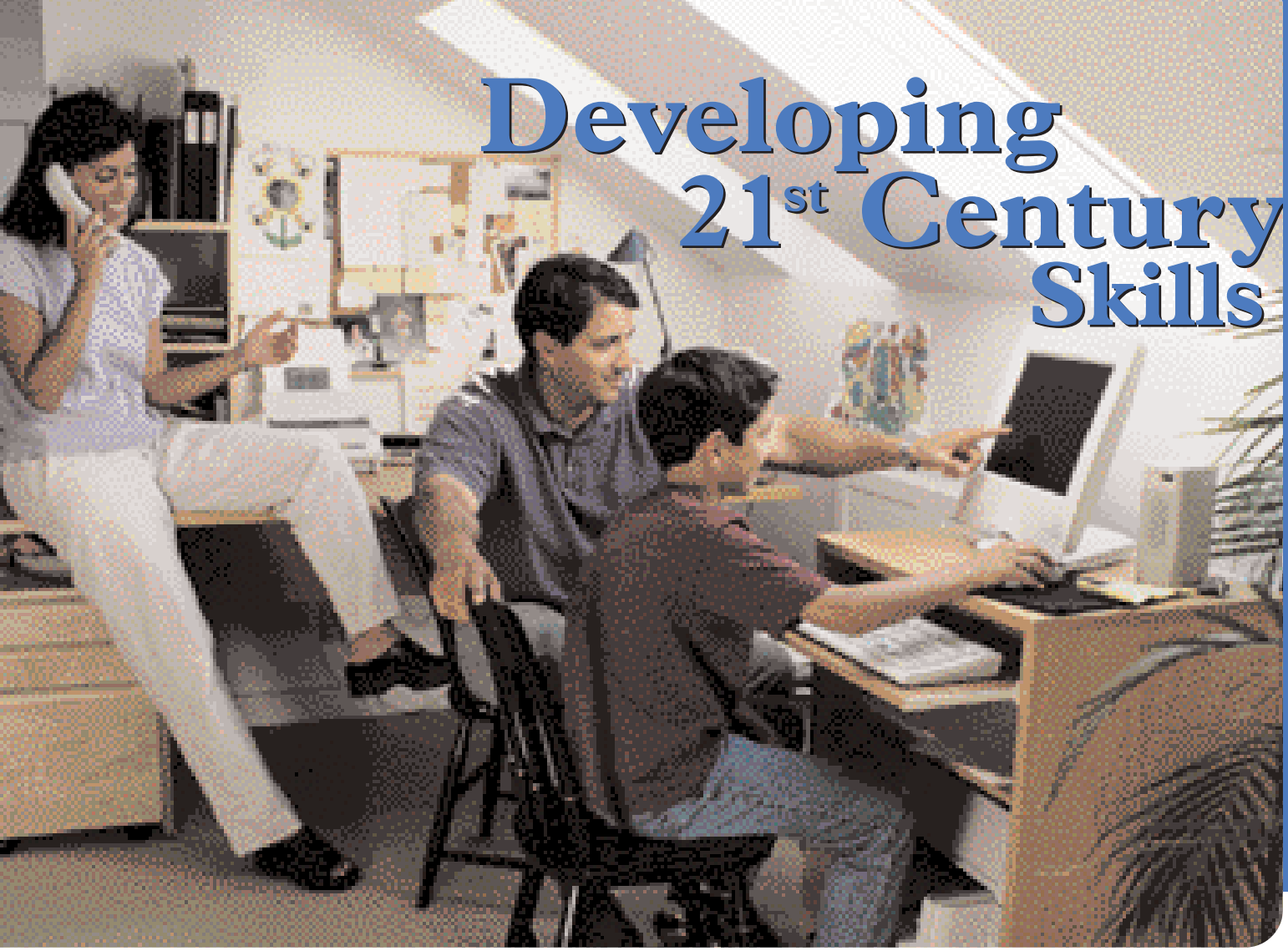
Fast-Forward

Algebra Texts Circa 2005

Welcome to tomorrow's virtual algebra "textbook." In addition to print-based texts, districts now have access to elaborate online communities focused on specific subjects. The algebra community offers standards-based resources from a variety of providers. A student who is studying quadratic equations, for example, can view video-based lessons taught by experienced master teachers, print out explanatory articles to read independently, access animations and movies that illustrate key points and engage with interactive tools and powerful simulations that facilitate understanding. Assessments, linked to the state standards, help students and teachers focus on areas that need reinforcement, offering suggestions for additional activities.

The content at the algebra site evolves and grows over time. There is a virtual teacher's lounge where educators gather to discuss challenges, pose questions to the master teachers, and exchange lesson ideas—earning continuing education credits in the process.

