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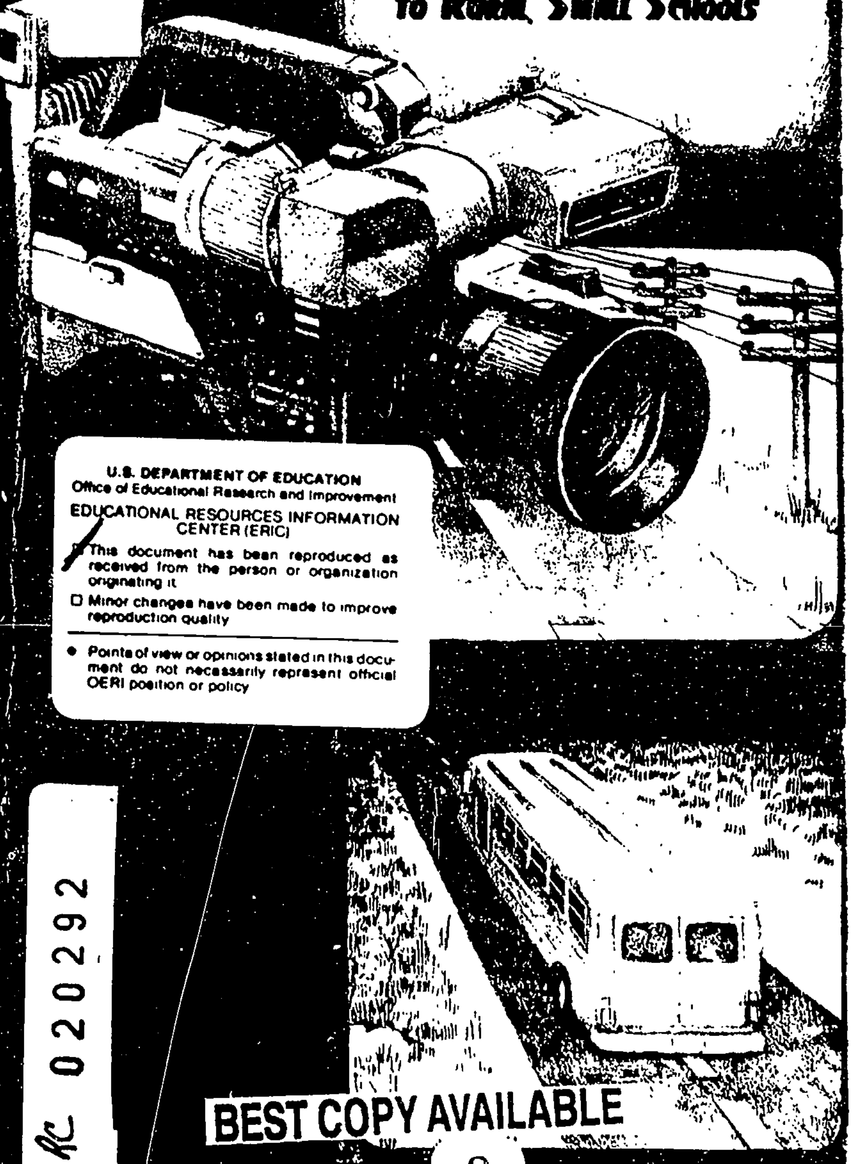
ABSTRACT

This book provides information supplemental to the accompanying videotape regarding the implementation and use of two-way, full-motion interactive television. Based on a study conducted by the Southwest Educational Development Laboratory, "Local Heroes" describes in detail how citizens have implemented the technology in small rural schools and communities in southwestern states and provides guidelines for implementing such technology. Six sections contain an overview of the role of rural schools as a focal point for the community and the role of telecommunications in preserving rural schools by providing services comparable to those in urban communities; an analysis of the technology; a "Getting Started" section, which goes from defining the primary need to bolster the curriculum, through working with the local phone company, to discussing the importance of the teacher to the success of the technology; guidelines and suggestions for implementation; a prototype detailing procedures for implementing full-motion interactive video in small rural schools; and a narrative depiction and history of six projects in the states of New Mexico, Oklahoma, and Texas. Appendices discuss existing research and give further details on the implementation process and the research methodology used. Contains 39 references. (TD)

LOCAL HEROES:

Bringing Telecommunications to Rural, Small Schools



Local Heroes

Bringing Telecommunications to Rural, Small Schools

These materials were designed and developed by the Rural Services for School Improvement (RSSI) staff at the Southwest Educational Development Laboratory (SEDL)

Michael Sullivan, M.A.
Research Associate

Deborah Jolly, Ed.D.
Vice President

David Foster, Ed.D.
Senior Technology Associate

Richard Tompkins, M.A.
Research Associate

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Southwest Educational Development Laboratory
211 East Seventh Street
Austin, Texas 78701
512/476-6861

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Bringing Telecommunications to Rural, Small Schools

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Acknowledgments

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Introduction

About this Guidebook

Local Heroes is an adjunct to the accompanying videotape of the same name. It provides supplemental information regarding the implementation and use of two-way, full-motion interactive television. Based on a study conducted by the Southwest Educational Development Laboratory, *Local Heroes* describes in detail how citizens have implemented the technology in small rural schools and communities in southwestern states and provides guidelines for implementing such technology.

Who Will Use this Guidebook

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

Organization

Local Heroes is organized into six sections:

- An overview articulating rationale;
- An analysis of the technology;
- A "Getting Started" section;
- Guidelines and suggestions for implementation;
- A prototype detailing procedures for implementing two-way interactive video in schools in small rural communities; and
- A narrative depiction and history of projects in the states of New Mexico, Oklahoma, and Texas.

Appendices provide information regarding current research that gives details on the implementation process and describes the research methodology used in gathering data for this guidebook.

Overview

The Challenge

The educational process is an integral part of the social and political fabric of the United States that cannot be addressed as an isolated entity. Like many other institutions, education has tended historically to operate in a linear, segmented fashion, modeled after the nineteenth and early twentieth 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 and when textbooks can become obsolete before going to print. Such isolation is particularly problematic in small rural schools where geographic as well as economic barriers are common. New technologies, specifically in the area of telecommunications, can facilitate a shift from isolation and communication deprivation to communication access and exchange.

Telecommunications give geographically isolated small schools the capacity to tie into 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.

Using interactive telecommunications, a teacher can simultaneously teach at multiple sites, providing educational curricula 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 brings to rural schools specialized resources needed to prepare students for the twenty-first century.

Knowledge is dynamic, being the intelligent synthesis of a dynamic flow of information which changes, reformulates, and grows instantly. Technology allows students and teachers immediate access to that information and those changes. The teacher's role, then, is to not only channel this perpetual stream of data, but to make it *relevant*. The teacher then becomes a conduit/facilitator and no longer merely a disseminator. The challenge here is not so much to present this cacophony of information, but to understand it and extract relevancy.

Rural Schools, Rural Communities, and New Technologies

The role of rural schools is beginning to extend beyond basic education for the youth of a community. Increasingly, the rural school serves 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 ensure the survival of the rural community, as well as its unique culture, and they have sought ways to protect this important symbiosis by keeping rural schools vigorous.

Prominent among the solutions that rural leaders have begun to investigate is the recent development and rapid growth of telecommunications technologies, which have been instrumental in making educational opportunities and social services available to rural communities. 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, legal and judicial professions, 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.

The promise of expanding course offerings through telecommunicated classes may further neutralize arguments for consolidation of rural districts (Jolly & Deloney, 1993). This technology will also broaden opportunities for sharing and cooperating with other rural districts in partial reorganizational arrangements. The very nature of the medium which links school districts electronically will ensure that rural districts making use of new technologies will be involved in cooperating with other districts or organizations in order to implement the technology and later to share resources.

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.

The Technology: Two-Way Interactive Video and Audio

As technology continues its nearly exponential evolution and costs continue to decline, high-tech accessibility to rural schools and attendant communities can be expected to increase dramatically. 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, giving them 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, such as a health clinic, 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

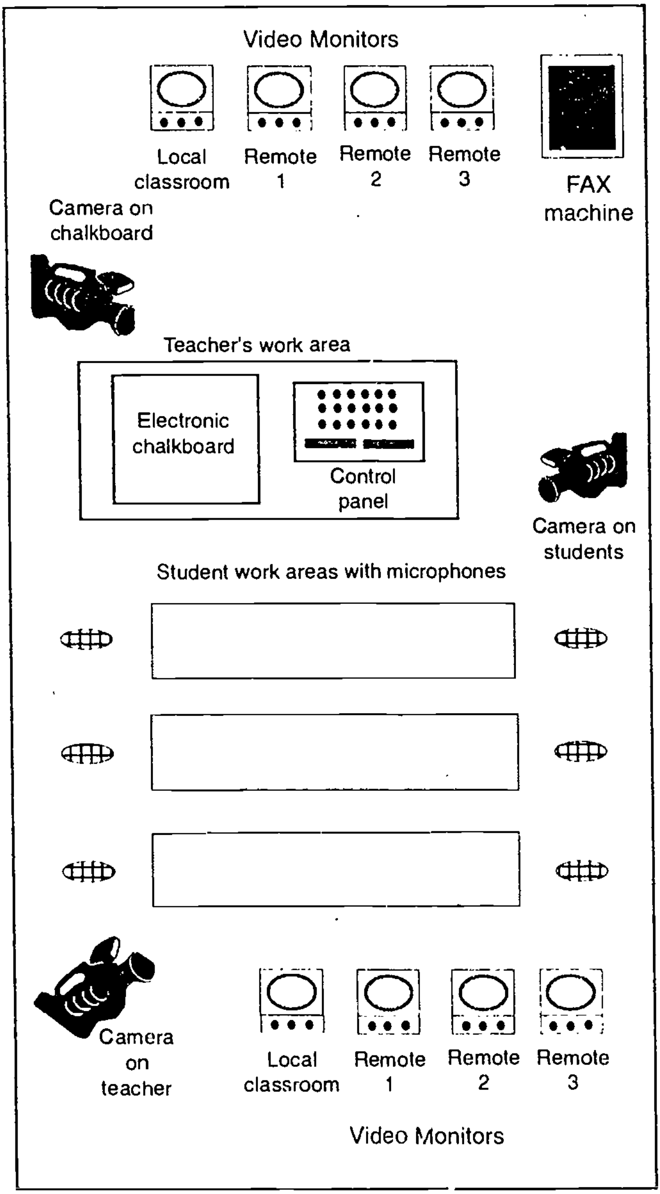
Two-way full-motion interactive video and audio has specific characteristics that make it attractive and feasible for rural, at-risk student populations. These include:

- *Continuous interactivity.* In contrast to education by satellite, which typically originates at a great distance with 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 with limited attention span to maintain active contact.
- *Relevance.* Two-way interactive video generally involves the clustering of several small student populations with a teacher positioned at one of the locations. This allows teaching to be specially designed to meet 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 for a pre-algebra class. The course was taught by a certified teacher on premises, assisted by a university professor linked from his classroom.

