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ABSTRACT

This handbook presents a snapshot view of the use of telecommunications technologies to deliver instruction to distant audiences of K-12 students in the United States. The information is intended specifically for people who work in and with small, rural, or remote schools. Available technologies and programming vary widely in offerings and quality. Before selecting a particular program or distant learning system, administrators must consider the issues of the system's purpose, who controls the system, costs, course offerings, scheduling, class size, level of teacher-student interaction, qualifications and evaluation of teleteachers, qualifications and duties of classroom facilitators, and grading and routing class materials. Thirteen types of interactive distance learning technologies are described, and typical costs are outlined. Details are provided on specific programs and projects that use audio conferencing, audiographics teleteaching, fiber optics or microwave, instructional television fixed services, and direct satellite broadcasts. Only limited research on the effectiveness of K-12 distance learning has been completed. This handbook reports available evidence on student achievement, instructional effectiveness, administrator and student satisfaction, teaching methods, teacher-student relationship, and cost effectiveness. Advantages and disadvantages are outlined for satellite, audiographics, and two-way full-motion TV delivery. The final chapter discusses the opportunities that distance education is providing to rural areas and the ways in which it changes the ongoing debate about small rural schools. This book contains 30 references and an annotated bibliography of 35 documents about distance education that are in the ERIC database. (SV)

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Bruce O. Barker

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THE DISTANCE EDUCATION HANDBOOK

An Administrator's Guide for Rural and Remote Schools

by

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January 1992

ERIC

Clearinghouse on Rural Education and Small Schools

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EDITOR'S PREFACE

Bruce Barker's 1987 publication for the Clearinghouse, *Interactive Distance Learning Technologies: A Resource Guide*, has been one of our most popular titles. Originally developed when the Clearinghouse was located in New Mexico, the *Resource Guide* has been reprinted several times. All that reprinting actually troubled us, because we have the uncomfortable honor of sitting astride the "cutting edge." And, on this topic, the sharp edge was beginning to hurt. We needed an update.

Sometime in January of 1991, I sat in my office doing what I usually do there—hunkering over text. But in the back of my mind was a worry. I'd just learned that an author of an important publication would not be able to keep the appointed deadline. As any editor knows, such worries come with the turf.

The phone rang—as it always does when I'm trying to concentrate. Expletives popped to the very front of my mind on the first ring, but I mustered the fortitude to be my cheery telephone self.

It was a good thing, because Bruce Barker, the author of this handbook, was on the other end. Bruce had a manuscript that (so he said) probably needed more work to fit our purposes, but might be something we'd be interested in. And how!

We are delighted to bring out this handbook as an updated and greatly expanded version of the 1987 *Resource Guide*, and trust it will be even more useful than the earlier publication.

The author and editor would like to thank Joe Newlin of the National Rural Education Association, Sue Raftery of Auburn University, and Todd Strohmenger, codirector of ERIC/CRESS, for providing helpful comments on an earlier draft of this handbook. Their insights helped us prepare a more accessible guide to a complex field.

Craig Howley
Codirector, ERIC/CRESS

INTRODUCTION

Here we are at the dawn of the "information age." It's an exciting and challenging time to be involved with education. In recent years a great many technological systems have been constructed to give students instructional opportunities that would otherwise pass them by.

These new delivery systems are based on diverse and, in some cases, complex technologies. They include telephone audioconferencing, cable television, fiber optics, microwave, Instructional Television Fixed Services (ITFS) signal, slow-scan TV, satellites, digitized video, and microcomputer networking.

Becoming conversant with this array *is* a challenge for all administrators—but perhaps especially for those working in rural, small, and remote schools. In such schools, administrators have many duties, of which overseeing educational programs is but one (if arguably the most important). This handbook is for them. It aims to provide a succinct presentation of the essentials that will support good decisionmaking.

Distance education[1] can be broadly defined as "the live, simultaneous transmission of a master teacher's lessons from a host classroom or studio to multiple receiving site classrooms in distant locations" (Barker, Frisbie, & Patrick, 1989, p. 27). Either a portion or all of the learning interactions between the teacher and students occurs in *real time* (Office of Technology Assessment, 1989).

From present appearances, it is probably safe to conclude that distance education will have an increasing impact on schooling and learning in this country. This is likely to be especially true among rural schools, where shortages in qualified staff (compounded by low student enrollments in specialized classes) severely limit program offerings. Distance education also has great potential to deliver staff development opportunities for teachers and administrators in rural schools.

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[1]Previously, "distance education" often also referred to correspondence courses, but that topic is outside the scope of this handbook, which focuses on the more recent phenomenon of telecommunicated distance education.

The purpose of this handbook is to present a snapshot view of various ways that telecommunications technologies are, at present, being used to deliver instruction to distant audiences of K-12 students across the United States. The information is intended specifically for people who work in and with small, rural, or remote schools—school administrators, teachers, school board members, and others who are looking for ways to improve educational opportunity for students.

The handbook focuses discussion within each chapter on these six important topics:

Distance Learning Issues and Concerns

Technologies differ significantly and programming by vendors varies widely—both in terms of offerings and in terms of quality. This section of the handbook *offers suggestions that administrators and other rural educators should carefully consider* before selecting a particular program or distance learning system. Successful use of distance learning technologies depends on asking certain questions. Administrators who are thinking of incorporating a distance learning program or system at their school(s) must be aware of the issues these questions address.

Types of Distance Learning Technologies

A variety of telecommunications technologies deliver live, two-way interactive instruction between a host teacher at one site and students at distant sites. Some technologies are relatively simple, but others are quite complicated. This portion of the handbook *provides brief descriptions of differing technologies* and some examples of ongoing programs.

Technology and Programming Costs

This section of the handbook *reviews the costs* of distance education. Costs of the various types of technologies vary widely, and administrators need to understand the options.

Examples of Distance Learning Projects and Programs

Distance learning may involve two sites or many sites. Present practice allows for live, teacher-student interaction. This interaction takes a variety of forms. It may, for example, entail: (1) one-way video, two-way audio exchanges between teacher and students; (2) two-way audio instruction only; or (3) two-way video, full-motion, and two-way audio interaction. This section of the handbook *describes several programs that use a variety of such formats.*

Evaluation of Distance Learning Programs

How effective are distance learning programs and how well do students learn via distance learning technologies? Only limited research on effectiveness of K-12 distance learning has been completed. This section of the handbook *reports available evidence.*

Technology Advantages and Disadvantages

In a surprisingly short period of time, telecommunications technologies have been accepted by many local, state, and national education leaders as viable means to deliver instruction. Although distance learning approaches hold great promise, they are not necessarily a "quick fix" to solve the problem of curriculum equity in rural schools. There are definite advantages and there are disadvantages to each technology, as well as differences between program providers of respective technologies. This section *reviews some of the advantages and disadvantages of three of the more popular technologies*—satellite delivery; audiographics delivery; and two-way, full-motion TV delivery.

The discussion in the handbook concludes with a chapter about the opportunities opened by distance education. Many people—practitioners as well as researchers—have noticed that distance education changes the terms of the debate about rural, small schools. Things that used to be impossible are now possible, but administrators need to ask themselves the right questions as they think about the new alternatives.

The handbook also includes two appendices. Appendix A presents an annotated bibliography of resources available on ERIC microfiche. Every one of these documents can be ordered directly from the ERIC Document Reproduction Service (EDRS) at nominal cost. Appendix B explains how to get additional information through ERIC/CRESS.

Finally, a big problem with information about a topic like this is that it often leaves the reader more confused than ever. I have done my very best, therefore, to make this a "user-friendly" handbook. It presents the essentials, but the discussion is clear and straightforward.

In 1987, fewer than ten states were promoting distance learning programs. Today, all of the 50 states have some type of distance education plan in place (Jordahl, 1991; Krebs, 1991). With limited fanfare, many schools across the United States have begun using distance learning technologies (1) to help them meet state-mandated curriculum requirements, (2) to offer elective or required courses for which a certified teacher is not available, and (3) to provide quality teacher inservice training that might not otherwise be available.

The interest in distance education has grown so rapidly in recent years that only a few of the important questions addressing pertinent issues have been asked. That circumstance is now changing, and rightly so.

Since most approaches to distance education involve a *substantial commitment* of time, money, and personnel, the failure to address pertinent issues can squander those resources. In addition, educators could form a negative opinion of a particular approach to distance education that, under more favorable circumstances, might have left a better impression.

Successful use of distance education technologies demands that certain issues be addressed. The ideas presented in this handbook are important matters to be considered by school administrators before joining an existing network or before deciding to implement a particular system.

Defining the System's Purpose

Before acquiring a teleteaching system, you should think about the needs you expect the system to meet. Questions to consider include:

- Is the system to be used primarily as *enrichment*, or will it be used as *the chief means of instruction* in a particular class or curriculum?

- Will the system be expected to fulfill state-mandated curriculum *requirements*, or will it be used only to offer *elective* courses?

- Will the system be used by *specific types of students* (for example, advanced placement, homebound, or general course students), or will the system be used by *all types of students*?

- Is the system expected to be used to deliver *inservice training* for the staff and/or to provide *classes for the community*?

You should consider these questions in terms of your users' short-term needs and long-term goals. If, for instance, you plan to use the system to deliver a wide range of programs, some of the more expensive and complex systems can be increasingly cost effective. Systems that meet a variety of needs can, in fact, show a lower cost per learner when they are made available to a wide, more diverse audience.

