

Foreword

Over the last decade, a tremendous investment has been made in Internet access for schools. In 1990, few U.S. schools had Internet connections, and many of these were low-speed, dial-up modem connections from a single computer. By 1994, the proportion of schools with Internet access was significant—at 35%—and by 1997, it had risen sharply to 75%.

School connections are just a rough indicator of access, of course, because they may be in an administrator's office that is off limits or in a lab or media center that is shared by so many classes that teachers cannot count on access when they need it. Thus, the figures for classroom Internet access are more pertinent, and here the change has been just as dramatic. In 1994, the proportion of U.S. classrooms with Internet access was just 3%; by 1997, it had grown to 27%. In early 1999, the U.S. Department of Education announced that over half the classrooms in the United States have Internet access; by the fall of 1999, the Department expects 80% of U.S. classrooms to be online. President Clinton's 1996 call for getting every classroom in America on the Internet no longer sounds like far-fetched political rhetoric. With so much progress on the infrastructure front, educators today are confronting the question, "Now what?"

Certainly, supporters of this multibillion-dollar investment have believed that network access would contribute significantly to the improvement of education. One of the best-articulated

applications of Internet access with promise for substantive contributions to learning is network science. Rather than simply searching for information and copying text or graphics, students in network science projects perform activities essential to the practice of science—taking measurements according to structured protocols, both contributing to and drawing from scientific databases, analyzing and interpreting data, and communicating and discussing their conclusions. The vision of students, teachers, and classrooms collaborating on investigations and sharing data and insights through the global network, in fact, preceded the World Wide Web. Without any of the ease of use associated with the graphical layout and interactive features of modern web sites, the National Geographic Kids Network project nevertheless pioneered classrooms sharing data with each other in 1989.

Yet a decade later, despite the greater usability of today's web interfaces, the best efforts of a large number of talented people, the vast improvement in computer and Internet access, and the conceptual compatibility of network science programs with national science and mathematics standards, collaborations between classrooms and distant partners over the network remain the exception rather than the rule. Becker and Anderson's national survey of teachers in 1998, for example, found that only 6% had their students collaborate with other classrooms over the Internet during the 1997–1998 school year.

Why are network science programs so slow to take hold? When they do get started, why are so few teachers taking advantage of the opportunity to have their students collaborate with distant classrooms? Feldman, Konold, and Coulter address these questions based on over a decade of experience with a succession of network-based science programs. Much of the pioneering work in cross-classroom science inquiry was done at TERC. The candid reflections of these authors help us understand the classroom realities that often undermine the ideal of student scientists working on significant investigations through the Net.

Two aspects of their analysis strike me as fundamental. First, the teacher's role is pivotal in inquiry-oriented science teaching, regardless of whether telecommunications are involved. Oversimplified characterizations of the teacher's role as that of "guide on the side," responding to student requests for assistance, can leave the erroneous impression that students can be launched

into an investigation posed by a curriculum developer with little teacher involvement beyond availability for responding to questions. Detailed studies of classroom interaction suggest that, on the contrary, successful student investigations occur in classrooms where teachers give students considerable responsibility but still actively shape the nature of both their queries and their analyses and interpretations.

Technology proponents have suggested that we need to transform teachers into proficient users of Internet resources and tools. The experience of network science projects suggests that comfort with technology tools per se may be much less an issue than comfort with the subject matter and data analysis at the heart of network science projects. Teaching teachers to use Internet browsers and spreadsheet software will not be enough; we need to make sure that they understand the science, the kinds of questions that can be addressed with data, and the analytic techniques that can address those questions with data. Moreover, teachers need to be able to make these difficult concepts accessible to their students. This book has far-reaching implications for the design of teacher professional development that will support effective educational uses of the Internet; those implications run counter to the narrower, technology-training path now taken by many districts and universities.

The second fundamental aspect of the authors' analysis is their argument that the kind of adult and peer support that can come from sharing data and interpretations are more likely to arise in the face-to-face classroom setting than over a network. Experience shows that few student exchanges in network science projects deal with scientific substance. Students are more likely to engage in social exchanges over the network and deal with data analysis and interpretation locally.

Certainly, the discussions that occur asynchronously over a network are more loosely coupled than those that occur in real time face to face. A student's question or conjecture sent out over the network is not likely to be answered immediately. In fact, more often than not it receives no response at all. Under such circumstances, it should not be surprising that students rarely attain new insights through their network interactions.

If the goals of network-based collaboration are to be attained, project participants need to develop a shared set of interaction

patterns and norms conducive to reflection and intellectual growth. Because they have little experience with conversations about the analysis and interpretation of data, it is little wonder that few students engage in such conversations asynchronously over a network. Providing models of such exchanges and teaching students to be active participants in them, as the authors assert, are best done locally. Once such norms are established, project participants can reinforce the idea that they apply within the electronic realm as well as within the four walls of the classroom.

An elementary classroom I observed using the Computer-Supported Intentional Learning Environment (CSILE), for example, preceded use of this local-area-network technology by developing a set of norms for classroom interactions. Students were taught not just to avoid put downs, but to offer helpful, thoughtful responses. Their teachers stressed giving peers feedback that provides information or an idea to help the original speaker improve his or her work. The students learned that, although compliments are nice, they do not support improvement in the way that helpful, thoughtful comments do. Teachers found that their students extended the practice of providing helpful, thoughtful comments developed for face-to-face interaction to their work on the computer network.

Network science projects typically have devoted little attention to developing roles and norms for interactions. Without such norms, students feel little obligation to respond to the queries and conjectures of distant participants they have never met. The sense of mutual obligation is never established, and local priorities naturally take over.

In the end, I finished this book with two reactions. First, it reinforces my conviction that teachers' science knowledge and nontechnology skills are critical in making network science work for students. Second, despite technology having changed so drastically over the last 10 years, we have benefited greatly from the lessons learned in the early network science classrooms. Although the original vision was in some ways flawed, and these authors articulate and explain the nature of those flaws, that vision did inspire innovative classroom projects that generated a knowledge base on which later programs could build. The efforts of the early network science classrooms and project designers have made it possible for us to design programs using today's technology with

a much better understanding of both the elements for successful classroom telecommunications and the role of data-driven inquiry in science education. As network technology matures and spreads, we will continue to draw on the lessons provided by these pioneering teachers and program developers.

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