Students belong to virtual study groups with partners at other schools and grade levels. There are weekly algebra contests, with virtual awards ceremonies during which the winners explain their work and new challenges are announced. Students also join collaborative projects involving everything from running simulated businesses to data exchanges with other communities.



Developing 21st Century Skills

We live in a time of exponential growth. As authors Ian Jukes and Ted McCain explain: "It is safe to suggest that the technological and informational transformations of the past 10,000 years will be absolutely dwarfed by the transformations we will experience in the next three to five years of our lives." How do we help prepare young people for a world we can barely conceive of?

Clearly, the skills needed by students in the early 21st century go far beyond those measurable by conventional tests. The CEO Forum (www.ceoforum.org), consisting of CEOs and directors of 22 high-tech companies, made the following points in their 2001 Report, *Key Building Blocks for Student Achievement in the 21st Century*: "In the rapidly changing economy, there is a corresponding shift in the skills and abilities that students will need to thrive in the future. These twenty-first century skills include digital literacy, inventive thinking, effective communication, teamwork and the ability to create high-quality products." Next-generation Internet technology can help students acquire these skills and become important contributors to a global knowledge community.

Students as Researchers and Authors

Gail Desler, fifth-grade teacher at Morse Elementary School in Elk Grove, is well-known in Sacramento County for the creative social science projects her students engage in with help from technology. Learning from primary source materials is central to these projects, and the fact that high-bandwidth primary sources can now be digitally delivered will help tremendously. One example Desler believes holds great promise is the idea of easy access to the thousands of videotapes created by the Shoah Foundation from their interviews of Holocaust survivors and rescuers. With the average age for hate group participants ranging from 12 to 22, Morse sees plenty of reason to work with students on such difficult issues before they reach high school.

Along these same lines, she has her students interview local Elk Grove residents, many of whom are of Japanese heritage, about World War II internment experiences. In this case, the students will be the ones in the position to create and post the video interviews for others to access over high-speed Internet. In addition, Desler would like to be able to facilitate situations in which students use videoconferencing to conduct real-time interviews with people in other parts of the country.

As the tools and media to which learners have easy access change, so will our definitions of digital literacy and effective communication. Bill Engelhardt, director of curriculum and instructional technology for the San Joaquin County Office of Education, imagines school districts creating their own "cybraries"—including a huge array of downloaded copyright-free resources, as well as a growing collection of school-grown contributions. The idea is to create a digital sandbox where students could explore and author their own materials. "There would be tools that they could drag and drop, and elements that they could assemble for themselves," Engelhardt says. "These wouldn't just be video clips or static information. Students would also be able to control a microscope, activate a robot that lets them pan in on a site, or fire up a camera to explore a real aquarium."

Collaborating Online

Ever since the Internet reached K–12 classrooms, teachers have been finding ways to involve their students in projects that have them collaborating with peers in faraway places. Examples include "quests" in which students participate virtually in real-world expeditions, and data collection projects that involve classrooms all over the globe sharing information such as pollution readings or sightings of migrating animals.

Bandwidth limitations have often caused such experiences to be asynchronous and text-based; reports are posted at a Web site for others to access at a later time. Realistic multiple-point video will make it far easier for the participants to see, hear and take part in the adventure in a realistic way. As Scott Coletti, technology coordinator for CTAP Region 1, puts it, "In real science, unexpected things happen. Being there, in real time, gives students a feeling of participation and excitement. They know they are a part of history as it's being made."

Other collaborative experiences become possible with next-generation connectivity as well. Coletti is enthusiastic about the role of visual image analysis tools in collaborative learning. "These tools create multiple large files, a problem with low speed networks," he says, "but it will soon be easy to send and share models such as these online." For example, groups of students working together remotely might take turns manipulating models of two carbon structures—diamonds and graphite—to demonstrate for one another why one structure is so hard while the other is soft enough to write with. Eventually, suggests Coletti, we can expect some of these shared experiences to be "tele-immersive" simulations in which the students fly by and through the 3-D structures as they discuss their properties.

Another collaboration example comes from an Internet2 project in which musicians at many locations come together to play music as part of a virtual orchestra. One could imagine a similarly powerful experience involving K–12 students from all over the world performing together with guidance from a famous conductor. Other possibilities include students at a variety of sites working together to create an animated film or taking part in United Nations-style meetings to discuss world problems.

Bev Blaylock, director of technology and communication services for the Santee school district, sees these sorts of collaborations as crucial to student learning. "We should be looking for ways to have children throughout the state working together in groups to solve sophisticated problems. They might be building a space ship together, for example. As they work, the results appear on the Internet for others to see and add to. That is the way people work in the real world—you are part of a team that is solving one part of a bigger problem. It would be great for a student to know 'I'm only in elementary school but I'm inventing my own space ship with another class of students.'"

