Journal of Research in Rural Education, Spring, 1993, Vol. 9, No. 1, 51-55

A Concluding Reflection

Richard Ruopp
TERC, Inc.

This special issue of *The Journal of Research in Rural Education* is about a relatively new medium—telecommunication; about messengers sending and receiving in support of one another—teachers principally, but also students; and about a particular kind of message—project-enhanced science learning. And the teacher essays set the context in rural settings.

All four of these factors—medium, messengers, message, context—must be part of the research equation. We have learned from the essays something about how these factors play themselves out in rural settings. Perhaps the most powerful effect is the overcoming of isolation: The hooking up with teachers and students in other places and thereby gaining access to important sources of information and glimpses of other worlds. We have also learned something about potential barriers: lack of money and resistance to change. Each of these dimensions represents its own set of research questions.

There is still an extraordinary opportunity to do natural studies in rural schools that have no telecommunication experience. Many isolated areas of the country are untouched by this technology, have no community of practice, and no contact with PESL. Baseline data could be carefully collected and then the communication medium and the message of hands-on science introduced. In fact, LabNet would cooperate with any researcher who wanted to pursue such an investigation (contact Shahaf Gal at TERC).

Before closing, I want to return once again to the three themes cast in terms of a future agenda both for the community of practice and for telecommunication.

A Future Agenda for Messengers, Medium, and Message

What we of the LabNet staff have to say about agenda setting for the future must necessarily be modest. The LabNet project itself is a modest, although seminal, effort. It is not a policy study but a demonstration—although, to be sure, it has policy implications. It is always tempting, in the debate about improving education, to be expansive. We have resisted that temptation and reduced our recommended agenda for an uncertain future to three items:

1. We believe that science teachers can and should take an active leadership role in building a community of practice. They can effectively nourish both their own professional development and the growth of the community. And we believe it's critical that they do so.

2. We believe that NSF has a crucial role to play in building a national telecommunication system. NSF should forcefully move to create a nationwide telecommunication capacity to serve teachers and students in both secondary and elementary schools. As a first step, NSF should fund an effort to collate the knowledge of system design that has already been amassed in demonstration projects. The agency should then fund "design experiments," as necessary, to fill important gaps in existing knowledge.

3. We believe that NSF has a dual role to play with regard to project-enhanced science learning. NSF should provisionally encourage implementation of the project approach. Specifically, it should launch a small grants program to enable teachers to disseminate the PESL philosophy and project ideas; and it should explore ways of bringing scientists and teachers together. And it should, at the same time, fund careful research on the immediate and long-term impact of projects on students' learning in order to build the project-enhanced science learning data base.

Building the Community of Practice

Based on LabNet's experience, what are the key traits of the model of a community of practice we espouse?

It must be self-generating and self-sustaining. Although the initial impetus may have come from the LabNet staff, we now see teachers supporting each other, teachers taking leadership roles. Surely, these are the most important characteristics if there is to be permanent and durable change in science teaching and learning—not top-down change, but incremental gains that proceed from the inside-out.

Dick Ruopp is LabNet's Principal Investigator at TERC, Inc., 2067 Massachusetts Avenue, Cambridge, MA 02140.

It must be a community committed to reform. This is not a necessary or universal characteristic of professional groups. Formal professional associations can be quite conservative, especially if they are self-regulating, like the American Bar Association or the American Medical Association. And we know that high school science teachers run the gamut of perspectives about what works in education. But there are two significant differences between the science-teaching profession and other disciplines. Teaching is ultimately about learning, and learning is about change and growth. And science is ultimately about exploring the unknown. Thus, the profession has an inherent forward motion that can only be accelerated by the failure of the current textbook-lecture-lab approach.

It must be a community that includes educational researchers and innovators. A compelling case can be made that an outside party like TERC is necessary not only to provide the initial stimulus but also to play an ongoing role as a source of information—a gadfly, perhaps, to insure sufficient reflection and, most important, a pipeline to new innovations. There are important discoveries in the learning sciences on the one hand, and powerful and useful learning technologies like telecommunication and MBL on the other, that emerge in research and development settings.

Because teachers' central task is teaching, they are rarely in a position to know about these developments, nor do they have time to evaluate them independently. But through the community participation of researcher-developers, teachers can become aware of new opportunities that are directly applicable to their craft.

It must be a community of equals. The LabNet experience has clearly demonstrated the value of a collaboration in which the contributions of the partners are seen as equal. "You know about teaching physics. I know about developments that support the use of projects to enhance science learning, and about networks and MBLs as powerful tools. Let's get together and see what new syntheses we can forge that will inform both practice and further research and development. I'll respect and listen to your expertise. You do the same for mine."

It is a delicate balance: If academic and policy agencies are allowed to assume the role of "expert," with teachers as the recipients of the "expertise," the dynamics of real reform are jeopardized. Teachers are on the front line, experts are not. The situation is analogous to students being passive recipients of teachers-as-authorities. They may do well on tests, but can they think and act for themselves?