Establishing Who Controls the System

When considering a teleteaching system, you should decide how much control you wish to maintain over the system and how much control you are willing to relinquish. Large satellite networks such as TI-IN or Oklahoma State University's Arts and Sciences Teleconferencing Service are multistate systems that provide a "turn-key" approach. In these networks, and others like them, control of instruction, grading, selection of the teleteacher(s), and other details are largely centralized. With hundreds of sites linked to a network, individual schools have only limited input about how the system is operated.

An option that allows increased local control over a distance learning system is the "local" cooperative. Under this option, a group of local schools or districts band together to offer programming. Such a group might design its own system around a computer-networked audiographics approach or a closed-circuit TV approach. Questions you should consider in relation to control of a telesystem include:

- Who is *in charge*?

- Who has the *final say if a disagreement* arises?
- Who will *evaluate* the system?
- Whom does the *teleteacher* answer to?
- What are the *costs* to each participating site?
- How will the system be *maintained and upgraded?*

Costs

The matter of costs brings up a whole array of issues. These issues crop up whatever the type of technology or approach selected. Investing in a telesystem can represent a major commitment in terms of a school's budget. Some of the questions that you might ask include:

- How much will it cost to *get started?*
- How much will it cost *each semester* to operate the system?
- Who is responsible for *maintaining* the equipment?
- Will the system require *periodic upgrades* and, if so, who absorbs the cost of updating equipment or facilities?
- Can the school *lease* the equipment or do you have to *purchase* the equipment?
- Can the equipment be used for *other purposes* than distance education?

Some distance education vendors allow the subscriber to lease the equipment. Then, if the equipment is upgraded or requires maintenance, the vendor bears the cost. Of course, the expense will likely be passed on to subscribers via increased subscription fees.

Some systems are funded partially or entirely from state or federal grants. Others are subsidized with money from private enterprises. You should make sure that the system you buy into, or subscribe to, will continue to operate in the event that outside funding sources are reduced or discontinued.

Equipment should provide as broad a service as possible. For instance, a steerable satellite dish that has both a Ku-band and C-band feedhorn will be able to receive educational programming from a variety of satellite sources. Some vendors sell schools a "fixed" dish that is locked on to one satellite. In that case, schools have only limited flexibility to receive programs broadcast by other distance education providers.

Course Offerings

An important factor in selecting a distance learning vendor is the number and types of courses they offer. The more students that can be served by a system, the more cost effective it can be. You should realize that courses are not necessarily restricted to students. Teachers and administrators need inservice training. Most rural communities would also welcome adult education or community classes, as well. Questions that you might ask when considering a distance education provider include:

- Are the courses offered intended for *remedial, average, advanced,* or a combination of all three types of students?
- Do the courses offered meet *state certification requirements*?
- Are student enrichment *(noncredit) courses* offered?
- Are *college prep* or *advanced placement* courses offered?
- Does the vendor offer *courses to prepare students for standardized tests* such as the SAT and the ACT?
- Are teacher/administrator *inservice courses or adult education* classes offered?

Scheduling

When two or more school systems are linked together, it is more than likely that there will be schedule conflicts. The main issues involve daily bell schedules, vacation schedules, and the days that a school year starts and ends. Problems can also arise when one school is forced to close due to bad weather and other schools on the network are able to hold classes. Scheduling is a major challenge in most distance learning programs and is not easily resolved. It becomes especially evident in large networks (chiefly satellite systems) that deliver instruction to students in multiple states across different time zones. The question is not necessarily, "Can the schedules be made to match?" Chances are, they cannot. A more realistic question is, "Are adequate provisions made for allowing the students to make up classes or portions of classes that they miss?" Chances are, such arrangements *can* be worked out. In addressing the problem of scheduling, administrators might consider:

- Does the distance learning system allow enough time each semester for *makeup work?*
- How many *days each week* does the system conduct classes?
- Can classes be *videotaped and viewed later* by students who miss a class or portions of a class?
- Are a few *lessons prepared beforehand* for broadcast in case the teleteacher is unable to conduct the class "live"?
- Does the teleteacher have *"office hours"* during which time he or she can be reached "after hours," that is, when lessons are not being conducted?
- How *early or late* in the day are courses conducted?

Not all distance learning classes are conducted five days a week. Days in which lessons are neither broadcast nor transmitted are usually devoted to activities that do not require the teleteacher—for example, tests, makeup work, and assignments.

Class Size

Since most distance education systems are geared toward small and rural schools, class size at local school sites is usually not a problem. At individual sites, such classes are usually small. Problems develop when the teleteacher has to provide instruction to too many remote sites. For instance, ten small sites, each with ten students, becomes a much larger class of one hundred students.

It is not unusual for some satellite TV classes to have 300 to 1,000 students enrolled in the same class scattered across many states linking together a large number of schools. In these circumstances, a legitimate question is whether or not the teleteacher is able to establish and maintain a meaningful interpersonal relationship with students. As class size increases, the level and extent of teacher-student interaction is directly affected. The question of overall class size over a network is an important one. Questions you might consider include:

- Is the telesystem designed to limit *local class size?*
- Is the telesystem designed to limit *overall class size* among all the participating sites?
- Are maximum class sizes determined according to the *nature of the subject matter* being taught?
- Does the teleteacher maintain a *high level of teacher-student interaction* with students at each school participating in the network, or are students at local schools only "vaguely" known by the teleteacher?

Level of Teacher-Student Interaction

Many telesystems place a premium on some sort of real-time interaction between the teleteacher and the students at distant sites. Usually, less attention is devoted to providing an opportunity for students at one site to interact with students at another site.

Some technologies allow the teleteacher and the students to see each other. Such instruction occurs in a mode known as "two-way video, two-way audio." Other systems only allow the students to see the teleteacher, but permit student talk-back, usually over telephone lines. This mode is known as "one-way video, two-way audio." Other, lower-level systems—such as microcomputer-aided audiographics—allow audio interaction mixed with a common sharing of computer graphics; the teacher and students do not see each other at all. The following questions can help you assess your own view of the importance of teacher-student interaction in a distance learning system:

- Does the teacher *need to see the students* in order to successfully conduct the class?

- Do students at remote sites need to interact freely with *students at other remote sites*?

- Can students easily *get in contact with the teleteacher* during class, as well as after class?

- Does the teleteacher *visit the remote sites regularly* to get better acquainted with students and provide more personalized instruction?

Teleteachers

The matter of recruiting, selecting, and training teleteachers has to be addressed by those involved with running, or even subscribing to, a telesystem. Paying the teleteacher, determining the course load, and establishing who will be the teleteacher's immediate superior are also important questions.

If a telecourse originates in one state and is received in another state, teacher certification issues may have to be dealt with. State approval of textbooks and other course materials may present additional problems. Questions to consider include:

- Who *recruits, trains, and pays* the teleteacher?

- Are the teleteachers *properly certified* to teach in the state?

- Have the teleteacher's *ancillary materials* been properly approved by the state?

- Is the teleteacher *formally evaluated* and, if so, by whom?

Classroom Facilitators

Most distance learning programs require that an adult supervisor or classroom facilitator remain in the teleclass to take care of the normal classroom administrative details. Such details include, for example, checking the role, passing out and taking up class materials, proctoring tests, and monitoring student behavior. Questions that you should consider when thinking about facilitators include:

- Is the facilitator required to be a *certified teacher*?
- What are the facilitator's *responsibilities*?
- Is the facilitator *required to be present* in the classroom at all times?
- How much *training* does the facilitator receive?
- Who *recruits, trains, and pays* the facilitator?

Grading and Routing Class Materials

To get homework assignments, tests, and printed materials to and from students, many telesystems depend upon the regular postal service. This arrangement, of course, is not always reliable—no arrangements are infallible. Others use couriers or facsimile ("FAX") machines. Some technologies permit the teleteacher simply to use the telesystem to transmit data either to a printer or to a computer screen so that the students can include it with their class notes.

Routing materials is a significant issue. Many students in ongoing distance learning classes have complained that delays in the return of homework and tests have caused frustration Questions that address these issues include:

- Who is responsible for *collecting and distributing* class materials at the local site?
- Who is responsible for *grading* student work?

- How will class materials get back and forth *between the students and the teleteacher?*

- What *types of reports* will be sent to the *students and their parents?*

Selecting a System

Many issues need to be considered before deciding on a distance education system. Some administrators may value convenience; others may value the importance of local control. In the final analysis, the key is to select the approach that (1) best meets local needs and (2) is affordable. These are the underlying issues that were raised by the questions in this section.

By "technologies," I mean the media used to transmit information, rather than the content of programs delivered over the media. Many technologies deliver interactive distance learning between host locations and distant sites. The basic media are easy to describe and understand, but you should realize that particular vendors and systems can combine them in many ways.

As a result, some telesystems are relatively simple, whereas others are very complex. Some of the most common technologies that fall within the definition of interactive distance learning are described below (Learning Services, 1988; Norenberg & Lundblad, 1987):

- **Audio conferencing**: telephone contact between two or more sites, usually connected by means of a telephone bridge and via speaker phones. Unless video phones are used, there is no visual communication.

- **Audiographic systems**: combination of an audio conference used with graphic support, such as an electronic blackboard, writing tablet, still video, or computer-generated visual material. There is two-way audio interactivity and two-way visual exchange of electronic text and/or graphics.