- *Stimulating Learning Environment.* Using multiple cameras from different angles and variable fields of view, videotape, and computer display, enables classroom teachers to present a variety of perspectives and high quality images. The credibility of these near network-quality images together 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 typical classroom methodology.
- *Flexibility.* Linkage among schools and connection with institutions of higher learning help schools shape their curricula to meet educational and community needs. Many examples are already in practice. Team teaching, with teachers contributing from different network sites, is a possibility. An example of this configuration is described in the TeleCommUNITY Network section of this guidebook. Dual-enrollment courses, whereby students are taught by a higher education instructor and receive both college and high school credit, are available in networks studied. Visits by specialized experts are practical with the technology in place. Education departments of universities and colleges are beginning to monitor field experiences of student teachers, as well as to document exemplary teaching practices.
- *Affordable Cost.* With dramatic advances in media technology, the use of consumer-oriented video and audio production equipment, and aggressive seeking out of business partnerships, many school districts will be able to equip classrooms (media centers) at moderate cost. The classroom equipment necessary to purchase and maintain a teacher-student operated electronic environment is outlined in these pages.

- *Telephone Company or Cooperative Participation.* Incentives in the form of grants, profit opportunities, public relations and deregulation motivate telephone businesses, particularly small, local entities serving rural populations, to be major participants in making two-way video available in schools.
- *Access to Information.* Once linked with two-way video, a classroom has the potential to receive other information available within the network. Once classrooms have been equipped, information from videos, laser discs, satellite feeds, and computer networks can all be easily transferred from one classroom to another.
- *School/Community Production Center.* At its inception, television was viewed merely as a means to chronicle live news events. As it has become much more than that, 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 capacity for a studio audience, that can go live to other schools and/or be recorded for videotape distribution. And once a two-way video system is in place, linkage into such distribution modes as community cable systems becomes relatively affordable, creating the potential for shared community meetings, guest lecturers for the school or community, adult education, live school news production, dramatic presentations, and much more.

Figure 1. Two-Way Interactive Classroom Model



The Typical Classroom

The typical classroom is equipped with three video cameras: the first is an overhead camera that can display teacher and student work and serve as an electronic chalk board or overhead projector, the second electronically captures the teacher (when present), and a third captures the class.

All cameras can be manipulated to cover varying fields of view. For example, a camera can change from a wide coverage of the classroom to a closeup of an individual student. Generally, the field of view can be controlled electronically from the teacher's desk with a multiple-source control panel, although in some instances cameras had to be adjusted manually. The control panel also enables the user to switch from one camera to another, depending on which of the three cameras he or she wants to be accessible for network distribution. The control panel can also activate other multimedia devices such as video feeds from satellite downlinks, computers, CD-ROMs, laser disc players, and VCRs.

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 to the electronic chalkboard. Monitor racks are usually located at the front of the room (for students to watch) and in the center or rear of the room (for teachers). The two banks of monitors display the same images. One monitor shows the teacher or the image the teacher has selected by using the multiple source control panel. 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 their teacher on the classroom monitor and in person at the same time.

Audio is captured by placement of multiple microphones throughout the classroom and an attached microphone (lavaliere) worn by the teacher. In newer systems, wireless lavalieres allow the teacher more freedom of movement. Camera housings that can actually follow the teacher as she/he moves about the classroom are now available. Most classes are equipped with a fax for distributing materials and assignments, but frequently, a teacher or staff member living in a neighboring community may personally deliver materials to a linked school while commuting.

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

Fiber-optic Technology and Bandwidth Transmission Options

Fiber-optic cable has several significant advantages over the conventional copper cable that has been used since the dawn of telecommunications. Fiber-optic's most noteworthy feature is its ability to transport any type of signal, be it voice, video or data, over long distances with little degradation of signal. Once information has been transmitted through guided light waves in a nearly microscopic optical fiber, it can travel vast distances without the assistance of a repeater or signal booster. Full-motion video, in particular, requires an extraordinary amount of bandwidth for transmission (approximately 700 times more than a digital phone call). Optical fibers and their attendant electronics have that capacity. Fibers are also highly durable and resistant to electrical 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, using a codec (coder/decoder unit), which passes the digitized signals at 45 megabits/second (DS-3, a nominal 2:1 compression rate) to a fiber multiplex terminal. The terminal then combines the digitized signals and transmits them over a pair of fiber-optic strands 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).

Another digital system uses a T-1 transmission rate which passes the digitized signals at 1.5 megabits/second and requires only 1/28 of the bandwidth of a DS-3 signal. However, T-1 transmission requires a compression rate of at least 60:1. This compression factor (30 times that of DS-3), which essentially deletes a significant portions of the video artifacts being transmitted, tends to result in a degraded video image, particularly noticeable when there is movement on the screen. Two advantages of the smaller T-1 bandwidth transmission are that the signal can be transmitted at a lesser cost and via traditional copper wiring, thus obviating the need for fiber-optic installation. Current research is dedicated to improving the quality of the T-1 video signal by further identifying redundancies in images by improving coding methods, as well as increasing the compression rate to further reduce bandwidth requirements (Brooksby, 1992). One of the projects cited in this guidebook is planning to implement a T-1 system. The other projects are currently using or planning to implement DS-3 systems.

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Getting Started: From Vision to Implementation

This section outlines steps necessary for the implementation of two-way full-motion interactive video in small rural schools.

Defining the Need

The projects that were included in SEDL's study of interactive video technology in small rural schools had experienced specific educational needs that were not being addressed. Two areas of almost universal need emerged: 1) schools could not offer all the state-mandated courses necessary for high school graduation; and 2) they were unable to deliver the coursework necessary for their students to meet rigorous collect entrance requirer..ents.

Although they knew that the technology was able to do much more than bring specific classes to students, curriculum was always the priority of those involved with the initiatives. Any other use of the technology was considered a fringe benefit.

Emergence of the Local Hero

During the formative stages of implementation, the need and subsequent vision to meet the need was usually communicated by an individual or group of individuals within the community who had an extraordinary grasp of the problem and a relentless tenacity in resolving it. "Local heroes" came from the educational arena, the business community, and the community at large. The site studies that follow this section, as well as the accompanying videotape, *Local Heroes*, portray in detail the efforts of these visionaries.

Find Your Partner

In order to engage in a collaborative effort such as two-way interactive video, linkage with other entities is necessary. An isolated school district often needs to share resources with other school districts or higher education entities but is unclear as how to proceed. The first priority is to locate other institutions with a strong need for linkage and the ability to share a vision that will ultimately require a herculean effort to realize.

Generally, SEDL's investigation indicates that small rural schools have greater success linking with school districts that have similar curriculum deficits to their own than with schools that already have complete programs. Larger school districts, have been less inclined to participate simply because there is less immediate need to justify a significant contribution of both financial and staff resources. All participants have to benefit equally from the implementation of the technology, and all participants must have a strong sense of need and shared vision.

Entities other than small rural schools that have a natural interest in linkage are community colleges with a mandate to serve the community and a desire for increased enrollment, and colleges and/or universities with such agendas as expanding enrollment, improvement of teacher training, or research needs. Generally, the more established and entrenched the educational institution, the less flexible it will be in implementing innovation.

The addition of other partners to a network cluster often adds an element of confusion to the implementation of the network. School districts and higher education groups, for example, frequently do not have the same planning agenda or purposes for the network. The key to creating equitable and sustainable partnerships among K–12 school districts and higher education lies in informed compromise. Each partner must understand that the network is a shared resource in which contributions and benefits must equal out for all partners.

The Shared Vision

During the formative stage of any local interactive technology cluster involving partners in the community, the most critical indicator of eventual success lies in identifying the common need or needs driving the implementation of the project. Without a shared vision for use of the network, the necessary impetus to plan and launch the network will rarely prevail. Finding this critical level of agreement can be a difficult process, since many of the partners, including neighboring school districts, are frequently unaccustomed to working closely with one another. Additional confusion arises when the educational partners are faced with the layering of exotic technologies into a unique cooperative endeavor whose goals are often not clearly stated.

A critical error made by groups planning an interactive network lies in proceeding with implementation of a project when the reason for its existence has not been made clear to all involved. Perhaps the most common error seen in educational networks involving interactive technologies is the creation of networks for the sake of the technology, rather than to address real needs of the participants, although this was not found to be the case in projects included in this study. Most often, a technical partner is enlisted by a governing body or local official to install the network. If the network is installed prior to actual understanding and assignment of roles and responsibilities on the parts of the users (schools, universities, training institutes, etc.), the usual result is a failure of the network to thrive.