In summary, the community of practice must take the responsibility to create, re-create, and sustain itself over the long run—inviting in and welcoming collaborators as they are needed. Who better to be the agents of change than teachers themselves? This is a pretty heady vision: teachers reclaiming the ancient role of determining what gets taught and how it gets taught—and regaining the dwindling respect for their profession.

Building a National Telecommunication Network

In addition to the National Geographic Society Kids Network, other experiments and demonstrations offer a wealth of experience on which to build. But no existing network comes close to fulfilling the requirements for a national network to serve high school science teachers.

Project-oriented telecomputing efforts like the Quill project (Bruce & Rubin, 1992), TERC's various efforts like the Star Schools project, the Kids Network, the LabNetwork, the Global Lab network—or more general networks like K-12Net, FrEdMail, PSINet—have paved the way for broader and deeper exploitation of the telecomputing medium for science teachers and their students. But efforts have been sporadic and uncoordinated.

Like the telephone system in its early days, more than 100 different systems exist, both private (e.g., CompuServe, Prodigy, GEnie, America Online, AppleLink, Delphi) and public (e.g., BITNET, NSFNET, NEARnet, UUNet). Some can connect with each other, others cannot. Some are sophisticated and easy to use, others provide only basic text transfer and are used with difficulty. Some are costly, others are quite inexpensive.

Perhaps the most useful model of coordination of networks for widespread access is the Internet. It ties together more than 5,000 networks in some 107 countries primarily in the service of the university and research communities. Recently, the Virginia Public Education Network (VA.PEN) has set about making access to Internet part of a statewide educational network available to all teachers (Bull, Harris, & Cothern, 1992). A newer similar effort is taking place in Texas (Stout, 1992). These state-level efforts are demonstrations of particular importance, given the political boundaries of education.

However, except for a few experimental demonstrations like LabNet, no nationwide telecomputing network has yet been designed or redesigned with the high school or elementary school science-teaching community of practice specifically in mind. We believe such a network could contribute materially to the improvement of science learning. It is time for NSF to address this situation. And it is in the process of doing so through its participation in the development of the National Research and Education Network (NREN):

> The vision of... NREN is of an interconnection of the nation's educational infrastructure to its knowledge and information centers. In this system, elementary schools, high schools, two- and four-year colleges will be linked with research centers and laboratories. (Office of Science and Technology Policy, 1991, pp. 18-19)

Beverly Hunter, formerly of NSF and now at TERC, described the potential of a national network to be a vehicle for education reform. The time table? "A reasonable goal is to have in place by 1995 the intellectual, technological, educational, and organizational foundation necessary for productive and efficient use of computer-communications networks for education on a nationwide scale" (Hunter, 1992, p. 31). Assuming this schedule is correct—it's probably optimistic—there is only a short time to do a considerable amount of important work.

There are three kinds of issues that must be addressed if a *working* national network in support of science education is to be achieved. The first two deal fundamentally with ease of use and access: The telecomputing technology needs to be improved and the cost to the local school has to come down, or be borne by the public (as in Virginia and Texas). For example, the TERC Alice project is creating both user and host software that will make possible easy transmission of text, data, and graphics from different computers over virtually any network that makes use of it (Parker, 1992). Costs will come down as demand rises and the public benefit is established.

The third issue is more substantive: What message on this medium will make a difference to working teachers? Solving the problems of ease of use and cost by themselves won't guarantee that the community of practice will be strengthened or that science learning will be improved. Having the ability to easily transmit and receive information won't ensure its utility. Reduced costs may not correlate with increased value. It is precisely the intellectual content on a network and its utility for the daily needs of the working teacher that is at issue. Being able to tap the information sources of the nation is meaningless unless that information is in a form that can be used. We know something about what's important to teachers of physics from LabNet, and a bit more from the literature detailing other projects. We need to know much more if we are to specify accurately the human dimensions of a working K–12 science-telecomputing network.

It is important not to let technological capacity determine the future of telecomputing in schools. Telecomputing is a tool, nothing more. There now has been enough experience to derive a good deal of knowledge to inform both practice and further action research. It is appropriate for NSF to act in two areas.

Collating What We Know. It would be timely to assemble a compendium of what has been learned about the human factors operative in telecomputing. There is now a fair amount of literature on the subject that could be organized and plumbed both for insights and yet-to-be-answered questions. Perhaps a conference, "Assessing the State of the Art of Telecommunication," could be used as a mechanism for rapidly drawing together needed information. What inhibits or ensures the success of a network? What are the clues that could keep an expanding national science network from becoming a modern-day Tower of Babel? Do we already know how to organize a network in support of science improvement so that it doesn't fall prey to a new kind of education bureaucracy? These and other pertinent questions should organize our way of looking at what we know in the service of improving practice.

Implementing Design Experiments. There are things we may not know yet from the literature. For example, if we want to build and test an on-line database of project ideas, how can it be done most effectively? What taxonomy should be employed? How can users contribute a running commentary of their experience? How much management is required? Can it be done by volunteers? The assumption is universally held that access to information will lead to good things. This assumption needs to be tested.