Fast-Forward

Collaborating to Prepare for the Next Quake

In the year 2006, if California residents are looking for help figuring out how to prepare for or respond to a major earthquake, perhaps the assistance will come from K–12 students. That is because next-generation Internet will make it possible for people of all ages, and in all locations, to work together solving collective problems and challenges.

Imagine teams of students from all over California converging virtually to learn about earthquakes. One team is working with the U.S. Geological Society and California colleges and universities to access real instruments that monitor seismic activity. These same students learn ways to conduct their own measurements of local earth movement, and work with professional organizations on experimental systems to alert people of an impending quake.

Other teams, once again consisting of students from many parts of the state, are in charge of video and news. Using computerized animation tools, school-shot video, and footage made available to them by news agencies, government groups and other student research teams, they create documentaries explaining the geology behind earthquakes. They are also involved in creating public service films on earthquake preparedness. A close working relationship has been developed with news organizations that help with the filming and show the best student reports on the air.

In keeping with the times, students spend relatively little time "tethered" to desktop machines. Instead, they conduct their research using small, video-camera-equipped mobile devices and wireless connections. In addition to working with teammates in other parts of California, they have connected with students in Turkey, Japan, Mexico and other earthquake-prone parts of the world, taking one another on virtual tours and discussing different ways of responding to seismic uncertainty.

Recruiting, Retaining and Supporting Professional Educators

According to the National Center for Education Statistics, the United States will need nearly three million new teachers in the next decade as a result of attrition, retirement, class-size reduction, and increased student enrollment. Current estimates put the number of new California teachers needed in that same period at 300,000. At the same time, a rapidly changing world requires existing teachers and administrators to work continually at building the skills required to keep up with the needs of their students. How can high-bandwidth connectivity help?

High-tech Recruiting

Many schools and organizations are turning to creative uses of technology to recruit teachers. At the Web site of the California Center for Teaching Careers (www.calteach.org), prospective teachers can read about job opportunities and post their resumes. With the help of high-speed connectivity, one can imagine CalTeach, and other sites such as Recruiting New Teachers Inc. (www.rnt.org), adding video interviews and multimedia portfolios to the process.

That is already happening in some forward-thinking California districts. The Los Angeles County Office of Education recently held a "virtual job fair," using a live television broadcast and Internet video streaming to attract high-quality teachers. Job fair participants were able to view video presentations online, chat in real-time with school administrators, send questions via e-mail, or call into the live television broadcast being aired on several local TV stations. With next-generation Internet, the video exchanges could originate from district offices or school buildings, be accessed from any site with high-speed connections, and be two-way, allowing participants to show lessons they have taught or presentations they have created.

In Hayward, California, the New Haven Unified School District's applicant tracking system makes it easy for administrators to locate qualified candidates and view their electronically-stored files from a computer desktop. After telephone screening, the top candidates are scheduled for live interviews—frequently conducted at a distance, using teleconferencing technology. According to assistant superintendent Donna Uyemoto, these virtual interviews now require interviewers to schedule time in a special room with video equipment. In the future, however, she hopes interviews can take place using high-speed connections and video-equipped computers residing in individual administrators' offices. Noting that many teacher preparation programs now require the creation of multimedia portfolios, Uyemoto suggests that it would be helpful to set up a split-screen format to allow a candidate to walk the administrator through the portfolio as part of the virtual interview.

Pre- and In-service Professional Development

High-performance networking holds a great deal of promise for preparing future teachers and supporting the ongoing professional growth of experienced ones. Elizabeth Stage, director of the state-funded Mathematics Professional Development Institute (www.tepd.ucop.edu/tepd/cpdi/mpdi_home.html), sees video case studies as a powerful way to support professional growth. She believes that American teachers have much to learn from a Japanese approach to professional development known as "lesson study." Described by James W. Stigler and James Hiebert in their 1999 book *The Teaching Gap*, this approach involves groups of teachers coming together, on several different occasions, to watch a particular lesson being taught and to discuss the content and pedagogy involved. The DCP will make it possible for such observations and discussions to involve participants at disparate locations.

The California Learning Interchange (www.gse.uci.edu/cli) offers another example of video used for professional development. Video case studies, prepared by the Orange County Department of Education in conjunction with UC Irvine, are currently available online to illustrate effective lessons in a number of subject areas. Right now, the clips are limited in size and length due to bandwidth constraints, but Joan Bissell, vice chair of UC Irvine's Department of Education, is

looking forward to developing a robust database of longer video examples supported by DCP technology. As she puts it, "Learning the craft of pedagogy requires you to see a longer lesson, an entire sequence."