A network's failure to thrive simply means that while the technical interconne itself may function perfectly, the actual use of the network is sub-standard. Teachers and other practitioners who are not invested in the network, either as part of their job or because of a personal consideration, will not extend themselves to make sure the network is employed at maximum potential. Lack of information and support from the partners employing and managing the network will result, at best, in apathetic performance from teachers and students. At worst, designated practitioners will tend to avoid the network and leave it idle rather than face the frustration and confusion of trying to work with the network unsupported (Lloyd, 1993).

Formation of a Coalition

Once the need, vision, and partners have been identified, it is necessary to organize the leadership structure for the long-term management of the project. In most cases, it was desirable for participants to create a legal bond in the form of a nonprofit organization or joint powers agreement in order to make collective purchases and apply for grants. Ideally the planning committee of such a coalition comprises an equal and fair representation of the committed partners in the network.

As will be seen in the site studies, it is frequently one key figure or occasionally two, either from the educational or business community, who becomes the focus of the development of the project. This person, or "local hero," becomes essential to the successful construction and implementation of the technical interconnect. This trend is not necessarily a bad one; a singular focus during the developmental stage of the network is usually necessary. However, once a committed coalition is in place and the "vision" has been communicated to others, the leadership and responsibilities of leadership must be shared.

It is recommended that planning groups attempt to delegate responsibilities and share aspects of the creative developmental process among members of a core planning committee, prior to any actual purchase or implementation of the technical network. Otherwise, the departure or unanticipated absence of the "local hero" who implanted the vision can be disastrous to a developing network. In most cases studied, the "local hero" had moved or retired from the community where his/her efforts had been concentrated; yet the vision had been so well communicated, and the organization so well established, that networks continued to grow and thrive.

Some general guidelines for assigning roles of participating partners are outlined below.

- *Role Assignment*. It is usually up to the initiator to take charge of assigning roles and responsibilities among the potential network members. It is necessary that the initiator be in a position to delegate portions of the network development, and that the formative group be capable of accepting tasks and carrying them out.
- *Membership Management*. The process of developing a network is fragile and interconnected, to the point that even one missed or disputed step in the planning or implementation scheme can arrest or destroy the entire process. Thus, the manager of the planning process must be a position to ensure compliance within the planning group. That managing entity should, if possible, have an equal investment in the daily operations of the network in relation to that of the other partners.
- *Shared Authority*. No one partner on any network can or should "run the show" alone. The largest and/or most influential partner in the network membership will sometimes try to take over the process, perhaps out of habit, perhaps because of frustration over the speed or direction of the planning process. The introduction of a "Big Brother" element into the planning group almost always brings resentment and resistance from the other partners.
- *Limits of Authority*. It is very important that decisive planning authority reside within a partner or entity removed from the actual daily operation of the network's on-line activities. In some cases, the partner with the least investment in daily operations (content and curriculum issues) is the

telephone company providing the service to the schools or an outside consultant who is employed to make sure that all parties are represented equally.

A practical recommendation to planning groups is to consider collaboratively hiring a manager or consultant who will represent all parties within the network. That person might have an office within the community: at the telephone company, the Chamber of Commerce, a community service organization, a business, or even at the school district offices. He or she should not, however, be an elected official. It is further recommended that long-term arrangements be made by the planning group to employ a full-time director for the effort.

In addition to the players mentioned above, the roles of the local school board and other governing bodies in the partnership are important to the integrity of the network. It is absolutely critical that local school boards (in the case of a local interactive video connect involving primarily K-12 districts), as well as governing groups from other network partners, clearly understand the need for and the responsibilities attending the development of a network. Boards must be responsible for setting certain policies up front in the integration of the network. Issues for consideration will arise in such areas as teacher salaries, rights of teachers and others under contract to the school district, maintenance contracts for equipment, insurance and liability, and coordination of activities with other schools and partners on the network.

The Right Choice

It is important for school districts to be aware of the wide range of choices available to them toward the goal of meeting their curriculum needs. There is often more than one solution available to a district, and two-way full-motion interactive video may not be the most practicable for all districts. Consolidation, although typically met with resistance and hostility, has long been an option; traveling teachers is another possibility. Other options involving telecommunications are courses by satellite, compressed video, audiographics and other computer linkages. Districts desiring to increase educational opportunities for their students must explore all possibilities and stay current with inevitable new developments. The sites featured in the story of "Local Heroes" went through this process and only after an exhaustive study concluded that two-way interactive video was the most feasible technology to meet their needs.

Dealing with Vendors and Manufacturers

The choice for technology has to take many other factors into consideration. Those who are considering it should be aware that there is a dearth of education-oriented technology on the market, as well as a lack of reliable information and technical support from vendors.

Education is a "stepchild" in the realm of technology development. The majority of devices and systems were developed for use in environments other than schools. An occasional exception exists — perhaps notably at Apple Computer, where a significant focus of its computer development is directed at the education market. However, in large part, technology and telecommunications developments are aimed at industry and other for-profit environments whose needs and financial options are very different from those of the schools. Schools that choose to be progressive are forced to deal with the existing and evolving technologies and adapt them as best they can for educational uses.

Directly related to the dearth of education-oriented technology tools is a lack of information and marketing specifically targeting schools. Schools turn to a number of traditional reference points for assistance with advanced technologies. One of the most logical sources is the vendor community who typically sell directly to businesses and not to the general public. A limitation inherent in working with vendors is that while the product representatives may be very knowledgeable about the items they sell, they may know little about compatibility with other technical devices or networking tools. Also, because of the rapid evolution of technology, vendors simply may not be aware of the latest trends, particularly if those trends have been developed by competitors. This is an important factor to consider if the planners intend to create a network capable of supporting multiple technology platforms. The phrase *caveat emptor* is applicable here.

Interoperability (the ability of various technical devices to communicate with one another) will become more of an issue in the near future, as the "electronic information highway" continues to advance into homes and schools. Schools should be wary of falling into the trap of creating a network plan that includes only one brand of technology to the exclusion of other options.

Retail sources and outlets that market to the general public for technical devices are another reference point for details about educational technologies. Again, the sales staff may be well informed about the devices they are selling but may not be able to offer assistance with other aspects of the network design. Support for existing technologies is sometimes equally spotty and unreliable. Perhaps the most dangerous aspect of dealing with a vendor or retail source during the planning phase lies in limiting the network to those technical devices that are "on the shelf" and may already be outmoded by the time the schools purchase and install them.

Long-distance video equipment, needed to connect local clusters to remote resources, can be especially confusing. The facilities and equipment needed to accomplish the interconnects described in this guidebook all use digital, high bandwidth transmission systems. The devices used in these networks are not marketed to schools and would not in any case be something the schools might normally purchase. In fact, in all of the operational networks described here, the telephone company partner owns and maintains the digital video devices (called codecs, or *coder-dec*oders) and other components of the system which are expensive and require specially trained technicians for daily and long-term maintenance.

A number of devices for transmitting video signals now on the market employ much lower bandwidths for video and audio signals than do full-motion video systems. These video conferencing units are generically referred to as "compressed video" systems and usually operate at a fraction of the bandwidth used in full-motion systems. The resulting video signal tends to be noticeably jerky and often out of synch with audio signals (i.e., voices of speakers may not match lip movements on the screen, due to a lag caused by lack of bandwidth). All digital systems are technically using "compressed" signals, including the high bandwidth networks using DS3 (or 45 MB/s) transmission. The compression algorithms used in high bandwidth codec units produce a video signal with synchronous audio, operating at a rate where the compression is not noticeable to the human eye.

Video-conferencing equipment from a number of vendors is beginning to find its way into public schools, usually in relation to a research project with a local higher education partner. These business-oriented video-conferencing units feature portability as a selling point, irrelevant to the permanent installation required in the case of a full-motion interactive video network like those described here. Schools need to be educated in the area of bandwidth acquisition before considering purchase of any video interactive system. Each video transmission system, regardless of the amount of bandwidth required or and the quality of the video signal, has both limitations and positive qualities.

On-site Demonstrations by Educators

Conferences and seminars may be a good source of information for schools that are serious about creating a viable network for serving teachers and students. The information presented at technology and telecommunications meetings is more likely to be "leading edge" material, and the presentations of technologies will generally be more appropriate and understandable in the context of a demonstration or vendor workshop aimed at education.

Most useful are seminars and conferences focused on networking and targeting school groups who use the technology. It is, however, important to keep in mind that most of these gatherings are based on one particular technology and may exclude other relevant technologies in which the sponsoring entity is not invested. Few demonstration sites feature multiple technology networks.

Perhaps the best source of real information about interactive networking options is an existing interactive cluster of schools. Although arranging trips to experience an operational network can be expensive and time-consuming, and most schools engaged in operating a two-way interactive network do not have the time or resources to act as more than a casual advisor to visiting schools, they are generally a good source of information, provided the visitors know the right questions to ask.

In assessing the technologies related to interactive video networks, one crucial question must be answered definitively: is two-way interactive video necessary to meet educational goals? This question spawns a welter of other issues to address. Schools must ask if potentially less expensive options available in the educational technology market are appropriate or acceptable. In the realm of bandwidth and access for video services, what amounts to overkill and what is unacceptable? Is true full-motion video necessary or would compressed video with a lesser bandwidth and less than full-motion be acceptable? Many questions remain unaddressed at present, including the eventual effects and effectiveness of video interactive systems of all descriptions. Schools and local partners can assist the educational community at large by taking steps to educate themselves and the technology vendors about the needs and requirements of the educational marketplace for video services (Lloyd, 1993).

