

ROY D. PEA

CENTER FOR TECHNOLOGY IN LEARNING, SRI INTERNATIONAL

My plan in this paper is to provide a brief background on current research and policy issues in equitable access to information technology and the Internet for K-12 learning. I direct a center, funded by the National Science Foundation, called the Center for Innovative Learning Technologies, or CILT (<http://www.cilt.org>). Each year we bring together a community of top researchers, educators, developers, and policy makers to design informed responses to pressing challenges in learning technology innovation and research.

This year at CILT 2000 in Washington DC, we asked about what the key policy issues are that face learning technology innovators concerned with technology and equity. While these concerns are not always central to the research work conducted by this interdisciplinary field, as empowering and fundamental roles for technology use throughout society become more evident, issues of equitable access to technologies that make a difference to learning and teaching become more central to address.

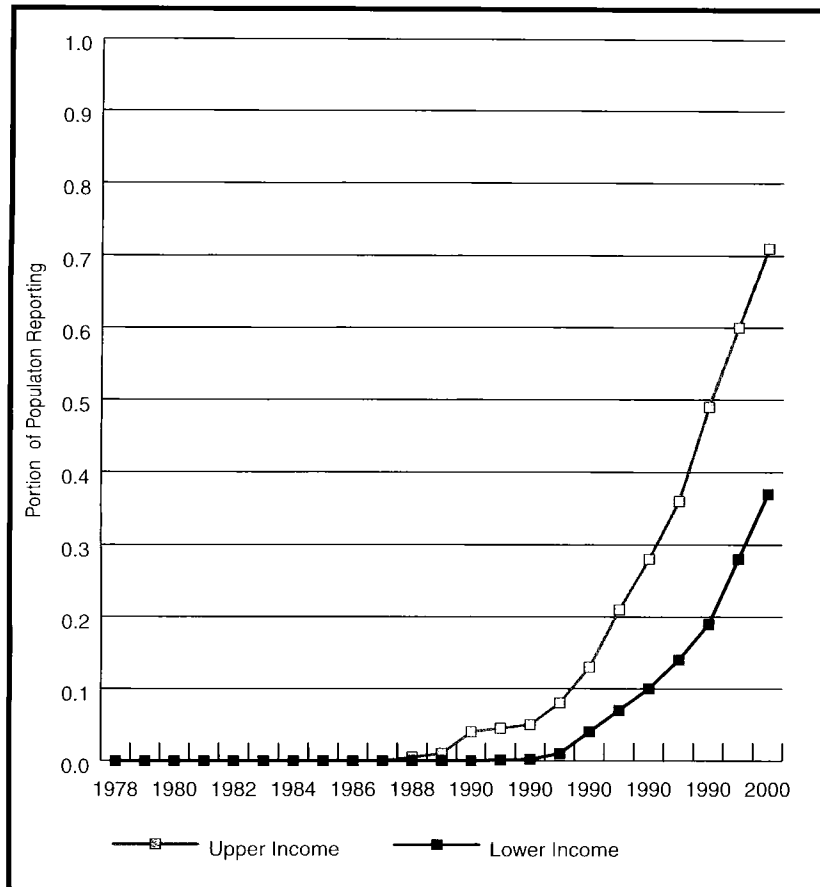
We have been very influenced in our thinking about these matters by the rationale and the data provided by the U.S. Department of Commerce reports on *Falling Through the Net*:

"The Internet is becoming an increasingly vital tool in our information society. More Americans are going online to conduct such day-to-day activities as business transactions, personal correspondence, research and information-gathering, and shopping. Each year, being digitally connected becomes ever more critical to economic, educational, and social advancement. Now that a large number of Americans regularly use the Internet to conduct daily activities, people who lack access to those tools are at a growing disadvantage. Therefore, raising the level of digital inclusion - by increasing the number of Americans using the technology tools of the digital age - is a vitally important national goal." (*Falling Through the Net: Executive Summary*, U.S. Department of Commerce, October 2000.)

In the Executive summary, the increasingly fundamental role of the Internet in American society and its basic activities is used to argue for the crucial policy goal of digital inclusion. Similarly, there has been throughout 2000 a profusion of policy reports in which the digital divide and digital inclusion issues are raised, analyzed and discussed in ways relevant for K-12 Education. These include:

1. "Resolving the Digital Divide" (The President's Information Technology Advisory Committee, also known as PITAC)
2. "Who's not on-line" Internet and American Life Project (Pew Foundation)
3. "On-line content for low-income and under-served Americans" (Children's Partnership)
4. "Disconnected, Disadvantaged, and Disenfranchised" (Consumers Union; Consumer Federation of America)
5. "Internet access in public schools and classrooms: 1994-1999;" and "Teacher use of computers and the Internet in public schools: 1999" (U.S. Department of Education, National Center for Educational Statistics, or NCES)

Figure 1
Diffusion of Internet Use
Households Above/Below Median Income,
(Year of First Use of Current, Home Users)



The terms of analysis for digital divide are worth reviewing for our consideration. The United States Commerce Department defines digital divide as “differences in the shares of each group that is digitally connected.” The groups and data that are analyzed in the Commerce Department reports include income level, educational level, race and ethnic origins, location, disabilities (for example, visual, manual dexterity, hearing, and mobility), age level, household type (single or two-parent), and gender.

One of the most striking statistics is presented in the key policy report called *Disconnected, Disadvantaged, and Disenfranchised*. In this figure, the authors depict the proportion of the population above and below the median income and the diffusion of Internet use.

