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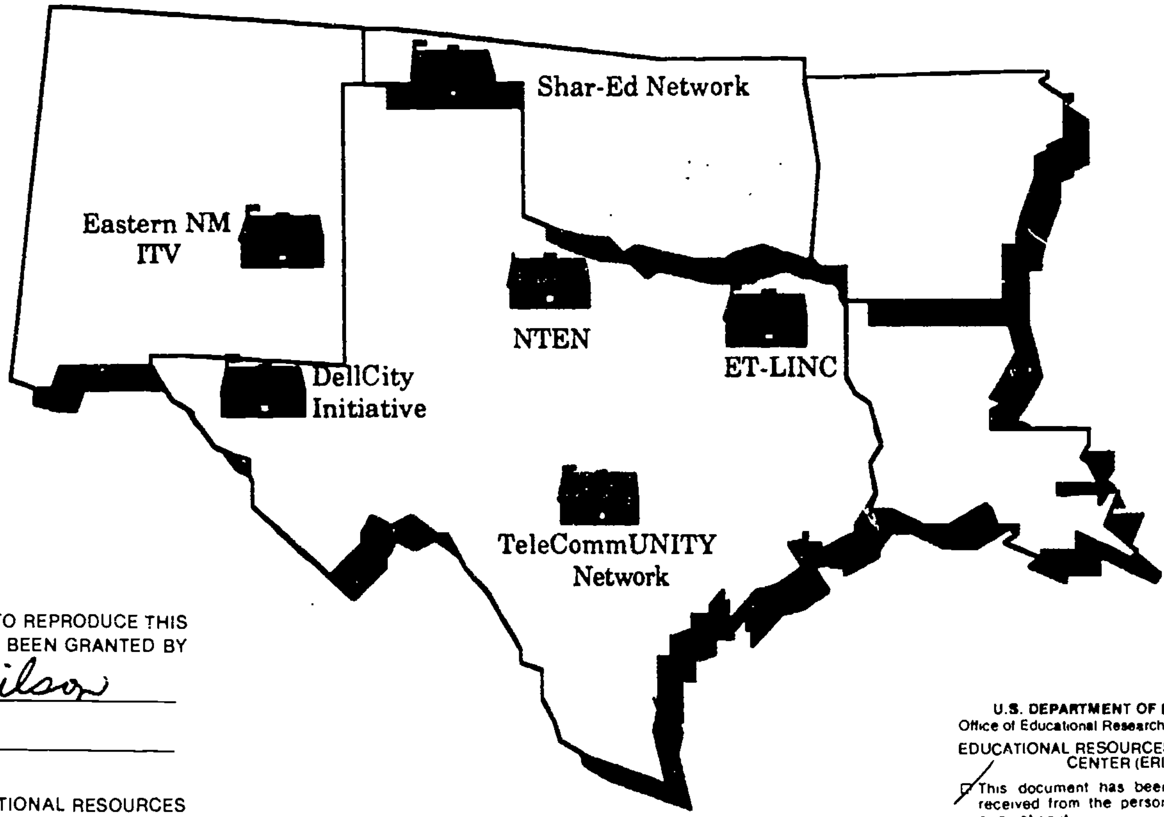
ABSTRACT

In three southwestern states, grassroots movements of citizens, educators, and local businesses developed and implemented two-way interactive television projects in their schools and communities. A descriptive multiple case study design was used to examine six project sites in New Mexico, Texas, and Oklahoma. Research questions were categorized in a framework that may serve as a prototype for project replication; categories included the context of project development, concerns or needs that sparked the project, the shared vision, community and administrative support, planning and resource allocation, monitoring and problem solving, and barriers to implementation and ongoing support. Data sources included extensive interviews, classroom observation during site visits, and documents and records. Findings cover: (1) the specific characteristics of two-way interactive full-motion video that make it attractive and feasible for use with rural at-risk student populations; (2) the electronic classroom model; (3) fiber-optic technology; (4) cost categories; (5) details of the development of the most mature project, the Oklahoma Panhandle Shar-Ed Video Network; and (6) additional events unique to the other five projects. Other projects were the New Mexico Eastern Plains Interactive TV Cooperative, the TeleCommUNITY Network, North Texas Educational Network, East Texas Learning Interactive Network Consortium, and the Dell City Initiative. Guidelines are presented for implementation of similar projects. (SV)

Rural Communities Communicating:

The Emergence of Two-Way Interactive Video in Southwestern, Rural, Small Schools



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Introduction

About this Paper

Rural Communities Communicating provides information regarding the implementation and use of full motion, two-way interactive television. Its contents, based upon research conducted by the Southwest Educational Development Laboratory, describe in detail how citizens have implemented the technology in rural, small schools and communities in southwestern states, and provide a methodology for implementing such technology. A video, entitled *Local Heroes,* has also been produced.

Who Will Use this Information

Intended audiences are educators committed to rural, small schools; state departments of education; rural citizenry; educational organizations with a rural focus; teachers' organizations; rural school administrator groups; and telecommunications professionals.

Organization

Rural Communities Communicating is organized into five sections:

- an overview articulating rationale;
- a deptiction of research methodology
- an analysis of the technology;
- an narrative depiction and history of projects in the states of New Mexico, Oklahoma, and Texas;
- a prototype detailing procedures for implementing two-way interactive video in schools in rural, small communities; and
- guidelines and suggestions for implementation.

Overview

The Challenge

The educational process is an integral part of the social and political fabric of the United States, and cannot be addressed as an isolated entity. In the past, education, as well as other institutions, have tended to operate in a linear, segmented fashion, modeled after the 19th and early 20th century manufacturing concept of compartmentalization, with each segment an autonomous unit. Entities naturally evolved in this manner when the potential for communication was limited and the exchange of information was a laborious, complex process.

Education occurring within such a context of independence, isolation, and information deprivation has become less effective in an age when the exchange and sharing of information is vital, where textbooks can be obsolete before going to print. Such isolation is particularly problematic in rural, small schools where geographic, as well as economic barriers, are common. New technologies, specifically in the area of telecommunications, can facilitate a shift from communication isolation and deprivation to communication access and exchange.

Thus, geographically isolated, small schools can have the capacity to tie in to the swirl of information once available only to those located near the source of such information. The challenge is to use new technologies creatively to restructure the learning experience to meet the demands of a world in technological revolution.

Through modern telecommunications, a teacher who is present at one location can simultaneously teach at multiple sites, supplying educational elements that would otherwise not be available. Teachers can no longer be expected to know everything in their field, and it would be a disservice to limit learning to their experience. The sharing of teachers through telecommunications technologies allows rural schools to share specialized teacher resources needed to prepare students for the 21st century.

Knowledge is dynamic. Information changes, reformulates, grows instantly. Technology allows students and teachers immediate access to that information. The teacher's role then is to make information available and more importantly, to make it relevant. The teacher becomes a conduit/facilitator and no longer merely a disseminator of information. The challenge here is not so much to channel this cacophony of information, but to understand and extract relevancy.

Rural Schools, Rural Communities, and New Technologies

The role of rural schools is beginning to extend beyond the basic education of a community's youth. Increasingly, rural schools serve as a focal point and resource for the rural community at large. Today, many rural schools function as the local clearinghouse for the dissemination of information, health care, counseling, and community support services. Consequently, the closing of rural schools has frequently spelled the decline of the surrounding communities (Jolly & Deloney, 1993). Concerned citizens have recognized that their rural schools must survive to insure the survival of the rural community, as well as its unique culture, and have sought ways to keep rural schools alive and communities intact.

Rural leaders have begun to investigate the application of new technologies to rural education and community services, which leaders envision as a means to secure the continuing viability of the rural lifestyle. The recent development and rapid growth of telecommunications technologies have been instrumental in making educational opportunities and social services available to rural communities. Potential services are medical and EMS training; medical diagnosis and treatment regime; community planning and networking; professional training for firefighters, police officers, lawyers, educators, and other citizens interested in improving their professional status. As new technologies continue a near exponential evolution and costs continue to decline, high-tech accessibility to rural schools and attendant communities can be expected to increase dramatically.

While the promise of expanding course offerings through telecommunicated classes may further neutralize arguments for consolidation of rural districts, this technology will also broaden opportunities for sharing and cooperating with other rural districts in partial reorganizational arrangements. The very nature of the medium will ensure that rural districts, making use of new technologies, will be involved in cooperating with other districts or organizations.

New telecommunications technologies now available to rural communities can offer a unique opportunity to reshape the educational environment, as well as have impact on the social, communication, political, economic, and recreational aspects of rural life.

Existing Research

To date, there has been little research conducted on the effectiveness of telecommunicated distance education as compared to other methods of instruction. Yet, most authors appear to be convinced that these technologies are promising. Barker (1990) concludes that the research base suggests that students who study via distance education approaches perform as well as their counterparts in traditional classes. Barker further notes that the success of the technology depends more upon the quality of instruction delivered than on the type of technology used (p. 255). Kober (1990) also suggests that this technology can be as effective as traditional instruction (p. 20).

Most of the scant research relating to telecommunications and education has dealt with secondary courses for college-bound students. Little is known about its effectiveness with elementary students or at-risk students. One study, however, deals specifically with elementary age students and two-way interactive video. In January 1991, Region 5 Rural Technical Assistance Center of Denver, Colorado, undertook a three-month study to explore the feasibility of using distance education as a means for providing Chapter I remedial courses to eligible children. Mathematics instruction was provided to third and fourth grade students via interactive television with one teacher at the sending site and three facilitators at the remote sites. Four schools in the Oklahoma Panhandle Shar-Ed Network (one of the six projects presented in this paper) were selected for the first phase of the study. For the second phase in summer 1991, four sites in southeastern Kansas were selected.
The author of the study made the following observations:

- Chapter 1 instruction could be effectively delivered via two-way interactive video.
- Classes were at least as effective as traditional instruction delivery systems in producing student achievement.
- Interactive television was successful in actively engaging the students for the entire program.
- Since the technology was already in place Chapter 1 delivery was no more expensive than the cost of a traditional Chapter 1 program.
- Advantages of using two-way interactive video included sharing of human and material resources, increased teacher support through networking, visual clarity of objects, and staff development through modeling.

- Teleteachers, facilitators, superintendents, and parents responded positively to the distance education project in surveys and interviews (Lawyer-Brook, 1991).

Lawyer-Brook also identifies issues that could be problematic as the commitment of time and money; the need for specific teleteaching training; the difficulty of establishing a schedule; the possible limitations of the classroom environment; and differences in classroom management among schools.

Several authors advise that facilitators be available at remote sites to offer support and guidance to students, especially in large classes. Joiner, Silverstein, and Clay (1981) found that students were less independent than first thought. They concluded that the facilitator is critical to the success of independent learning. Kober (1990) cites a study conducted by Robert Threlkeld at California State Polytechnic showing that "high interactors," students who interacted with the instructor two or more times a week, "received substantially better grades, enjoyed their classes more, and felt more involved than low interactors."

In terms of the implementation of the technology, references to the "facilitative leader" (Hord, 1992) needed to drive the implementation of an innovation are pervasive in the literature (Deal, 1990; Glatter, 1987; Duttweiler and Hord, 1987; Rutherford, 1985; Hord, 1992).

Bilow (1986) whose study dealt with the implementation of two-way interactive video in rural New York State made the following observations:

- More preparation time was needed, since materials were delivered to the participating schools by shuttle.
- Since direct contact with students in other districts was considered important, teachers were required to leave the home district occasionally.
- The districts had to develop common scheduling.
- Discipline presented the biggest problem. It was recommended that no more than four students be in a classroom in the remote sites. Honors students created fewer problems.
- Teachers worried about the elimination of positions.

Monk (1990) advises that cooperative arrangements involving telecommunicated distance education will require formal organizations because of the complexity of the programs and their resource requirements. Barker (1990) suggests the following twelve issues that need to be addressed by administrators who are considering distance education programs: extent of course offerings; selection of teachers for distance education delivery; teacher training; local control; classroom management; scheduling; levels of interaction; remote site visits by teachers; the "personal touch;" technical breakdowns; materials transfer; and class size.

The results of SEDL's research on six sites in the Southwest which form the foundation for this paper are generally consistent with the findings cited above. However, despite many remote sites not having a classroom facilitator present, few problems were reported regarding discipline and effectiveness.

Reasons cited for success were:
- The size of classes were almost always small;
- Entry into an interactive television (ITV) class was granted only by permission;
- Students had to sign contracts regarding expectations and comportment prior to being admitted to the class;
- Students had at least one year of high school and were generally college-bound.

All interactive television classes studied involving younger students had facilitators present or were team-taught.

SEDL Research

The Descriptive Study
Since little research exists involving the *implementation* of full motion interactive video in schools, SEDL conducted a study (1992-93) of six sites in New Mexico, Oklahoma, and Texas, using a descriptive multiple case study design (Yin, 1984). The case unit was composed of the two-way interactive video projects, that linked participating schools within a given region as far apart as 200 miles.