Interconnectivity

One of the greatest challenges to school districts that want to link with other districts or other entities by means of two-way interactive video is the means of achieving interconnectivity. Fiber-optic linkages are available to school districts through:

- local telephone cooperatives or companies,
- the eight Regional Bell Operating Companies (REBOC's),
- major independent telephone companies such as GTE or Century Telephone,
- state implementation,
- an independent contractor, and
- self implementation.

The above interconnectivity models are not necessarily mutually exclusive, and it is expected that as the technology matures, one or more of the providers will be involved with the linkage of a given network.

All of the projects studied for this guidebook contracted with a local telephone cooperative or local telephone company in order to connect schools by means of fiber-optic technology, to configure the classrooms, and to train personnel. Most of these local telephone entities initially provided this service at a tremendous discount and in one case covered startup costs with the expectation of eventual reimbursement by the state department of education.

The local telephone cooperative or company model, however, although currently the dominant model in the

Southwest, is not applicable to all rural school districts. Not all small rural phone cooperatives or companies are willing or able to link schools with the technology; furthermore, many rural school districts wanting to connect are served by several different phone entities, and coordination among these has proven difficult. Finally, many small rural school districts are not even served by local telephone cooperatives or companies. Sometimes the only possibility for bringing an ITV network to these areas is working with the serving REBOC or other major independent telephone company. Below are examples of alternative models to linking interactive video sites.

Working with REBOCS. Although there are approximately 1,400 local telephone companies in the U.S., many small rural communities are served by REBOC's or other major independent telephone companies (Parker & Hudson, 1992, pp. 36–38). Until recently the larger companies have been disinclined or unable to offer affordable linkage rates to small rural school districts in their southwestern service areas; however, recent developments in south central Oklahoma indicate a willingness by the REBOC serving that area to provide linkage of the technology at affordable rates. In conjunction with the serving REBOC, four schools in Grady County formed the Grady County IETV Network in fall 1991 and were in operation by fall 1992. The Network offers a full day schedule with academic classes originating from the four county schools, and vo-tech classes originating from an area junior college.

A school district superintendent participating in the project reports that interaction with the REBOC has been very positive, and the rates proposed by the telephone company were quite reasonable. Schools were charged neither up front for the installation of the fiber-optic cable nor for connection into the system. They are charged a monthly fee of $1,400 ($16,800 annually), which is consistent with the rate charged to most of the other projects studied. Grady County schools did pay for their own classroom studios and contracted with the serving telephone company for the installation. This procedure was also common among projects studied. The cost of a studio classroom for this network was reported to be about $32,000. This cost was somewhat above classroom studios in other projects studied, but superintendents wanted special features such as an echo noise-suppression device that facilitated clear audio transmission. Good audio that can be clearly understood by all participants has been a problem among schools studied.

Participating school district superintendents state that the network has been extremely successful and that students are learning by means of the technology, which has, for the most part, been free of technical malfunctions. All schools have agreed upon common school calendars so that classes can be efficiently scheduled. Future plans that will expand the use of the network include connecting with an area junior college, offering collaborative opportunities for local businesses, offering medical services and additional vo-tech courses. The REBOC is talking to approximately 15 other potential networks in Oklahoma.

Self implementation. A linkage model being considered in central and southern Oklahoma and East Texas is for aspiring educational interactive networks to install, own, and operate all of the fiber-optic lines and connections, rather than leasing from a telephone company or cooperative. Participating schools are forming consortia to finance, install, connect, and ultimately own all components of an area network.

Although implementation of this model is just beginning in the Southwest, it has proven practicable in other areas. In rural Michigan, for example, a consortium including the Shiawassee Intermediate School District in conjunction with seven neighboring districts, as well as local universities and hospitals, has installed 65 miles of fiber-optics for approximately $95,000 per district for startup and $7,000 annually for maintenance and operation of the network. The consortium justified this investment by reducing costs of bussing, which required a forty-mile round trip each class day. Also, districts are hoping use the fiber-optic system for all data transmission which is currently being done on leased phone lines (Satterlund & Knox-Pipes, 1993).

In Oklahoma, two projects, the Connors State College Area Interactive Television Network (CSA I-TVN) and the Johnston County I-TVN, are in the planning stages of owning and operating their own systems. The project director for both networks is an educator who has extensive experience in educational technologies and is working out of Connors State College. Much planning and coordination has already taken place. The project director has used the videotape *Local Heroes: Bringing Telecommunications to Rural, Small Schools* extensively in meetings in order to communicate the potential of the technology to school district superintendents, school board members, and the community at large. While the two projects have similar objectives and planning strategies, the CSA I-TVN project is particularly intriguing because of its extraordinary scope.

Ultimately, CSA I-TVN intends to link by means of fiber-optic 40 school districts, institutions of higher learning, medical and business entities, and a state corrections facility. Although the scope is large, school districts will be organized into eight smaller local area networks (LAN's) so that interaction among schools will effective. Although the LAN's will be relatively autonomous, the project director wants to begin construction and implementation concurrently to enable a more efficient and cost-effective installation. Financing the network, including classroom construction, fiber-optic installation, switching, and project management, will be accomplished by underwriting a long-term loan whereby school districts will pay back their portion of the loan over a period of time. It is expected that the debt obligation would be about $8,000 a year, substantially less than for other projects cited, and the cooperative members of the network would *own* the system as opposed to leasing it. This ownership could conceivably produce other revenue in the future (Rampp, 1993). At this point, plans are in the early formative stage.

Cost Issues Relating to a Two-Way Interactive Video System

Technical and managerial issues involved in the development of interactive networks often pale in comparison with the financial and funding issues related to these projects. In projects featured in the *Local Heroes* video and guidebook, financial facilitators included local telephone companies as major players. This situation is not a shared feature of networks nationally, but the trend appears to be more common in networks that have evolved during the past five years.

The technical elements involved in interactive networks and telecommunications infrastructure almost *require* the involvement of a telephone company or telecom-munications expert if the schools are to get the best arrangement of networking and equipment at the most reasonable price. Numerous options exist for the local school cluster, options that may or may not involve use of the existing communications lines. When possible, it is generally cheaper and more logical for the schools to partner with a telephone company or other utility provider, rather than to build a parallel private fiber-optic network or to use another option such as microwave transmission. However, as noted above, initiatives in Oklahoma and East Texas are beginning with the objective of putting in their own fiber-optic lines. These initiatives will bear watching. More linkage models will result in greater implementation opportunities and thus greater diffusion of the technology.

Educators approaching a telephone company for assistance should realize that the majority of local and regional providers do not view the local school environment as a customer for anything other than basic telephone service. The customer service representatives and sales staff (if there are any) at the local telephone company office are unlikely to know what the schools are asking for when they request assistance with a two-way interactive video network. Most telephone companies, while vitally interested in new lines of business dealing with video, data, and wireless technologies, are not in the business of anticipating the technology needs of the schools in their service areas. In fact, without a reason to do so, phone companies will rarely develop strategies for dealing with interactive networking for education as a line of business.

Even when asked specifically by the local educational entities for assistance, the telephone company may not be able to respond immediately. Potential partners need to understand the relationship of the local telephone provider to the schools and other partners in the network. Most often, interactive clusters with a telephone company acting as a "hands-on" partner are situated in territory served by an independent telephone company or cooperative. Each of these companies has the interest and ability to donate time, equipment, expertise, research and development, and funding needed to facilitate the development and installation of the local network cluster. Larger, regional telephone companies often are less able to collaborate directly with the schools, due to different regulatory environments and other factors. A network in central Oklahoma has just been implemented with the cooperation of a major telephone company. It is the first such alliance in the Southwest and if successful will provide a model for the wider dispersal of the technology.

The pricing and availability of the types of lines and bandwidth required for interactive projects like those described in this guidebook are not always in the hands of the telephone company, but may be restricted by state and federal regulatory guidelines. This is not to say that the guidelines cannot be changed or adapted to better serve the needs of the schools. However, the process is not a simple one. It is also unlikely to occur without the instigation of the schools or an agent representing the schools. A critical mass of the educational population needs to become informed and ready to testify as to exactly what types of changes are needed in the regulatory environment in order to encourage school use of the infrastructure. Requests from such a group would facilitate action at the state regulatory agency.

Direct funding for the specific purpose of developing a two-way interactive video network for education is scarce. Private funding from a partner is sometimes seen during the pilot and start-up years of interactive networks. With a few exceptions, state-directed moneys are rarely earmarked for local development of interactive clusters. The lack of state funding for network development can be directly attributed to the general lack of knowledge among state agencies and state officials regarding the option of locally controlled interactive networks for schools. Again, it is helpful if the schools requesting the funding spend time educating the appropriate policy makers and officials regarding the technology funding desired.

Costs and financial management at the district and local levels also present some unique problems for planners and implementers of interactive networks. Schools that are already involved in some type of cooperative purchasing arrangement tend to do better as partners in an interactive network than those whose budget processes are typically more isolated and independent. A critical step for schools seriously considering the development of a shared network is the establishment of a joint powers agreement or some other type of formal arrangement for cost-sharing. It is imperative that partners account for shared costs and refine independent budgets. In the building of interactive networks, unlike entities must often learn to communicate with one another on a fiscal basis.

The process of developing financial arrangements represents a step toward creating an appropriate culture for the network's growth. It is very important that all involved parties understand that buying and installing the equipment needed to create the physical interconnect is only the tip of the proverbial iceberg. Money for support of the network, expanded technical tools, and other long-term commitments will be major factors in budgeting for years following any pilot or demonstration situation. Stipends and teacher attitudes toward the network are directly related. Advanced and specialized training for teachers, staff, administrators, and board members should also be considered as ongoing costs for schools involved in interactive networking.