- **Broadcast television**: transmission of picture (video) and sound (audio) over standard UHF and VHF television channels. Interactivity between origination and reception sites *is* possible using telephones.

- **Coaxial cable**: a metal cable consisting of a conductor surrounded by another conductor (as in "cable TV"), which can carry video, audio, and data signals from point to point. TV transmission is in full motion. Commercial cable companies provide the service in most cases. Although cable technology is capable of transmitting two-way video instruction, most educational systems using cable are in a one-way video, two-way audio mode. Audio interaction is typically over telephone lines.

- **Direct Broadcast Satellite (DBS)**: full motion television programming transmitted via satellite directly to the user, who receives video and audio information using a satellite antenna or receiver dish. This is a one-way (outgoing from origination site) transmission. Audio interaction by students is through telephones.

- **Facsimile ("FAX") machines**: a photocopy device that transmits printed information to distance sites via telephone connection.

- **Fiber optics**: a rapidly developing and emerging medium that transmits voice, full-motion video, and data by sending light impulses through ultra-thin glass fibers. Fiber optics permits two-way, full-motion video and two-way audio interaction between participating sites.

- **Freeze frame/slow scan**: still pictures (no motion) of instructional content are transmitted over regular telephone lines. The user must have special equipment that decodes the visual information onto a television monitor. The visuals are received in a "slow-scan" format— that is, a new picture can be replaced in set intervals ranging from eight to 45 seconds. Audio interaction, in this case, also occurs via telephone lines.

- **Instructional Television Fixed Services (ITFS)**: ITFS is a one-way microwave technology capable of serving limited geographical areas (maximum distance is a radius of 20 miles). Both the visual and sound components of a program are transmitted directly to the user. Signals are received by a specialized antenna or receiver. Interactivity requires the use of telephones.

- **Low-power television**: broadcast medium similar to commercial television, except that the low-power signal limits the broadcast area. The technology permits one-way, full-motion video. Audio interaction is by telephones.

- **Microwave**: used to send and deliver audio and video signals. Like direct broadcast satellite, microwave transmissions require special transmitters and receivers. The transmitters and receivers must be in "line of sight"— they must be aligned within sight of each other. Many microwave systems are capable of two-way audio and two-way video, full-motion transmission. Interaction between origination and reception sites occurs directly over the microwave system.

- **Telephone**: telephone lines are now capable of transmitting more than voice. With appropriate equipment, they can also transmit still-frame or full-motion television images and data (printed) information. Telephones, and the use of telephone lines, are, in fact, a central component of every interactive distance learning system.

- **Vertical blanking interval (VBI)**: an unseen part of the standard broadcast signal used to transmit television. Using special equipment, this signal can be encoded and decoded to transmit additional information. VBI is frequently used for freeze-frame or slow-scan transmission of visual information. Audio interaction between sites occurs over telephone lines.

These are the major technologies currently being used for distance education in the United States. In addition to telephones, the media receiving the most attention are satellite systems, fiber optics, facsimile machines, ITFS, microwave, audiographics, and audio conferencing.

Of course, you need to realize that not all of these media are equally available in remote or isolated school settings. Even telephone service in some remote areas is sporadic, and, moreover, installing additional phone lines might be too expensive or might take a very long time. As telecommunications technologies continue to evolve, however, services to isolated areas will probably improve and costs will probably decline.

The costs of distance learning technologies and programs vary widely. Costs can be divided into two categories: (1) up-front costs for equipment and (2) continuing costs for programming and operation.

Schools or districts that operate their own systems must pay all equipment and operation costs necessary to develop, send, and receive transmissions. Subscribers to the services of a distance education provider, however, usually pay only for equipment (lease, purchase, or lease/purchase arrangements) and remit program subscription fees.

Approximate costs of the more popular systems and selected program providers are included in this handbook. Costs are reported in terms of what a school could expect to pay to receive programming from an educational provider. Estimated costs to create their own distance learning network using audiographics or audio conferencing with cooperating schools in the area are also reported.

The costs of setting up an *entire* ITFS, satellite, or microwave system are not reported, however. The costs of such systems would be prohibitive for most readers of this handbook.[2] Moreover, schools or districts participating in such large telesystems would typically do so as subscribers to a centralized service, thereby paying a programming subscription fee.

Estimated costs to rural schools to use selected technologies in a distance learning mode or to receive programming from a distance learning provider are:

- **Audio conferencing**: The expense for telephone audio conferencing is relatively small. Speaker telephones can range as low as $50 to $400. If the bridge equipment is purchased, it can cost anywhere from $1,000 to $3,000 per port. Each site will need a port. Ongoing costs include the price of the long-distance phone calls and, if the bridge equipment is leased, 15 to 35 cents per port per minute (Barker, 1989).

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[2]The cost of a complete satellite uplink facility, for example, typically ranges between $500,000 and $1 million.

- **Audiographics**: Most audiographic networks are small co-operatives between two to five schools. Required equipment typically includes microcomputers, speaker telephones, modems, graphics tablets, scanners, facsimile machines, an audio bridge if more than two sites form the network, and associated software. Average equipments costs *per school* range between $6,000 to $13,000 (Barker, 1989; Jordahl, 1991; Office of Technology Assessment, 1989). Users will also have to pay for long-distance tolls, unless the schools are within local calling distance. If more than three sites are linked together, they will need to either purchase or lease a conference bridge. Most audiographic networks also require access to *two separate telephone lines*— one for voice interaction between schools and one for data communication between computers or electronic chalkboards.

- **Fiber Optics**: The cost of constructing a fiber optics system is high and is usually done in partnership with a local telephone company or cooperative. The cost for equipment and installation at each site can be as high as $45,000 (Office of Technology Assessment, 1989).

- **ITFS**: The cost of an antenna and tower (depending on height of the tower) will range between $3,000 to $50,000; downconverters and electronics (depending on number needed) will range between $350 to $3,000; and voice response equipment (depending on number) will range between $2,500 to $5,000 (Office of Technology Assessment, 1989). Programming fees would be determined by the provider.

- **Satellite**: Downlink or receive dishes vary in cost depending on the type (C or Ku) and features desired. Steerable dishes that let the user aim the dish at different satellites cost three to four times as much as fixed dishes, which are aimed at a particular satellite. C-band receive dishes range from $5,000 to $10,000; Ku-band, from $800 to $5,000; and dual C/Ku-band are about $8,000 (Office of Technology Assessment, 1989). Subscription rates vary among program providers. For example, the annual subscription rate to receive TI-IN satellite courses is $5,050, courses cost $240 per student per semester, and teacher inservice courses range from $2,200 to $8,000, depending on district size (Office of Technology Assessment, 1989).

- **Microwave**: Microwave is a point-to-point system that enables *each site* to both transmit and receive signals. The cost of transmitters, receivers, and required electronics for a single channel can range from $40,000 to $65,000. Antenna costs (depending on the height of the tower needed) can vary from $5,000 to $50,000 or more (Office of Technology Assessment, 1989).

No doubt about it: distance learning *is* a costly venture. Even the lower-level systems, such as audio conferencing or audiographics, can prove to be quite expensive. Many ongoing distance learning programs and projects have been supported by state, federal, or private grants. In recent years, the costs of telecommunications and electronic components have, however, declined. In the future, experts expect costs to decline even further.

EXAMPLES OF DISTANCE LEARNING PROJECTS AND PROGRAMS

Interest in telecommunicated distance education has grown so rapidly in recent years that it is very difficult to keep current with the many projects underway or being planned in the United States. The most massive recent effort, however, is the Star Schools Program.

In September 1988, Public Law 100-297 created the Star Schools Program to expand educational opportunities for elementary and secondary school students in geographically isolated, small, and disadvantaged schools in the United States (Withrow, 1990). Since 1988, $53.8 million has been allocated from Star Schools funding for distance education projects in the United States (Krebs, 1991). The U.S. Congress' Office of Technology Assessment (1989) states in its report, *Linking for Learning: A New Course for Education*, that over 100,000 students in 3,000 schools across 45 states benefited from the first year of Star Schools funding.

Interest in and growth of distance learning is hardly confined to Star Schools projects or funding, however. Most ongoing projects are independent of Star Schools. It is true, nonetheless, that most such programs have received external funding of some sort, either to establish or maintain programming. Brief descriptions of several selected programs follow. These are only a few of the many hundreds of distance learning projects in our nation's schools.

Audio Conferencing

The telephone is a nonthreatening medium that people of all ages are familiar with. Even when dozens of people are participating in a telephone conversation through the use of voice-activated speaker phones and teleconferencing bridges, the technology is still relatively simple to use. Teachers and students at different sites can use existing telephone services to form an audio link between them. The level of interactivity can be extremely high. The students at the various sites can interact with the students at other locations, as well as with the teacher.

Rural students in the **Delaware-Chenango BOCES** of upstate New York go on "electronic field trips," using telephone audio conferencing. The students are able to talk to rock musicians, actors, scientists, and authors. A "low-tech" option such as this can be a boon to educators who are otherwise unable to attract a celebrity or an expert to their classroom (Clark, 1989; Gorton, personal communication, May 2, 1991). A similar project is being carried out by the Cooperative Education Service Agency #4's **Teleconference Network** in La Crosse, Wisconsin. More than 40 districts participate (Whisler, 1988). Other audio teleconferencing projects operate in Louisiana, where high school math and science instruction are offered, and in Tucson, Arizona, where the **Homebound/Teleteaching Program** is giving handicapped students the chance to participate in regular classes.

