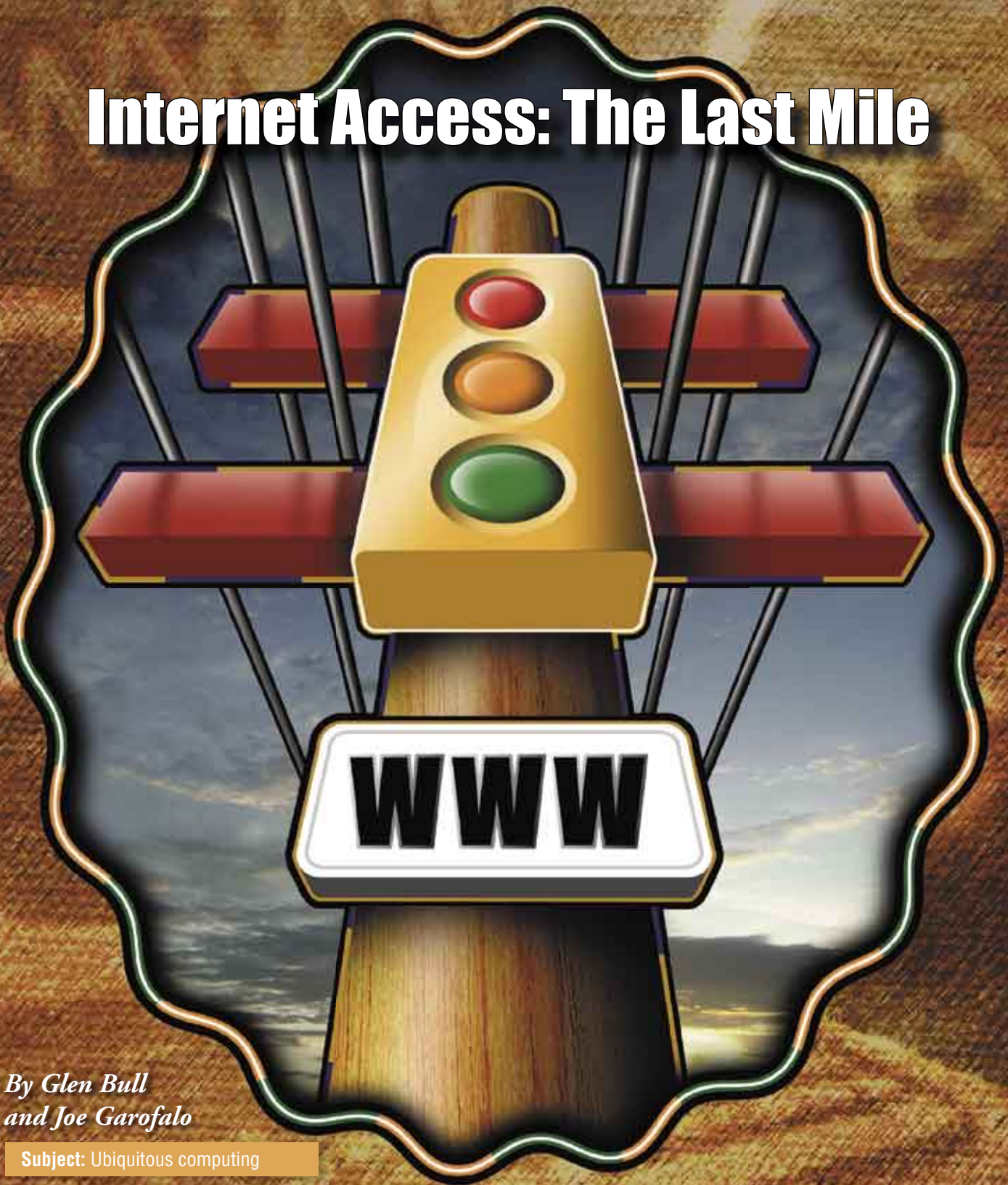
Internet Access: The Last Mile



By Glen Bull and Joe Garofalo

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Imagine a business that with great ingenuity and expenditure of resources placed a telephone line in every worker's office, but failed to provide phone receivers for them. A new CEO of the firm would immediately recognize the need to place a phone receiver in every office with a phone line to make those lines usable.

This scenario is absurd because it would not be sensible to deliver phone lines to offices without phone receivers. In fact, it is inconceivable that the business market would create such a system. Yet this is precisely the current state of affairs in schools. For a number of years, Henry Jay Becker and his colleagues have conducted a series of studies monitoring use of computers in schools. In their 1999 report, *Teacher and Teacher Directed Use of Computers & Software,* they noted that, "Regular use of computers with students is highly dependent on access to computers … most teachers have relatively few computers compared to the number of students in their classroom." (***Editor's note:*** For this and other resources, see Resources on p. 19.)

An average classroom today has only one to three computers—an insufficient number to allow a class of 25–30 students appreciable access to the Internet. In a 2003 survey by Norris et al., *No Access, No Use, No Impact: Snapshot Surveys of Educational Technology in K–12*, half of responding teachers reported using computers with their students less than 15 minutes per week. Less than one-fifth of the teachers reported using computers 45 minutes or more per week. The teachers attributed failure to use computers with their students to lack of access.