Cost categories vary but basically include:

- *The original installation of cable.* This can include the cost of the fiber-optic cable, installation of the cable, securing rights of way, and bringing fiber-optic to the school door. 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 nonparticipating 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, which can be done by direct rebate to customers or by improving the community structure, i.e., educational opportunities. The appeal of the latter alternative is that a strengthened community strengthens the subscriber base. Two of the six projects discussed here are supported by for-profit, small, rural telephone companies. Although profit based, these companies are strongly motivated to plow a portion of their profits back into the community for the reasons mentioned above.

- *Installation and maintenance of telecommunications equipment.* This equipment 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*. This 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 $20,000 and $28,000. Typically, one classroom is equipped in each participating school.
- *Line usage fees*. All telephone companies or cooperatives expect to be reimbursed for the use and maintenance of their fiber-optic lines and auxiliary equipment. The cost is negotiable, and once again some motivated telephone companies or cooperatives will defer costs to facilitate implementation. Generally speaking, annual costs being quoted are somewhere between $15,000 and $25,000 per school.

Network Staffing, Management, Training and Support

The most critical element of any school-based interactive network is the teacher. Two-way interactive networks are unlike any other technology in use currently in a school. Educational technologies generally perform some demonstrable function, such as playing back a videotape, creating a file or chart, or displaying on demand some instructional material for use by a teacher or student. Two-way interactive video networks only function if the teachers understand their roles and are invested in the project. In fact, multiple site interactive networks are utterly unique in the level of interactivity available (everyone on-line can see and hear everyone else simultaneously) and in their ability to serve as "virtual classrooms" for the exploration of new ways of teaching. It is the open nature of the system that makes it particularly at risk of failure if the faculty running it do not understand the network and the behavior required to make it functional.

Planners and implementers of high-end technical systems such as the interactive projects in this guidebook realize very quickly that teachers are not afraid of technology per se, but rather of receiving more responsibilities and fewer resources, more jobs, and less support. Technologies are an expensive form of intervention and innovation. Interactive networks are therefore especially threatening if they are unsupported by training, due to the fact that if the teacher does not properly facilitate and use it, the teacher — not the technology — has failed in the role of innovator. If the viewpoints of the teachers and staff using the network are limited by lack of information and professional support, the vision of the network will be similarly restricted.

The Local Network Director

While a local network director exists in only one of the four functioning networks studied, such a person can be an asset to the eventual health and advancement of the local network. Networks involving "school-to-school" arrangement tend to fare better than interconnects involving disparate partners, simply because of similarities in general daily behavior. But even the most harmonious interconnect can experience a flattening out or plateau of use if no one is in charge of supporting the network operations. Someone within the partnership group should be selected to "nurture" the network. The director is a single source of information, support, scheduling, and management of the network. The person in this position should be a full-time employee of the network consortium and have at least some of the following characteristics:

- Background in several areas of education (more crucial in school-to-school networks) and/or training experience. It is a logical pattern for a teacher or other staff member within one of the partner schools to transfer to the job of director.

- Formal training in educational and network technologies is generally not required of the director, but a very high interest in discovering, adapting, and modifying technologies within the network is essential. The director must be willing to try and sometimes fail at innovation if the network is to advance.
- Experience with managing people and organizational structures is useful. Although the management of a local two-way cluster is unique in the extreme, a working knowledge of the change process and the ability to deal with a variety of levels of concern from teachers, parents, and other partners in the network is crucial.
- The job of the director must be accepted as a full-time position. Very involved and innovative superintendents and principals tend to take on directing the network as a "second job," especially at the inception of the network. If the person filling this role wishes to continue as director after the installation of the network, he or she must do so full-time, relinquishing any other existing role within the school district. Experienced leaders in interactive video networks generally agree that running a multiple-site interactive network is not a part-time endeavor and cannot realistically be woven into an existing job description (Lloyd, 1993).

Guidelines for Implementation of Two-Way Interactive Video

Jolly and Deloney (1993) in *Guidelines for Cooperative Arrangements* suggest a checklist for cooperative arrangements that provides a basis for the development of guidelines for the implementation of two-way interactive video in rural schools.

Formative Stage

1. Identify other school districts and other organizations (colleges, universities, other public service organizations, and local businesses such as telephone companies and 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, and local businesses, and seek to enroll everyone in the vision.

3. Clarify and thoroughly explore participants' needs and their 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, write grant proposals, and accept funds.
6. Acquire commitments from all partners 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 including 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, training and familiarization; bring in experts to assist with this phase.
3. Maintain a high community profile by exposing the community to the technology during the training period and allowing them to use it through prototype community programs.

4. Have administrators in small rural schools acquire expertise with the technology through staff development and through 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 by means of fiber-optic connection, attended by administrators, teachers, telephone company or cooperative representatives, students, and other interested parties 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 with teachers and the community extracurricular possibilities for expanding usage and familiarization.

A Prototype Based on Research Findings

Jolly & Deloney (1993) present a framework of conditions that facilitate new program development for interacting 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 small rural school districts. Their criteria include the context, concerns/needs, shared vision/commitment, community/administrative support and assistance, planning/resource allocation, monitoring/problem solving, and ongoing assistance. The following section contains a brief discussion of each criterion and details findings derived from SEDL's research that are applicable to each criterion and to the successful implementation of the technology.

The Context

The context comprises the area in which all other criteria function. Boyd (1992) defines school context as consisting of two dimensions: ecology (inorganic elements, such as the resources available, the policies, rules, and school size), and the culture (informal side, such as observed behavioral norms, dominant values, philosophy). A similar context exists for technology innovation. 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, complicated by regulations and scheduling problems that were obstacles to the implementation of the technology. On the other hand, the school and community cultures were benevolent, allowing for an environment of innovation and risk-taking.
- Where no preexisting relationships and regulations were found to accommodate implementation, such relationships and regulations could be forged through rigorous self-discipline and strong desire to implement the technology; however 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. These cooperative arrangements were superficial in comparison to the amount of coordination necessary to implement an interactive television (ITV) network, but they did serve as a positive first step.
- Although the novelty of the program could be a significant element in the early success of a project, the most mature program (five years in duration) has grown stronger with time and is currently an integral part of the school and curriculum.
- In order to accommodate the introduction of the technology, adjustments to rules, regulations, and school policies have been necessary at both 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 networked technologies cannot occur.

Concerns/Needs

The transition from concern/need to action is significant, particularly in the arena of such established entities 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. The following is a list of major concerns or needs SEDL found to be driving the acquisition of a two-way interactive television system in the school environment:

- *Increased curriculum demands* stemming from various state level initiatives and more rigorous college entrance requirements.
- The *threat of consolidation* because of curricular deficiencies and low attendance.

- A *well-defined need or set of circumstances for the technology to address.* Repeated emphasis was placed on the precise articulation of the need, rather than unfocused excitement about the "potential" of the technology. This specificity so necessary for success can also have a downside, in that once the original objective has been met, there may be little motivation to explore further potential.
- The *desire to provide the best possible education* for the children of the community and "and bring them in to the twenty-first century."

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*, DePree (1989) 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, 1990; Carlson, 1987; Miles and Louis, 1990).

- The vision was initially perceived by an individual(s), a "local hero," who saw a need to improve educational opportunities for the community. 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 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 commitment 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.

Community/Administrative Support and Assistance

Strong support from school administrative and community leadership (technical support, infrastructure, public relations, and 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. v). Glatter (1987) states: "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, members of communities where the technology was implemented became advocates 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. Some administrators were apprehensive at first, but generally became advocates when the technology was implemented.
- Although expensive, the technology is affordable, especially with 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 interest. Larger telephone companies with less investment in specific communities did not participate in the studied projects. However, as the technology becomes more diffuse, larger companies are beginning to express more interest.

- While most projects started out with specific classroom courses, all 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 nurtured further support and assistance.
- Rural 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 such special considerations as technical expertise. Resources include everything that is needed to bring a program into existence (facilities, 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 the 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 by the school districts or state departments of education occurring over time.
- In most cases, preliminary funding through grants 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. These resources, however, were insufficient to actually implement the technology.

Monitoring/Problem Solving

Systematic monitoring 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, acknowledge, and confront 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 has been done 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 using 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 by computer would be much more efficient and is possible through the technology. Computer interaction that would allow the electronic conveyance of materials has not yet been implemented.

- The technology tends to make teachers more organized and more conscious of the teaching process.
- Education by means of the two-way interactive video, when properly implemented with appropriate staff development, was reported to be as effective as conventional education.
- Typically, the interactive video system was resisted by many of the teaching staff who feared that their jobs would be phased out. The technology itself appeared to answer their objections 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."

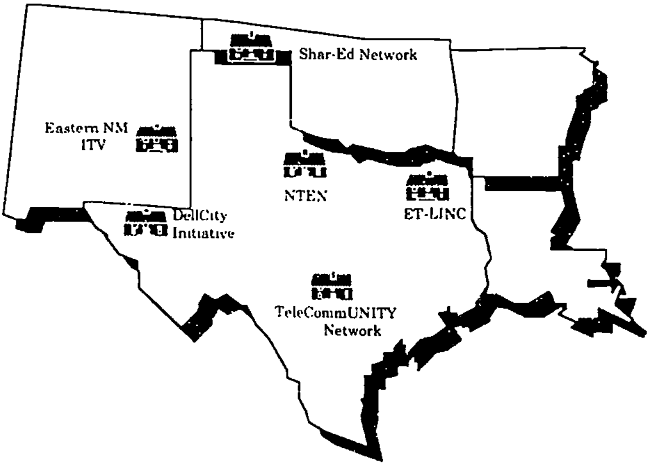
Ongoing Assistance and Support

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 usually 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 through staff development, miniclasses, or teacher conferences, they became less intimidated by the technology.
- A major factor to overcoming resistance was careful planning that made the technology work from the onset, resulting in the technology's becoming a matter of course 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 its success became widely known. It was the objective of all participants first to build a credible model, gain support from state and federal decisionmakers, and then encourage the spread of the technology.