Audio conferencing is easy to implement and uses existing, reliable telephone technology. With a minimum amount of planning, the calls are easy to make. Each participating classroom must, of course, have the proper equipment. If the call is to be a one-on-one conversation between the teacher and a student, regular telephones are all that is necessary. If several students will be at a site, a speaker phone or a converter is needed.

A converter is a device that has microphones plugged into it. If the microphones have activating switches, background noise can be reduced by turning on the microphone only when necessary. Converters also produce better sound quality than speaker phones (Whisler, 1988).

Conference calls between three or more sites require an audio bridge in order for all of the sites to be linked together. The bridge might be an end-line bridge, owned and operated by the educational institution. Other options might be a fully automatic centralized bridge owned by the telephone company or a conference-operator bridge, through which the telephone company operator makes the various calls manually (Norenberg & Lundblad, 1987).

Audiographics Teleteaching

With an audiographics system, a teacher can transmit text or graphic materials to distant classrooms, and, through the use of audio teleconferencing, interact verbally with the distant students. All sites share the same visual reference, and audio interaction typically occurs over speaker telephones. The technique can be implemented by using several technologies. Regular telephone lines are used to deliver the graphic images via electronic blackboards or computer monitors.

Six schools in the **Beaufort County and Hyde County** school districts in North Carolina use this approach to deliver vocational classes to one another. The project was funded in 1985 with a federal grant from the Carl Perkins Vocational Education Act. The visual portion of the programming is provided by an "electronic blackboard." The electronic blackboard operates much like a regular chalkboard, except that it is pressure-sensitive. As the instructor writes or draws on the surface of the board, the image (words or figures) on the board is transmitted over a phone line to the distant classrooms, where it appears on a TV monitor (Bond, 1987).

Each classroom is equipped with an electronic blackboard and monitor, computers, a printer, a speaker, microphones, and a modem. Since each classroom has an electronic blackboard, *instruction can originate from any of the sites.* Each site in the North Carolina program also has a certified teacher, who acts as a facilitator.

The **Pennsylvania Teleteaching Project** (PTP) is a audiographics system based on personal computers (PCs). This system uses computer-generated graphics that serve essentially the same purpose as images generated on an electronic blackboard. The system requires telecommunications software in order to link the teacher with the distant students. The software also lets the teacher generate text and create computer graphics known as "slides." The slides can be transmitted from one computer to another via telephone lines. The entire system operates on a "common screen" basis. That is, whatever graphic is showing on one computer screen is showing on the others as well.

The teacher and students can use a light pen or a graphics tablet to manipulate a pointer that appears on all of the computer screens simultaneously. This feature allows a common frame of reference. If a student has a question, the instructor can simply relinquish control of the system to the appropriate site. The remote site then has the same capability to control the other computer screens, including the instructor's.

This capacity is ideal for indicating to the instructor what portion of a graphic has confused students. Verbal questions or comments between the teacher and students are transmitted over a separate audio link. Students at each participating site can monitor the audio interaction and pose questions of their own. Video (still frame) and audio interaction takes place in real time between the teacher and the students at the distant sites (Barker, 1991).

The Pennsylvania Teleteaching Project was formed in 1986 with a $526,000 grant from the Pennsylvania Department of Education. The project is managed by the Riverview Intermediate Unit in Shippenville, Pennsylvania, and is the largest state-sponsored, PC-based audiographics system in the United States. Almost 50 schools are members of the project. These are chiefly rural schools, but participating members also include several intermediate units (educational service centers) and two juvenile detention facilities. The PTP's model for PC-based audiographic networking is usually a joint arrangement between two or three high schools, which agree to share teachers and courses. As a result, local school administrators maintain direct control of the audiographics teleteacher, curriculum, programming, and scheduling (Hajdu, personal communication, May 30, 1989).

Fiber Optics or Microwave

The distance education technique that most closely resembles a traditional classroom is one that allows the teacher to see every student, and the students to see the teacher and all other students (the "two-way video, two-way audio" arrangement). Properly configured, every classroom in such a system must be a receiving, as well as a transmitting, site.

Fiber optics technology, microwave technology, and cable networks equipped with the necessary hardware are each able to provide two-way video and two-way audio interaction between all connected sites. Several cameras are necessary. Most systems have a camera focused on the teacher, an overhead camera focused on the teacher's desk (so that visuals can be displayed), and a camera focused on the students in the class at each site. In addition to the cameras, each class has TV monitors that show students at the other classes.

An example of a microwave project of this type is the **TWIT (Two-Way Instructional Television System) Network**, which links three small rural schools in Iowa. The system began operating more than ten years ago in 1980. Each school has its own tower and microwave dish that receives and transmits TV signals. Each school also has its own classroom studio complete with a portable color camera, three television monitors, two wall-mounted external speakers, two unidirectional microphones, and an audio/video switching unit (Nelson, 1985). A similar program in **Carroll County, Illinois**, joins four schools and a local cable television system. This system permits live broadcasts between the four sites (West, Robinson, & Collins, 1986).

About 50 school districts grouped in seven cooperatives are using a combination of technologies for two-way TV instruction among **several Minnesota networks**. Each cooperating district has a TV classroom with three cameras and several monitors. The signals are transmitted by cable, microwave, fiber optics, or low-power TV broadcasting. Most of the programs have been funded by the Minnesota state legislature (Whisler, 1988).

In the panhandle of Oklahoma, four small school districts began in the fall of 1988 to operate a two-way video telesystem using fiber optics. Known as the **Panhandle Share-Ed Video Network**, the system offers a variety of courses among participating schools. The four school districts formed a partnership with the Panhandle Telephone Cooperative Inc. of Guymon, Oklahoma, which installed 51 miles of fiber optic cable between the schools. A number of other schools in northwest Oklahoma have since joined the network (Barker, 1991).

Instructional Television Fixed Services (ITFS)

ITFS uses an area on the electromagnetic broadcast spectrum that is set aside by the Federal Communications Commission for the transmission of instructional and cultural programs. Transmission is carried on a point-to-point basis over a low-frequency microwave signal. A broadcast signal can cover a 15- to 20-mile radius. This radius can be increased by raising the height of the transmitting and receiving equipment, by using relay equipment, or by increasing the amount of power in the transmitted signal. Downconverters at the receive sites convert the microwave signal to one that is compatible with a standard (VHF/UHF) television.

The **InterAct Instructional Television Network**, operated by Region IV Education Service Center in Houston, Texas, uses ITFS technology to broadcast programming to 57 school districts in a seven-county area around Houston and the Texas Gulf Coast. Instructional programming is provided for K-12 classes, teacher inservice, college credit courses, and corporate personnel training (Barker, 1989).

InterAct teleteachers use two cameras while teaching a class. One camera is directed at the teacher and the other is mounted over the teacher's desk. As in other systems, the overhead camera is used to show visual aids. Over 95 percent of the students communicate with the teacher over microwave signals. These are generated by push-to-talk microphones in each classroom. In addition, a few students at some sites use dedicated phone lines to interact with the teacher. The microphone system seems to provide faster service, since there is no telephone switching equipment to go through. Audio exchanges occur in a manner similar to a citizen's band radio. Print materials are delivered to participating schools via Region IV courier service.

Direct Satellite Broadcasts

Satellite systems provide one-way video, two-way audio interaction. Students can see and hear the teacher and can hear students at other sites, but they cannot see the other students. The teleteacher cannot see students. Audio communication takes place over telephone lines.

TI-IN is a private satellite network founded in 1984 and headquartered in San Antonio, Texas. It is the largest private instructional satellite system in the United States, and it delivers high school credit, enrichment, staff development, and college-level courses to schools. In 1990, nearly 6,000 students in over 1,000 school districts across 39 states received TI-IN programming. The network has received $9.8 million in federal Star Schools funding (Pease, 1991). Broadcast signals can be received in either a Ku- or C-band frequency. High school classes are broadcast five days per week to subscribing schools.

The Arts and Sciences Teleconferencing System at Oklahoma State University was also a first-round recipient of Star Schools funding as part of the Midlands Consortium Star Schools Project ($9.6 million). The system broadcasts on a C-band signal. Most high school classes are broadcast either two or three days per week, with other days devoted to in-class problem-solving and computer simulations at local site schools. In 1990, the system broadcast courses to more than 500 schools in 42 states (Holt, 1991; Jordahl, 1991).

The **Satellite Telecommunications Educational Programming Network** is a second-round recipient of Star Schools monies ($5 million). Instruction originates from broadcast studios in Spokane, Washington. High school credit courses are transmitted four days per week. Fridays are reserved for students to work on assignments and exams (Barker, 1991).

The **Kentucky Star Channels Network** has been described as one of the nation's most ambitious educational satellite TV systems (Jordahl, 1991). Educational programming is beamed from a communications center in Lexington to 1,300 elementary and secondary schools in the state. Star Channels was initiated in 1986 with an $11.4 million appropriation from the Kentucky state legislature (Tassie, 1991). In addition to audio communication over telephone lines, students at receiving sites also use interactive key pads. When the teacher asks a questions, students enter answers on their key pads. Answers are transmitted into a computer at the teacher's studio, where they are automatically compiled and displayed so the teacher can see how well students understand the lesson concepts (Webb, 1990).