Equally exciting is the opportunity to offer videoconferencing experiences with multiple point interactivity. Bissell describes a recent pilot during which Jeff Hruby from the California Math Project, and Kimberly Burge, from the California Arts Project, co-taught a lesson on tesselations for elementary school teachers, administrators and preservice students in the UCI teacher credential program. "There were two cameras at each site, which allowed us to look at the shapes participants were making," she explains. "Jeff and Kim would ask questions about the shapes, and clarify or explain based on what they saw. I have been teaching distance courses for years, but I've never experienced anything like this! To be able to get feedback from experts, see what others are doing and hear multiple perspectives is very powerful. It really convinced us not only of the efficiency of this approach but also of the impact it can have."

Spreading the Wealth

The distributed education model used to offer virtual courses for K–12 students clearly is applicability to professional development as well. A growing number of virtual degree programs for educators, including Pepperdine's and CSU's online Masters' programs, are now being offered in California. While participants in these programs expect that occasional face-to-face meetings will continue to be an important supplement to the online learning experience, realistic videoconferencing enabled by the DCP will do a lot to enhance day-to-day connections.

Not surprisingly, rural communities have been some of the first to begin experimenting with telecommunications-based professional development. Region 1 of the California Technology Assistance Project (CTAP), which covers a huge geographic area in northwestern California, has been using ISDN telephone lines in recent years to facilitate regional meetings. Dave Johnston, director of regional technology grants for CTAP Region 1, explains, "We couldn't get everybody together to meet regularly, since it is too far to travel, so we started virtual meetings like our 'Tech Tuesdays' where technology support staff use the ISDN connections to share ideas and resources or take part in a presentation."

Johnston looks forward to DCP connectivity, which will eliminate expensive ISDN charges and increase the number of sites from which people have access. In addition, the higher-quality network will make it easier for participants to view digitized handouts, images or video, and work collaboratively on shared documents. A high-priority CTAP Region 1 goal is to extend these sorts of virtual learning options to principals, with support from AB 75, the statewide Principal Training Program.