Figure 2. Two-Way Interactive Video Sites in the Southwest



The Sites

This section describes six two-way, full-motion video and audio projects in New Mexico, Oklahoma, and Texas that are in varying stages of development as of this writing. A detailed description of SEDL's research methodology is contained in Appendix A. 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 is 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.

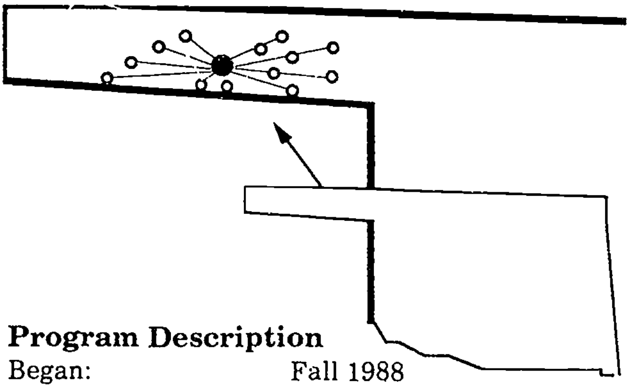
In addition to temporal distinctions, the three relatively mature projects were chosen because each has unique characteristics that give us special information on the two-way interactive video process. The mature projects are among the few in operation in the Southwest and have been visited by many other 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 New Mexico, Oklahoma, and Texas, all hit hard by economic setbacks in the oil and/or 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

Twelve High Schools and One University



Program Description

Began:	Fall 1988
Number of Schools:	13
Initial Funding:	Grants, Industry Support
Local Visionaries:	School Superintendents
Industry Participant:	Rural Telephone Cooperative

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 to link 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 has been 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. Because of this program, the school gained national recognition as one of fifteen exemplary U.S. schools. 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 for all four schools. Ideally, the school districts would share foreign language and other teachers within the county, thus providing courses tailored to the specific needs of their students.

The four county superintendents attended a demonstration in rural, western Wisconsin relating to interactive television distributed by microwave. Two of the superintendents were impressed by the interactive nature of the system and students' ability to accept the technology and respond to teachers as if both teachers and students were in the same room. 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, the Beaver 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. Gaining local support for the program was not difficult since the county 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 contributions, budgets were already stretched tight.

Originally, a distribution system involving microwave technology, modeled after the Wisconsin project, was planned. Beaver 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, however, 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. Money began to trickle in from limited state assistance and grants, 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 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, operating under federal guidelines, was required to reinvest profits back into the community or to issue capital credit refunds 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. Generally when small telephone companies or cooperatives have attempted to extend an educational network into areas controlled by larger companies, they have had little success arriving at affordable transmission costs for that extension.

Meetings ensued and an accord was reached. The local telephone cooperative, serving a three-county area which makes up the Oklahoma panhandle, wanted to provide the same educational opportunity, in addition to Beaver county, to the schools in Texas and Cimarron counties that wished to participate. But it was agreed for the first phase that 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 class schedules and calendars. 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 calendar had to be aligned. 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 they 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 remote 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 had to 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 fall 1988. Classes offered were advanced placement (AP) English, Spanish, art, and accounting. Classes originated from different schools; instructors selected to teach the ITV classes were among the best in the county and were enthusiastic about the possibilities of teaching over the network. The telephone cooperative's installation of the complex system functioned well from the onset, and few technical or procedural difficulties were encountered.

The new technology posed some problems for teachers. Some of the teachers who were not involved with the ITV classes expressed fears 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 was available about teaching on this new technology.

Teachers who pioneered the system, however, have been able to help train and advise educators implementing other networks, as well as the other teachers on their own network. Continued exposure to the technology reduced apprehension among faculty, particularly when they perceived that rather than replacing teachers, the technology would make available course that the existing faculty could not provide because of lack of training or low enrollment.

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 AP English, Spanish, college level general psychology, and advanced mathematics. At this time there was no sharing between the two clusters because of technical limitations 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 Appendix A.

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). Three schools in Cimarron County, just west of Texas County, formed a third cluster in 1991 that now offers a nearly full network schedule including mechanical drawing, trigonometry/calculus, AP English, Spanish, and speech from within the cluster. The cluster also receives an art class from the Texas County cluster and economics from the regional university. The economics course, as well as others offered by the regional university, is classified as dual enrollment, meaning that passing students will receive both college and high-school credit. These courses are available in all three counties. However, Beaver County has had difficulty in taking advantage of the dual enrollment courses because of an already full network schedule.

By the 1992–93 school year, all schools in the three Panhandle counties that wished to connect were on 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 noncredit courses, paraprofessional training, and intercommunity meetings during nonschool hours.

A 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 on two-way interactive television.

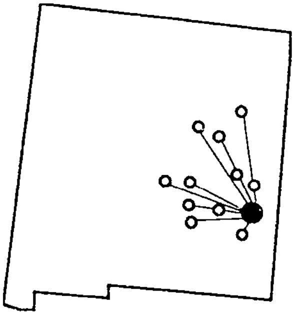
The program offers rural students an opportunity to learn to become effective entrepreneurs, with emphasis placed on developing enterprises in the rural community. Academic work includes courses in entrepreneurship and small business management. Course work merges with a business development project 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 improve the 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 possibilities for the network include:

- Connecting with a southwestern Kansas interactive TV network, giving them access to Fort Hays 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 computer training from Panhandle State University; and
- Expanding community participation.

Figure 4. New Mexico Eastern Plains Instructional Television Consortium



Program Description

Began:	Fall 1990
Number of Schools:	12
Initial Funding:	Rural Telephone Cooperative
Local Visionaries:	Rural Telephone Cooperative Management
Industry Participant:	Rural Telephone Cooperative

THE EASTERN NEW MEXICO INSTRUCTIONAL TELEVISION CONSORTIUM

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 Texas;
- Providing community health facilities with access to medical training and technical support from the Lubbock Health Sciences Center;

- Making training over the network available to industries located in networked communities; and
- Delivering university courses and professional training for community members.

The 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 — their subscription base.

The cooperative approached schools that were already accessible by fiber-optics and offered them the opportunity to participate in a pilot project. Under the pilot agreement, the cooperative assumed all costs for setting up the network, including installation of production gear for studio classrooms. The local telephone cooperative sought support from the state legislature but was unsuccessful. 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 cooperative decided to establish a successful program and then petition the state legislature for reimbursement.

Unfortunately, Texas schools in the cooperative's serving area were unable to participate with New Mexico schools because of the differences in educational requirements for both states. Texas schools are still desirous of participating, but bureaucratic problems remain.

The obligation of connected schools would be the implementation of the network which would require the coordination of schedules and classes so that the system could be effectively used. This was not a simple task since school districts tended to have different schedules.

Two clusters of networked schools were conceived, both in eastern New Mexico. One cluster linked schools that had classes five days a week. The other cluster of networked schools held classes four days a week. 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 lack of shared course offerings proved to be problematic in that the technology was not fully used.

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 five-day schools at the extreme ends of the network, and only one shared class between them.

The four-day cluster, in addition to the former five-day school mentioned above, added another school, resulting in a total membership of five. Ultimately, 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 for a network schedule that none include 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 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 percent 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 K–8 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, which translated into more than 18,000 miles a year per student. Prior to leaving for the high school, most of these students had to first ride a bus to the elementary school, further increasing travel time. Travel was particularly difficult for ninth-graders who were unaccustomed to being away from home for such extended periods of time.

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

The president of the school board, who was also the office manager for the local telephone cooperative 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 initial efforts to persuade the school district superintendent to install a remote ninth-grade classroom were not well received. Other distance learning programs — courses delivered by satellite — had been costly and unsuccessful in the area. However, after some persuasion, and the visiting of two-way interactive sites in operation, the school district decided to implement the program. Not being part of the pilot initiative, the school district had to bear the cost of equipping classrooms with necessary video equipment.

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

- Even though students had 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 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, stated that her class with the network students was one of the best she has ever had.

The school district was later connected to the community college, enabling students to take dual enrollment classes and local inhabitants to pursue college degrees.

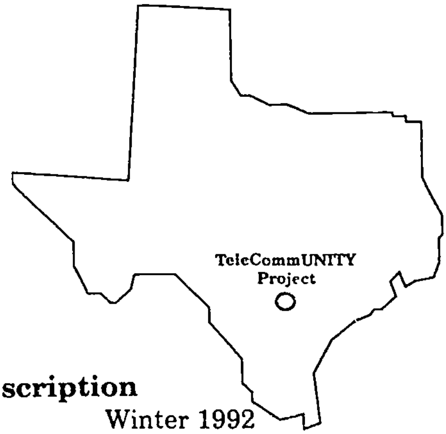
Another development in the 1992–93 school year was an increase in the role of the community college in the network. Two schools in the four-day cluster were unable to contribute courses to the network because of faculty changes. The community college was in a position to increase its participation and did so by offering dual enrollment courses to high-school students over the interactive network. 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 with 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 at a given school. Courses offered included accounting, art appreciation, English composition, American government, and psychology. In fall 1993, banking and criminal justice was added in response to local requests.