As you can see (figure 1), the year of first use of current home-based Internet users is dramatically different in this high-low demographic split, which represents a rate of roughly double the proportion of above-median income households using the Internet in 2000 over below-median income households (about 71% vs. 37%).

In a histogram representation from the U.S. Department of Commerce’s *Falling through the Net* report last year (figure 2), this simple above-below median income split is examined in more detail. Results are differentiated to indicate how, at six different levels of household income, from under \$15K at the low end to over \$75K at the high end, the percentage of U.S. households with Internet access ramps up. There is a vast six-times spread over this range,



Figure 2
Percent of U.S. Households with Internet Access
By Income (\$000s), 1998 and 2000

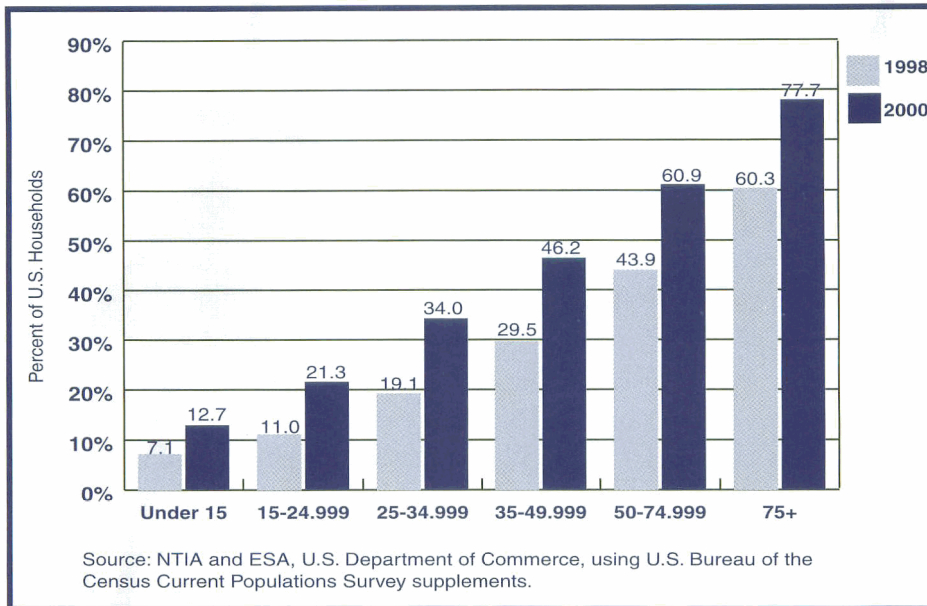
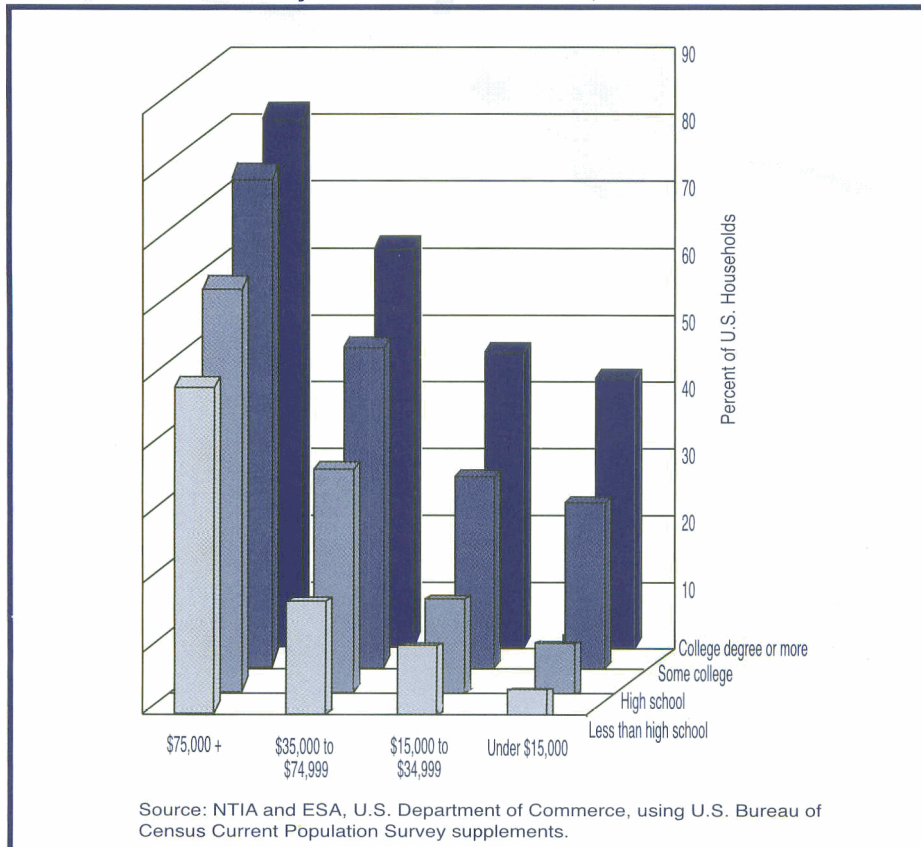


Figure 3
Percent of U.S. Households with Home Internet Access
By Income and Education, 2000



with the under-\$15K household income percentage of internet-enabled households at 12.7% compared to 77.7% for the \$75K-plus households.

This graphic also dramatically illustrates the pace of this appropriation of Internet access by U.S. households, with a sizeable spike of 30% or more from 1998 to 2000 at most of these household income levels, with the most sizeable base percentage increases at the lower income levels, nearly doubling.