Structure of the Research Report
The research report was written to inform an audience of citizens and educational professionals interested in implementing interactive two-way video systems in their own schools. Before writing, an outline was developed to include the following components: purpose of the study; methodology, presentation of the data; validation and verification of the findings; and conclusions and recommendations (Patton, 1980).

Research questions
The following questions are categorized within a framework that serves as prototype for implementation of the technology. Discussion of the categories and outcomes derived from research methodology will be presented in the "Toward a Prototype" section.

The Context
- How does the school setting support technology innovation?
- What were the basic attitudes and beliefs about the innovation before, during and after it was in place?
- Is there an atmosphere of risk taking?
- Were adequate time and resources devoted initially to the innovation?
- Was the actual physical structure of the school conducive to the innovation?
- Were other aspects directly related to the school conducive to the innovation (scheduling, school size, working conditions, etc.)?
- Did the innovation require departures from district or state policies and regulations?

Concerns/Needs

- What was the concern, need, or problem that led to the acquisition of a two-way interactive television system?
- Who saw the needs? Who didn't?
- What needs are being met? How well?
- Has anyone worked closely with you? Who? How? When?

Shared Vision

- What was the vision?
- Who first envisioned the technological innovation?
- Where did the vision come from?
- Did the vision evolve or spring full-born into the mind/minds of the local hero/heroes?
- Who or what contributed to the vision?
- Were there competing visions? If so, how was the decision to develop the current innovation resolved?
- Is the vision still expanding?
- Is the vision shared by everyone who is involved? (mid-management, faculty, students, and community)
- Has the community at large (or the school community) made a commitment to the vision?
- Have the faculty and students supported the vision.
- How was the vision communicated, and with which local constituencies?
- How did participants at different locations communicate?
- How did planners share vision with state departments of education and other regulatory entities in order to accommodate existing regulations to this new technology?

Community/Administrative Support

- How was project supported by school administration?
- Where did the local support come from and how was it developed? (Phone company, other local business and industry, schools, churches, local government, community leaders, medical, legal/law enforcement professions, banking)
- Was there state or regional support? (grants, money, legislation, mandates, regulations, knowledge, technical assistance, evaluation)
- Did you have foundation support? (grants, money, guidance)
- Did you have federal support? (grants, money, legislation, mandates, regulations, knowledge, technical assistance, evaluation)
- Did you have any other type of support?
- Who has been the "linking agent" in the process of implementation?

Planning/Resource Allocation

- How were schedules synchronized among participating schools?
- What steps were taken to ensure the selection of appropriate technology?
- What steps were to taken to ensure success?
- What resources were in place to support project?
- What resources were lacking?

Monitoring/Problem Solving
- How did technology play a role in the monitoring function?
- How did the community monitor the project?
- How structured was the monitoring process?

Assistance/On-Going Assistance
- How was assistance and support provided to those directly involved with the innovation?
- Did initial support continue over time?
- Did support for the project grow?
- What were the financial, technological, infrastructure, knowledge/information, political, and regulative impediments to this project and the use of advanced telecommunication in the community? (Training, scheduling, ongoing costs, technophobia, policy disincentives, technical support, infrastructure)
- What factor did resistance play?

Data collection
Data sources for each case study included:
- face-to-face interviews during site visits, recorded on video and/or audio tape;
- observations and video recording of interactive video classes during site visits; and
- community, school, telephone companies or cooperatives, and government documents and records

Documents included newspaper articles, memos, letters, minutes of meetings or financial reports.

Interviews were conducted with such individuals as superintendents, principals, school board members, telephone company or cooperative liaison representatives, interactive video coordinators, parents, teachers, and learners who had used the technology. Participants were selected through a process of snowball sampling (Patton, 1990) by which interviewees nominate others to be interviewed. To help ensure that multiple viewpoints were represented, the principle of maximum variation sampling was observed in selecting from among nominated individuals (Lincoln & Guba, 1985).

Although formal interviews were conducted on-site with key individuals, additional data were collected through informal discussions and conversations with other community members, and follow-up interviews were conducted by phone.

Data were collected by three investigators during a minimum of two site visits of two to three days each. In light of the distance between the research center and the sites, as well as the number of sites, additional site visits were impractical. Numerous phone interviews were made before and after site visits.

Data Analysis
Each site's development of interractive technology capabilities occurred in ways both unique to the specific location and common to other locations. Although all projects began by local initiative, federal and state participation emerged (to varying degrees) during the course of implementation of the technology, allowing for further description and clustering of variables. Common factors have been synthesized and presented in the implementation prototype, as well as in an edited videotape.

Data were analyzed throughout the data collection process in order to monitor their sufficiency and focus (Bogdan & Biklen, 1982). Data collection was considered completed when continuing efforts produced very small pieces of information in proportion to the energy expended, and regularities began to emerge in the data (Lincoln & Guba, 1985).

Since the purpose of the study is a descriptive account of how citizens implemented two-way interactive video systems in rural, small schools, definitive analyses or interpretation of data were avoided. Rather, the data handling process focused on compressing and linking the data into a narrative form that conveys information needed to understand the implementation process at each site (Merriam, 1988).

The following steps structured the analysis process:

- Data were initially sorted to form a case record of each project site.
- The data within each case were then sorted into simple categories, guided by the questions in the interview protocol.
- Additional categories were developed to encompass issues frequently mentioned by participants or information of particular interest to the audience for whom the research was written (Lincoln & Guba, 1988).
- To support the concrete descriptive purpose of the study, more rather than fewer categories were formed, since fewer categories tend to lead to higher levels of abstraction during the reporting phase of the study (Merriam, 1988).
- Finally, the cases were compared to identify similarities and differences. Recurring patterns were assumed to have a high likelihood of applicability to similar settings.

In order to strengthen internal validity, the following steps were taken:

- There was a triangulation of data sources and investigators (Denzin, 1970).
- Data and interpretations were checked with research participants to verify plausibility (Lincoln & Guba, 1985).
- Data was gathered repeatedly during site visits and through telephone interviews over an eight month period.
- The findings were examined and critiqued by peers.
- The researcher's assumptions, world view, and theoretical orientation as they relate to the research topic were clarified before the study began (Merriam, 1988).

Applying the concept of reliability to the human instrument, the following techniques were used to strengthen reliability:

- Triangulation;
- Clarification of assumptions and theory behind the study; and
- Maintenance of an audit trail by the principal investigator describing in detail how data were collected, categories derived and decisions made throughout the inquiry (Guba & Lincoln, 1981).

To help apply the findings to other situations, the following steps were taken:

- Thick description was provided (Lincoln & Guba, 1985);
- The typicality of the sites and projects was described (Goetz & LeCompte, 1984); and
- Cross-case analyses were conducted.

Structure of the Research Report

The research report was written to inform an audience of citizens and educational professionals interested in implementing interactive two-way video systems in their own schools. Before writing, an outline was developed to include the following components: purpose of the study; methodology, presentation of the data; validation and verification of the findings; and conclusions and recommendations (Patton, 1980).

Data are presented in three parts:

- A description of the technology with some technical data provided;
- The story of each site's efforts to implement the technology; and
- A comparison of the similarities and differences among the sites on issues salient to the intended audience.

Included in the presentation of data are:

- A thorough description of the setting for each case;
- A description of the key elements studied in depth both case-by-case and comparatively; and
- A discussion of the "lessons to be learned" from the study (Lincoln & Guba, 1985).

Specific issues under investigation are:

- Technical description of the telecommunication process as it relates to rural small schools;
- Coordination between rural, small school districts and local telephone companies or cooperatives;
- Coordination (or lack of it) among involved telephone companies or cooperatives regarding signal transmission;
- Federal, state and local support for educational two-way interactive video; and
- Technical and cost description of implementation of two-way interactive classrooms

In composing the paper, a preference has been observed for writing thick description rather than highly abstract and inferential analysis by the researcher, so as to allow the study participants to tell their own story as much as possible (Denzin, 1989).

Findings from this research have served to form the foundation of this paper, as well as the video, *Local Heroes, Bringing Telecommunications to Rural, Small Schools.*

The Technology: Two-Way Interactive Video and Audio

In an effort to preserve the rural American lifestyle, community leaders have begun to consider the application of advanced telecommunications for rural education, human services, business, and local government. New telephone, computer, and video telecommunications technologies can empower rural communities by offering creative ways to provide services comparable to those in urban communities. Telecommunications are being used by rural communities to support and enhance the arts and cultural activities, economic and business development, the legal and justice profession, health and human services, training and education, and a broad spectrum of political, government, community and individual interests. Visionary rural leaders are limited only by their imagination.

One of many advanced telecommunications systems, two-way, full motion, interactive video and audio, is particularly applicable to rural education and community needs. In essence, two-way interactive video and audio can network rural schools, colleges and/or service centers that have the capability to transmit and receive live programming. This capability is particularly relevant where populations are sparse, and expertise limited. Two-way video enables the classroom or community service center to transmit and receive images and sound similar in quality to those found on professionally produced, commercial television. Used creatively, this technology can revitalize rural communities.

Specific Characteristics

Two-way interactive, full motion video and audio has specific characteristics that make it attractive and feasible for rural, at-risk, student populations. These include:

1. *Immediacy.* In contrast to education by satellite which typically originates at a great distance with severely limited opportunity for student participation, two-way video and audio allows constant interaction between students and teachers who are usually located in the same or nearby communities. This immediacy of feedback allows students who have limited attention spans to maintain active contact.
2. *Relevancy.* Two-way interactive video generally involves the clustering of several small student populations with a teacher located at one of the locations. This allows teaching to be specially designed to the needs of students involved. The most common configuration among sites studied was one teacher in a classroom simultaneously delivering instruction to an additional three classrooms usually separated by less than forty miles. One site had a unique team-teaching configuration involving a pre-algebra class.

The course was taught by a certified teacher on premises, assisted by a university professor who was linked via the technology.

3. *Stimulating Learning Environment.* Two-way video enables the teacher to present a variety of perspectives and images via multiple cameras from different angles and variable fields of view, videotape, and computer display. Images and sound are close in quality to those found on professionally produced, commercial television. Such credible imagery, with the additional stimulation of multiple visual and aural fields and complemented with continuous student feedback, has the potential to engage students, including those with learning disabilities, in ways that go beyond current classroom methodology.
4. *Flexibility.* Linkage among schools and connection with institutions of higher learning afford the possibility of shaping curricula to meet educational and community needs. Already in practice are: team teaching, dual-enrollment courses, availability of specialized experts, monitoring field experiences of student teachers, and the documentation of exemplary teaching practices.
5. *Affordable Cost.* With dramatic advances in media technology and use of consumer oriented video and audio production equipment, school districts can equip classrooms (media centers) at a moderate cost. This paper will outline the classroom equipment necessary to purchase and maintain a teacher/student operated electronic environment.
6. *Telephone Company or Cooperative Participation.* There are increasing incentives in the form of grants, profit opportunities, public relations and deregulation to motivate telephone businesses, particularly small, local entities serving rural populations, to be major participants in making two-way video available in schools.
7. *Access to Information.* Once linked with two-way video, a classroom has the potential to receive other information available within the network. Once equipped, information from videos, laser discs, satellite feeds, and computer networks can all be easily transferred from one classroom to another.
8. *School/Community Production Center.* Originally, television was viewed as merely a means to chronicle live news events. It has become much more. So too, the electronic classroom has the potential to exceed its original expectations. In essence, each classroom equipped with two-way video becomes a fully functioning television studio, complete with a capacity for a studio audience, that can either go live to other schools and/or be recorded for videotape distribution. And once a two-way video system is in place, linkage into distribution modes such as community cable systems becomes relatively affordable, creating the potential for shared community meetings, guest lecturers for the school/community, adult education, live school news production, dramatic presentations and much more. A typical quote from system advocates was, "The uses of two-way interactive television are limited only by the extent of our imagination."

The Typical Classroom
The typical classroom is equipped with three video cameras: an overhead camera that can display teacher and student work, and serve as an electronic chalk board; a camera to capture the teacher (when present); and a camera to capture the class.