Fast-Forward

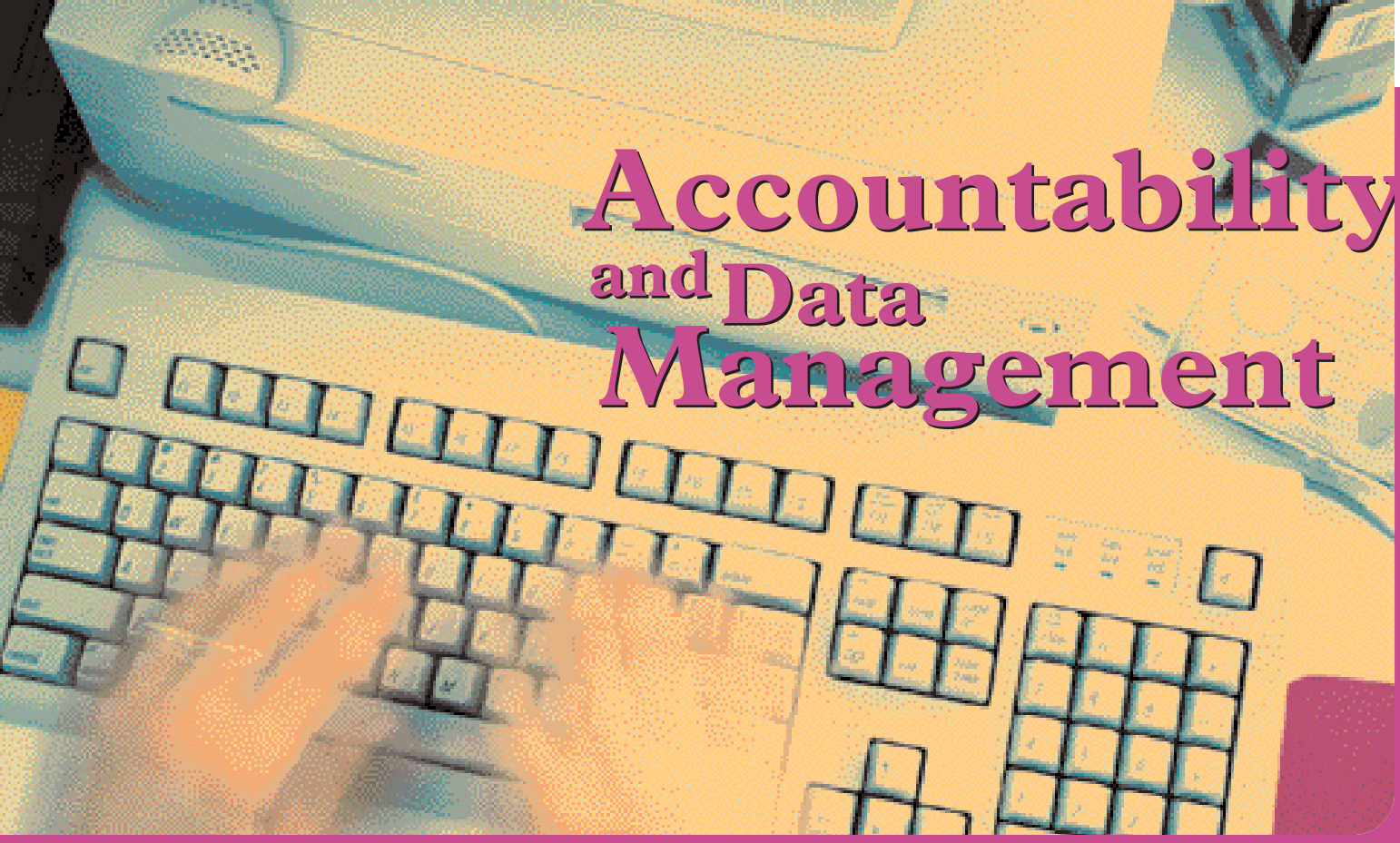
Professional Development in the DCP Era

Several years from now, we anticipate that schools of education and other teacher preparation programs will have come together with county offices of education and additional providers of professional development to develop consortia aimed at professional growth. Perhaps they will look something like this:

Educators are organized into collaborative teams, which work together over a number of years. Teacher teams include mentor teachers in more than one location, other educators who want to learn from them, professors of education and pre-service student teachers, who remain on board as they become new teachers. Since these teams meet virtually, geography is not an issue. Members can self-select based on common interests, grade levels, and personal affinities deduced from online get-to-know-one-another conversations and conferences.

Mentor teachers and professors serve as coordinators for the team, helping to drive content. Many of the exchanges involve video footage of master classes, followed by live video conferences that allow team members to discuss what they observed. Mentor teachers and professors have their own supervisory discussions during which they exchange information, and observe and provide feedback to one another.

Student interns and first-year practitioners have supervised observation times, with feedback from various mentors, not just their on-site supervisors. Positive examples are selected by the mentors and compiled into presentations for others. Periodically, virtual symposia are held, involving participants from many different teams. One might be geared at future teachers, for example, offering them the chance to ask questions of experienced educators. Others allow teachers of a particular subject area, or with a particular concern, to meet virtually for collaborative problem-solving and discussion.



Accountability and Data Management

In addition to an emphasis on standards-driven curriculum, school accountability requires sophisticated tools to keep track of student progress, analyze data for decision-making purposes and locate a wide array of materials to support standards-based learning. Fortunately, another aspect of robust, high-bandwidth telecommunications is the ability to access and process large amounts of distributed data in a powerful way.

Online Data Solutions

A growing number of applications service providers (ASPs) have entered the K–12 scene in recent years, with the ability to manage student data at an off-site location with encrypted online access. The appeal of such systems will undoubtedly be enhanced by the faster and more reliable Internet connections made possible by the DCP. Even if a district opts to keep its data locally, high-speed connectivity can enable administrators to download new tools, access frequently-updated standards lists, work with outside technicians to troubleshoot information systems remotely, or transfer student records conveniently and securely from one school to another.

Districts interested in developing more robust data management tools and learning what other schools are doing in this area have turned to the California School Information System (CSIS) (www.csis.k12.ca.us) for guidance and support. Participants are selecting their own data management partners but working together to address such challenges as the most secure, seamless way to exchange student data with other schools. Many of the newest CSIS projects are considering options that will be enhanced or made possible by DCP technology.

Nowhere is data-driven goal setting as important as in special education, where the creation of individualized student plans (IEPs or ILPs) is the norm. Until recently, however, the logistics of managing the documentation required by federal regulations has been daunting for many schools. More robust connectivity, along with powerful data management and assessment tools, can ease the reporting process and provide parents, students and teachers with ready access to relevant information about progress and suggested next steps.

New forms of online communication facilitated by high-speed connectivity offer an important new chance for administrators to collaborate on accountability challenges. A potential example is the Western States Benchmarking Consortium, consisting of seven suburban school districts in California and other states. This group began working together a few years ago, with the idea that benchmarking their performance against other schools with comparable resources, teaching philosophies and student backgrounds was the best way to drive improvement. Quarterly meetings are currently held in person, supplemented by e-mail communication, but the need for travel could be reduced with help from videoconferencing, virtual white boards and other next-generation Internet tools that facilitate collaboration at a distance.

