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ABSTRACT

The instructional media created by microcomputers interconnected by modems to form long-distance networks present some powerful new opportunities for education. While other uses of computers in education have been built on conventional instructional models of classroom interaction, instructional electronic networks facilitate a wider use of apprenticeship education, in which students learn skills and acquire knowledge in contexts similar to those in which they will be used. To investigate these possibilities, an instructional electronic network (the Intercultural Learning Network) interconnecting students and teachers in the United States, Mexico, Japan, and Israel has been developed. For one project conducted in this network, students tackled a problem in their own community, the problem of the shortage of water. By addressing a problem shared across the different locations, students learned to transfer solutions used elsewhere to their own problems. They also acquired science concepts in an instructional setting that provided dynamic support for the acquisition of problem solving skills. This study raises a challenge to education: that the dominant form of instruction could become "teleapprenticeships." In this form of instruction, students would participate in globally distributed electronic problem solving networks, jointly tackling problems with other students, with teachers, and with adults outside the school. (9 references) (Author/GL)

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# Education on the Electronic Frontier: Teleapprentices in Globally Distributed Educational Contexts

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# Education on the Electronic Frontier: Teleapprentices in Globally Distributed Educational Contexts

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The instructional media created by microcomputers interconnected by modems to form long-distance networks present some powerful new opportunities for education. While other uses of computers in education have been built on conventional instructional models of classroom interaction, instructional electronic networks facilitate a wider use of apprenticeship education, in which students learn skills and acquire knowledge in contexts similar to those in which they will be used. To investigate these possibilities, we have created an instructional electronic network interconnecting students and teachers in the United States, Mexico, Japan, and Israel. In this paper, we analyze one project conducted in this Inter-Cultural Network. Students tackled a problem in their own community, the problem of the shortage of water. By addressing a problem shared across the different locations, students learned to transfer solutions used elsewhere to their own problems, which is one strategy for dealing with the difficulty people have with transferring knowledge from one domain to another. They also acquired science concepts in an instructional setting that provided dynamic support for the acquisition of problem solving skills. This study raises a challenge to education: that the dominant form of instruction could become "teleapprenticeships." In this form of instruction, students would participate in globally distributed electronic problem solving networks, jointly tackling problems with other students, with teachers, and with adults outside the school. 

Thanks to Welda Johnson at the University of California, San Diego and the students at Lincoln Middle School, Vista, CA for their hard work on the Water Problem-Solving Project. The equipment for this research was provided by the Apple Education Foundation. Thanks to [illegible] Levin for comments on previous versions of this paper. Requests for reprints should be sent to Dr. James A. Levin, Dept. of Educational Psychology, University of Illinois, 1310 South 6th Street, Champaign, IL 61820.







Computers are now present in almost all schools, in ever increasing numbers (Becker, 1986). Yet, where's the revolution? In what sense have computers changed the nature of what is happening in education? For example, Mehan (1979) has found that classroom interaction typically has a three part "Initiation–Reply–Evaluation" structure. A teacher will address a class of students with some sort of initiation, some student (or set of students) will reply, and the teacher will then evaluate that response. For example:

| | |
|---|---|
| Teacher initiates: | What is the capital of Ohio? |
| Student replies: | Columbus. |
| Teacher evaluates: | Very good. |
| Teacher initiates again: | Now, what is the capital of Illinois? |
| (etc.) | |

This interactional pattern exists in much of today's computer aided instruction (CAI), which is the most common use for computers today (Becker, 1986).

| | |
|---|---|
| Computer initiates: | What is the capital of Ohio? |
| Student replies: | Columbus. |
| Computer evaluates: | Very good. |
| Computer initiates again: | Now, what is the capital of Illinois? |
| (etc.) | |

So, despite the appearance of change, we see that the form of instruction is the same. We have been exploring some ways in which computers, especially microcomputers interconnected to form long-distance electronic networks, can facilitate fundamentally different forms of education.