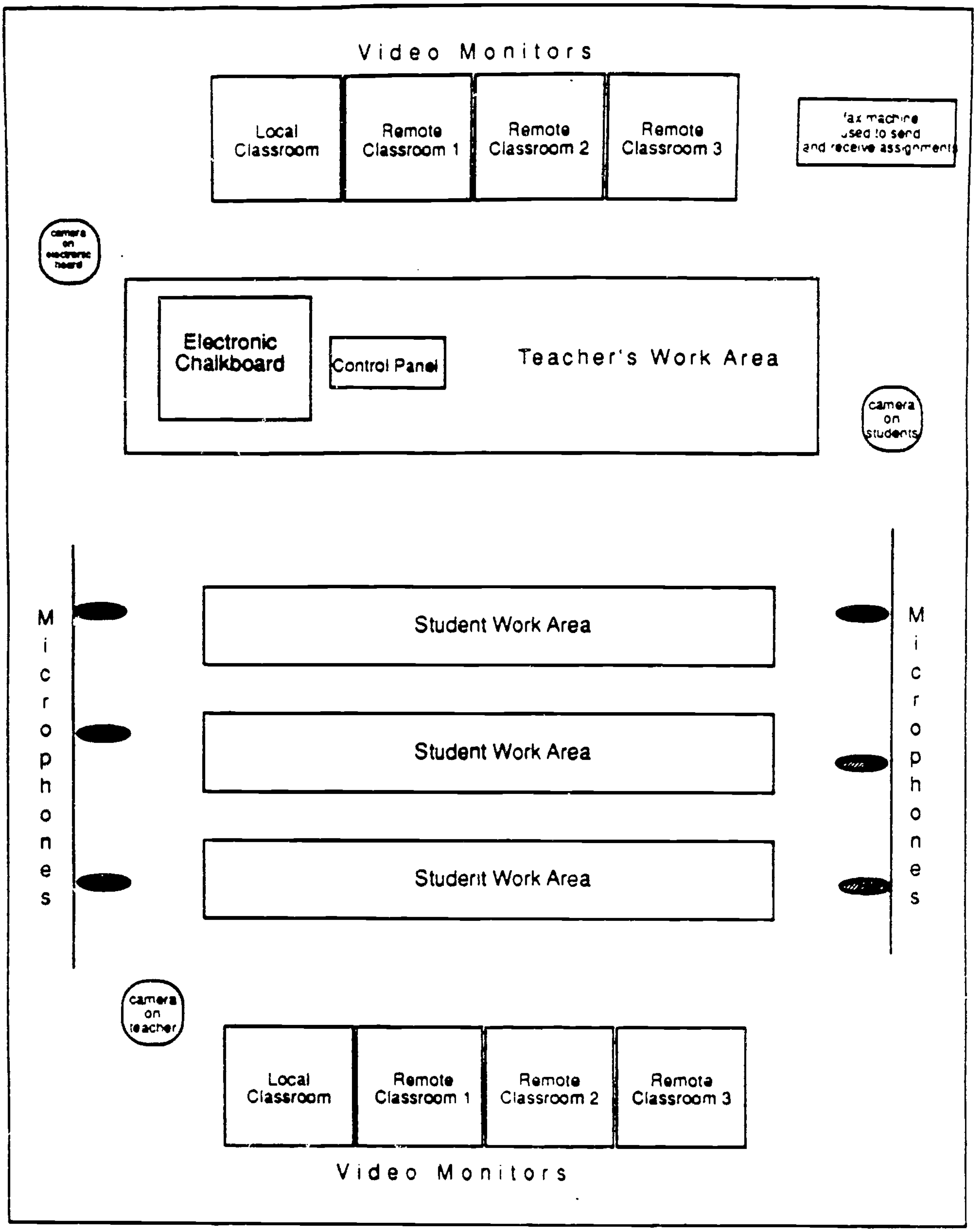
All cameras can be manipulated to cover varying fields of view. The teacher or student has the ability to switch from one camera to the other via a switching board generally located at the teacher's work station which also houses other multimedia equipment.

Two banks of three to five monitors are situated to provide both students and teacher visual access to other classrooms in the cluster, as well as the electronic chalk board. Both banks of monitors display the same images. One monitor shows the teacher or the image from the overhead camera. The other monitors display the students at remote sites. The difference between the teaching classroom and the remote classrooms is that the students in the teaching classroom see the teacher both on video and live.

Audio is captured by placement of multiple microphones throughout the classroom and an attached microphone (lavaliere) worn by the teacher. Each class is equipped with a fax to distribute materials and assignments. Frequently, a teacher or staff member living in a neighboring community, transports materials to a linked school when returning home or coming to school.

All video cabling within the classroom and school is coaxial, carrying an analog signal. Transmission between the sites is digital via fiber-optic cable. The video and audio signals generated by classroom cameras and microphones are routed to a control panel and split, one set of signals routed to the originating classroom and the other converted to digital information for transmission to other classrooms via fiber-optic cable.

Figure 1 - Two-way Interactive Classroom Model



Fiber-optic Technology
Fiber-optic cable has several significant advantages over the conventional copper cable that has been used since the dawn of telecommunications. Once information has been transmitted via guided light waves in a nearly microscopic optical fiber, it can travel vast distances without assistance of a repeater or signal booster.

Fiber-optic's most noteworthy feature is its ability to transport any type of signal - be it voice, video or data. Full motion video, in particular, requires an extraordinary amount of bandwidth for transmission, and optical fibers have that capacity. Fibers are also highly durable and resistant to interference, which makes them ideal for the transmission of video signals and computer data. In spite of their increased capacity, fiber cables are smaller in size and less expensive than (traditional) copper cable (Greenfield, 1993).

Transmission of video and audio signals is achieved by the digital conversion of conventional analog information, such as a video image captured by a conventional classroom camera, via a codec (coder/decoder unit), which passes the digitized signals at 45 megabits/second (DS-3) to a fiber multiplex terminal (FMT-150). The terminal then combines the digitized signals and transmits them over one fiber-optic pair to other locations, permitting full-motion, multiple site (continuous presence) video, with simultaneous audio and computer data signals among networked sites. The glass fiber traps a beam of light produced by an optical source (transmitter) such as an LED or semiconductor laser diode, then guides it through the fiber to the detector (receiver) located at the opposite end. During transmission, all signals remain digital, which ensures clarity, regardless of distance or number of times multiplexed (Northern Telcom, 1991).

Cost Categories of a Two-Way Interactive Video System
Cost categories vary but basically include:

- *The original installation of cable* which can include the cost of the fiber-optic cable, installation of the cable, securing rights of way, and bringing fiber-optic to schools. These costs have often been absorbed by local telephone companies or cooperatives. Generally, participating telephone companies or cooperatives have been willing to connect schools to their fiber-optic cable when schools were located near existing or planned fiber-optic lines. Upon occasion, local telephone companies or cooperatives and their subsidiaries have been willing to extend lines substantial distances to connect educational entities, sometimes to the point of paralleling existing cable laid by non-participating telephone companies. Local telephone companies or cooperatives hope to recover costs by also making fiber cable available to government entities, local businesses, medical facilities, and other commercial carriers. As one consultant for a small rural telephone cooperative put it, "We tend to go wherever the big boys don't want to."

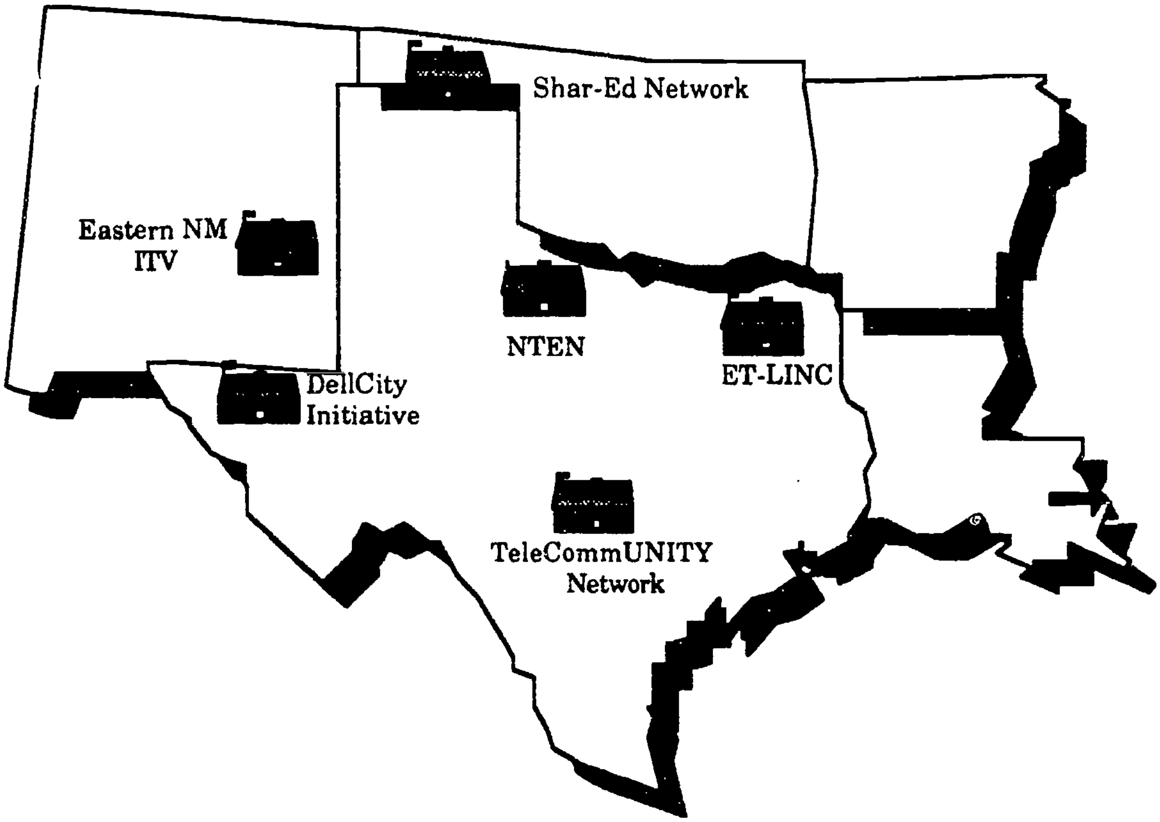
  Certainly, small telephone companies or cooperatives eventually hope to recover costs on their investment, but they also make a convincing argument for wanting to improve the community. Local telephone company or cooperative managers or owners live and frequently have grown up in the community, as opposed to larger telephone companies whose management may be located thousands of miles away. Their children and their employees' children attend local schools. From a pragmatic perspective, the success of their business is directly related to the vitality of their community. Furthermore, telephone cooperatives are mandated by law to recycle profits back to members. This can be done by direct rebate to customers or improving the community structure, i.e., educational opportunities. The latter has appeal in that a strengthened community strengthens the subscriber base. Two of the six projects are supported by for-profit, small, rural telephone companies. Although profit based, there is also strong motivation to plow a portion of those profits back into the community for reasons mentioned above.

- *Installation and maintenance of telecommunications equipment* that converts the analog video and audio signal generated by the studio classroom to digital. Components are a coder/decoder (codec), transmitter and transformer. Typically, the telephone company or cooperative underwrites this expense initially with the expectation of being reimbursed at a later date. Some telephone companies or cooperatives have worked out five-year payback plans with participating school districts.

- *The cost of classroom studio equipment* is typically borne by each participating school, although some motivated telephone companies or cooperatives have been willing to assume this cost in order to facilitate implementation. Generally, the cost to equip an existing classroom is between $15,000 and $20,000. Typically, one classroom is equipped in each participating school.

- *Line usage fees.* All telephone companies or cooperatives expect to be reimbursed for the use of their fiber-optic lines. The cost is negotiable, and once again some motivated telephone companies or cooperatives will defer costs to facilitate implementation. Generally speaking, costs being quoted are "somewhere in the area of one teacher's salary."

Figure 2 - Two-way Interactive Video Sites in the Southwest



The Sites

This paper describes six two-way, full motion video and audio projects in Oklahoma, New Mexico and Texas that are in varying stages of development as of this writing. In order to avoid redundancy the description of the first sites will be much more detailed than subsequent ones. Only events unique to a specific project will be dealt with in detail in subsequent descriptions.