Powerful Assessment Tools

A frequently-cited difficulty with standardized tests is that they do little to help teachers diagnose the needs of individual students. For that, it is necessary to have more frequent forms of assessment with rapid and sophisticated feedback. This is the sort of functionality offered currently by some comprehensive learning systems installed on school-based network servers. The advent of super-speed connectivity, however, will offer schools an even wider range of assessment options, including new-and-improved online tests that are scored immediately—with instant feedback to students, teachers and parents, and suggestions to guide the creation of personalized study plans.

Next-generation Internet can also help with the sort of performance-based assessment so many schools have committed to in recent years. The Grossmont Union High School District, for example, is using their internal high-speed network to help teachers learn to evaluate digitized student speeches, by grad-

ing them against rubrics and comparing their results with those from expert speech teachers. With the DCP, it should soon be possible to certify a cadre of speech evaluators in this way, empowering them to assess students from all over the state. One can also expect high-bandwidth wireless connections, in conjunction with personal digital assistants (PDAs), to play an increasing role in performance assessment—allowing teachers to gather information on students as they work or perform and beam it into the system for powerful interpretation and reporting.

Digital portfolios, already used in many districts to supplement traditional report cards, can be enhanced by DCP capabilities. Here again, Grossmont Union High School District, which has gone online with its portfolios, serves as an example. Each student is allocated a hefty amount of storage space on the district server and invited to save representative work in a digital locker. An actress might digitize a scene from a school play; a mathematician might explain a complex proof; and a poet might read a recent work. Other digital locker items are teacher-selected. For example, digitized student speeches can be stored along with the teacher's evaluative comments to be played for parents.

Assistant superintendent Warren Williams explains that bandwidth is key to this whole process. Grossmont uses a high-capacity internal network—as well as CD-ROMs—to store and access the locker contents, and hopes to take advantage of the DCP connections to transmit the portfolios to universities or other school districts. Knowing that high-speed connectivity will take longer to reach homes, the district is experimenting with lower-bandwidth versions that parents can view over the regular Internet.

Managing the Content

As illustrated on previous pages, high-bandwidth connectivity can play an important role in connecting students with standards-based learning materials. The statewide California Learning Resource Network (CLRN) project, designed to evaluate supplemental electronic learning resources aligned to state standards, is evaluating high-bandwidth content as it becomes available. Some educators are hoping that CLRN and other statewide initiatives will evolve into a California education portal that schools can visit to access a variety of free and licensed high-bandwidth resources, as well as previewing new commercial applications for possible purchase.

With next-generation connectivity, online curriculum offerings are likely to feature increasingly robust management and assessment tools that tie together learning experiences and direct students and teachers to appropriate next steps. With help from industry initiatives aimed at standardizing educational data, one can imagine powerful new Internet-based management tools that accompany students on their online learning adventures, compiling an ongoing record of standards mastered and landmarks achieved.

Fast-Forward

You CAN Take It with You

Let's look ahead a few years to see how student data management might work in a high-bandwidth digital environment. Each student has access to a roomy "locker" on a district server. Security is tight, to ensure that grades and other private information can only be accessed by authorized individuals, but it is easy for students, teachers and parents to access the data in appropriate ways. Students all carry smart i.d. cards and personal digital assistants to keep track of everything from assignments to personal messages to school purchases. With help from high-speed wireless networks, it is easy for students to transmit multimedia homework assignments to teacher spaces on the system, and beam new items to the portfolio section of their own record space.

A more diagnostic section of the portfolio contains the results of performance assessments, accompanied by teachers' comments, video clips of students interacting with peers, major writing assignments with feedback and so on. An important part of this evaluative record is an evolving checklist of standards mastered or being practiced. This is used not only to report to parents but also to place students in a variety of independent classes, tutorials and other personalized virtual lessons.

Entire records can be transferred electronically to other schools when students graduate or move. And select portions can be made accessible online to colleges or others with an interest in a particular student's achievement. As an increasing number of homes, businesses and community centers begin to be connected to high-bandwidth Internet, students or parents will be able to pull up portions of the record space to show family members, tutors or prospective employers. Parents, summer employers or others working closely with the student outside of school hours can also submit relevant items, explanations and recommendations.

New Challenges Ahead

We know we are walking a fine line in this publication—between sparking excitement about what is possible and setting realistic expectations. It is important not to overhype the capabilities of the new technologies or underestimate the challenges that they bring with them. That is why we chose to end this piece with a look at some of these challenges and the ways in which we might respond to them. High-bandwidth connectivity will not, by itself, "revolutionize" K–12 education. But, with students and curriculum guiding the decisions that are made about its implementation, it can be a tremendously positive tool.