The community college is also providing studio space to the New Mexico Department of Labor, which uses the system during off hours to provide information and client intake services to community residents linked through the network. Additional uses under consideration include client services by the New Mexico Department of Human Services and in-service training to personnel of the participating school districts.

The community college is writing a grant to upgrade its network facilities in order to further expand course offerings, and has already approved a budget for a technology and training center which will include a new ITV center, providing two studio/classrooms.

The original vision of the manager/CEO of the local telephone cooperative has been scaled back for the time being. The cooperative 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. The local telephone cooperative was partially compensated by the state for the network installation. In 1991, the legislature appropriated $140,000 to two network schools for implementation costs. In 1992, the legislature appropriated $300,000 for implementation costs at five other network schools. One other school was added for the 1993-94 school year, bringing the number of participating schools to ten. At present, the network reaches over 22,000 inhabitants who are sparsely scattered throughout eastern plains of New Mexico. However, it is unlikely that the telephone cooperative will make any further large scale investment unless the state and/or school districts agree to support the initiative up front.

Figure 5. TeleCommUNITY Network



Program Description

Began:	Winter 1992
Number of Schools:	3
Initial Funding:	Local Telephone Company, Grants
Local Visionaries:	Asst. School District Superintendent, Higher Education Faculty, Community Members, Local Telephone Company
Industry Participant:	University, School District Educators, Telco Management

THE TELECOMMUNITY NETWORK

Located in a small town in Central Texas, this project began operations in January 1992. Although TeleCommUNITY Network came on line recently, it was the first fully functioning full-motion two-way video and audio network in Texas K–12 schools. This project has perhaps the strongest community focus of projects studied in that the first phase of implementation occurred exclusively within one community: the local high school, a regional university, the local independent telephone company, and the second largest Job Corps center in the U.S., which is located on the outskirts of town.

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

With a 14-member planning team, TeleCommUNITY 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, the university, and a lot of leg work by all entities involved, TeleCommUNITY began a unique program called Partnerships for Access to Higher Mathematics (PATH Mathematics), a two-year partnership that was funded by the U.S. Department of Education to "... conduct research on mathematics teaching and learning and research in social services" (Kennedy & Chavkin, 1992—93). PATH Mathematics was designed by two professors at the university, one in mathematics, and the other in social work, in collaboration with teachers at the area high school.

The curriculum combines innovative teaching techniques to prepare students for higher order mathematics with a social support strategy involving a dedicated PATH social worker, university social work interns, and other helping professionals from the community to help students cope with nonacademic pressures. The course was team taught by the above-mentioned university mathematics professor, located at the university and linked through the network, and by a school district mathematics teacher on the premises. More than 80 percent of the students passed the course. Students' progress will be monitored as they continue with mathematics and other studies.

The PATH project used the technology primarily as a vehicle for field testing and revising curriculum whereby the designers of the curriculum could participate in the teaching process using two-way interactive video to monitor the effectiveness of teaching and social service strategies. This use of the technology is radically different from other projects mentioned in which teachers are shared by schools within a network cluster (Kennedy & Chavkin, 1992–93).

In the second year of operation, PATH Math continued as a regular course offering, with the university/school district team-teaching model still in place. By the completion of the 1992–93 school year, more than 200 students had successfully completed the requirements of the Path Math curriculum. Other unique elements relating to PATH Math include:

- school social workers interfacing with students and parents to increase contact and positive attitudes toward the school and mathematics;
- establishment of a homework hotline whereby students could access a cable generated TV program produced by the university and telephone from home to ask specific questions; and
- the use of graphing calculators, interactive computer linkages, and "teacher in window" split-video signals where students could see the teacher in one corner of the TV screen as he explained math calculations that were displayed on the rest of the screen.

In addition to the PATH Mathematics project, the university is offering dual enrollment calculus to high-school and Job Corps students over the network. The Job Corps is offering specialized vocational training to high-school students and residents of the community. Planned courses include Russian, Japanese, and college English.

Also active on the network are two programs that address the needs of adult learners. The first is the World of Work (WOW) program, in which adults, including Job Corps students and community members, study literacy and job initiative strategies. The classes are delivered from the site at the Job Corps, with instructors and tutors present at each on line site.

Another major project underway is the Southwest Texas Center for Professional Development in Technology (SWT-CPDT). Currently funded with a $1.1 million grant from the state education agency, the Center is offering instruction to in-service classroom teachers in methods and techniques for using technologies in education. SWT-CPDT is concentrating on advanced applications of digital fiber-optics including extensive integration of the Internet in elementary classrooms, and creative uses of interactive multimedia networks and workstations.

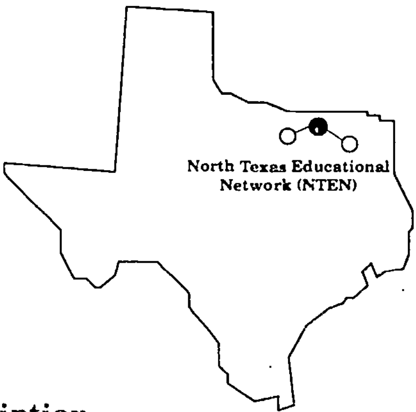
Other plans for the network are:

- to expand the network to outlying areas in adjoining counties, as well as within the community;
- to construct additional classroom sites at the school district and university, featuring fully interactive video, audio, and data capabilities that will interface with other on-line class labs;
- to support activities, including on-line computing and video for child and adult clients of family literacy projects;
- to connect with an ITV network that is developing in a nearby metropolitan area; and
- to add other sites to the community network — including a church, a library, a resort conference center, and a local detention center for drug offenders — in order to offer wider dispersion of adult education programs.

On the Verge

The following projects are in various 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*)



Program Description

Began:	Fall 1993
Number of Schools:	3
Initial Funding:	Local Telephone Company, School Districts
Local Visionaries:	School District Supt.
Industry Participant:	Local Telephone Co-op

* The NTEN project was not included in the video because of time constraints. However, the authors feel that the project is worthy of discussion in the guidebook. NTEN's initial goal is the sharing of teaching expertise among the schools.

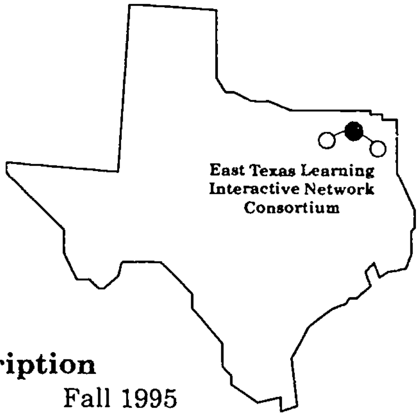
NORTH TEXAS EDUCATIONAL NETWORK (NTEN) *

This project is a partnership among three North Texas school districts 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 a locally controlled network could strengthen area schools, thereby preventing further erosion of the rural population. At the time of writing the owner is seeking support from additional school districts in the area, 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.

Fiber-optic cable has been installed between school districts, and NTEN has equipped classrooms at three school districts with necessary equipment to begin using the system. All equipment for implementation has been purchased by the local telephone cooperative. In an effort to enlist support of area communities, NTEN held a two-way video demonstration at an area college in summer 1992 where hundreds of citizens 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. Training sessions to familiarize teachers with the system took place in the summer of 1993, and three area schools began exchanging a limited number of classes in the fall of 1993. During the primary phase of implementation classes were offered in reading (junior high), microcomputing, and foreign language.

Expected future benefits 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



Program Description

To Begin:	Fall 1995
Number of Schools:	3-4
Initial Funding:	Local Telephone Company, School Districts, University
Local Visionaries:	School District personnel, University administration
Industry Participant:	Local Telephone Co-op, Local industry

EAST TEXAS LEARNING INTERACTIVE NETWORK CONSORTIUM (ET-LINC)

This project originally comprised two northeastern Texas school districts, a local telephone cooperative, a locally based aerospace company, and a regional university. Currently, school districts interested in the technology and possible participants in ET-LINC number more than 15. The first formal initiative came in fall 1991, when a school district media coordinator recommended sending an expert to visit the TeleCommUNITY project. A telecommunications specialist from a local aerospace company, who had a strong interest in educational technologies was selected to go. The visit proved very productive, both as an information gleaning experience for the ET-LINC project and as the groundwork for 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 school district involved with the TeleCommUNITY project moved to a school district in northeastern 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 and 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 northeastern Texas with similar technology.

Many school districts currently involved in the project have relatively complete curricula and are not primarily interested in the project for the purpose of sharing teachers at the high-school level, which has been typical of other projects. However, potential participants are extremely interested in making university-level courses available to their students and community, and the participation of the university has been essential for participation. The school districts and the university see linkage by two-way interactive video as 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 taught by university faculty;
- Graduate courses for in-service teachers;
- Undergraduate courses for school district paraprofessionals and place-bound community members;
- Sharing of actual classroom practices with preservice teachers at the university;
- Monitoring of preservice teachers while student teaching; and
- Demystification of the university environment, thus making higher education more accessible.

Also strengthening the project was a recent donation to a private foundation aligned with ET-LINC of broad-band switches from a major long distance carrier. Each digital cross-connect switch costs more than $200,000 and is capable of linking at least 60 sites with full-motion video. While a donation of switches and light-wave terminals that have the potential of interconnecting as many as 540 sites seems to be "overkill" in a project beginning with a few schools and one regional university, it significantly strengthens the credibility of the project. Furthermore, the switches may greatly reduce the installation cost per site and will offer an incentive for other schools to join the project. Ultimately, project planners from the foundation hope to disperse the equipment throughout the state of Texas, linking many small rural schools with each other and with institutions of higher learning, medical centers, and other appropriate entities. The equipment is being received by the TeleCommUNITY Foundation, since it is a legal nonprofit entity and ET-LINC has not yet attained that legal status.