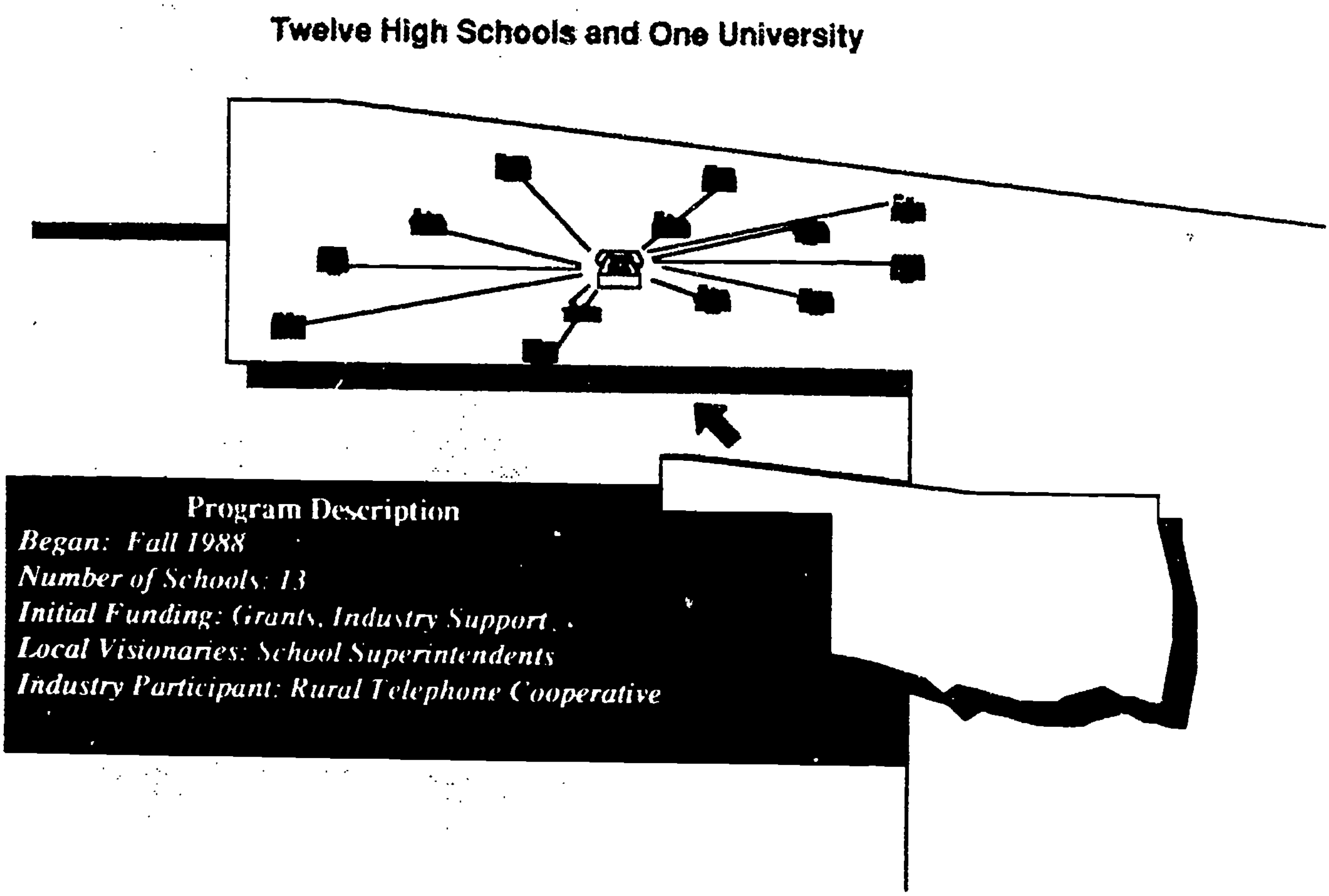
Projects in varying phases of the implementation process were selected in order to give the reader/viewer a comprehensive overview of the implementation process. Three sites have been on-line for varying period of time, the shortest being almost two years, and the longest being five years. One site is in the intermediate stage, having made agreements with participants, and in the process of installing equipment in those schools. Two sites are in the formative stage, i.e., forming alliances and securing funding for the project.

In addition to temporal distinctions, the three relatively mature projects were chosen because each has unique characteristics that inform upon the two-way interactive video process. The mature projects are among the few in operation in the Southwest and have been visited by many other educational entities interested in considering this technology.

All schools in the project were considered at risk because they were not able to provide education comparable to larger and less isolated schools. Sites were selected from the southwestern states of Texas, Oklahoma, and New Mexico, states that were hit hard by economic setbacks in the oil and agricultural industries. Sites had little if any governmental funding at national, state, or local level for implementation of innovative technologies. Selected projects were conceived and funded (at least in the pilot phase) from within the community, primarily from nongovernmental sources.

The partnership between local schools and indigenous private businesses provides a unique perspective in terms of the implementation of innovative technologies in education. These "grass roots" initiatives contrast with projects in Wisconsin, Minnesota, Kansas, Iowa, and Mississippi that received a significant portion of their funding from public sources such as tax bonds, state departments of education, and/or district funding.

Figure 3 - The Oklahoma Panhandle Shar-Ed Video Network



Up and Running

The Oklahoma Panhandle Shar-Ed Video Network

This project is the most mature network, having come on line at the beginning of the 1988-89 school year and linking four schools in one county. Although the current configuration of the Shar-Ed Network involves 12 schools and one regional university across a three-county area, the original initiative involved only the four schools in Beaver County, the easternmost county in the Panhandle. Generally, the trend among projects was to start with a cluster of schools and then expand as a project developed. Initiatives for Beaver County began in 1985 in response to funding cutbacks as a result of declining tax revenues, as well as state mandates to provide additional courses. Also, the Oklahoma College Board, which establishes college entrance requirements, came out with minimum competencies for six subject areas that required additional courses for college-bound students. County schools were advised by the dean of education at Oklahoma State University (OSU) that their college-bound students were not fully prepared for higher education.

In response, Beaver High School developed an innovative "School Before School" program where college-bound students would arrive at school an hour before regular classes began to take college preparatory classes. A curriculum was developed and classes taught in conjunction with OSU faculty. The program gained national recognition as one of fifteen U.S. schools cited as being exemplary. Although this innovative program did not use new technologies, it gave local educators the confidence and community support to try other educational innovations.

Beaver High School began receiving foreign languages, as well as other courses from OSU via satellite. While county students tested well and the initiative was considered successful, area educators felt that inability of students to interact directly with teachers failed to provide the best learning environment possible. There were good teachers in the county who could provide college preparatory classes, but not enough teachers for all four schools. Ideally, the school districts would share foregn language and other teachers within the county, thus providing courses tailored to the specific needs of their students.

County superintendents attended a demonstration in rural, western Wisconsin relating to interactive television distributed via microwave. Two of the four superintendents were impressed by the interactive nature of the system and students' ability to accept the technology and learn from it. Their first selling job was convincing the other two superintendents to join the quest. The result was the formation of the Beaver County Interactive TV Cooperative.

Upon returning from Wisconsin, county superintendents reasoned "...if they can do it, why can't we?" and began the long odyssey of getting support and funding for the implementation of two-way interactive video in their county. Local support for the program was not difficult since the county's schools had already gained considerable credibility from the "School Before School" and the satellite programs. However, support for the interactive video initiative did not extend to financial contribution. Budgets were already stretched tight.

Originally, a distribution system involving microwave technology, modeled after the Wisconsin project, was planned. County superintendents forged a relationship with oil companies in the area to assist with access to existing microwave towers and technical expertise. Even with the support of oil companies, costs in the area of $700,000 were expected, and little if any would come from local school district moneys. Months of knocking on doors, meetings, presentations, and grant writing ensued. Some efforts were successful, others less so. A typical example was an appeal to the state appropriations committee of the Oklahoma State Legislature. The Chair replied, "Wiley I like what you're doing but it's in the wrong district." Beaver County did get $50,000, but the Chair's home district got $200,000.

Money began to trickle in, but not nearly enough to fund the project. To make matters worse, oil company microwave engineers were growing pessimistic about the feasibility of a microwave system working in the Panhandle without the construction of additional and extremely expensive microwave towers.

The superintendents kept knocking on doors. Fiber-optic cable was beginning to be installed by phone companies and was being heralded as a revolution in the field of communications. The superintendents decided to call on a major telephone company. One of the county's high school graduates was an executive there, and they reasoned that such a connection would avail them a sympathetic ear. Approaches to the phone company did indeed yield a sympathetic ear, but little in the way of tangible support.

A Beaver county school board member was also a board member of the local telephone cooperative, which is a rural cooperative that provides telephone service to the Panhandle and surrounding areas. He suggested approaching the local telephone cooperative for the following reasons:

- The local telephone cooperative, although relatively small, was progressive and had been installing fiber-optic cable in the area, as well as upgrading many of its other services.
- The cooperative, being a federally mandated, was required to reinvest profits back into the community or to issue capital credit funds to customer-members. Supplying the schools with interactive television made sense, because fiber-optic lines could be used to carry signals other than those necessary to link the schools.
- The local telephone cooperative had a vested interest in the survival of the schools because it believed that the school was essential to the survival of the community, and that without the community its subscriber base would dissipate.
- The local telephone cooperative had an opportunity to implement "a cutting edge technology" that would place it in a strategic position when broader applications of the technology were sought.
- The telephone cooperative generated good public relations, both within and outside the community... to the point of receiving national recognition for its initiative.

- Local telephone cooperative employees and board members were part of the community with family members attending local schools.

The relationship between the Beaver County educators and the local telephone cooperative proved to be fruitful. Indeed, this liaison between county school districts and the small, rural telephone cooperative proved to be a model for all projects described herein. Small telephone companies or cooperatives typically have been much more responsive to the needs of their communities than larger telephone companies, and generally when small telephone companies or cooperatives have attempted to extend an educational network into areas controlled by larger companies, they have had success.

Meetings ensued and an accord was reached. The local telephone cooperative, serving a three-county area, wanted to provide the same educational opportunity to the schools in Texas and Cimarron counties that wished to participate. But it was agreed for the first phase, the local telephone cooperative would connect the four schools in Beaver County with 52 miles of fiber-optic cable, and provide maintenance, transmitting equipment, and transmission access. The Beaver County ITV Cooperative, through its accumulation of grant moneys, would partially reimburse the local telephone cooperative over a five-year period at the rate of $45,000 a year, and would cover the costs of furnishing media labs with cameras, TV monitors, microphones, etc., in the four schools, costing about $20,000 per lab. Currently, each school in the network is paying the local telephone cooperative $11,000 per year for maintenance and transmission access.

In addition to reaching an accord with the local telephone cooperative, Beaver schools had to reach an accord among themselves in terms of aligning schedules. This turned out to be one of the more difficult obstacles to overcome. In order for schedules to match precisely, school days had to begin and end at the same time. Class periods and school calander had to be alligned. This "electronic consolidation" ran counter to the independent nature of the Panhandle superintendents and school boards. However, with a lot of "hair pulling," concessions, and cajoling, a unified schedule was hammered out that would allow courses to be taught over their interactive system.

Another obstacle encountered was a state regulation requiring a certified teacher to be physically present in every classroom. The model for Beaver County and subsequent expansion was to have one teacher for all four sites. There was also some skepticism in the community regarding control of students and cheating in satellite classes. State authorities and the community were ultimately satisfied by the requirement that each student and his/her parents would sign a contract according to which the student must maintain a certain standard of behavior and satisfactory academic progress. The student would be removed from the class for violating the contract. Also, classrooms were monitored by school principals or superintendents who had connected televisions in their offices. Surprisingly few disciplinary problems have been reported since the inception of the program.

Courses began to be exchanged over the Beaver County two-way ITV network in the fall of 1988. Classes offered were Advanced Placement English, Spanish, art, and accounting. Classes originated from different schools and few glitches were encountered. The telephone cooperative's installation of the complex system functioned well from the onset. Instructors selected to teach the ITV classes were among the best i the county and were enthusiastic about the possibilities of teaching over the network.

Other teachers expressed strong reservations, fearing that the sharing of teachers might phase out teaching positions. Training was minimal, generally limited to familiarizing the teacher with equipment operation. Very little information about teaching on this new technology was available. Teachers who gained experience on this network have subsequently helped train and advise educators implementing other networks. Continued exposure to the technology reduced apprension among faculty, particulalry when it was perceived that the technology would not replace teachers. Rather, it would make courses available that the existing faculty could not provide.

During the 1990-91 school year three schools in Texas county, Beaver's western neighbor, were added to the network to form a second cluster of schools. The cost to connect to the network was $17,000. These schools shared their own classes, including advanced placement English, Spanish, college level general psychology, and advanced mathematics. At this time there was no sharing between the two clusters because of technical litmitations and the full schedule of the Beaver cluster.

Beginning in January 1991, the network offered its first course from an institution of higher learning, a graduate class in educational administration from Northwestern Oklahoma State University. The class was transmitted from one site in Texas county and available in both Beaver and Texas counties.

Also beginning in January 1991, Region 5 Rural Technical Assistance Center of Denver, Colorado, undertook a three month study to explore the feasibility of using distance learning as a means for providing Chapter I remedial courses to eligible children. Details of this study are presented in the "Existing Research" section.

During the 1991-92 school year two more schools were added in Texas County making a total of five in that cluster. A regional university, located in Texas county, came on line in summer 1991. The university began offering college courses in English, history, economics, sociology, and government to qualifying high school students (seniors with a 3.0 or better grade point average). These courses were dual enrollment, meaning that passing students would receive both college and high school credit, and were available in all three counties. However, Beaver County had difficulty in taking advantage of the dual enrollment courses because of an already full network schedule.

Three schools in Cimarron County, just west of Texas County, formed a third cluster. This cluster offers a nearly full schedule via the network including mechanical drawing, trigonometry/calculus, AP English, Spanish, and speech from within the cluster; art from the Texas County cluster; and economics, a dual enrollment course from Panhandle State University.

By the 1992-93 school year, all schools in the three counties of the Panhandle that wished to do so were connected to the network. Area schools then concentrated on upgrading teaching of existing courses. Sharing of courses among clusters has increased somewhat, but essentially school networking patterns have stabilized. Community access was expanded in the form of non-credit courses, paraprofessional training, and inter-community meeting opportunities during non-school hours.

One unique network program was established in Beaver County "to encourage rural entrepreneurship," which community leaders believe to be an essential component in preserving and improving rural economies and communities. REAL Enterprises (Rural Entrepreneurship through Action Learning), a pilot project funded by grants from the Oklahoma Department of Education and the local telephone cooperative, is the first such program in the United States to be taught via two-way interactive television.