Income level is one key predictor and digital divide for Internet access, but education is also very significant. This two factor effect is illustrated in the preceding graphic (figure 3), that provides a steep slide down from a peak of about 80% for households with a college degree education or more and \$75K-plus annual income level, down to a nadir of about 5% for those with less than high school education and annual income under \$15K. At this lowest corner of the graphic, there is very little use of the Internet at home.

It should not come as a surprise that such data affect the K-12 students in those households. 70% of parents with incomes of \$75K or more report that one or more of their children use the Internet, compared to 35% of parents with incomes under \$40K (Source: "Safe and smart: Research and guidelines for children's use of the Internet," 2000).

Now let's consider the differential access for U.S. households by race and ethnic origin from 2000 data (figure 4): Asian-American and Pacific Islanders lead (56.8%), with Whites close behind (46.1%), and Hispanic (23.6%) and Black (23.5%) households much less connected to the Internet. It is critical to note the astounding pace of connection to the Internet from 1998 to 2000, with a near-doubling of connectivity rate for the Black and Hispanic households and a roughly 50% increase over that two-year period for the White and Asian American/Pacific Island demographic groups.

When we turn to age as a demographic consideration, there are profound differences that appear in Internet use as well, with December 1998 and August 2000 as data points. In the

Figure 4
Percent of U.S. Households with Internet Access
By Race/Hispanic Origin, 1998 and 2000

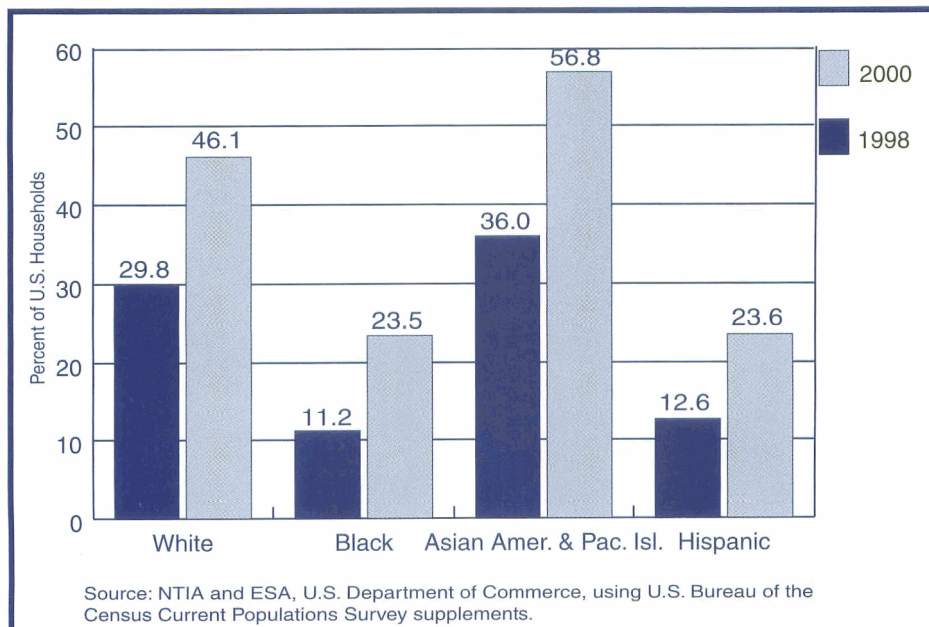
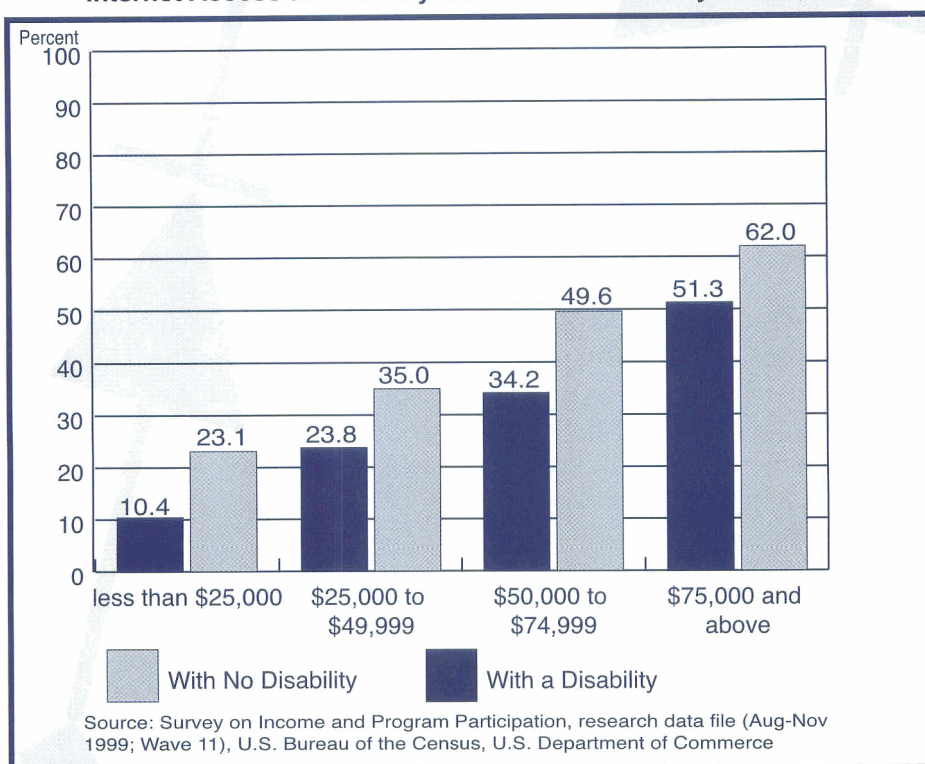


Figure 5
Internet Access at Home by Income and Disability Status, 1999



2000 data, the percent of Internet users is at its peak at 14 years of age with 65% of respondents, with a usage plateau of 50-60% of users from 18 to 52 years of age, and then we see a precipitous slide down to under 10% by age 80. Over the 1998-2000 period, there is increasing adoption at all age levels, with greater percentage gains among the more senior age cohorts.