Besides these, several other providers are using satellite technology to deliver K-12 instruction throughout the United States. A few of these producers include **SciStar**, a program focusing on science programs originating from Avon, Connecticut; **Satellite Education Resources Consortium** (SERC), a multistate collaboration of state departments of education, local school districts, state and local television entities, university educators, and private industry; and the **Public Broadcasting Service's (PBS) Elementary/Secondary Service**, which offers satellite-delivered instruction for classroom use in grades K-12.

In addition to these, new satellite providers are continually entering the marketplace. In each case, satellite technology permits one-way video (full-motion), two-way audio interaction. The student talk-back is via telephone lines.

How effectively do students learn when involved in distance education courses? In-depth evaluations of K-12 distance education are, so far, rare. The available literature consists mostly of case studies and opinions (Moore, Thompson, Quigley, Clark, & Goff, 1990). More rigorous evaluations are clearly needed.

Research Findings on Regular Instructional Television

Although literature on K-12 distance learning programs is scant, research on instructional television has been conducted over a period of many years. While such instruction takes place in a "one-way delivery mode"—which precludes live interaction between students and teachers—findings do relate to distance learning effectiveness in general. In a thorough review of the literature on one-way instructional television, Whittington (1987, pp. 54-55) concluded:

1. Compara studies indicate that students taking courses via television achieve, in most cases, as well as students taking courses via traditional methods.

2. Findings of equivalent student achievement hold, even when rigorous methodological research standards are applied.

3. Television is a technological device for transmitting communication and has no intrinsic effect, for good or ill, on student achievement.

4. Effective instructional design and techniques are the crucial elements in student achievement whether instruction is delivered by television or by traditional means.

5. National producers and founders of telecourses employ rigorous standards and procedures to create academically

acceptable products that will withstand the critical scrutiny of scholars.

Some studies on the effectiveness of instructional television and their findings have been viewed with skepticism, particularly those that claim that televised instruction is superior to traditional instruction (Salomon & Clark, 1977; Clark, 1983). Clark (1983) suggested that many of the researchers had a vested interest in the technologies being studied. Also, our society has tended to accept the claims of instructional technologists because of our high expectations for technology of all kinds.

Research on K-12 Distance Learning

Although the research base on K-12 distance learning is still limited, the Office of Technology Assessment (1989) cites several studies of interactive distance learning programs in Iowa and Minnesota. This research reported no significant differences in student achievement between distance learning delivery and traditional instruction.

In the spring of 1986, 30 principals from different TI-IN Network subscribing schools responded to a 20-item questionnaire designed to document user satisfaction with the system. Eighty-two percent of the principals felt that satellite courses had become an integral part of their school's curriculum and would be used the following year. Most felt that the TI-IN Network service was worth the money. Overall, principals were very positive in their view of the satellite courses (Barker, 1987).

In its first year of operation, the TI-IN staff conducted a survey of students who had taken courses during the first semester. At the time, 330 students had been enrolled in TI-IN courses, most of them enrolled in upper division courses. Sixty percent of the students reported that their final grade was the same, if not better, than the grade they would have expected in a traditional classroom (Pease & Tinsley, 1986). A later evaluation conducted by the Texas Education Agency determined that there was no significant difference between student performance in a TI-IN classroom and a traditional classroom (Pease & Kitchen, 1987).

A more comprehensive study of satellite instruction was initiated in May 1988 of Oklahoma State University's Arts and Sciences Teleconferencing Service (ASTS). Sponsored by the Mid-continent Regional Educational Laboratory and the University of Missouri's Department of Agricultural Economics, the study surveyed 21 secondary schools in Missouri and North Dakota that were subscribing to ASTS's German I by Satellite course. The researchers were interested in student success as measured by student test scores, whether or not students would enroll in another satellite class, student perceptions of content learned, and student perceptions of whether improvements were needed in the class (Hobbs & Osburn, 1988). At the end of the first semester, 80 percent of the students had earned an "A" or a "B" in the course. On the National Association of Teachers of German Level 1 Test, the only standardized normed test available for the subject, 40 percent of the high school students performed nearly as well as a group of college students at the University of Colorado-Boulder who had just completed their first semester of German in a traditional setting. Fifty-four percent of the high school students said that they would enroll in another satellite course. Forty-six percent felt that they had learned an acceptable amount, while the remainder did not feel that they had learned as much as they should have. Fifty-seven percent of the students felt that the course could be improved.

In a study conducted by Patrick (1989), 21 hours of instructional programming delivered by the TI-IN Network were transcribed and analyzed in order to determine whether or not teachers using the medium displayed effective teaching characteristics. The study involved three instructors, each of them teaching a total of seven hours. Neither the students nor the instructors were aware that the study was taking place. Close examination of the transcripts revealed evidence of several effective teaching practices being carried out.

In this study, all three teachers were interacting with their students. All three used advance organizers and content reviews during every class that was observed. Each informed their students about what was expected of them several times during class. All three demonstrated effective questioning techniques, using a good mix of high-level and low-level questions. Each of the instructors gave students an adequate amount of time to answer questions before offering prompts.

Once a question had been answered, all of the instructors under observation praised the students or provided corrective feedback appropriately.

The three teachers also appeared to have established good rapport with their students. Each of them displayed a genuine interest in their students' affairs—not only with classroom matters, but with other matters as well. The teachers' interest extended to sports activities between schools, the achievements of individual students, recreational activities in the local community, and so forth. Two of the teachers were usually able to recognize their students' voices and frequently called them by name. This projected a personalizing touch, which promoted a good teacher-student relationship (Patrick, 1989).

A study of the interactive Carroll Instructional Television Consortium in Carroll County, Illinois, reported that student achievement in interactive TV classes was similiar to that in traditional classes. The study involved 183 students in three schools studying Spanish and French (Robinson & West, 1986, 1987).

Finally, studies of cost effectiveness suggest that distance learning is cost-effective when compared with traditional approaches to instruction. Savings occur on travel and employee time (Moore et. al., 1990; Office of Technology Assessment, 1989). As noted previously, however, the best way to lower costs per learner (students, staff, and community members) is to make the widest possible use of whatever system you adopt.

The capabilities of the technologies reviewed in this handbook differ—in some cases, significantly. There are definite advantages and disadvantages associated with each technology currently being used. In the same respect, there are differences in program practices between program providers using the same or similar technologies.

Some of the advantages and disadvantages of three of the more popular technologies—satellite delivery, audiographics delivery, and two-way full-motion TV delivery (via fiber optics, microwave, or cable)—are listed in the following section. The lists have been compiled from the perspective of K-12 instruction. They are intended to provoke thought and are by no means exhaustive (Barker, 1991).

Advantages of Satellite TV Teaching

- Students can *see the teacher.*
- *Full-motion* video exists.
- Teacher-student *audio interaction* is possible.
- *Real-time print distribution* of instructional materials is possible with most systems. That is, the teacher at the host site can activate a printer at the respective remote sites to deliver handouts, tests, and assignments.
- Satellite signals are *not sensitive to distance*—large geographical areas and many remote sites can be covered simultaneously, defraying costs among a large number of users. The larger the system, the lower the transmission cost.
- Most satellite systems are *"turn-key" operations.* Program offerings, scheduling, instruction, grading of students, distribution of materials, and so forth are provided by the vendor.

- Satellite programming is the most widely known distance learning technology. Because of its *notoriety*, it is often easier to get local boards and decisionmakers to release funds to implement distance learning. Satellite programs also have a good track record for receiving federal and state funds.

Disadvantages of Satellite TV Teaching

- Program *offerings are centralized*, thereby limiting control by local districts. This feature may result in loss of local control of teaching and interpretation of the curriculum by local education agencies.

- *The TV teacher cannot see the students.* Satellite technology incorporates one-way video, two-way audio interactions (via phone connection) between students and teacher.

- Students at receiving sites *cannot see their fellow students* at other sites. Nor are they able, in most cases, to freely interact via audio with their counterparts.

- Telephone contact during class is *not immediate*. Unless previously on-line with the classroom studio, students must dial the studio and await response from the teacher. This "hassle" prevents some students from calling in. It is not unusual for students to initiate a call and find that the line is busy with other students (at different sites) also calling in.

- An *audio "echo"* is often inherent in student talk-back through the TV system when telephoning to interact with the TV teacher. Interference from florescent lights in some receiving classrooms can also cause "noise" during the audio connection by telephone.

- Some receive dishes (Ku band) are *weather sensitive*— during heavy rains, snow, or dust storms, the signal can be lost. Signal interruption can also result from both Ku- and C-band reception during periods of *"sun outages."* This occurs intermittently for a few minutes over several days every six months when the orbiting satellite's TV-transmitted signals are aligned directly with the sun.

- The potential exists for *large class size.* It is not unusual to have a class with 200 to 300 students or more. Some vendors currently offering satellite courses have classes with as many as 1,000 students. Large class size severely limits opportunities for teacher-student interaction. Furthermore, most rural schools cherish a tradition of small classes.

- Student-to-student *interaction between different sites is extremely limited* at best, or nonexistent at worst. The technology does not allow students to see each other at different sites. They can only hear or interact with each other if more than one site is connected at the same time via telephone with the classroom studio. Most systems have a limited number of telephone lines (4-6) that can be "tied in" with the classroom studio simultaneously. In terms of interaction, the technology chiefly promotes teacher-student interaction, not student-to-student interaction between sites.

- In addition to start-up *costs* for a satellite dish and other appropriate receiving equipment, the school must pay an annual subscription fee (often several thousand dollars) to the satellite vendor in order to receive continued programming.