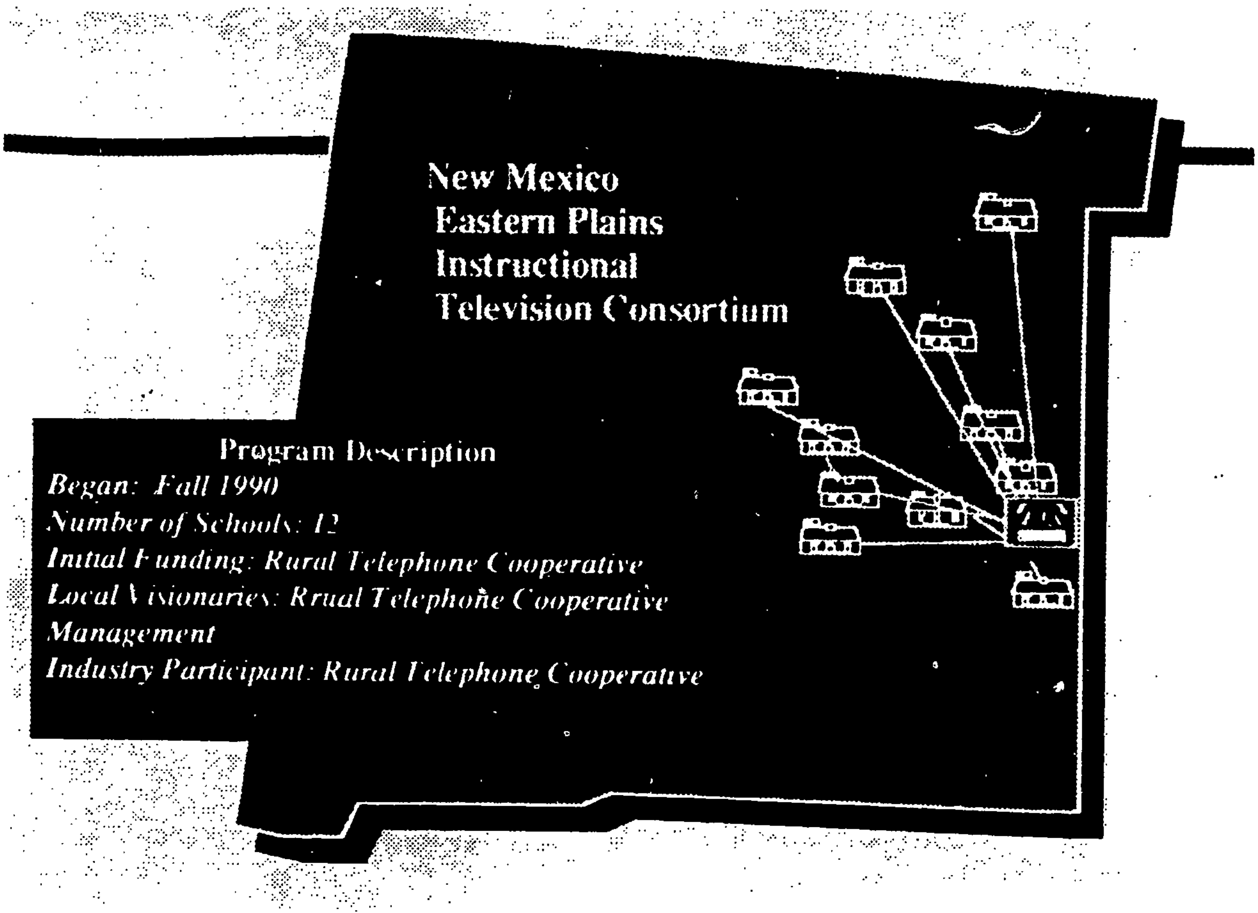
The program offers rural students an opportunity to learn to become effective entrepreneurs with emphasis being placed on developing enterprises in the rural community. Academic work includes courses in entrepreneurship and small business management. Course work merges with a business development project in which students research, plan, operate, and eventually own their own businesses. Throughout the process, a Community Support Team, made up of business leaders and other interested individuals from the area actively assists students and teachers. To develop an understanding of the unique conditions of each site and to interface with the community more effectively, the teacher travels to all sites during the semester, rather than always teaching from the same location.

Community expectations are high. The REAL project is designed to elevate business skills of the students and improvethe business environment of the community. As one participating school's district superintendent enthusiastically put it, "It'll only take one idea to put us on the map. One student with the right idea. With modern technologies, we can communicate with anyone anywhere. Our potential is unlimited. And at the same time our kids are learning about the real world."

Future plans for the network possibly include:

- Connecting with a southwestern Kansas interactive TV network, giving them access to Fort Hayes State University, which has a strong graduate program;
- Connecting with Oklahoma State University and/or the University of Oklahoma;
- Offering foreign language awareness courses at the elementary school level;
- Offering vocational training courses in Cimarron County;
- Providing computer data transmission, including student access to Internet, and compputer training from Panhandle State University; and
- Expanded community participation.

Figure 4 - The New Mexico Eastern Plains Interactive TV Cooperative



The New Mexico Eastern Plains Interactive TV Cooperative
This project came on line for the 1990-91 school year. Although inspired by the Oklahoma Panhandle Shar-Ed Network, it evolved quite differently. Rather than originating from educators, the vision and implementation came from the manager/CEO, and the board members of a rural telephone cooperative whose service area covered 2,500 square miles in eastern New Mexico and western Texas.

That original vision included:

- linking together twenty schools in New Mexico and in west Texas;
- providing access to medical training and technical support from the Lubbock Health Sciences Center to community health facilities;
- making on-site training available to outlying industries; and
- delivering university courses and professional training for community members.

The local telephone cooperative's position was one of pragmatism. It was convinced that the viability of the rural school was essential to the survival of the surrounding population which was the local telephone cooperative's subscription base.

The local telephone cooperative approached schools that were already accessible by fiber-optic and offered them the opportunity to participate in a pilot project whereby the local telephone cooperative would assume all costs for setting up the network, including installation of production gear for studio classrooms. The local telephone cooperative had sought support from the state legislature but had not been successful. The only governmental support available was an interest-free loan from the Rural Electrification Administration (REA). Rather than wait for additional moneys to be allocated, the local telephone cooperative decided to establish a successful program, then petition the state legislature for reimbursement. The obligation of the schools would be to coordinate schedules and classes so that the system could be effectively used.

From the beginning, two network clusters were conceived, one linking schools that had classes five days a week, and one that held classes on four days. The three schools that formed the five-day-a-week cluster, spanned a distance of nearly 200 miles. Because of disparate curriculum needs, participating schools were only able to share courses in art and Spanish. This paucity of course offerings has proven to be problematic.

The second cluster, with only two four-day schools participating, shared art, physics, geometry, Spanish and algebra. A major problem occurred because one school was closed on Friday and the other closed on Monday. The schools could not agree to be closed on the same day, so each had automated taping facilities that recorded classes transmitted on the day they were closed. Although both clusters had less than an ideal beginning, the project was deemed successful and attracted a lot of attention.

The 1991-92 school year witnessed the consolidation of one cluster and the weakening of the other. The five-day cluster lost one of its schools which converted to a four-day week and joined the other cluster, leaving only two schools at the extreme ends of the network, and only one shared class between them.

The four-day cluster, in addition to the defection mentioned above, added another school, resulting in a total membership of five. All schools within the cluster agreed to a Monday-Thursday week, eliminating the necessity of students having to attend one day of taped classes. Each school supplied one course, with a network schedule including physics, algebra, Spanish, Southwestern literature, and art appreciation.

A local community college also joined the network during the 1991-92 school year, having been invited to do so by the manager/CEO of the local telephone cooperative with all costs to the college being waived for one year. The college was able to offer a number of dual-enrollment courses to qualifying high school students, including psychology, sociology, algebra, English, Spanish, and art appreciation. These courses were particularly attractive to college-bound students, typically 40-60% of the school population, because courses were offered at no cost to the students and textbooks were provided. Some students have been able to accumulate as many as 24 hours of college credit prior to graduating from high school.

For the 1992-93 school year a third and highly unique cluster was formed involving a high school and a remote elementary school in the same district, but located 45 miles apart. Previously, students graduating from the elementary school each year had to travel nearly 100 miles a day to attend the high school. That translated into more than 18,000 miles a year per student. Prior to leaving for the high school, most of these students first had ride[illegible]s to the elementary school, increasing travel time ever further. Traveling was particularly difficult for ninth graders who were unaccustomed to being away from home for such extended periods of time.

The president of the school board, who was also the manager for the local telephone cooperative office in that area and a graduate of the distant elementary school, was a strong advocate of technology in education. He had assisted in the installation of media labs in other schools on the network. His first efforts to convince the school district superintendent to install a remote ninth grade classroom were not well received. Other distance learning programs, courses via satellite, had not been successful in the area, and had been costly. However, after some persuasion, and the visiting of two-way interactive sites in operation, the school district decided to implement the program. Not being a part of the pilot initiative, the school district had to bear the cost of equipping classrooms with production equipment.

This initiative differs from others in the network since the vision came from a local resident, rather than the manager/CEO at the telephone cooperative whose central office is located about 100 miles from the high school. Rather than providing an opportunity to share teachers, this initiative sought to set up a satellite classroom which delivered a full complement of ninth grade classes from the high school to the ninth grade students in their home community. Because of the youth of the students, a facilitator was on the premises at the remote classroom during classes.

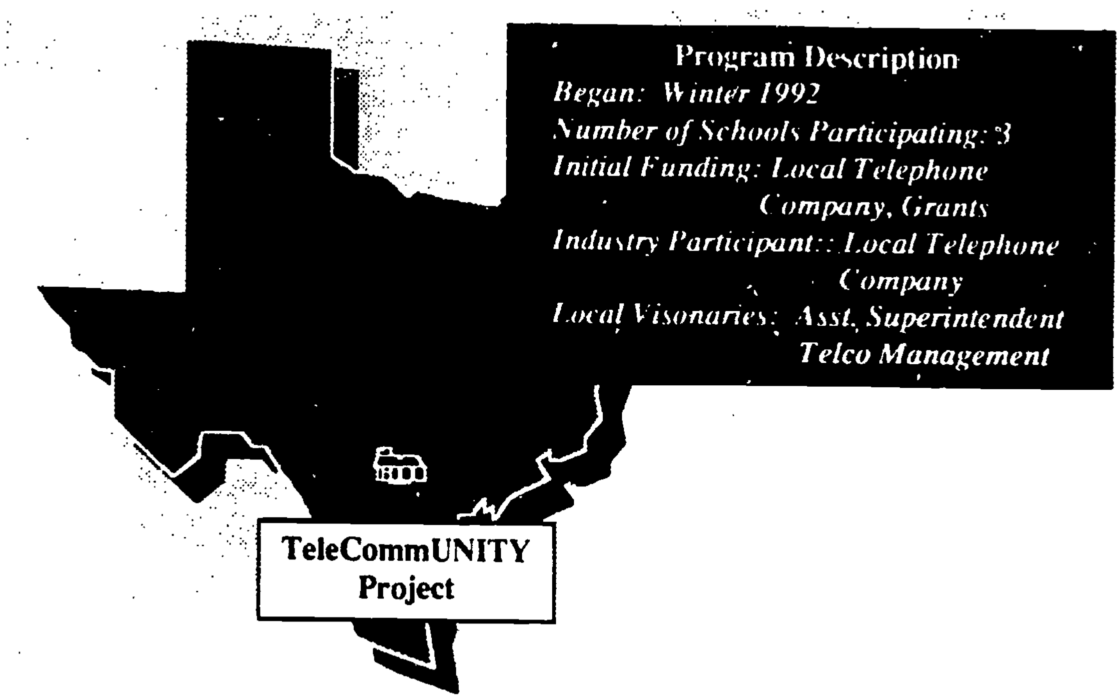
The program began in fall 1992 with very little teacher preparation. However, there are already indications of success.

- Even though students have the option of staying at the elementary school for the ninth grade or bussing to the high school with older students from the area, eight out of the ten students who started the fall semester elected to continue taking classes over the network.
- Grades for the ninth graders at the elementary school were as good as or better than those of their peers at the high school.
- The English teacher, who was initially terrified at the prospect of using the technology at first, stated that her class with the network students was one of the best she has ever had.

Another development in the 1992-93 school year was the increased role of the community college in the network. Two schools in the four-day cluster were unable to contribute courses to the network because of faculty changes. The community college was in a position to increase its participation and did so by offering dual enrollment course to high school students over the ITV. Some school superintendents expressed a preference for courses offered by the college because of the dual enrollment advantages, and they felt that the accelerated pace of the college level courses worked well via a television format. Also, the community college began to offer a number of college level courses in the evening for community members, with as many as 28 students enrolled in a given school. Courses offered included accounting, art appreciation, English composition, American government, and psychology. The community college is currently writing a grant to upgrade its network facilities in order to further expand course offerings.