Disabilities (figure 5) provide yet another major demographic area for a look at digital divide issues in Internet access (Source: Table III-1, Survey on Income and Program Participation, Research data file (August -November 1999, Wave 11), U.S. Census Bureau, U.S. Department of Commerce). With a total population over 16 years of age in late 1999 of 208.8 Million, 21.8%, or 45.4 Million, has some form of disability. These disabilities include: Difficulty Walking (9.2 million, or 4.4%), Vision Problems (7.3 million, or 3.5%), Hearing Problems (7.0 million, or 3.3%), Difficulty using Hands (6.3 million, or 3.0%), and Learning Disability (2.9 million, or 1.4%). Even considering income-level equivalence, there are profound negative consequences of disability access for Internet access at home, with the greatest relative percentage digital divides at the lower income levels.

In summary, the U.S. Department of Commerce has highlighted “progress but concerns” in its most recent reports summarizing changes over the past few years across the different categories for its empirical analyses of the digital divide: income level, educational level, race and ethnic origins, location, disabilities, age level, household type (single or two-parent), and gender. The Falling through the Net report emphasizes that:

“If current trends continue, we expect more than half of all U.S. households will be connected to the Internet by the end of 2000, and more than half of all individuals will be using the Internet by the middle of 2001. We are approaching the point where not having

access to these tools is likely to put an individual at a competitive disadvantage and in a position of being a less-than-full participant in the digital economy. Most groups, regardless of income, education, race or ethnicity, location, age, or gender are making dramatic gains. Nevertheless, some large divides still exist and groups are going online at different rates.”

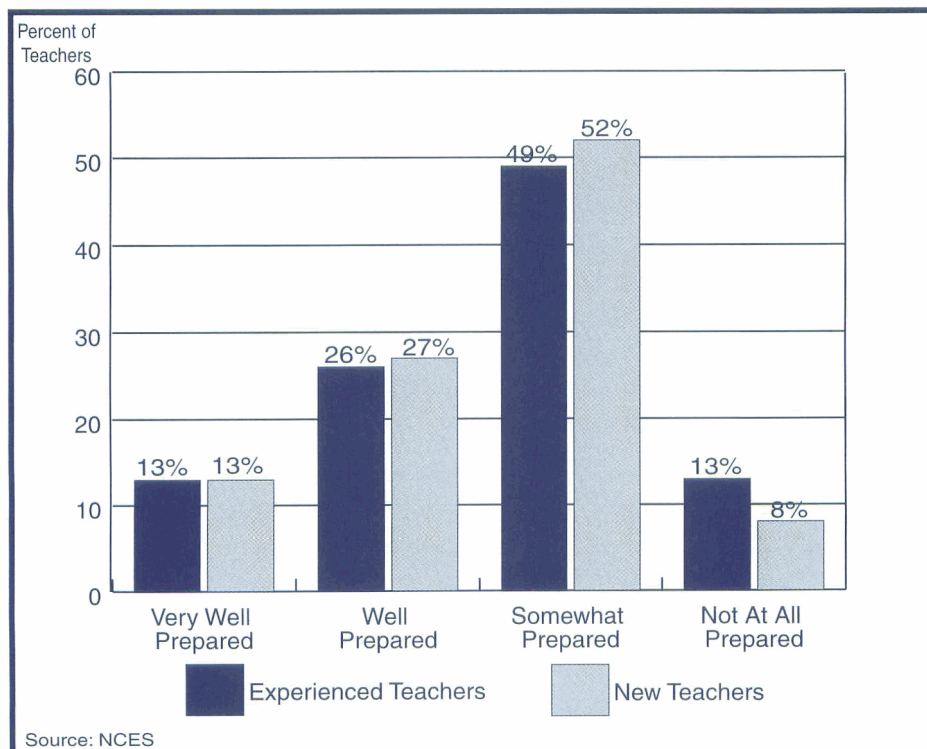
IN EDUCATION, SCHOOL INTERNET ACCESS IS GROWING RAPIDLY

After many years of a slowly shrinking ratio of students per computer in American schools, there has been exceptionally rapid adoption of Internet access in K-12 schools. Data from the U.S. National Center for Educational Statistics (NCES) reveals that from 1994 to 1999, the percent of schools with Internet access in public schools has grown from 35% to 95%; the percent of Instructional Rooms that are connected to the Net has increased from 3% to 63%. Furthermore, in 1999, Internet connectivity methods have developed considerably beyond the assumption of slow dial-up modem connections-fully 64% of schools in 1999 had dedicated WAN lines, with only 14% using dial-up. And the classroom computers are not isolated from one another within these schools, as 84% of public schools reported use of LANs in 1999 (unfortunately not reporting what proportion of their classroom computers are connected to their LANs).