Starting with the Vision

Just because technology is there, is not a reason to use it. It is essential for instructional and educational needs to drive choices. It is also important to prepare and involve everybody in the school community—from parents to administrators—in the ways their roles and responsibilities are likely to change in this new environment. Without flexibility and a vision, the new technology is likely to be used in mundane ways—or not be used at all.

Letting the Students Lead

When it comes to new technologies, students frequently understand what is needed far better than adults. Reverse mentoring, in which young people develop digital content and collaborate with educators on many aspects of the vision-setting process, is important for all of us. A big challenge—and opportunity—is to watch what students are doing naturally and learn from them.

Keeping the Teacher in the Loop

As with any educational innovations, those suggested in this booklet will never happen unless they are embraced by teachers who are, in turn, supported by school and district leadership. The idea is not to replace face-to-face teaching but to supplement and enhance it. The uses for the new technology must address real needs and be sensitive to today's school environment and culture, at the same time that they push us to think and learn in new ways.

Going the Last Mile

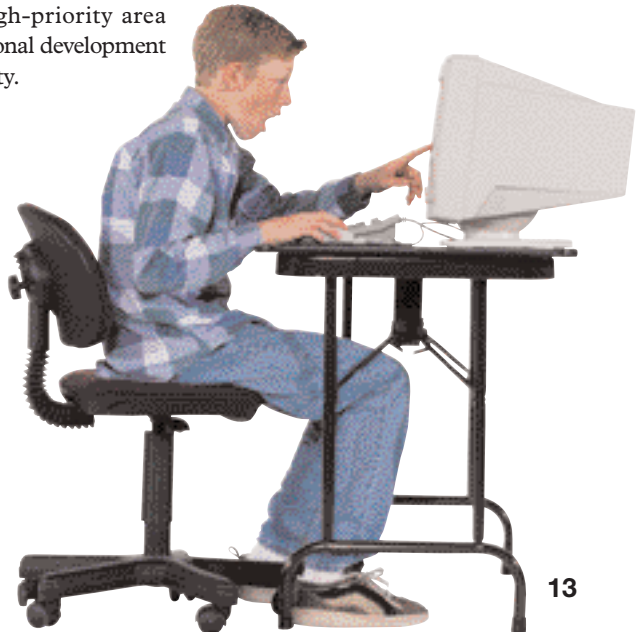
The DCP creates the infrastructure that delivers next-generation Internet to every county in the state. However, districts remain responsible for paying for and running the high-speed cables from the nearest DCP node to individual school buildings and classrooms. Districts that want to join the Internet2 Age will need to find funding—locally or through grants—for the internal infrastructure as well as the hardware necessary to engage in such activities as videoconferencing. In the interim, a number of counties are experimenting with downloading data from nodes to school networks over lower-speed connections during off hours.

Not Home Yet

In order for parents and other community members to tap into the capabilities offered by high-bandwidth connectivity, homes will need to be connected to the new infrastructure as well—and that is not within the funding scope of the DCP. We can expect commercial providers to offer this option eventually, but it raises serious concerns about widening the digital divide for homes that can't afford the connectivity. To bring low-income homes into the fold, it is important to look for ways to extend the high-speed network to the community at large—through after-school access to school buildings or the extension of school wiring to local community centers, museums and libraries.

Equity Issues at School, Too

It is important to ensure that all schools, not just those in higher-income communities, have equal opportunities to address the last-mile issues. The good news is that the California Public Utilities Commission's California Teleconnect Fund and federal programs such as the E-rate go a long way toward making this happen. Other funds can help as well, if the new technology addresses a high-priority area such as professional development or accountability.



Don't Forget the People Infrastructure

Wiring and connectivity will make no difference unless we also budget and plan for the human infrastructure. High-speed connectivity will require a substantial amount of time on the part of many people—not only to plan, install and maintain the network systems, but, most important, to help educators understand how to use them in meaningful ways. Professional development can be helped tremendously by the new technology but it is unrealistic to think human time will be saved. When done right, professional development is ongoing, time-consuming and essential.

Keeping It Safe and Secure

None of the security issues of concern with today's Internet disappear when implementing the Internet of tomorrow. A safe and appropriate security infrastructure will be essential to the functionality of the new Net. And careful thought will need to be given to data security issues—including policies that determine where and how student information is to be stored and protected.

How Many Is Too Many?

With new-generation Internet technology it is theoretically possible for a single teacher to deliver instruction to many, many students. But is it desirable? It will be important for schools to set guidelines about how many students should be enrolled in a single online class and what the teacher/student ratio should be. Removing some of the instructional burden with tutorials, intelligent assessment tools and opportunities for individualized, student-directed learning does allow online teachers to interact with more students, in the role of "guide on the side." However, there is inevitably a limit to the number of students with whom a virtual mentor can develop a meaningful relationship.