The original vision of the manager/CEO of the local telephone cooperative has been scaled back for the time being. Originally, the company had planned to put as many as 20 schools on the network, and a number of schools have petitioned the local telephone cooperative for network access. Although the local telephone cooperative was partially compensated by the state for classroom installation, it is unlikely that the cooperative will make any further large scale investment unless the state and/or school districts agree to support the initiative up front. Company officials state that only one other school is slated for network access in the near future, bringing the number of participating schools to ten.

Figure 5 - The TeleCommUNITY Network



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The TeleCommUNITY Network

This project, located in a small town in Central Texas began operations in winter 1992. Although TeleCommUNITY Network came on-line recently, it was the first fully functioning two-way video and audio network in Texas K-12 schools. This project has perhaps the strongest community focus among projects studied in that the first phase of implementation involved participants only from within one community. Participants are: the local school district, specifically the high school; a regional university; the local telephone company, a small commercial telephone company, rather than a telephone cooperative; and a Job Corps Center located on the outskirts of town.

The initial vision came from an assistant superintendent and a school psychologist who were strong advocates of educational technologies. Support quickly followed from the local telephone company who hired the school psychologist and a two-way interactive TV specialist, trained on the technology in Minnesota, to facilitate the program. This is the only instance among the projects studied where professional facilitators were brought in to develop and coordinate the program. The telephone company also financed the installation of the technical network, including classroom equipment. The three on-line sites agreed to partially reimburse the telephone company over a five-year period.

TeleCommUNITY, with a 14 member planning team, started meeting in January, 1990 and implemented its network in January, 1992, linking three sites in the community. Through a series of grants and support from the telephone company and the university, TeleCommUNITY began a unique program called PATH Math (Partners for Access to Higher Mathematics). This program introduced pre-algebra skills to students who had previously failed in mathematics and were at risk in other higher order skills related to computational tasks. The course was team-taught by a university mathematics professor, located at the university and linked via the network, and by a school district mathematics teacher who was on the premises. Over 80 per cent of the students passed the course. Students' progress will be monitored as they continue with mathematics and other studies.

Currently, the university is offering dual enrollment calculus to high school and Job Corps students over the network. The Job Corps plans to offer specialized vocational training to high schools students and residents.

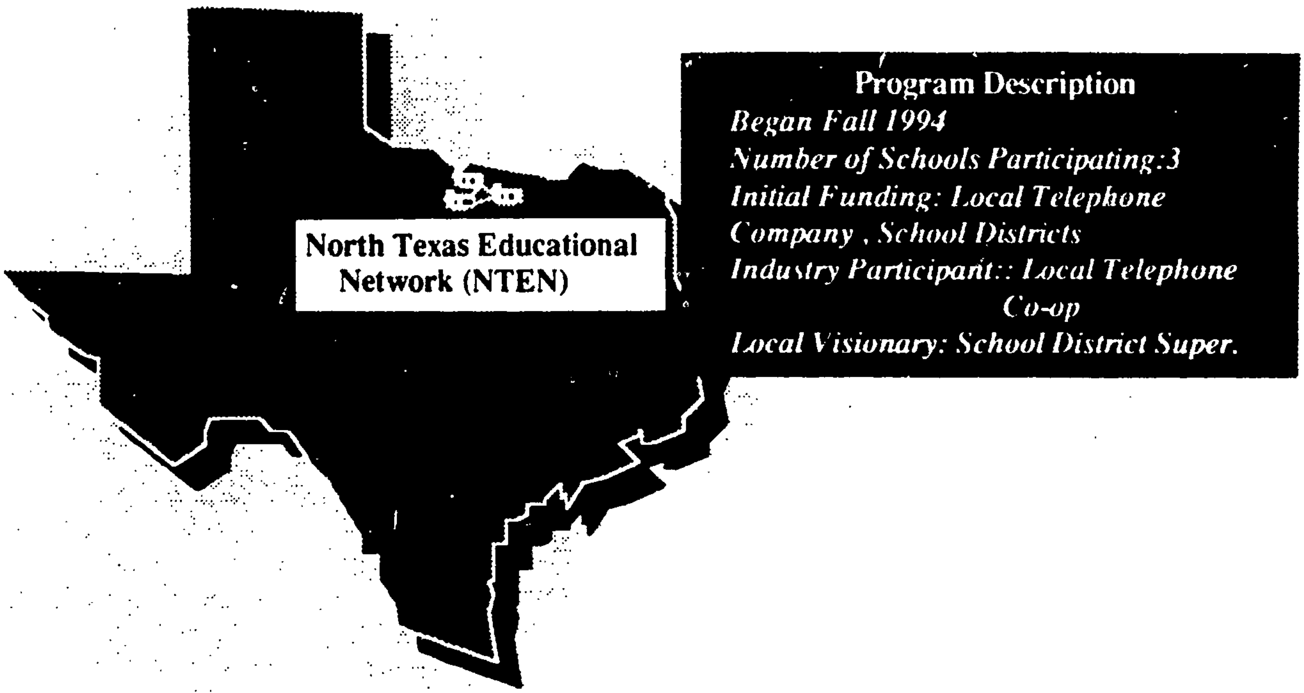
Other plans for the network are:

- To expand the network to outlying areas;
- To construct and additional classroom site at the university featuring fully interactive video, audio, and data capabilities which will interface with other on-line class labs;
- To grant access to on-line teaching at the high school for participants in local literacy programs, which would originate at the Job Corps;
- To support activities, including on-line computing and video for children and adults of family literacy projects; and
- To connect with an ITV network that is developing in a nearby metropolitan area.

On the Verge

The following projects are in varying stages of planning the implementation of an interactive educational television network. Prognosis for successful completion of all three projects is good.

Figure 6- North Texas Educational Network (NTEN)



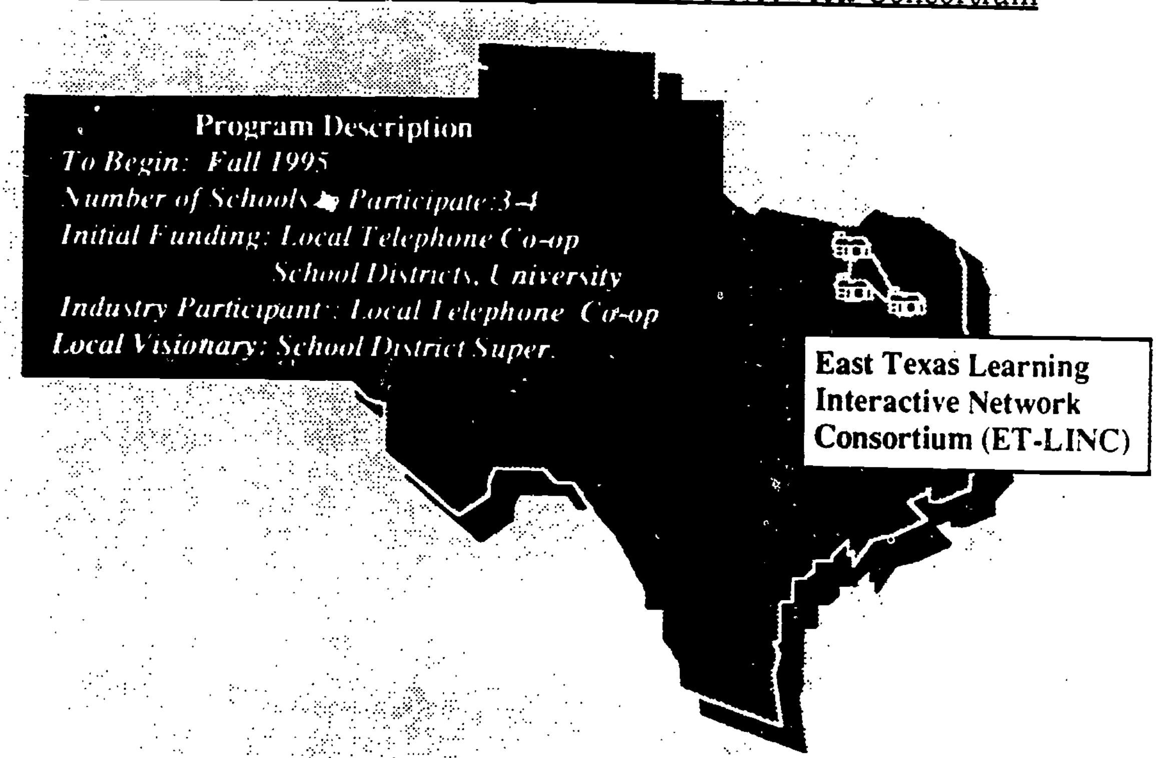
North Texas Educational Network (NTEN)

This project is a partnership among three North Texas school districts, a parochial school, and a rural telephone company. The vision came from the owner and general manager of the telephone company who had seen demonstrations of the Oklahoma Panhandle system. He believed that an area network could strengthen area schools, thereby preventing further erosion of the rural population. The owner has been successful in getting participation from the school districts mentioned above, and is seeking support from additional school districts, as well as an area college. Contractual arrangements with the on-board schools include reimbursement for the classroom equipment and an annual fee for fiber-optic access.

NTEN is in the development stage, and is in the process of equipping classrooms with necessary equipment to begin using the system. Fiber-optic cable has been installed between school districts. All equipment for implementation has been purchased by the local telephone cooperative. Training sessions to familiarize teachers with the system are expected to begin in the fall of 1993. In an effort to enlist support of area communities, NTEN held a two-way video demonstration for residents at an area college in summer 1992. The demonstration attracted hundreds of citizens who actually participated in an ITV classroom setup that connected four locations. NTEN has also participated in technology workshops and conferences to promote its initiative, and to learn about others.

Expected benefits for the future are an expanded and enhanced K-12 curriculum, dual high school and college credit, job training workshops and symposiums for the rural communities, programming capabilities for health care in rural areas, and other community services.

Figure 7 - East Texas Learning Interactive Network Consortium



East Texas Learning Interactive Network Consortium (E-T LINC)
This project presently comprises two northeastern Texas school districts, a local telephone cooperative, a locally based aerospace company, and a regional university. The first formal initiative came in fall 1991 when a school district media coordinator recommended sending an expert to visit the San Marcos TeleCommUNITY project. A telecommunications specialist from a local aerospace company, who had a strong interest in educational technologies, was selected to go. This visit proved very productive in terms of enlightening the E-T LINC project, and forming an alliance with the TeleCommUNITY project that has been instrumental in the progress ET-LINC has made up to this point. The visit also solidified relations between the school district and the local aerospace company. The telecommunications specialist became a strong advocate of the two-way interactive program and a participant in its formation.

A local telephone cooperative expressed strong interest in being involved and offering support. A consultant for the cooperative was already familiar with the TeleCommUNITY operation and was an enthusiastic advocate of the technology. The project gained further strength in fall 1992 when the assistant superintendent of the San Marcos school district moved to a nearby school district in northeast Texas, bringing her expertise and enthusiasm. She soon enlisted the support of her superintendent.

Formal meetings that included visionaries from the two school districts, the telephone cooperative, and the aerospace company began in fall 1992. These have continued on a monthly basis. Soon thereafter, the local telephone cooperative established a liaison with the dean of education at a regional university who also joined the effort. The dean had been involved in distance learning technologies in another state and was interested in reaching out to area schools in northeast Texas with similar technology.