- Bell *scheduling conflicts*, time zone differences, differences in dates for scheduling spring breaks, holidays, and so forth often conflict with local school schedules and are not easy to resolve.

Audiographic Teleteaching Advantages

- Local schools *maintain control* of the master teacher, programming, and scheduling. Because the network is typically small, locally controlled changes—for example, in selection of a teacher, program offerings, and scheduling—are easy to make.

- *Small class size is guaranteed.* This type of technology does not permit linkage with more than a few sites simultaneously.

- The system supports *student-to-student interaction* between sites, in addition to teacher-student interaction. The speaker telephones act much like an "open" microphone. Once the classes are connected, students in one location can speak at will to their teacher or to other students in another location. Telephone links don't have to be re-established each time a student wishes to ask a question or make a comment.

- Hardware, software, and maintenance *costs are low*. Start-up costs for an individual school to participate fully in an audiographics cooperative network range between $6,000 to $13,000. The actual costs depend on software and equipment requirements, which can vary between systems. There is usually no annual subscription fee for courses, as with most satellite or microwave distance learning courses. The ongoing operation costs are usually limited to the telephone charges involved (monthly fees and toll charges, if any).

- An audiographics system is relatively *simple to learn and to operate*. Learning to use and operate an audiographics teleteaching system does not require extensive technical knowledge or training on the part of the user. Most teachers who know how to use a microcomputer for word processing can quickly learn the skills and technique necessary to successfully operate an audiographics system.

- Any participating site can serve in either a "receive" or a "transmit" mode. Hence, *instruction can come from any participating site*. Therefore, each school on the network can offer courses electronically, as well as receive them.

- The computer- or electronic chalkboard-generated visuals can be activated and accessed by the teacher, as well as any student at any remote site. *Control of the system can be switched* from one site to another in a matter of one to two seconds. This allows for *high levels of interaction* between teacher and students.

- *Instructional content* is focused more on the organization of the material than on the personality of the teacher. Students at distant sites do not see the teacher. A common visual reference is shared on the computer screen, and students and teachers freely interact orally via the speaker telephone. Hence, the charisma or personality of the teacher seems to be less of a factor in learning than is the content.

- The network operates over *regular telephone lines*. Therefore, linkages between distant sites can easily be made almost anywhere in the world.

Audiographic Teleteaching Disadvantages

- *Motion is not possible.* Display of visuals on the computer screen is in a still-picture or freeze-frame mode.

- The instructor *cannot see the student*, nor can students see the instructor or other students at distant sites. The teacher and students at each site all share a common computer- or electronic chalkboard-generated graphic on their respective computer screens, but they do not see each other.

- *Loss of transmission connection* occasionally occurs. Extraneous noise or interference on the telephone lines can cause voice transmission on the speaker telephones to occasionally "break up," resulting in a loss of transmission or disconnection.

- The video graphics *image is limited in size* to the size of the computer screen, unless additional hardware is added. Additional hardware may include a large TV monitor (for example, with a 25-inch screen) or use of an Liquid Crystal Diode (LCD) projector ("plasma display screen," used in tandem with a conventional overhead projector) to project the computer image onto a screen or wall.

- *Lesson planning is time-consuming* for the teacher (creating computer visuals). In addition, floppy disks used to store the slides created for each lesson must be distributed to all remote sites and loaded into networked computers prior to transmission of a lesson.

- Transmission costs for telephone *toll charges* can become excessive. Most current audiographic networks operate on two separate telephone lines—one for computer connection and one for speaker phone connection. Unless distance sites have access to WATS lines or other lower cost carriers, telephone toll costs can become burdensome.

- Audiographics is *not a "turn-key" operation.* Managing a computer teleteaching network or electronic chalkboard system requires a commitment by local school administrators. Teachers need training in order to adapt instructional techniques to the audiographics format and they need extra time to prepare materials to transmit over the system. By contrast, many satellite and microwave TV systems are administered in a distant location separate from the local school, thereby requiring very limited oversight.

Two-way TV (Fiber Optics, Some Microwave and Cable Systems) Advantages

- *Two-way, full-motion video* is possible among *all sites.* Students can see the teacher, as well as see and hear other students at all sites. The teacher can see and hear all students at all sites.

- Most systems presently in operation are small networks that promote *local control* of the teacher and the curriculum, and generally maintain *small class size.*

- Open-line microphones allow for *full interaction* (teacher-student and student-to-student). That is, students can interact audibly not only with the TV teacher, but also with students at other sites. Furthermore, *audio interaction is immediate*; no telephone dialing is required because open-line microphones are used for the audio.

- Most signals over current media are *not affected by weather.*

- Any site on the network can *serve as the host classroom.*

There is *no* designated studio or host classroom. Instruction can originate from any participating site, and the teacher can travel to any of the classrooms and broadcast from there to all sites.

- Unless required by law, the presence of an adult or classroom *facilitator at remote sites is typically not necessary*. Because of the two-way video aspect of such systems, the distant teacher is able to see and monitor student behavior.

Two-way TV (Fiber Optics, Some Microwave and Cable Systems) Disadvantages

- Cable (used as an extra broadcast channel for distance education) is still *not available in many rural areas.*
- Fiber optics is still *not available in many rural communities*, although it is slowly becoming more common. In addition, lines are very expensive to lay and to install.
- Virtually all successful two-way interactive TV systems are founded on a partnership of school and businesses in the local area. The *human and financial capital* needed for a partnership like this are not accessible to many rural areas.
- Most systems require a *large capital investment* to pay for start-up costs.
- The technology *does best as a small network.* Linking more than about ten sites together makes for a costly system. In addition, the addition of each participating site (above the typical configuration of three to five sites) makes it increasingly difficult to maintain the two-way "visibility" among all sites that is the strength of such systems.

THE DILEMMA OF SMALL AND LARGE: TECHNOLOGICAL OPTIONS

Traditionally, small schools have had a lot to offer their students—in particular, small classes and personalized attention from teachers. Such advantages become disadvantages, however, when the issue at hand is the cost-effectiveness of hiring teachers qualified to deliver advanced courses. Many times, small schools in remote or isolated locations have not been able *to find* such teachers, even when they could *pay them.*

Obviously, college-bound students in rural and small schools would benefit by taking "advanced" subjects like physics, chemistry, computer science, calculus, differential equations, or a variety of foreign languages. Obviously, faculty and administrators would benefit from easier access to education courses and inservice training. Obviously, community members would benefit from access to special courses on a range of topics.

Unfortunately, several features of rural location have worked against these "obvious" needs: low student enrollment, occasional demand for specialized courses, geographical isolation, and a shortage of qualified teachers. Expectations are changing, however, and—often as the result of state-level reform—administrators in small and rural schools face the challenge of providing a full range of course offerings to their students. Better incentives for forming closer links to the community and for providing staff development opportunities are also beginning to affect rural schools more strongly than ever before.

But, until recently, ways to address the traditional predicament in which rural schools continue to exist were limited. Strategies like correspondence study and school district consolidation were common. Far from ideal, such "alternatives" were often simply dictated by one kind of necessity or another.

Today, however, improved communications media make it increasingly easy to stage instructionally useful events over geographically forbidding distances. The technology of distance learning is no longer the exotic creature it was just five years ago. Existing networks will expand and new projects will be established in future years.

Distance education in its many forms will probably benefit students and educators throughout rural America in the years to come. Distance learning technologies and programs are reaching out to diverse audiences and providing increased opportunities for educational growth and advancement in many communities in rural America.

Current practice suggests that successful programs come in many different forms. As a result, there is no "one-best" method or "most promising" approach for distance learning. Disadvantages of one method are the advantages of another; moreover, the advantages of using one system in one school can actually be disadvantages elsewhere.

Thus, distance education is not an educational panacea. We are learning that good teaching can take place under many circumstances—distance education is but one.

You should give careful thought to the type of system or program that best meets local needs. It is a question of ends and means. What are you after? Why? What are the options? Which make sense?

Ask yourself these basic questions before making a decision to use distance education at all, before you join a distance learning program already up and running, or before you decide to form a network with area schools.

Lloyd (1988, p. 20) has some more specific advice:

> There are several factors that need to be considered in looking at the potential of alternative distance learning programs: curriculum benefits, teacher response, and community acceptance. How can such a system benefit the curricula of the members of an education technology cooperative? Will the distance learning be used to help schools meet state graduation requirements? Or will the system help expand the variety of curriculum offerings for all students? How do the teachers feel about the supplemental distance learning programs? Are they adequately prepared to use the technology-based systems effectively in inservice programs particularly designed for teachers? Where can effective inservice programs be found? These questions are important, because the answers can mean the difference between a distance learning

project that is merely functional or one that is far-reaching and dynamic.

The concept of distance education has captured the attention of many local, state, and national officials. Distance learning programs and technologies have brought rural and small school districts new ways to coordinate schedules and to share resources for the benefit of student, staff, and community.

In geographically remote and isolated schools, instruction via some form of telecommunicated distance learning may indeed be the "next best thing to being there." In many cases, it will have clear advantages over some of the more traditional alternatives.

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Pease, P., & Tinsley, P. (1986, October). *Reaching rural schools using an interactive satellite-based educational network: Evaluating TI-IN network's first year.* Paper presented at the annual meeting of the National Rural and Small Schools Consortium, Bellingham, WA. (ERIC Document Reproduction Service No. ED 281 681)

Robinson, R., & West, P. (1986). *Interactive cable television: An evaluation study.* Paper presented at the annual meeting of the Association for Educational Communications and Technology, Las Vegas, NV. (ERIC Document Reproduction Service No. ED 267 789)

Robinson, R., & West, P. (1987). *Carroll instructional television* (Fourth Year Evaluation Report). DeKalb, IL: Northern Illinois University.