When you introduce a substantial change like a new communication medium into a complicated system like the educational system, it is often useful to reconsider the assumptions underlying the way things are currently done. In particular, the introduction of microcomputers into schools and their ability to be linked through the telephone system into long-distance networks allows us to reconsider tradeoffs involved between conventional classroom interaction and other forms of instructional interaction. What are the benefits and costs of current practices? What are the comparative costs and benefits of alternative ways of teaching and learning?

## THE INTER-CULTURAL NETWORK

To explore these issues, we created an electronic network, which we call the Inter-Cultural Network, as a sort of global laboratory for examining the properties of the new electronic medium of instruction. Active sites on this network are in the United States (CA, AK, HI, CT); Tijuana, Mexico; Tokyo, Japan; and Jerusalem, Israel. Participants in this network include university faculty and staff, graduate students, undergraduates, teachers, high school students, middle school students, and upper elementary grade students. They create text messages on their local microcomputers, send and receive them electronically via commercial networks as electronic mail, and read and analyze the messages from other sites on their microcomputers.

A wide range of educational activities have been conducted on this network, including news writing (Levin, Riel, Rowe, & Boruta, 1985; Riel, 1985), science projects (Levin & Cohen, 1985), and social science activities (Cohen, Levin, & Riel, 1986). In this paper we want to focus on a study of distributed problem-solving instruction, focusing on the problem of water shortages.

*The Water Problem-Solving Project*

Several of the sites on the network had a common problem in their communities: shortages of water. The following initial message was sent on the network:

From: STK148 (San Diego) 221-Lines
On: 22 AUGUST 1985 AI 01 43 Copy BC
Subject projects

Water Project

This project will involve students in a joint problem-solving effort, dealing with problems of water shortage and conservation, a particularly appropriate project for sites where the availability of fresh drinkable water is a problem.

Local data gathering: The first step will be for students in each participating site to obtain information about how water is gathered, transported, used and reused, and disposed of in their site.

Data sharing: Descriptions at each site will be shared with other participating sites.

Comparison of other's approaches to one's own: Students in each site will determine whether techniques used in the other sites are used in their own location. For those that are not shared, students will analyze the reasons why not. During this analysis, students may want to get further feedback from the other site. Each site will then write a report of their study, focusing on techniques used elsewhere that might be solutions to the local problems with water.

For example, here is the message from Juneau, Alaska describing water problems there and how they solve those problems.

TO: J/Levin
FROM: SHF R/DAUENHAUER
SENT: 28 NOV 85 13.16:20
READ: / 30 NOV 85 20.18:56

Water shortage in Juneau—our problem is that not all folks have city water. Ours is a cistern from rainfall and snowmelt; one big subdivision taps a mountain stream. The weather is very cold. We are not getting new water in the cistern, and will eventually run out. We will need to buy a truck load if it doesn't thaw and rain. The big subdivision had its stream freeze up. So, in the rain forest, things can get tight when it freezes!

Water, water all around . . .

dd

ps. Our road has no city water, so that is a problem when there is a fire. The fire dept has to haul water in tank trucks. Some folks out the road lost their house totally a few weeks ago.

Meanwhile, an eighth-grade class in Vista, California, was learning about the water situation in San Diego County, under the guidance of Welda Johnson, a graduate student at UCSD. After learning about the ways that southern California deals with problems of water shortages by constructing huge aqueducts to bring in water from hundreds of miles away, the class divided up into teams to consider the descriptions of how water problems are dealt with in other places.

Several of the teams sent messages on the network seeking more information about the water problems and techniques used elsewhere. Here is a message sent back to Juneau both to seek further information and to describe their own problems.

From. STK148 (SAN-DIEGO) 12-Lines
On 28 DEC AI:02:57 Copy BC
Subject SD28DE-WA ATTENTION TOKYO AND JUNEAU
To Juneau Alaska
About Water

Why can't you heat the ice, or is it too expensive? What would you use if you could heat the frozen water? How many days does the sun shine? We hope that you can find another resource to solve your water problems. Speaking of water and aqueducts, our Colorado aqueduct is going to be having tough problems. We made sort of a deal with Arizona, that we would share the water from the aqueduct, because they have a right to have some of the water too, but if they are really in need of water, and have a shortage, they will take most of our water, then we will be in a similar situation as you are now. So we hope you can find a way to take care of your water problems.