Demonstrating a strong commitment, the regional university has recently hired a program coordinator to facilitate the implementation and management of the system, as well as other outreach programs in area K–12 schools. The university plans to be fully functional with its own interactive teaching studio by summer 1995. The coordinator is currently organizing meetings with interested school superintendents in the area and showing the video *Local Heroes* in order to communicate the potential of the technology. She is also making copies of the video available to superintendents so that they may show it to school board and community members. The coordinator's activities has been influential, along with above-mentioned visionaries, in accelerating momentum toward the implementation of the technology.

The confluence of diverse influential entities, including ongoing support from the TeleCommUNITY Project and the addition of a professional organizer, is anomalous among the six projects studied and bodes well for the success of the project. ET-LINC participants are busily writing grants for additional support, forming alliances in Northeastern Texas, and seeking firm commitments from a small number of school districts to forge ahead with the hard planning and resource allocation necessary to begin the first phase of implementation.

Figure 8. The Dell City Initiative

Program Description

To Begin:	Fall 1992
Number of Schools:	3-4
Initial Funding:	Local Telephone Company, School Districts, State Grant
Local Visionaries:	School District Supt.
Industry Participant:	Local Telephone Co-op

THE DELL CITY INITIATIVE

This project originated in a remote, sparsely populated school district in far West Texas, about 90 miles east of El Paso, that 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 two years 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 had hoped 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 a larger, regional telephone company which makes coordination problematic. Discussions with the larger telephone company have not met with success to date. 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 using DS-3 transmission rates, obviously a prohibitive cost.

Late last year, the state-supported, regional educational service center in El Paso, in conjunction with the regional university located in El Paso, won a grant relating to in-service training for teachers through telecommunications. The university already had in place the less expensive T-1 interactive video system, which links the numerous regional universities throughout the state, and invited Dell City schools to join the consortium along with another rural school east of El Paso. The T-1 transmission technology is inconsistent and of lesser bandwidth (not currently enabling full-motion video) with the DS-3 full-motion fiber-optic system that Dell City was planning. However, the prospect of being up and running within less than a year and receiving dual enrollment courses from the university, in-service training from the regional service center, affordable linkage, and connection with outside world was an offer the Dell City community was prepared to accept. As the Dell City ISD superintendent put it, "There's no point in having the Cadillac of ITV systems (DS-3) if you don't have anybody to connect with."

Dell City has secured community funding for a media center that is near completion. The superintendent has also been instrumental in forging an alliance with a conglomeration of rural and small community telephone companies or cooperatives that extends from Lubbock up to El Paso. The ultimate strategy is to connect small rural schools in the region with The University of Texas at El Paso and El Paso Community College. Plans also include connecting with the University of Juarez in

Figure 9. Two-Way Interactive Educational Television Systems in the Southwest

Project Title	# of Units, at Start	Began Plan	Implementation Efforts	Startup Date	Length Project months
Oklahoma Panhandle Shar-Ed Network	4	1985	Grant writing state /foundation / industry support	Fall 1988	51
NM Eastern Plains Instructional TV Consortium	5	1989	Industry support	Fall 1990	27
[illegible] Network, San Marcos, TX	3	1990-91	Industry, university, Job Corps, ISD partnership / grant writing	Winter 1992	12
North Texas Educational Network	3	1991	Local telco and school district partnership	Fall 1993	N/A
Dell City 2 Way Interactive TV Project	4	1991	Partner with local telco, regional service center, university, grant writing	Fall 1994 (proj)	N/A
East Texas Learning Interactive Network Consortium	in flux	1991	Telco, ISD's, hi-tech industry, higher ed partnership / grant writing	Winter 1995 (proj)	N/A

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# of Present Units	Local Instigators	Sources of Inspiration	Higher Ed Participant	Industry Participant	Future Growth
13	Beaver Co. superintendent	Wisc. MN 2-Way Video Networks	OK Panhandle State University	OK Panhandle Tele. Co-op	Link with SW Kansas network Kansas reg. university
13	ENMR tele co-op management	OK Panhandle Shar-Ed ITV Network	Clovis Community College	ENMR Tele Co-op	Link with other higher ed; additional TX, NM schools, additional community services
3	Century Telephone of San Marcos, SWTSU, San Marcos ISD, Gary Job Corp.	Minn. ITV, OK Panhandle	SWTSU	Century Telephone of San Marcos	Link with adjacent schools, other higher ed, using other telecommunication technologies
3	Muenster Telephone Co	OK Panhandle Project, TekCommUNITY Network	none at present	Muenster Telco	Link w/area community college, other area schools
4	Dell City ISD superintendent	Century Telephone of San Marcos, OK Panhandle ITV	UT-El Paso	Dell City Telephone Co-op	Link from Dell City to Lubbock, TX Juarez University, Mexico
in flux	People's Telco, ISD visionaries, E-systems, Dean of Education East Texas State	TekCommUNITY Network	East Texas State University	People's Telephone Co-op	Add other schools; community services; teacher training

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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 an international test site. For the present, however, the superintendent at the Dell City school district will be content to be up and running with the newly formed consortium. She expects the effort to be fully functional by fall 1994.

Although the 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 and/or cooperatives, and getting authorization, as well as support, for the installation of fiber-optic cable necessary to enable dedicated signal transmission. The district's vision of a network, be it a DS-3 or a T-1 transmission rate, that extends through much of West Texas and into Mexico will bear watching.

Conclusion

Everett M. Rogers (1981) states that the implementation of new ideas, new concepts is not easy, even though such implementation could be beneficial. In many fields the distance between the discovery and widespread adoption of innovations is considerable. Frequently, years pass before a useful discovery takes its place in the mainstream culture. The educational arena is often categorized as being particularly slow to adopt innovation. However, a number of 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 two-way, full-motion 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. Our research supp s 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 early, clear identification of the goal enabled success. Projects that have already been implemented through 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 in the very near future.

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Appendix A

Existing Research

To date, little research has been conducted on the effectiveness of telecommunicated distance education as compared to other methods of instruction. Studies relating to effects and effectiveness of interactive telecommunications networks for education tend to be limited in scope, focusing on local school results and limited use of control groups. Yet, most authors appear to be convinced that these technologies are promising. Barker (1991) concludes that the research base suggests that "...students who study via telecommunicated distance education approaches perform as well as their counterparts in traditional classroom settings." (p. 235) Barker further notes that the success of the technology depends more upon the quality of instruction delivered than on the type of technology used. Kober (1990) also suggests that this technology can be as effective as traditional instruction.

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, the Region 5 Rural Technical Assistance Center of Denver, Colorado, undertook a three-month study (Lawyer-Brook, 1991) to explore the feasibility of using distance education as a means for providing Chapter I remedial courses to eligible children. Interactive television was used to provide mathematics instruction to third and fourth-grade students with one teacher at the sending site and facilitators at the three remote sites. Four schools in the Oklahoma Panhandle Shar-Ed Network (one of the six projects presented in this guidebook) were selected for the first phase of the study.

For the second phase in summer 1991, four sites in southeastern Kansas were selected. The selected networks feature multiple sites with fully interactive video, where each site can see and hear all others.

The author made the following observations:

- Chapter I instruction could be effectively delivered using 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 I delivery was no more expensive than the cost of a traditional Chapter I 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 problem issues such 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 at remote sites were less independent than first thought. The authors 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, did better academically, had more affinity for classes, and had more sense of involvement 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 & Hord, 1987; Rutherford, 1985).

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 (1991) advised that cooperative arrangements involving telecommunicated distance education will require formal organizations because of the complexity of the programs and their resource requirements. Barker (1991) suggests that administrators who are considering distance education programs pay close attention to the following twelve issues: 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 (please see Appendix B), which form the foundation for this guidebook and videotape, are generally consistent with the findings cited above. However, despite the lack of a classroom facilitator at many remote sites few problems regarding discipline or effectiveness were reported.

Reasons cited for success were:

- 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; and
- Students had at least one year of high school and were college-bound.

All interactive television classes studied involving younger students had facilitators present or were team taught, with instructors or facilitators at each participating site.

Appendix B

SEDL's 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 two-way interactive video projects that linked participating schools as far apart as 200 miles within a given region.

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, 1990).

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 section entitled "A Prototype Based on Research Findings."

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 of the school, such as scheduling, school size, working conditions, etc., conducive to the innovation?
- 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 to accomplish your goal of implementation? 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 their 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 the 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)
- Was there foundation support? (grants, money, guidance)
- Was there federal support? (grants, money, legislation, mandates, regulations, knowledge, technical assistance, evaluation)
- Was there 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/ONGOING ASSISTANCE

- How were 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, infrastructural, knowledge/informational, 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 resistance was met, and how did it affect the project?

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, and 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 nominated 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 interactive 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 to monitor their sufficiency and focus (Bogdan & Biklen, 1982). Data collection was considered complete 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 small rural 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, 1985).
- 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:

- Triangulation of data sources and investigators was undertaken (Denzin, 1970).
- Data and interpretations were checked with research participants to verify plausibility (Lincoln & Guba, 1985).
- Data were 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, 1990).

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 small rural schools;
- Coordination between small rural 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 report, 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 guidebook, as well as the accompanying videotape, *Local Heroes*.

"Local Heroes" are the implementors of advanced telecommunications. They're the dedicated, motivated citizens who work to better serve their rural, small schools and communities. These local heroes realize that telecommunications can play an important role in maintaining the integrity of education. This guidebook tells their story along with details for successful implementation in rural, small schools.

SEDL/OERI

Southwest Educational Development Laboratory
211 East 7th Street
Austin, Texas 78701
512/476-6861

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