There are many design experiments of this kind that could profitably be carried out. What kind of training best prepares teachers for telecomputing? How can teacher-training institutions be made active collaborators in building a national network? The Virginia PEN is organized regionally; is this an advantageous arrangement? Is it transportable? Does giving teachers access to telecomputing from their homes fuel more rapid development of the community of practice? What are the best ways of incorporating working scientists and others from allied professions on a network? (TERC's experience in this matter is far from clear.) As an alternative or addition, could college science students be effectively utilized as "telecomputing aides"? How do you effectively organize a network with thousands of users to serve local needs? What is the best way of keeping alive and making easily accessible many topic threads on a forum? How can students doing projects be integrated on a network without adding heavy administrative layers or excessive "volunteer" teacher time?

Again, a design conference to lay out an action research agenda, tied to developments like NREN, could be a powerful way to narrow attention to the most crucial questions.

Final Thoughts

Will a community of practice grow and flourish among high school science teachers, perhaps eventually reaching those who teach science in elementary schools? Will networks become the principal medium for teachers to talk to each other about their work, thereby supporting the growth of a national community of practice? Will student-selected and student-initiated projects spread and become the principal *leitmotif* for reshaping science learning?

In short, will a community of science teachers, dedicated to project-enhanced science learning and sharing their craft via telecommunication, excite more students to take science courses and increase both the number of scientists and science-literate citizens?

We wish we could say that the unqualified answer to each of these questions is "yes." Both by conviction and by the incomplete but compelling evidence from the LabNet experience, we think that these three elements properly integrated—community of practice, telecommunication, projects—can be a powerful force for the reform of science education, particularly in rural settings. But gazing into the crystal ball and predicting the direction of reform is an uncertain business at best. There is no historic precedent for a long-term, sustained, coherent, national effort to improve science education.

Rather than a crystal ball, the more apt image is one of those Christmas glass balls you shake to make a blizzard. In this country, the winds of educational change blow from all directions; vision is often obscured. Even when there is agreement on a problem—falling test scores, fewer students taking science courses, fewer teachers preparing for science teaching—proposed solutions come from every ideological quarter and often are incompatible. Requiring more instructional time, more rigorous standards, and more sanctions for failure all are light-years away from engaging students so that they spend more time doing school work because they want to, teaching them to tackle important questions and problems on their own initiative, and helping them to see failure as an avenue to enlightenment.

This multiplicity of views of what is wrong with schools, and competing prescriptions of how to fix them, is both the zenith and nadir of educational reform. It means continuing concern and debate. It also means endless controversy and internecine conflict. New solutions have short lives as they are displaced by contending remedies. One generation of parents may join the fray and influence new practices, but then they are gone and a new cohort has to learn the issues all over again. This is also true of school boards, teachers, and other educational professionals.

To date, no stable view of the learner and the learning process has emerged. Physics can adopt indisputably the theory of relativity. The findings of medicine coupled with techniques of Madison Avenue can decisively change smoking habits. Satellite photography can chart beyond question areas of drought and the destruction of rain forests and the traces of ancient civilizations. But what has been established about how children develop and learn is not widely understood, when known not necessarily believed, and is not now generally implemented in either public or private education (or for that matter, in the home).

And this is the nub of the issue of intentional change in education. Curriculum reform, teacher-training initiatives, reconstruction of the system to revalue the authority and role of the teacher, setting national standards, and new assessment efforts will never be enough by themselves to fix what is wrong. For any meaningful and durable reform, there must be a clearer understanding of, and more unified agreement about, who the child is and how the child learns. There must be a much better forecasting of what knowledge, skills, and attitudes the young will need to lead productive lives in their future. And there must be a much more decisive commitment to planning and action that span decades, with the concomitant allocation of necessary resources. All of these steps require wide cooperation, deep and careful thought, and a profound change in the politics of perception. Will this kind of reform happen? It is difficult to see how. But that makes it no less necessary if our children are ever to be in fact our principal national resource for the future.

References

Bruce, C., & Rubin, A. (1992). *Electronic quills: A situated evaluation of using computers for writing in classrooms.* Hillsdale, NJ: Erlbaum.

Bull, G. L., Harris, C. M., & Cothern, H. (1992). Considerations underlying the architecture of a state public school telecomputing network. In R. F. Tinker & P. M. Kapisovsky (Eds.), *Prospects for educational telecomputing: Selected readings* (pp. 121-134). Cambridge, MA: TERC.

Hunter, B. (1992). Linking for learning: Computer- and communications network support for nationwide innovation in education. *Journal of Science and Technology, 1*(1), 22-34.

Parker, P. (1992). Alice: Telecommunications for education. In R. F. Tinker & P. M. Kapisovsky (Eds.), *Prospects for educational telecomputing: Selected readings* (pp. 111-120). Cambridge, MA: TERC.

Office of Science and Technology Policy. (1991). *Grand challenges: High performance computing and communications.* Washington, DC: National Science Foundation Committee on Physical, Mathematical and Engineering Sciences.

Stout, C. (1992). TENET: Texas education network. In R. F. Tinker & P. M. Kapisovsky (Eds.), *Prospects for educational telecomputing: Selected readings* (pp. 135-140). Cambridge, MA: TERC.