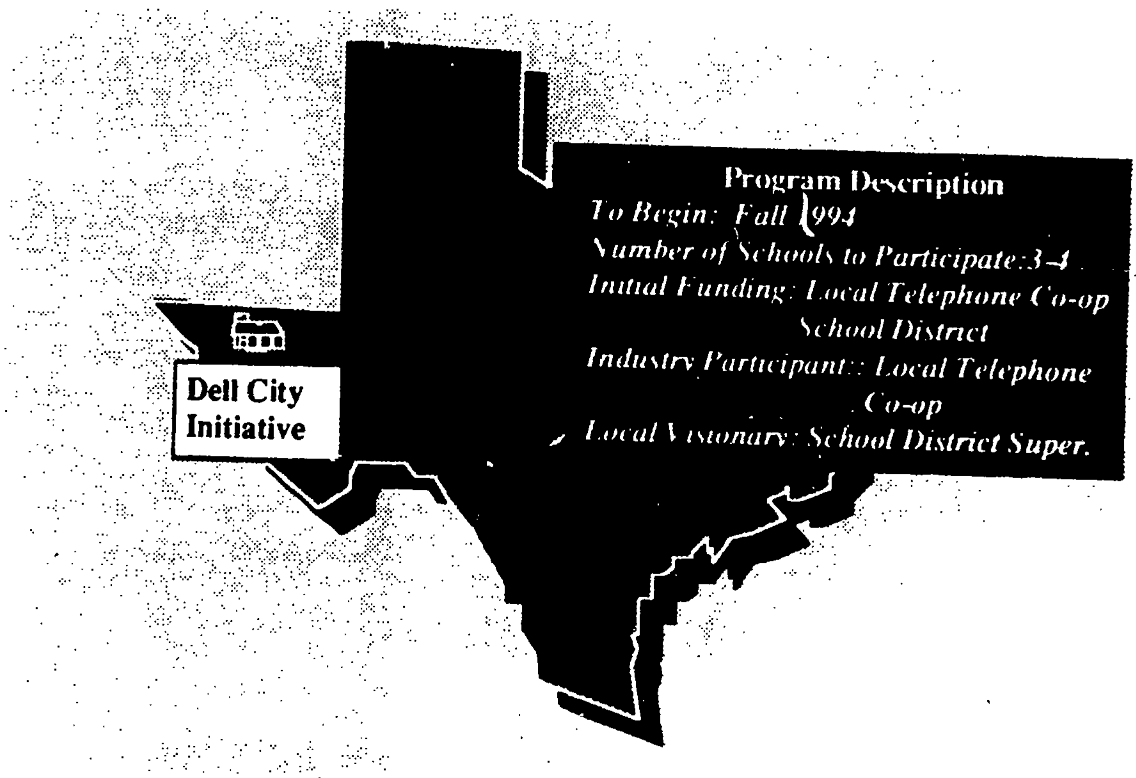
Both school districts currently involved in the project had relatively complete curricula and were not strongly motivated to share teachers at the high school level. However, they were extremely interested in making university-level courses available to their students and community, and the participation of the university was essential for their continued interest. The school districts and the university see linkage via two-way interactive video a benefit for the following reasons:

- Classroom enrichment for school district students with participation of university professors serving as "master teachers";
- Dual-enrollment courses for high school students;
- Graduate courses for in-service teachers;
- Undergraduate courses for school district paraprofessionals and place-bound community members;
- Sharing of actual classroom practices with pre-service teachers at the university;
- Monitoring of pre-service teachers while student teaching; and
- Demystification of the university environment, thus making higher education more accessible.

Also strengthening the project was a recent donation of nine DS-3 Dax broad band digital switchers from a major long distance carrier. Each switcher, which costs over $200,000.00, is capable of linking 60 sites. While a donation of switchers that has the potential of interconnecting as many as 540 sites seems to be "overkill" in a project beginning with two schools and one regional university, it significantly strengthens the credibility of the project. Furthermore, the switchers reduce the installation cost per site by $5,000.00, resulting in an initial savings of $15,000.00 for the project, and will offer an incentive for other schools to join the project. Ultimately, project planners hope to disperse the switchers throughout the state of Texas, linking many rural, small schools with each other, institutions of higher learning, medical centers, and other appropriate entities. The equipment is being received by the TeleCommUNITY Project since it is a legal, nonprofit entity and E-T LINC has not yet attained that status.

The confluence of diverse, influential entities, including ongoing support from the TeleCommUNITY project is anomalous among the six projects studied and bodes well for the success of the project. E-T LINC participants agree that the next step is to become a recognized nonprofit entity so that they can receive donations directly and write grants. At present, they have the option of joining the TeleCommUNITY project or forming their own independent organization.

Figure 8- The Dell City Initiative



The Dell City Initiative

This project originated in a remote, underpopulated school district in far west Texas, about 90 miles east of El Paso, and is facing the specter of consolidation. The vision to reach out with technology to strengthen the school and the community was first articulated by the Dell City school district superintendent who had seen and studied some of the programs mentioned above. The superintendent has spent the last year forging relationships with other area schools, and her efforts are near fruition. The manager of the local telephone cooperative has promised support, and is in the process of connecting schools in the cooperative serving area.

Initially, the project hopes to link three school districts and a community college in El Paso. All institutions have access to fiber-optic cable; however two of them, located in El Paso, are served by another larger, regional telephone company which makes coordination problematic. Discussions with the larger telephone company have not to date met with success. In order to connect the network school districts with El Paso Community College, the regional telephone company would charge the network approximately $17,000 a month, a prohibitive cost. Alternative plans for linkage are underway, the most feasible being a microwave link.

Dell City, having been involved with the project for some time, has already secured community funding for a media center, and has been instrumental in forging an alliance with a conglomeration of rural and small community telephone companies or telephone cooperatives that extends from Lubbock up to but not including El Paso, Texas. The ultimate strategy is to connect rural, small schools in the region, The University of Texas at El Paso and El Paso Community College. Plans also include connecting with the University of Juarez in Mexico which is located just across the border from El Paso. Such a link would be the first in the United States and would provide a international test site. For the present, however, the superintendent at the Dell City school district would be content to be up and running with nearby school districts and the community college in El Paso. She wants to be fully functional by 1994.

Although Dell City school district is still in the genesis phase of implementation, it has already made enormous progress in getting right-of-way agreements with many telephone companies or cooperatives, and getting authorization, as well as support, for the installation of necessary fiber-optic cable enabling dedicated signal transmission.

Two-Way Interactive Educational Television Systems

Project Title	# of Beginning Units	Began Plan	Implementation Efforts	Date of Implementation	Duration Project	# Present Units	Local Instigator(s)	Sources of Inspiration	Higher Ed Participant	Industry Participant	Future Growth	Role Model for Program
Oklahoma Panhandle Share Ed Network	4	1985	Grant Writing State/Foundation/ Industry Support	Fall 1988	51	13	Beaver Co Superintendent	Wisc Minn 2-Way Video Networks	OK Panhandle State University	OK Panhandle Tele Co-op	Link with SW Kansas Network Kansas Regional [illegible] ersity	Eastern NM, Southwest KS Mississippi North Texas San Marcos
NM Eastern Plains Instructional TV Consortium	5	1989	Industry Support	Fall 1990	27	12	ENMR Tele coop Management	OK Panhandle ITV System	Clovis Com College	ENMR Tele coop	Link with other higher ed Additional TX, NM schools additional community services	Dell City 2 way Interactive TV Project
TeleCommUNITY Network, San Marcos, Texas	3	1990-1991	Industry, University, Job Corps, ISD Partnership/ Grant Writing	Winter 1992	12	3	San Marcos Telco SW TX State San Marcos ISD Gary Job Corp	Minnesota ITV, OK Panhandle	Southwest Texas State University	San Marcos Telco	Link with adjacent schools other higher ed using other telcom technologies	ET Link North Texas
North Texas Educational Network	3	1991	Local Telco and School District Partnership	Fall 1993	N/A	3	Muenster Telephone Company	OK Panhandle Project, TeleCommUNITY project	none at present	Muenster Telco	Links w/ Cooke Community College Other Area Schools	N/A
Dell City 2-Way Interactive TV Project	4-Mar	1991	Partner with Local Telco, Grant Writing	Fall 1994 (projected)	N/A	4	Dell City ISD Superintendent	San Marcos Telco, OK Panhandle ITV	El Paso Community College	Dell City Telephone Co-op	Link from Dell City to Lubbock, TX Juarez University, Mexico	N/A
East Texas Learning Interactive Consortium	3	1991	Telco, ISD's, Hi-Tech Indus. Higher Ed Partnership/ Grant Writing	Winter 1995 (projected)	N/A	4 Mar	Quitman Telco, ISD Visionaries, E-Systems, Dean of Education Northeast Texas State	TeleComm UNITY Network	Northeast Texas State	Quitman Telephone Cooperative	Add other schools, community services; teacher training	N/A

Figure 9 - [illegible]

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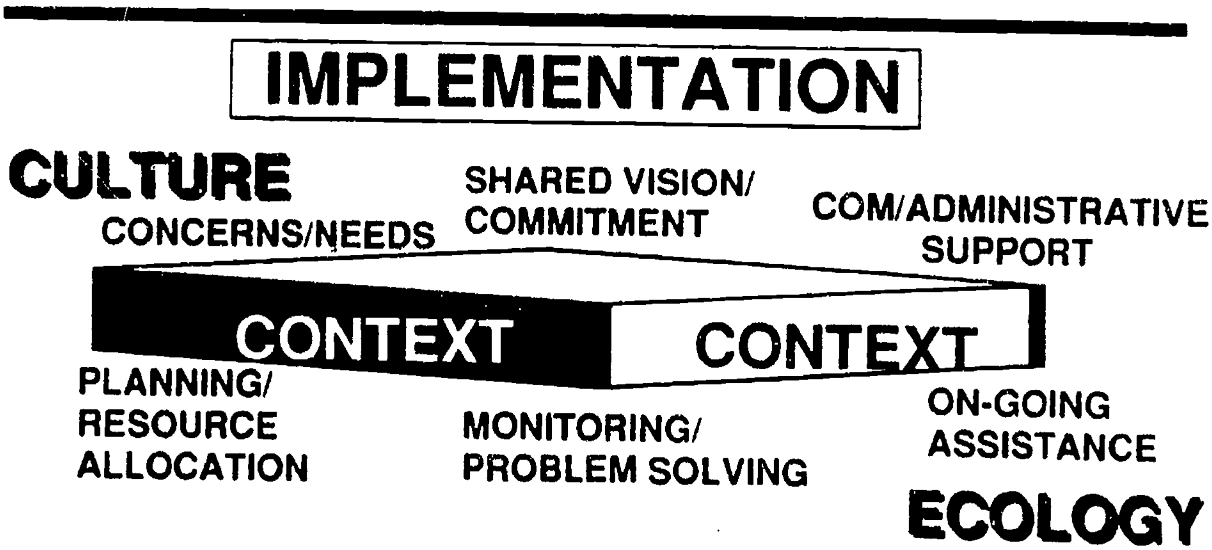
Toward a Prototype

Jolly & Deloney (1993) present a number of general criteria that constitute a framework of conditions that facilitate new program development when interacting with other educational entities. Their framework, a compilation of seven criteria, was modified to serve as a prototype for the cooperative implementation of full motion, interactive video among rural, small school districts. They are: The Context; Concerns/Needs; Shared Vision/Commitment; Community/Administrative Support and Assistance; Planning/Resource Allocation; Monitoring/Problem Solving; and On-Going Assistance.

The following section contains a brief discussion of each criterion and defines elements of SEDL's research that relate directly to the successful implementation of the technology.

Figure 10 - Toward a Prototype



The Context

The context comprises the area in which all other criteria function. Boyd (1992) defines school context as consisting of two dimensions: ecology (the inorganic elements, such as the resources available, the policies, and rules, the school size), and the culture (the informal side, such as observed behavioral regularities, norms, dominant values, philosophy). A similar context exists for technology innovation, and this context must be conducive to positive change and supportive of cooperation between organizations in order for implementation to occur.

- In almost all locations studied, the ecology was unfavorable, i.e., a dearth of physical resources, funding, space, and a number of regulations and scheduling problems that were obstacles to the implementation of the

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technology. However, the school and community cultures were benevolent, allowing for an environment of innovation and risk-taking.

- Where no pre-existing relationships and regulations were found to accommodate implementation, such relationships and regulations were forged through rigorous self-discipline and strong desire to implement the technology. Even so, the forming of alliances and the establishment of guidelines were not always easy.
- Because of the proximity of players within a given network, participants had already established a norm for cooperation through athletic events, district overlaps etc. However, these cooperative arrangements were superficial in comparison to the amount of coordination necessary to implement an ITV network, but they did serve as a positive first step.
- Although the novelty of the program could be a significant element in explaining a project's early success, the most mature program (five years in duration) grew stronger as time progressed and is currently an integral part of the school and curriculum.
- In order to accomodate the introducation of the technolgy, adjustments to rules, regulations, and school policies were necessary both at the state and local levels.
- More coordination and flexibility in terms of federal and state regulations is necessary to accommodate new communications technologies. Without adjustments, widespread use of the technology will not occur.

Concerns/Needs

The transition from concern/need to action is a significant one, particularly in the arena of established entities such as school districts. Articulating the specific concerns/needs that ultimately result in change is essential. Without clear objectives that address clear concerns, implementation will be either aborted or flawed.

- A major concern or need driving the acquisition of a two-way interactive television system was increased curriculum demands stemming from various state level initiatives and more rigorous college entrance requirements.
- As noted above, the threat of consolidation was a major concern for some school districts.
- Repeated emphasis was placed on the precise articulation of the need, rather than some amorphous excitement about the "potential" of the technology. In order for the implementation of the technology to succeed, there has to be a well-defined need for the technology to address. This specificity can also have a downside, in that once the original objective has been met, there may be little motivation to explore further potential.
- Another need, perhaps more fundamental, was the desire to provide the best possible education for the children of the community and "and bring them in to the twenty-first century."
- The needs were initially felt and identified by local school district personnel. Typically a "local hero" emerged -- an individual who was involved in some way in the identification of the need. This person became the champion of the cause, driving the adoption and implementation processes. Ironically, in some instances champions were only tangentially impacted by the

technology once in place. Their commitment stemmed from their passion and belief in the potential of the technology for the common good. As one reluctant (at first) superintendent put it, "Altruism was rampant."
- In two instances the technology was made available before action was taken or the need was evident to educators. Once the advantage of the technology became apparent, however, clear objectives were identified.