The Last Mile Problem

The term *last mile* was coined by the telecommunications industry to describe the unwieldy mile of copper cable that inefficiently completed connections for Alexander Graham Bell's photophone, the precursor to fiber optics. Today, it is used to describe any innovation that involves exceptional expense or difficulty to complete the connection at the end point of a network that makes the innovation usable.

The last mile problem proved to be a challenge for extension of telephones, water and sewer lines, and rural electrification. For example, even though the electrical grid was begun at the end of the 19th century, it was well after World War II in the 20th century before the majority of rural homes in the United States were connected to the electrical system.

In the case of the Internet, even though links have been brought to the walls of the classroom, the last remaining gap between the network and the learner has yet to be bridged. Norris and colleagues note that the majority of schools do not provide a way for students to interact with the technology despite the investment made to bring Internet connections to schools.

The educational system has accomplished the equivalent of delivering telephone lines to every classroom while failing to provide phone receivers that allow learners to make use of this resource in school. The 2002 Pew Foundation report, *Digital Disconnect,* documents the Internet as having substantial positive effects on learning, but not in schools: "Internet-savvy students rely on the Internet to help them do their schoolwork—and for good reason. Students told us they complete their schoolwork more quickly; they are less likely to get stymied by material they don't understand; their papers and projects are more likely to draw upon up-to-date sources and state-of-the-art knowledge; and they are better at juggling their school assignments and extracurricular activities when they use the Internet." This report notes that schools have, in general, failed to recognize this transformation in learning.

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Next Steps

Three steps are necessary to rectify this state of affairs:

1. Schools and national educational agencies and associations must recognize this state of affairs exists.
2. Technological strategies need to be devised to bridge the last mile and place technology in learners' hands.
3. Leadership policies need to be developed that will ensure that access to technology will lead to gains in learning and achievement.

The leadership dimension is important. The Pew Foundation study found that even when access was potentially available in schools, educational benefits were undermined by a failure of leadership. Policies were often restrictive rather than facilitative. It was clear from the report that until school administrators provide leadership, nothing will happen, even when the technology is in place. "School administrators and not teachers set the tone for Internet use at school. The differences among the schools attended by students were striking."

Strategies for Technological Access

A variety of technological strategies can be used to address the access problem. Access strategies could include providing a computer projector to every Internet-connected classroom or one-to-one computing strategies such as placing a handheld or portable computer in the hands of every learner.

Every teacher knows it is not possible for 30 students to huddle around a single computer monitor to view the Internet and other digital content. One obvious solution is a computer projector. A tool is only as effective as the teaching methodology employed, however. It is possible to use a projector for didactic presentations to passive, unengaged students. This use, of course, does not reflect sound pedagogy and does not take full advantage of the potential of this technology. The technology need not and should not be used in this way. Well-prepared teachers who have access to a computer projector in their classrooms often use this technology as a vehicle for facilitating student inquiry, creativity, and engagement, even in a whole-class setting.

We recently conducted several formal and informal studies on the effects of computers and projectors in schools. Students and teachers in classrooms we observed use projectors to display student-generated and Web-derived graphs, data, images, simulations, and text for interactive whole-class discussion and analyses, and access background support materials such as primary digital sources and simulations to provide context for the exploration of topics.

The students in these classes used projection displays in concert with a wireless keyboard that could be passed from student to student. Students in language arts classes used this capability to collectively brainstorm ideas and to co-author essays and poems. They also used the display to analyze text and images and share their compositions and haikus with the whole class. Students in mathematics classes demonstrated and discussed interactive mathematics applets. They also presented collaboratively written chapter reviews highlighting important concepts, definitions, procedures, and applications. The teachers in these classes displayed samples of written work for small group and whole class analyses. They also accessed Web sites and streaming videos related to class topics.

Their classrooms are highly interactive during these activities, with students enthusiastically and actively generating, analyzing, and interpreting content and concepts. One teacher commented on the instructional effects of a projector, "I bought this laptop last year thinking it would be useful in the classroom. All I ended up doing with it was writing lesson plans. Without a projector, it's a planning tool, not a teaching tool. With a projector, it is a teaching tool."

Even when every student has a computer, a projector is still needed. Another teacher whose students all had wireless handheld computers commented that having a projector in her room was crucial. She explained, "Having 17 kids on 17 computers creates a need for crowd control—it's hard to know where and when all 17 are focusing. The projector adds a focal point to the class."

This classroom situation parallels the evolution of graphing calculators. Early adopters of graphing calculators immediately realized the need for a projection system, even though each student had a graphing calculator. The projection devices that manufacturers subsequently developed for these calculators are widely used in today's math classrooms.

Classes can be equipped with projectors for a fraction of the cost of developing the infrastructure for bringing the Internet to classrooms. Adding a projector to every classroom with an Internet connection could make it possible to realize substantial benefits from the previously made investment.