NONETHELESS, THERE ARE SCHOOL-TYPE EFFECTS IN INTERNET ACCESS

NCES data released in its February 2000 report demonstrated a significant digital divide in schools serving lower-income communities. Schools with the highest concentration of poverty had 16 students per instructional computer with Internet access, compared to 7 among schools with the lowest concentration of poverty. And beyond such SES effects, there were important results for geographical region and for school size. Rural schools and

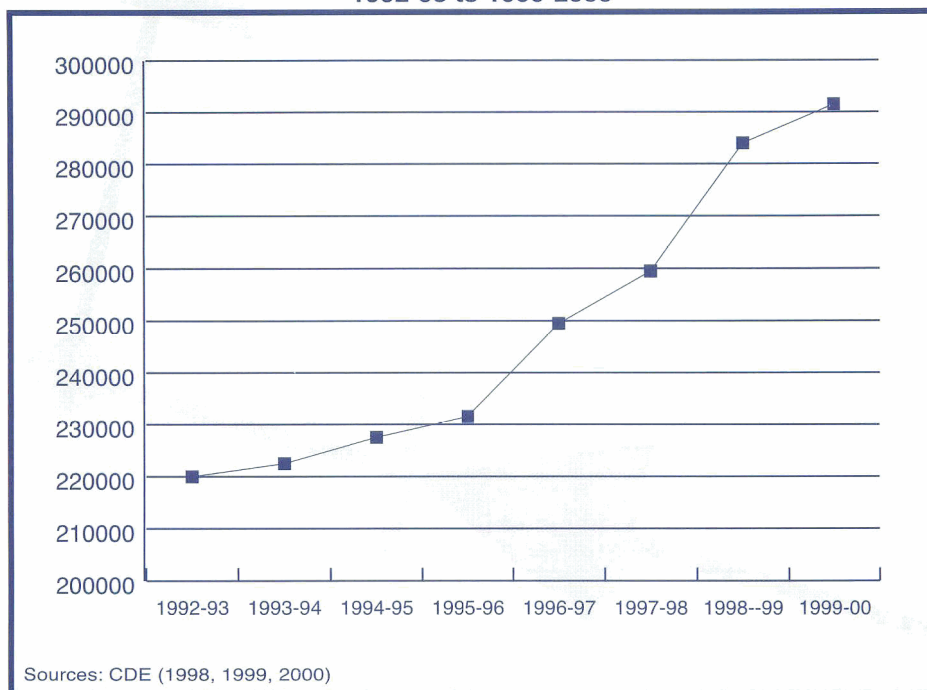
Figure 6
Teacher Preparedness for Technology



smaller schools are ahead of city school and larger schools in their provision of instructional computers with Internet access. In rural schools, there are 7 students per computer but in city schools, 11 students per computer. In smaller schools, there are 6 students per computer, but 10 students per computer in large schools.

The assumption in these benchmark comparisons are that more meaningful interactions with technology-enhanced learning environments are more likely with more computer access in the classroom. We need to know far more about which specific applications and digital content are being used in these classrooms, by which range and groups of students, and with what learning outcomes under different conditions of implementation, such as

Figure 7
Historical Demand for Teachers in California,
1992-93 to 1999-2000



level of teacher preparation, indexing to academic standards of the learning applications, home access to technology, and other such systemic concerns with learning environments (Roschelle et al., 2001).

TEACHER PROFESSIONAL DEVELOPMENT PROVIDES CRITICAL CHALLENGES

After years of focus on students and computer learning, teachers' preparation for integrating computers into their instruction has become a key topic for research. The most recent work in this vein from NCES is telling: fully 2/3rds of K-12 teachers use computers or the Internet for some classroom purposes, but most do not feel well prepared (figure 6). And this preponderance of ill-preparedness fits with data from self-reports on training: 81% had under 10 hrs of training with technology in the previous year (Source: Market Data Retrieval).

A related challenge to teacher preparedness to help students utilize the tools on the access side of the digital divide is that of recruiting and supporting professional development for a

Figure 8
Average Percent Underqualified Teachers
by School-Level API Score, 1999-2000