Thank you.

(the names of the Vista students)

Several weeks later, these students received a detailed response from Juneau pointing out that "It costs too much money to melt the ice, because of the cost of fuel."

Then some of these students raised the next level of problems: the need to purify the water and the difficulty of getting people to implement a solution. They were thinking fairly deeply about the issues. As one student put it in a message, "I never knew there was so much to learn about water."

*Evaluating the Project*

What have we learned from this pilot project of distributed problem-solving instruction? So far, this ongoing problem-solving project has not produced any earth-shaking solutions to real and difficult water problems. However, the participants have learned a great deal about water and the different ways of seeking solutions for such problems. More importantly, participants saw various people, both adults and students, grappling with a real, difficult problem. Perhaps the most valuable lesson might be seeing that many problems in the out-of-school world don't have ready-to-use answers in the back of the book. In such electronic message exchanges people can join in the problem solving whatever their level of knowledge and skills. With such ongoing activities, newcomers to a network activity usually start by reading the message interactions. Then, when they feel they have something to contribute, they join in, gradually taking a more active role in the activity.

## TELEAPPRENTICESHIPS

### *A Way to Extend Learning beyond the Schoolhouse*

This learning environment has the flexibility to allow novices to follow an ongoing interaction without disrupting it and then gradually to take a more and more active role. This process is an important element of apprenticeship learning. According to studies of apprenticeships (Greenfield & Lave, 1983; Lave, 1977), novices in the domain initially take what appears to be a passive role located in the work setting but without any constant assigned task. Instead, they monitor the ongoing activity and are given parts of the work to carry out. However, unlike the case in schools, these tasks are not "exercises" to be carried out in isolation until they are mastered. Instead, the tasks are part of the ongoing activity that the novice has observed and the apprentice carries them out within the work setting. Gradually the apprentice masters more and more of the ongoing work, but within the context of the setting in which the skills and knowledge are to be applied.

With networks like the Inter-Cultural Network, we can now construct "teleapprenticeships" in which novices in a domain start out monitoring messages among a set of people tackling a specific problem and then gradually start to take a more active role in the process. In this sense, the electronic network provides some of the necessary "dynamic support" (Riel, Levin, & Miller-Souviney, 1984) for students to learn.

Apprenticeship learning of this sort can be done in an electronic medium because it is not as disruptive to the expert's work as is the case with face-to-face apprenticeships. Experts in a domain can add novices to an electronic mailing list without any inconvenience and can easily forward messages to an apprentice with an attached note requesting that the apprentice carry out some simple task. To do this face to face, the apprentice would have to be located in the adult expert's work location; to do this electronically, the apprentice can be located anywhere in the world.

### *How Novices Can Affect Experts and Other Adults*

There are advantages for adults to include students in problem-solving networks. Since the primary goal for the students' involvement is to learn and only secondarily to solve problems, these networks will be able to tackle "long-shot problems." These are problems that adult experts would judge not worth tackling, because the expected payoff is lower than the likelihood that the problems can be solved. Some of the student activity can focus on these "long-shot" problems. (Obviously, it might be demoralizing to give students only long-shot problems to solve.) But within a mix of other problems, if a large number of instructional problem-solving network groups tackled a given long-shot problem, then there is a good chance that one will come up with an interesting solution.

Another advantage is that students are likely to bring new points of view to a problem, which sometimes might be productive, especially a problem that has stumped the "experts." Also, students can serve as mediators between the adults in their own communities (their own parents and neighbors) and the expertise available from adults in other places.

## CHALLENGE TO EDUCATION

There is a real sense in which these new electronic media can open up the world to students and teachers. Instructional networks allow them to engage in activities far beyond the walls of their school which in the current educational system so effectively separate students and teachers from the rest of society. Distributed projects like the Water Problem-Solving Project can be easily integrated in schools, initially as an auxiliary activity for students But there is potential for these activities to become a major element of the education of students. In this sense, microcomputer-based networks may have a kind of revolutionary impact on education, breaking down the isolation of education in schools and making possible a new incarnation of a venerable instructional form, apprenticeships with a new title: "teleapprenticeships."

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