A viable alternative in the longer term is to provide each student with a portable, wireless computer. If we were designing such a device for schools, we might envision a device larger than a personal digital assistant (PDA) but small enough to fit in a backpack—perhaps the size of a paperback book. In essence, this would constitute an electronic learning slate.

Many secondary students already have access to one-to-one computing in mathematics, because of the availability of graphing calculators. These are specialized handheld computers designed to facilitate mathematics teaching. They have increased student learning in classes of capable teachers who understand best practices. Graphing calculators offer what mathematicians call a *proof of concept* that one-to-one computing is possible. However, they are single-subject devices, primarily useful in only one content area. A multi-subject personal learning device with a wireless Internet connection and software to facilitate teaching in all of the content areas would address the current digital disconnect in schools.

It appears likely that for a cost of two to three times that of a graphing calculator, it may be possible to provide each student with a portable, wireless learning device in the near future. Students could move from less than a half-hour of access per week to complete access throughout the entire time they are at school.

A Tale of Two Technologies

The contrast between introduction of the graphing calculator and introduction of the Internet in schools is instructive. Both occurred during approximately the same time frame, over the span of approximately a

decade. Both represented substantial investments in education. Both technologies are now present in virtually every secondary school. However, the results have been very different. One of these technologies has had a substantial, positive effect on teaching and learning. The other technology has thus far failed to demonstrate educational benefits commensurate with the size of the investment made.

The graphing calculator is the success story in this comparison. In 1990, virtually no mathematics classes used graphing calculators, and their use on advanced placement examinations was prohibited. They are now used on a one-to-one basis in mathematics classes in more than 90% of all high schools and are required on national Advanced Placement and state mathematics examinations.

The Internet is the technology in this comparison that has thus far failed to yield demonstrable educational benefits commensurate with the unprecedented investment made. In 1994 at the advent of the World Wide Web, few U.S. classrooms had Internet connections. In 2004, more than 90% of all U.S. classrooms have an Internet connection. Yet this increase in connectivity has had only a limited effect on teaching and learning because students have insufficient access in schools.

Need for Recognition

What is now needed is recognition that a last mile challenge exists in U.S. schools and the resolve to bridge this divide. In other disciplines, grand challenges are often used to focus attention on problems. For example, John F. Kennedy captured the national imagination with a grand challenge at the beginning of his presidency, asking the nation to commit itself to the goal of landing a man on the moon and returning him safely to Earth before the end of the decade.

The National Science Foundation routinely issues grand challenges in engineering and science. These challenges are used to secure legislative funding to address worthwhile problems and to focus the best minds and intellects on solutions.

It has been estimated that approximately $80 billion has been invested in U.S. schools over a decade to bring an Internet connection to almost every classroom. During the same time period, for only about $1 billion, schools and parents provided the majority of secondary mathematics students with graphing calculators.

A computer projector could be placed in every classroom with an Internet connection for a fraction of the cost that was required to develop this educational network, bridging the last mile between the network and the learner. In the longer term, Moore's Law will assure that it will be possible to provide every student with a portable, wireless learning device designed for schools.

This article is a call to educators to frame a grand challenge to the nation to address the last mile. With the leadership support of ISTE and under the auspices of the National Technology Leadership Coalition, a National Technology Leadership Summit (NTLS VI) will be convened this month. This coalition includes the national teacher educator associations representing the core content areas in science, mathematics, English, and social studies, as well as their counterparts representing educational technology. Their charge will be to identify appropriate strategies to address the last mile challenge in schools.

During September 2004, readers of *L&L* can post recommendations and suggestions for these educational leaders at http://www.teacherlink.org/lastmile/. We would like to know how you have addressed this issue in your schools, and how you believe this challenge might be met.

Conclusion

During the past decade, American taxpayers have provided billions to ensure that the Internet reaches every school and almost every classroom. This is the largest single discretionary investment that has been made in schools. We have a responsibility to make effective use of this investment to yield a commensurate educational return. The Pew Foundation report concludes, "In the final analysis, schools would do well to heed the Latin writer Seneca's words. 'The fates guide those who go willingly; those who do not, they drag.'"

If we are successful in meeting this challenge and providing the necessary leadership, the last mile technologically will become the first mile in educational advances for our students.

Resources

Becker, H., Ravitz, J., & Wong, Y. (1999). *Teacher and teacher-directed student use of computers and software.* Irvine, CA: Center for Research on Information Technology and Organizations. Available: http://www.crito.uci.edu/tlc/findings/computeruse/.

Norris, C., Sullivan, T., Poirot, J., & Soloway, E. (2003). No access, no use, no impact: Snapshot surveys of educational technology in K–12. *Journal of Research on Technology in Education, 36*(1), 15–27.

Pew Internet and American Life Project. (2002). *The digital disconnect: The widening gap between Internet-savvy students and their schools.* Washington, DC: Pew Research Center. Available: http://www.pewinternet.org/reports/toc.asp?Report=67.

Glen Bull is co-director of the Center for Technology and Teacher Education and Ward Professor of Education in the Curry School of Education at the University of Virginia.

Joe Garofalo is co-director of the Center for Technology and Teacher Education and an associate professor of mathematics education in the Curry School of Education at the University of Virginia.