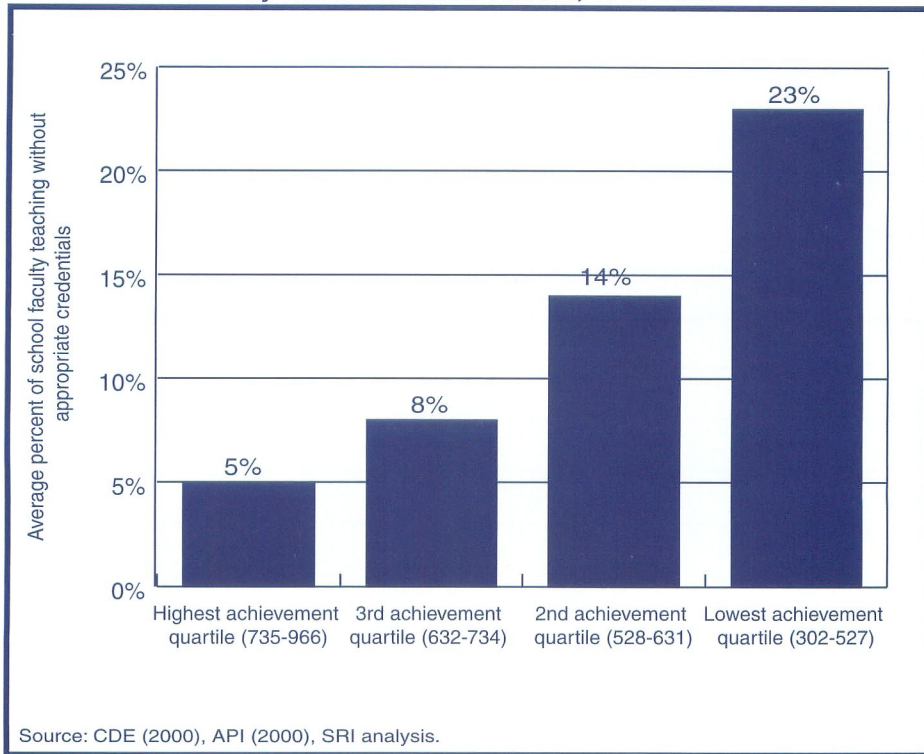
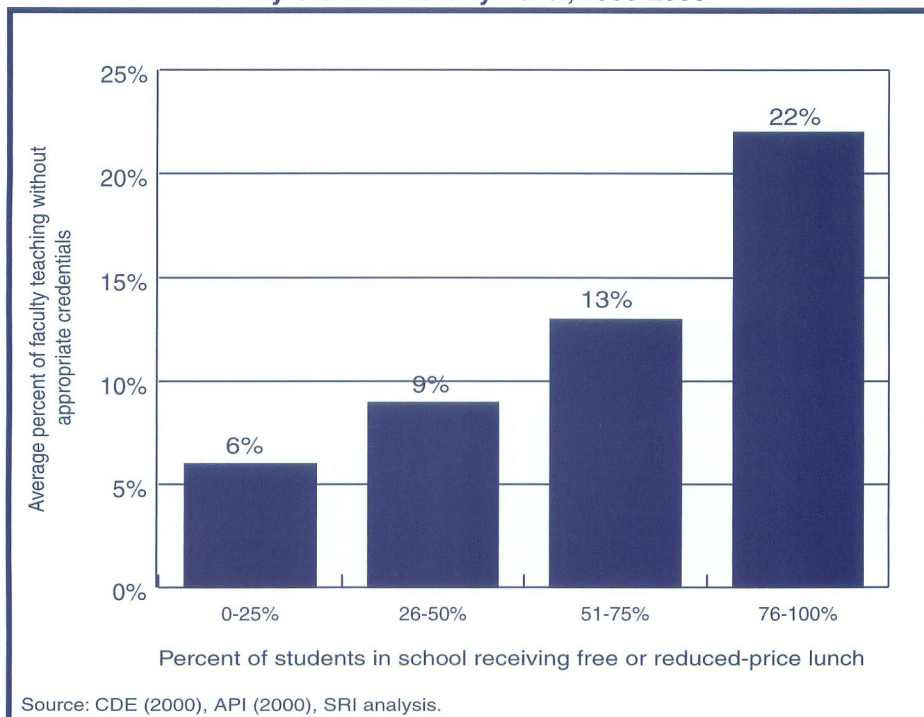


Figure 9
Distribution of Underqualified Teachers
by Student Poverty Level, 1999-2000



generation of new teachers. Due to retirements and increasing student enrollments, the projection for the number of newly hired public school teachers needed by 2008-09 ranges from 1.7 million to 2.7 million. (Source: U.S. Department of Education, Hussar, 1999).

A study conducted by SRI International, supported by Center for the Future of Teaching and Learning, and released in late 2000, identified the scope of the challenge for the State of California: with the demand for teachers at 291,000 and growing rapidly (figure 7).

And this report has sadly documented the present state of under-qualification among California's teachers. 14% of all California's teachers are under-qualified (over 40,000), with emergency permits or waivers, and 24% of schools have 20% or more under-qualified teachers (figure 8). And this study answers the question, with unfortunate results: Who are children most likely to be taught by an under-qualified teacher?

Quite simply, the average percent of under-qualified teachers goes up considerably as a function of the poverty level of the school (figure 9). And we can see the additional correlate of teacher under-qualification with student under-performances. When considering achievement data for students in their school-level API scores by quartile, we can see that for the four achievement levels that in the lowest achievement quartile, fully 23% of teachers are under-qualified and yet, in the highest achievement quartile, only 5% of teachers are under-qualified.

DIGITAL DIVIDE AND CALIFORNIA'S UNDER-QUALIFIED TEACHERS

Although the SRI report documents the scope and seriousness of California's problems with under-qualified teachers, we do not yet know about the relationships of high-poverty level schools, under-qualified teachers, and digital inclusion. Given the trends in high-poverty and digital access for home Internet use and school Internet use, we may conjecture that high-poverty level schools will not only have more under-qualified teachers, but less digital inclusion.

EXTENSIVE FEDERAL, STATE AND PRIVATE EFFORTS

In considering this California policy question, it is worth highlighting the extensive federal, state and corporate efforts that have contributed to addressing the digital inclusion issue for K-12 education. Most significant, by all accounts, is what is commonly called the E-Rate program. The E-Rate program was developed following the Congressional authorization of the 1996 Telecommunications Act (as the bipartisan Snowe-Rockefeller-Exon-Kerrey amendment), and has been able to provide since January 1998 over \$5.7 Billion as a universal service program for public K-12 schools and libraries by discounting Internet and telecommunications technologies and services. With discounts from 20-90%, depending on level of poverty, the poorest schools and libraries have been benefiting most, from every state in the union. There have been three years of funding, beginning in January 1998, with 83,188 applications funded as of December 1st, 2000 (<http://www.sl.universalservice.org/>). Carvin (2000), in a report funded by the Benton Foundation, provides a compelling case study series for four Midwestern cities and what the E-Rate program has been able to achieve for them.