It's Not Just a Local Issue

The digital divide is not just an American issue; it's an international one. Recent estimates indicate that the United States is the user of a third of the world's Internet traffic. If we are trying to create global classrooms, we need to understand this reality and commit ourselves to helping to eliminate the global divide as well.

Mandatory Access, 24/7

While the advantages of "anywhere anytime" learning are enormous, maintaining 24-hour, every-day learning environments can take a toll on the people in charge. As we proceed in this direction, we need to set realistic expectations and systems that allow educators to set reasonable limits as to how many hours they are "on call."

Finding the Financial Balance Point

Without agreements between schools, content companies, and content creators, there will be issues around bandwidth. Good multimedia curriculum—no matter how it is delivered—is expensive to create. There need to be ways for companies that are developing in this space to recoup their investment and protect their content, while protecting schools from excessive or unpredictable costs.

Who Owns What?

With the proliferation of virtual learning comes a variety of legal and financial questions of the sort higher education institutions are already finding challenging. Who owns the course content for an online class: the course creator or the school at which he or she works? Who gets the money for students taking virtual courses in one state while residing in another? Which state regulates the content and issues the credit? If multiple districts are involved, how do they split the money? These are complex issues that will require ongoing attention in the years to come.

WHAT THE DIGITAL CALIFORNIA PROJECT MIGHT MEAN

For Students

- More opportunities to learn independently and in a multisensory way
- Access to distributed expertise
- Virtual and realistic field trips
- Synchronous and asynchronous connections with other students
- Virtual reference desks with a variety of learning materials
- New ways of sharing work with parents, peers and prospective colleges or employers
- Chances to collaborate online, using shared work spaces

For Teachers

- Productivity tools to make jobs easier and reduce time spent on classroom administration
- Increasingly robust systems to help manage learning resources, develop lesson plans and assess student work
- Ability to network with colleagues at other schools and districts to share ideas and do peer mentoring
- Opportunities to bring outside experts into the classroom to teach students and model other forms of teaching
- Access to a rich cyber library of learning materials

For Administrators

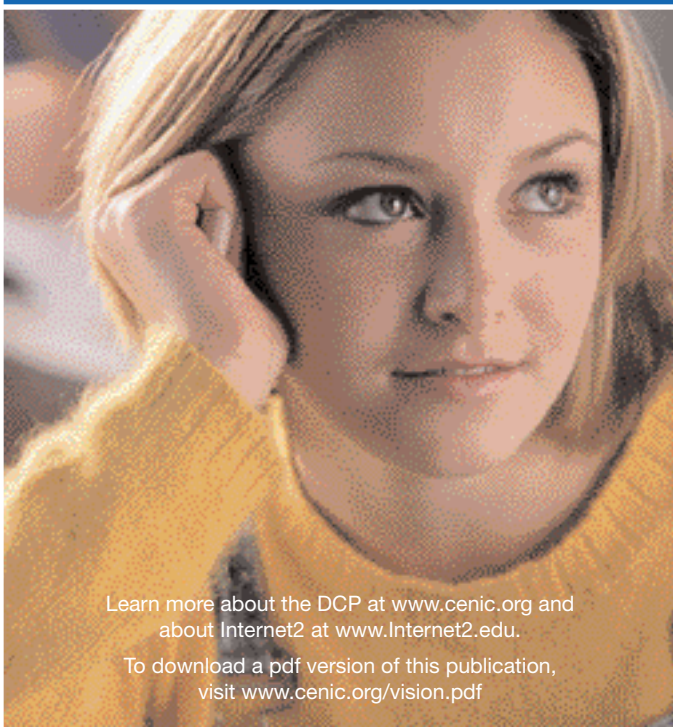
- Rapid feedback on student and school progress
- Access to real-time, rich data about students, teachers and classrooms
- Cost-effective staff development
- Opportunities for professional growth as administrators—breaking through the isolation to problem solve with colleagues in other districts
- Virtual access to experts on school administration

For Content Providers

- The chance to develop products that include powerful collaborative tools
- Real-time capabilities that allow users of a product to contribute and support one another
- More robust ways of delivering multimedia content, demos and upgrades to customers
- New ways of incorporating professional development into product offerings

For Universities, Businesses and Community Members

- New ways to partner and collaborate with educators and students
- Once high-bandwidth connectivity reaches homes and businesses, more chances for parents to observe children and communicate with teachers
- Opportunities for more individuals to grow and learn through a broader definition of school
- Community-wide projects using DCP-connected schools as a hub



Learn more about the DCP at www.cenic.org and about Internet2 at www.Internet2.edu.

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