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APPENDICES

APPENDIX A: BRIEF ANNOTATED BIBLIOGRAPHY

Appendix A is an annotated bibliography of 35 documents about distance education, most of them recently added to the ERIC database. The documents appear in six categories:

(1) how-to manuals and guides,

(2) resources,

(3) critique and analysis,

(4) evaluation,

(5) policy, and

(6) program descriptions and application issues.

Placing an EDRS Order

You can easily order copies of any of these resources from the ERIC Document Reproduction Service (EDRS) in Springfield, Virginia. The most important information for ordering is *the EDRS Price (number of pages in the document)* and *the ERIC Document Reproduction Service Number (ED #)*. This information appears in boldface type in the bibliography that follows.

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- Finally, if you are really *in a hurry*, EDRS can FAX the document to you for a modest additional charge.

As of this writing, paper copies are priced per 25-page unit (or part thereof) for each title (plus postage). The current price for each 25-page unit is $3.12. Microfiche copies are currently priced at $1.15 for the first 5 microfiche per title and $.25 for each additional microfiche for that title (plus postage).

The price of the first document listed below, for example, is 4 x $3.12 in paper copy ($12.48 plus postage) or 1 x $1.15 in microfiche copy ($1.15 plus postage).

How-to Manuals and Guides

Adams, J., Fjelstad, D., Scott, G., Persson, M., Liker, S., Miller, L., & Mohr, G. (1987). *Satellite receiving station handbook for rural school districts.* Chetek, WI: Chetek School District. (ERIC Document Reproduction Service No. **ED 306 063**)

Handbook developed to help rural school districts purchase, install, and use a satellite receiving station to improve the quality of education. Includes four appendices. **EDRS Price: MF01/PC04 Plus Postage (100pp).**

Earl, A. (1989, September). *Design of a telecourse: From registration to final exam.* Paper presented at the Annual Conference on Emerging Technologies in Education and Training, August, ME. (ERIC Document Reproduction Service No. **ED 317 182**)

Outlines four uses of (postsecondary) telecourses and describes three different options for telecourse design. Presents technical recommendations for developing course. Also treats implementation and evaluation issues. Includes checklist—decisionmaking aid for professors—keyed to text.
EDRS Price: MF01/PC02 Plus Postage (42pp).

Meacham, D., & Evans, D. (1989). *Distance education: The design of study materials* (Fifth Edition). Wagga Wagga, Australia: Charles Sturt University-Riverina, Distance Education Centre. (ERIC Document Reproduction Service No. **ED 321 754**)

Guide for the effective design of instructional materials for distance education. Explains model of instruction used, course design features, and features relevant to student learning and motivation.
EDRS Price: MF01/PC04 Plus Postage (83pp).

Resources

Burruss, B. (Comp.). (1990). *Resources for telecourses: A reference list* (Updated). Cupertino, CA: De Anza College. (ERIC Document Reproduction Service No. **ED 325 103**)

Provides information on the dissemination and practice of distance education, access to programs and agencies concerned with distance learning and telecourses, and bibliographic citations for evaluation studies that have researched the effectiveness of telecourses as instructional tools. Nine sections include information on organizations and vendors, telecourse and videotape availability, print resources, and conferences and associations.
EDRS Price: MF01/PC01 Plus Postage (18pp).

Holmberg, B. (1990). *A bibliography of writings on distance education.* Hagen, West Germany: FernUniversitat. (ERIC Document Reproduction Service No. **ED 326 738**)

Extensive bibliography (in English) of over 1,400 publications, primarily from the 1960s, 1970s, and 1980s. English-language works predominate. Works arranged in two lists: by author and by subject.
EDRS Price: MF01/PC11 Plus Postage (257pp).

Critique and Analysis

Barker, B. (1989, May). *Distance education technologies: All that glitters is not gold.* Paper presented at the Annual Meeting of the Decisions about Technology Conference, Bismarck, ND. (ERIC Document Reproduction Service No. **ED 309 894**)

Discusses the rise of telecommunicated distance education in the United States. Includes a list of eight successful distance education practices, ranging from careful planning to a reminder that course content, not the medium, is most important to the overall success of a program.
EDRS Price: MF01/PC01 Plus Postage (12pp).

Campion, M. (1986). *Distance education, efficiency, and scientific management: Some doubts* (ESTR Occasional Paper Number 12). Western Australia: Murdoch University. (ERIC Document Reproduction Service No. **ED 318 911**)

Critiques role of efficiency in distance education as resembling those of "scientific management." Questions appropriateness given the importance of students' contributions in face-to-face instructional settings. Notes that differing political commitments generate differing standards and measures of efficiency.
EDRS Price: MF01/PC01 Plus Postage (24pp).

Hobbs, D. (1985, August). *Bridging, linking, networking the gap: Uses of instructional technology in small rural schools* Paper presented at the National Rural Education Forum, Kansas City, MO. Washington, DC: U. S. Department of Education. (ERIC Document Reproduction Service No. **ED 258 786**)

Maintains that use of distance learning depends upon whether the technology can be tried first on a small scale, has compatability with existing behaviors and practices, is simple, has low cost and high effectiveness, and has a support system.
EDRS Price: MF01/PC02 Plus Postage (33pp).

Holmberg, B. (1990). *Perspectives of research on distance education* (2nd Updated and Expanded Edition). Hagen, West Germany: FernUniversitat. (ERIC Document Reproduction Service No. **ED 325 633**)

Updated overview (in English) of distance education research and a survey of some important trends in the history of this research. Includes information on rationales for use,

types of students best suited to distance education, programming considerations, administration, and history. Also includes 26 pages of references.
EDRS Price: MF01/PC02 Plus Postage (40pp).

Otterman, L., & Pease, P. (1989). *The role of private business in distance learning: The educational partnership.* San Antonio, TX: TI-IN Network, Inc. (ERIC Document Reproduction Service No. **ED 327 144**)

Explains private corporation's role in developing and executing educational partnerships to serve elementary and secondary schools, including impact on distance learning. Outlines critical needs and speculates on future. Includes 25 references.
EDRS Price: MF01/PC02 Plus Postage (28pp).

Evaluation

Barker, B. (1987, January). *An evaluation of interactive satellite television as a delivery system for high school instruction.* Paper presented at the Annual Meeting of the Southwest Educational Research Association, Dallas, TX. (ERIC Document Reproduction Service No. **ED 277 534**)

Presents results of a survey of 30 high school principals and 159 high school students who used the TI-IN Network. Lists strengths and weaknesses as reported by respondents.
EDRS Price: MF01/PC01 Plus Postage (14pp).

Barker, B., & Patrick, K. (1988, September). *Teacher effectiveness via interactive satellite: Preliminary findings from observation of three teachers over the TI-IN interactive satellite network.* Paper presented at the Annual Conference of the National Rural Education Association, Bismarck, ND. (ERIC Document Reproduction Service No. **ED 303 295**)

Examines effectiveness of instruction delivered by satellite on the TI-IN Network. Includes 20 references.
EDRS Price: MF01/PC01 Plus Postage (20pp).

Blanchard, W. (1989). *Telecourse effectiveness: A research-review update.* (ERIC Document Reproduction Service No. **ED 320 554**)

Reviews research from summer 1986 through fall 1989. Reports that telecourses are as effective as regular courses, are superior to correspondance courses, have improved access to courses, and provide rigor when well-produced. Concludes that effectiveness is not an issue per se, but that instructional and organizational planning is.
EDRS Price: MF01/PC01 Plus Postage (7pp).

Egan, M. (1988, April). *Two-way interactive television instruction: Comparative studies of instructional effectiveness in three rural/remote special education courses.* Paper presented at the Annual Meeting of the American Council on Rural Special Education, Arlington, VA. (ERIC Document Reproduction Service No. **ED 299 729**)

Examines effectiveness of three two-way interactive television courses offered by the University of Utah.
EDRS Price: MF01/PC01 Plus Postage (20pp).

Galvin, P., & Bruce, R. (1987). *Technology and rural education: The case of audiographic telecommunications.* Ithaca, NY: Cornell University. (ERIC Document Reproduction Service No. **ED 307 072**)

Reports results of a case-study evaluation of high school courses delivered by audiographic medium. Concludes that future of such programs depends more on administrative issues than on technical capabilities of audiographics.
EDRS Price: MF01/PC04 Plus Postage (82pp).

Hobbs, V. (1990). *Distance learning in North Dakota: A cross-technology study of the schools, administrators, coordinators, instructors, and students (two-way interactive television, audiographic tele-learning, [and] instruction by satellite).* Denver, CO: Mid-continent Regional Educational Laboratory. (ERIC Document Reproduction Service No. **ED 328 225**)

Reports comparative study of North Dakota student achievement across three forms of distance education. Includes data on attitudes and implementation, and rec. mendations for adopters.
EDRS Price: MF01/PC05 Plus Postage (103pp).