Shared Vision/Commitment

According to Senge (1990), a shared vision answers the question, "What do we want to create?" People who share a vision are bound together by a common caring. This shared vision expands the group's creativity and changes relationships. Leaders who have developed a shared vision with their faculty will also create common ground that serves to facilitate or compel action to the realization of this common vision (Mendez-Morse, 1992).

Current leadership literature characterizes the leader as the vision holder, the keeper of the dream, or the person who has a vision of the organization's purpose (Mendez-Morse, 1992). In *Leadership Is an Art* (1989), DePree asserts that "the first responsibility of a leader is to define reality" (p.9). Bennis (1990) writes that leaders "manage the dream" (p.46). Vision is defined as "the force which molds meaning for the people of an organization" by Manasse (1986, p. 150). Leaders who are successful with implementing innovations communicate the vision clearly to all involved. Failure to share information can cause a loss of commitment and momentum.

Numerous researchers have found that sharing a common vision increases the likelihood that school improvement efforts will succeed (Beer, Eisenstat, and Spector, 1990; Deal, 1985; Carlson, 1987; Miles and Louis, 1990)
- In all cases, school district participation in ITV was voluntary. The complexity and the difficulty of the undertaking served to eliminate participants who did not share the excitement of the vision. Considering the time and committment necessary to implement the system, it would have been counterproductive to *require* a professional to undertake the task.
- There were degrees of commitment among participants, but among the primary initiators, commitment went well beyond professional expectations. One visionary referred to herself as a "monomaniac on a mission."
- Technology cannot be implemented without the support of an extremely dedicated local visionary or visionaries. In all cases cited, the vision originated with one or two individuals who tenaciously persevered until the technology was implemented. All visionaries tended to be extremely persuasive and were successful in communicating the potential of the technology to other players and policymakers.
- Once the technology was implemented, participants, including students, teachers and administrators involved with the technology, tended to be strong advocates, even those who originally had strong reservations.
- For advocates to share their vision with other potential players, it has been necessary to show the technology in actual practice. For this reason, SEDL prod· :ed the videotape, *Local Heroes*, which accompanies this paper.

Community/Administrative Support and Assistance

Strong support from school administrative and community leadership (technical support, infrastructure, public relations, public support by community leaders) is essential to the effectiveness and longevity of innovations. Deal (1990) states, "nothing will happen without leadership from someone or someplace – energy needs to be created, released, channeled or mobilized to get the ball rolling in the right direction" (p.4). Glatter (1987) states that "There has too often been an assumption that you only need to introduce an innovation for it to be effectively absorbed by the institution" (p.61).

- Typically, communities where the technology was implemented became favorable once the technology was understood and differentiated from other less successful distance learning applications.
- Most participating local school district administrators were highly supportive of the technology and of the entire technology implementation process. Those administrators that were not supportive had not yet come to realize the full potential of the technology.
- Although expensive, the technology is affordable, but not without support from the business community, typically a local telephone cooperative or company.
- All projects had enthusiastic support from small rural telephone cooperatives or telephone companies who perceived that support to be in their best interests. Larger telephone companies with less investment in specific communities have not yet participated in the projects. Efforts are underway to encourge these telephone companies to participate.
- While all projects started out with specific classroom courses, they viewed the technology as a community resource. As projects matured, community offerings increased, particularly in the area of adult education.
- Invariably the primary "linking agent" in all cases has been the visionary or the "local hero." This person provided knowledge, information, and continual support needed to secure additional support from school, business, and community leaders.
- There was open and frequent communication among participants which nutured further support and assistance.
- Community members view the school as the hub of their community, and necessary to the survival of the community. School icons are frequently seen on community property such as water towers, walls and other large surfaces. Schools are often categorized as the "biggest business in town." Once the technology was understood, community members tended to be supportive. It must be noted, however, that implementation of the technology did not require additional community resources.
- Community support grew as reports from the children validated the success of the technology and as community services were made available through the technology.

Planning/Resource Allocation

Planning is defining all the structural and resource requirements for program implementation. In addition to the traditional planning steps that a single organization might take to develop an innovation, technology efforts require some special considerations such as technical expertise. Resources include everything that is needed to bring a program into existence (facilities, such as equipment, supplies, staff, skill acquisition, the time and energy of supportive staff, etc./ It also includes the individuals (human capital) who can ensure the allocation of resources needed for program operation and staff responsible for program implementation.

- All programs studied required extensive planning, from linkage of participating entities, to acquisition and installing of the of technology in classrooms, to scheduling, to training teachers, to preparing students. Indeed, the nature of the interactive process mandates a precise planning procedure.
- Resources were not available within the school budget allocation. This forced innovators to seek outside help. As mentioned above, in two projects unsolicited help came from local telephone entities.
- In general, the major costs of implementation were originally undertaken by the local telephone company or cooperative with partial reimbursement occurring over a period of time by the school districts or by state departments of education.
- In most cases preliminary funding through grants, foundations, and interest-free loans provided seed money that engendered credibility and enabled the onset of serious planning which generally included extensive travel to existing sites.

Monitoring/Problem Solving

Systematic montioring of the ongoing operation of the program is essential so that problems can be identified and resolved as quickly as possible. Successful implementation of innovations is dependent upon the ability of leaders to constantly search for, confront, and acknowledge problems when they appear and act rapidly to make major adjustments. (Hord, 1992). Superintendents play an active role in monitoring change and improvement (Pollack, Chrispeels, Watson, Brice, & McCormack, 1988). They use school and classroom visits to observe curriculum and instruction and to monitor the progress of the implementation of new curricula. They collect school and classroom products associated with the change (Hord, 1992).

- Very little formal monitoring of the effectiveness of education delivered by the technology is available at sites studied, the exception being the study by Lawyer-Brook (1991). However, anecdotal evidence by participants at the supervisor, teacher, student, and community levels suggests that the technology has been extremely useful in expanding educational opportunities.
- Although most projects don't have classroom facilitators at remote sites, activities are monitored by either the principal or superintendent via a linked television receiver installed in the office.
- Students and parents are required to sign contracts outlining the performance expectations and responsibilities of participants.

- The rural nature of projects studied required decisionmakers to be directly involved with all operational aspects of their schools - from serving lunch, to maintaining the technology, to getting feedback from the community, to driving school busses. Also, superintendents must coordinate classes with other schools and oversee classroom comportment. Such activities keep administrators in touch with the technology, and allow them to make informed judgments as to its efficacy and improvement.
- Distribution of materials is still problematic. Fax machines are present in all classrooms, but when large quantities of materials have to be sent, the fax is inadequate. Transfer of information via computer would be much more efficient and is possible through the technology. Computer linkage at present is in the infancy stage.
- The technology tends to make teachers more organized and more conscious of the teaching process.
- Education via the technology, when properly implemented with appropriate staff develolpment, was reported to be as effective as conventional education.
- Typically the technology was resisted most by the teaching staff who feared that their jobs would be phased out. The technology appeared to do the contrary in that it enabled the offering of more courses which reduced the threat of consolidation.
- Resistance both in the community and in the school was a factor, but not significant enough to deter implementation, and as the system matured, resistance tended to erode.
- The technology was used for a variety of educational configurations. Many advocates said that use of the technology "was only limited by the imagination."

On-Going Assistance and Support

The survival of innovation requires continuity of support, from initial set-up to maturity.

- Staff development is very important to the success of implementation. Delivery over the technology is substantially different from conventional classroom teaching. However, good classroom teachers make good teachers over the network. Teachers must be given time to develop skills and curricula for their ITV courses.
- There were enough enthusiastic teachers to fill the interactive television schedule, and as other teachers began to be exposed to the system via staff development, mini-classes, or teacher conferences, they became less intimidated by the technology.
- A major factor to overcoming resistance was adequate planning that made the technology work from the onset, resulting in the technology becoming a matter of course, i.e., transparent, and consequently widely accepted and supported.
- Teachers using the system are typically given more preparation time, but are not trained to fully maximize the system. Conferences involving interactive teachers should be developed to share information and design models for future possibilities. At present, there seems to be a leveling off of innovation because the needs for which the system was implemented are being met.

- In almost all cases, participants involved with the projects considered them successful and likely to continue.
- In many cases, state and federal support grew as the project matured, and the success of the project became widely known. It was the objective of all participants to first build a credible model, gain support from state and federal decisionmakers, and then encourage the spread of the technology.

Guidelines for Implementation of Two-Way Interactive Video

Jolly & Deloney (1993) suggest a checklist for cooperative arrangements which, with some modification, provides guidelines for implementation of the technology.

Formative Stage

1. Identify other school districts and other organizations (colleges, universities, other public service organizations, and local business such as telephone companies, telephone cooperatives) that may have interest in implementing the technology, and identify key players within those organizations.
2. Communicate the vision to these players, explore mutual benefits, and enlist dedicated support and commitment.
3. Establish efficient lines of communication among players.
4. Openly and candidly discuss the knowledge, skills and resources required for successfully implementing the technology, and arrange for training.
5. Identify policies, practices, and assumptions that may impede implementation, and explore possibilities for removal of barriers and/or strategies for circumventing them.
6. Identify state/federal policies or programs that may facilitate or impede implementation.
7. Identify agencies or nongovernmental entities that can provide convening/mediating/supportive roles.
8. Identify common needs, visions, and expected benefits to be gained by *all* participants.
9. Secure a tentative "agreement to cooperate" from participants and establish basic groundrules for planning and development of programs (e.g. frequency of meetings, expected levels of involvement, initial data gathering, etc.)

Planning Stage

1. Come to accord on a "consensus vision."
2. Share the vision with everyone who might be impacted by the technology, including local school boards, community members, local businesses, and seek to enroll everyone in the vision.
3. Clarify and thoroughly explore participants' needs and expectations of the technology.
4. Create a cooperative organization that considers the needs and expected contributions of all participants, and defines roles and responsibilities.
5. Create a cooperative organization that has the legal right to seek and accept contributions, and write grant proposals and accept funds.
6. Acquire commitment for adequate involvement of key personnel and for adequate time to allow the technology to prove itself.

7. Carefully research and make arrangements for the acquisition and implementation of all needed materials, human resources, and equipment.
8. Plan an efficient communication system for all participants.
9. Plan monitoring and evaluation timelines and responsibilities.
10. Assign responsibility for documentation of cooperative implementation and operation.

Implementation Stage

1. Periodically check equipment quality and functionality during the installation process by vendor(s).
2. Allow sufficient time for staff development and training and familiarization; bring in experts to assist.
3. Maintain a high community profile by exposing the community to the technology during the training period and allowing them to use it via prototype community programs.
4. Have administrators in rural, small schools acquire expertise with the technology through staff development, and their familiarizing themselves with the installation and minor maintenance of the equipment.
5. Give clear guidelines to students and their parents about equipment access, academic expectations, and comportment when participating in classes using the technology.
6. Expose all teachers to the technology regardless of their participation, and encourage them to experiment with it when not in use.
7. Hold periodic network meetings, consisting of administrators, teachers, telephone company or cooperative representatives, students, and other interested parties via the medium to discuss potential improvements, teaching techniques, and problems.
8. Assign a committee of users from each school to keep abreast of innovations, and explore new ways to enhance the potential of the medium.
9. Implement a monitoring procedure to track student performance and student attitude toward the technology.
10. Support administrator and teacher attendance at conferences relating to the technology.
11. Present extracurricular possibilities to teachers and the community to expand usage and familiarization.

Conclusion

Everett M. Rogers (1981) writes that "...getting a new idea adopted, even when it has obvious advantages, is often very difficult. There is a wide gap in many fields between what is known and what is actually put into use. Many innovations require a lengthy period, often of some years, from the time when they become available to the time when they are widely adopted."

The educational arena is often categorized as being particularly reticent in terms of the adoption of innovation. However, some school districts in the Southwest have embraced a rapidly evolving, highly dynamic technology that is just becoming accessible in order to enrich the academic opportunities of their students and communities. Even before the fiber-optic cable necessary to link schools for full motion, two-way video interaction had been put in place, school districts were aggressively positioning themselves to implement the new technology.

Rogers (1981) calls this phenomenon the "spontaneous diffusion of innovation" whereby local inhabitants serve as change-agents, visionaries, champions or local heroes to implement the technology. The research supports the Rogerian paradigm in that the innovative concept occurred to one or two individuals in a community who, with apparently boundless energy, attracted key supporters within the community and without to eventually effect change. In all cases the process of implementation was arduous, but tenacity and clear identification of the goal early on enabled success. Projects that have already implemented the technology have been deemed successful and the prognosis is good for those in planning and implementation stages.

A secondary level of spontaneous diffusion has occurred in that existing projects have provided motivation and expertise for the development of subsequent projects. In all cases, visionaries reported that their initial inspiration came from an existing project. As more projects come on line and as the technology becomes more available with decline in costs, the diffusion of the innovation could well become exponential, ultimately pervasive, and reach critical mass.

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