Other federally-motivated efforts have included the U.S. Department of Education's funded partnerships among communities, industry, governments and education known as the Technology Literacy Challenge Fund; an ambitious program in its second year from the

U.S. Department of Education called the PT3 program that is seeking to transform processes of teacher preparation in the U.S. to integrate effective uses of technology in instruction, and Community Technology Center programs for low-income areas.

Companies that have contributed substantially in addressing K-12 digital divide issues include, in alphabetical order: AOL, AT&T's Learning Network, Cisco Academies, Ford, Intel's Teach to the Future Program, and Microsoft.

GOING BEYOND THE ACCESS QUESTION: "ACCESS TO WHAT? AND FOR WHAT PURPOSE?"

While the statistics on computer and Internet access in schools illustrate remarkable and measurable progress toward the access goal in the 1996 National Educational Technology Plan developed by the U.S. Department of Education, educators, researchers, parents, and policymakers alike have been digging deeper. Once the NetDays are complete, and your school is wired, and there are enough computers in your K-12 classroom to enable students to work productively in small groups for some part of the school day, the critical question is what have I now gained access to as an educator or student, and for what purposes will such access be useful?

As policy studies and reports have begun to tackle these questions, they have begun to document new and emerging divides that have significant "digital" aspects. These new divides include "Content Divides" and "Quality of Service Divides."

A chilling report from the Children's Partnership (March 2000) highlights how "50 million Americans face one or more content-related barriers that stand between them and the benefits offered by the Internet." The barriers they document and analyze include: (1) high literacy levels (i.e., the level of reading skill required by most web sites is beyond meaningful access for prospective Internet users with low literacy levels); (2) English-only websites (as the language used on websites is predominantly English); (3) Lack of cultural relevance (for many ethnic and cultural groups); and (4) Lack of local information (for community, healthcare, education, environmental, employment, and other vital purposes). They propose a variety of actions that could help ameliorate these content divides for the Internet and its users.

New "Quality of Service Divides" are emerging in studies that recognize that Internet access alone is not the appropriate metric, as there are many differentiating qualities of that access that influence the purposes to which the access may be put. The most evident of these QOS divides is perhaps speed of connectivity, with time requirements for rich media (audio, video) and software downloads prohibitive for modem-only Internet access. And it is highlighted in the new e-learning national plan (see below): "The quality of Internet access is critical. Broadband access will be the new standard. Slow, unreliable connections that cannot support interactivity or multi-media content will no longer be sufficient. To take advantage of access to technology for improved teaching and learning, it will become increasingly important to build and support network infrastructures-wireless, desktop or handheld-that allow multiple devices to connect simultaneously to the Internet throughout every school building and community in the nation."

But the broadband QOS divide is simply the beginning. The telecommunications industry and various dot.coms are diligently advancing the state of the art of QOS differentiation so that packets of information can be streamed with different levels of priority, as a function of

costs or other metrics. So even as the pipelines for telecommunications widen, and the connectivity to schools and homes increases in its breadth and speed, the K-12 educational sector is unlikely to be anywhere near the head of the queue for information packet transmissions. Whether these new developments will create new and significant QOS divides that negatively impact learning and teaching processes and outcomes remains to be seen. But it is a topic on which we should remain vigilant.

A NEW E-LEARNING NATIONAL PLAN

In December 2000, the U.S. Department of Education released a very significant update to the 1996 National Educational Technology Plan that had defined four educational technology goals: a computer in every classroom and every classroom wired to the Internet, computer training for all teachers and instructional software available to all students (<http://www.ed.gov/Technology/Plan/>). After \$8 billion of investment toward these goals during the Clinton administration, according to this document, the time has come to move beyond access to focus on patterns of use. The new five goals highlight the importance of going beyond counting computers and connections to now identifying effective digital content and technology applications and their conditions of implementation, and focusing, with the third goal below, on the new literacies that are emerging in an information society. The teacher focus is also distinctive: from an earlier concern with “training” in technology use to a new focus on effective use and integration of technology tools in support of students’ achievement of higher learning standards.

2000 NATIONAL EDUCATIONAL TECHNOLOGY GOALS

- Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.
- Goal 2: All teachers will use technology effectively to help students achieve high academic standards.
- Goal 3: All students will have technology and information literacy skills.
- Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.
- Goal 5: Digital content and networked applications will transform teaching and learning.

The e-learning report highlights illustrative case studies that show exemplary developments toward these objectives, while also highlighting specific national, state, local and private sector actions that will be necessary for all student and teachers to take full advantage of the new opportunities from emerging technologies for improving learning and teaching for all.

PROVIDING INTERNET ACCESS ALONE IS AN OVER-SIMPLISTIC RESPONSE

As we reflect on the extraordinary attention that has been devoted to issues of the digital divide and digital inclusion over the past several years, it is worth emphasizing how limiting such considerations are if taken too much in isolation.

“Digital inclusion” for social mobility requires skills and knowledge ranging from basic literacy to new technical fluencies for participation—with different strategies for home, school, community, and work. There are skills and fluencies that Internet users will need to have available or to achieve in order to take real advantage of the Internet’s resources for the

diverse purposes of lifelong learning and living, as addressed in the National Research Council report (1999) on Being Fluent with Information Technologies.