Nowakowski, J., Faase, T., Hoke, G., Gooler, D., & Schwandt, T. (1988). *Wisconsin Rural Reading Improvement Project 1987-1988* (Evaluation Summary). Elmhurst, IL: North Central Regional Educational Laboratory. (ERIC Document Reproduction Service No. **ED 325 835**)

Evaluates innovative staff development program on "strategic reading." One of the four sections evaluates the role of distance education in this effort.
EDRS Price: MF01/PC01 Plus Postage (20pp).

Riddle, J. (1990, October). *Measuring affective change: Students in a distance education class.* Paper presented at the Annual Meeting of the Northern Rocky Mountain Educational Research Association, Greeley, CO. (ERIC Document Reproduction Service No. **ED 325 514**)

Describes Western Institute for Distance Education (WIDE) system to deliver education courses so that 98% of the state's population will be within 60 miles of distance education receiving sites. Discusses positive changes in student attitudes to distance education in one course. Recommends ways to help students adapt to distance education courses.
EDRS Price: MF01/PC01 Plus Postage (10pp).

Sponder, B. (1990). *Distance education in rural Alaska: An overview of teaching and learning practices in audioconference courses* (University of Alaska Monograph Series in Distance Education No. 1). Fairbanks, AK: Center for Cross-Cultural Studies. (ERIC Document Reproduction Service No. **ED 325 276**)

Examines the effectiveness of university-level audioconference courses and distance education in Alaska. Includes 44 references and appendices.
EDRS Price: MF01/PC06 Plus Postage (139pp).

Policy

Bradshaw, D., & Brown, P. (1989). *The promise of distance learning* (Policy Briefs Number Eight). San Francisco, CA:

Far West Laboratory for Educational Research and Development. (ERIC Document Reproduction Service No. **ED 323 909**)

Examines need for distance learning, promising technology, cost-effectiveness, projects, and policy implementation. Reports current applications of distance education in Arizona, California, Nevada, and Utah.
EDRS Price: MF01/PC01 Plus Postage (15pp).

Chow, S., Nelson, L., & Bradshaw, D. (1989). *A study of distance learning technology in Utah: A statewide overview.* San Francisco, CA: Far West Laboratory for Educational Research and Development. (ERIC Document Reproduction Service No. **ED 322 899**)

Includes statewide and district-by-district assessments, including information about costs. Concludes that science, math, and foreign languages (elementary school level) and advanced placement courses (high school level) are best candidates for distance learning applications. Appendices include data, discussion guide, and evaluation forms.
EDRS Price: MF01/PC03 Plus Postage (64pp).

Hansen, K. (1987). *Distance education and the small school: Policy issues* (Paper prepared for the Chief State School Officers of the Northwest and Pacific). Portland, OR: Northwest Regional Educational Laboratory. (ERIC Document Reproduction Service No. **ED 287 637**)

Discusses development of policy to support distance education. Local and state educational agencies require sound and informed policy ch[illegible]s, and they should also develop policy in cooperation with one another.
EDRS Price: MF01/PC01 Plus Postage (18pp).

Holznagel, D., & Olson, T. (1990). *A study of distance education policies in state education agencies.* Portland, OR: Northwest Regional Educational Laboratory. (ERIC Document Reproduction Service No. **ED 319 402**)

Identifies the current status of state policies on distance education in a sample of states and identifies changes in

federal, state, and local roles in developing policies for better use of technology for distance learning. Identifies certification, training, evaluation, planning, and funding as important issues. Includes information on eight statewide plans.
EDRS Price: MF01/PC02 Plus Postage (35pp).

Program Descriptions and Application Issues

Burton, L. (1989). *Communication technology for rural communities. A qualitative study of rural communities, northeastern Washington state* (Summary Report). Master's Thesis, Washington State University. (ERIC Document Reproduction Service No. **ED 325 296**)

Examines the perceptions of rural Washington community leaders about community information needs and role of communications technology. Reports success factors for rural information network. Notes positive reception to expansion of telecommunications programs and services in rural areas and optimism that it can help solve some rural community problems.
EDRS Price: MF01/PC01 Plus Postage (21pp).

Delaware-Chenango Board of Cooperative Educational Services. (1989). *Summer telelearning for academic renewal: A team-taught audiographic distance learning program for at-risk eighth graders.* Norwich, NY: Author, Telelearning Project. (ERIC Document Reproduction Service No. **ED 317 205**)

Describes Summer Telelearning for Academic Renewal (STAR) program, aimed at reducing risk of dropping out among at-risk eighth graders. Includes evaluation data and recommendations for program improvement.
EDRS Price: MF01/PC01 Plus Postage (23pp).

Everett, C., & Pershing, J. (1989). *Distance education and its applications for vocational education* (A VES Monograph). Bloomington, IN: Indiana University, Vocational Education Services. (ERIC Document Reproduction Service No. **ED 324 522**)

Provides policymakers and administrators an overview of distance education principles, technology, and application in context of vocational education. Presents program examples from Australia, Colorado, Oregon, and Texas. Includes descriptions of four program models and glossary.
EDRS Price: MF01/PC03 Plus Postage (53pp).

Gunawardena, C. (1988). *Using communications technologies for distance education: Report on current practices in the United States.* (ERIC Document Reproduction Service No. **ED 327 147**)

Reports results of survey of 70 postsecondary institutions. Noninteractive distance programs most common. Describes most helpful student support services.
EDRS Price: MF01/PC03 Plus Postage (71pp).

Holznagel, D. (1988). *Distance education: Promise, practice, and pedagogy* (Program Report). Portland, OR: Northwest Regional Educational Laboratory. (ERIC Document Reproduction Service No. **ED 308 052**)

Describes distance education projects in Northwest conducted in first year of Rural Education Initiative (sponsored by U. S. Department of Education). Describes eight programs.
EDRS Price: MF01/PC01 Plus Postage (10pp).

Kerwood, R., & Starsen, M. (1988). *Should we cheat the rural vocational education student? Model programs for rural vocational education.* Flagstaff, AZ: Northern Arizona University. (ERIC Document Reproduction Service No. **ED 300 573**)

Feasibility study to determine how best to serve the needs of rural vocational education students in Arizona. Considered 12 methods of ensuring quality (including many distance education formats). Concludes that it is cheaper to transport information than people.
EDRS Price: MF01/PC03 Plus Postage (51pp).

LeBaron, J. (1989). *Kids Interactive Telecommunications Project by Satellite (KITES): A telecommunications partner-*

ship to empower middle school students. (ERIC Document Reproduction Service No. **ED 315 032**)

Describes Kids Interactive Telecommunications Project by Satellite (KITES), a cooperative international telecommunications partnership. KITES establishes interactive video link between eighth grade students in Lowell (MA) and peers in Karlsruhe, West Germany. Includes evaluation data and recommendatins for improving program.
EDRS Price: MF01/PC01 Plus Postage (5pp).

Ming, M. (1988). *Telephone-tutoring in distance education.* (ERIC Document Reproduction Service No. **ED 316 194**)

Describes program to use telephone to increase completion rate in traditional correspondence courses. Program uses four features to achieve aims. Evaluation data show aims met. Appendix provides contact information.
EDRS Price: MF01/PC01 Plus Postage (9pp).

Odasz, F. (Comp.). (1990). *Big Sky Telegraph: Telecommunications guide to community action.* (ERIC Document Reproduction Service No. **ED 323 049**)

Describes Big Sky Telegraph, a Montana-based telecommunications network serving rural economic development organizations.
EDRS Price: MF01/PC07 Plus Postage (152pp).

Pease, P., & Kitchen, L. (1987, March). *Meeting the needs of rural special education in the information age: Using TI-IN Network's interactive satellite-based educational network.* Paper presented at the Annual Meeting of the American Council on Rural Special Education, Asheville, NC. (ERIC Document Reproduction Service No. **ED 295 351**)

Describes TI-IN Network inservice programming for special education and reports evaluation results (Texas State Education Agency). Also describes programming for special education students (gifted and handicapped).
EDRS Price: MF01/PC01 Plus Postage (14pp).

Thurston, L. (1990, June). *Girls, computers, and amber waves of grain: Computer equity programming for rural teachers.*

Paper presented at the Annual Conference of the National Women's Studies Association, Towson, MD. (ERIC Document Reproduction Service No. **ED 319 660**)

Describes program to increase gender equity in computer-based education, including telecommunications, among middle-school and upper-elementary students. Includes evaluation results.
EDRS Price: MF01/PC01 Plus Postage (18pp).

Verma, S., Land, J., Thomas, T., Trott, J., & McCameron, F. (1989, October). *Potential of audiographic computerized telelearning for distance extension education.* Paper presented at the Annual Meeting of the American Evaluation Association, San Francisco, CA. (ERIC Document Reproduction Service No. **ED 317 199**)

Describes characteristics of audiographic systems, exemplary programs (postsecondary), research findings, and potential in extension education, with particular emphasis on home economics education.
EDRS Price: MF01/PC01 Plus Postage (12pp).

APPENDIX B:
FOR MORE INFORMATION

Over 1,400 articles and documents in the ERIC database are indexed with the term "distance education." In more than 600, distance education is a *major topic*.

The documents in the annotated bibliography in Appendix A provide a great deal of information. The bibliography, however, does *not* contain any journal articles, and it contains only two documents published before 1987; most of the documents in the annotated bibliography were published in 1988 or later.

To get more information, or to get more specific information on a topic of special interest to you, call the staff of the ERIC Clearinghouse on Rural Education and Small Schools (ERIC/CRESS). The call is toll-free (1-800/624-9120, nationwide; 1-800/344-6646 in West Virginia).

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