And there are multiply-determined pathways—social, economic, political—to the creation of groups found to define the “digital divides” in the studies by the U.S. Department of Commerce and others. To work on universalizing access alone, and expect that social policy in this realm can eradicate deeper economic or educational differences is to minimize how those differences are constructed.

Finally, we cannot ever forget that there are other fundamental divides to tend to than digital divides. Differences in access to parent care, nutrition, shelter, safety, healthcare, and opportunities to learn and work remain obstacles to fulfillment of the promise of the human condition and everyone’s ability to live a quality life and contribute to the greater good of society.

REFERENCES

For additional reading, see:

American Council on Education (1999). *To Touch the Future: Transforming the Way Teachers Are Taught: An Action Agenda for College and University Presidents*. Washington, D.C.

Carvin, A. (2000). (Ed.). *The E-Rate in America: A tale of four cities*. Benton Foundation Communications Policy and Practice Program. (<http://www.benton.org/e-rate/e-rate.4cities.pdf>)

The CEO Forum on Education and Technology (2000). *Teacher Preparation StaR Chart: A Self-Assessment Tool for Colleges of Education - Preparing a New Generation of Teachers*. Washington, D.C.

The CEO Forum on Education and Technology (1999). *Professional Development: A Link to Better Learning. The CEO Forum School Technology and Readiness Report - Year Two*. Washington, D.C. (<http://www.ceo-forum.org/downloads/99report.pdf>)

The Children’s Partnership (2000). *Online Content for Low-Income and Underserved Americans: The Digital Divide’s New Frontier*. (http://www.childrenspartnership.org/pub/low_income/index.html)

Cooper, M. N. (October 2000). “Disconnected, disadvantaged, and disenfranchised: Explorations in the Digital Divide.” *Consumer Federation of America and Consumer Union*. (<http://www.consumerfed.org/digitaldivide/disconnected102000.pdf>)

FCC Cites a Higher-Speed Digital Divide (article). (<http://www.washingtonpost.com/wp-dyn/articles/A33100-2000Aug3.html>)

Glenn Commission (2000). “Before It’s Too Late. A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century.” Washington, D.C.: U.S. Department of Education. (<http://www.ed.gov/inits/Math/glenn>)

Hussar, W. J. (1999). “Predicting the Need for Newly Hired Teachers in the United States,” NCES 1999-026, by U.S. Department of Education, National Center for Education Statistics. (<http://nces.ed.gov/pubs99/1999026.pdf>)

Moursand, D., and Bielefeldt, T. (1999). Will New Teachers Be Prepared to Teach in a Digital Age? A National Survey on Information Technology in Teacher Education. Santa Monica, Calif.: Milken Family Foundation, Milken Exchange on Education Technology; The National Commission on Mathematics and Science Teaching for the 21st Century (2000).

National Research Council (1999). "Being Fluent with Information Technology." Committee on Information Technology Literacy. Washington DC: National Academy Press. (<http://www.nap.edu/books/030906399X/html/>)

National School Boards Foundation (2000). "Safe and smart: Research and guidelines for children's use of the Internet." (<http://www.nsb.org/safe-smart/full-report.htm>)

Pew Foundation (2000). Who's Not Online: 57% of those without Internet access say they do not plan to log on. (<http://www.pewinternet.org/reports/toc.asp?Report=21>)

Roschelle, J.M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2001). "Changing how and what children learn in school with computer-based technologies," The Future of Children, Special issue on Children and Computer Technology, Fall/Winter 2000, 10(2), pp. 76-101. Published by The David and Lucile Packard Foundation.

Solomon, L. and Wiederhorn, J. (2000). "Progress of Technology in the Schools: 1999-Report on 27 States." Milken Exchange on Education and Technology. Milken Family Foundation. Santa Monica: Calif: Milken Family Foundation.

U.S. Department of Commerce. (October 2000). "Falling through the net: Toward digital inclusion - A report on Americans' access to technology tools." (<http://www.esa.doc.gov/fttn00.pdf>)

U.S. Department of Education (June 29, 1996). "Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge- A Report to the Nation on Technology and Education." (<http://www.ed.gov/Technology/Plan/NatTechPlan/>)

U.S. Department of Education (September, 2000). "The E-Rate and the Digital Divide: A Preliminary Analysis From the Integrated Studies of Educational Technology," by Pumam, M. J. , Chaplin, D. D. & and Pape, A.D. (http://www.ed.gov/offices/OUS/eval/erate_fr.pdf)

U.S. Department of Education (December 15, 2000). "e-Learning – Putting a World-Class Education at the Fingertips of All Children: The National Educational Technology Plan." (<http://www.ed.gov/Technology/elearning/>)

U.S. Department of Education, National Center for Education Statistics (2000a). Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology, NCES 2000-102, by B. Smerdon, S. Cronen, L. Lanahan, J. Anderson, N. Iannotti and J. Angeles. Washington, D.C. (<http://nces.ed.gov/pub-search/pubsinfo.asp?pubid=2000102>)

U.S. Department of Education, National Center for Education Statistics (2000b). Teacher Use of Computers and the Internet in Public Schools, NCES 2000-090, by C. Rowand. Washington, D.C. (<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000090>)

U.S. Department of Education, National Center for Education Statistics (2000c). Internet Access in U.S. Public Schools and Classrooms: 1994-1999, NCES 2000-086, by C. Williams. Washington, D.C. (<http://nces.ed.gov/pub-search/pubsinfo.asp?pubid=2000086>)

