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ABSTRACT

A study examines the effectiveness of two major types of instructional technology used in a majority of federally supported bilingual education programs, computer assisted instruction, and video instruction. The videotape technologies examined were bidirectional or interactive television and videotape. The variations of computer technology examined were determined by the configuration of the computing equipment. The study found that technology can have a significant positive effect on limited-English-proficient (LEP) students. In the case of video, the effect was concentrated in two areas: bidirectional television was found to make scarce resources available to geographically dispersed students, and videotape brought the outside world into the classroom while giving the teacher a versatile tool. Computers were found to have the potential for permitting students to learn at their own speed in a highly motivating and non-threatening environment. It is suggested that to maximize the computer's potential, administrators and teachers need training structured for computer application to educational problems. The major impediment to the use of video technology in schools was found to be cost; impediments to the use of computer technology were the lack of instructionally and technologically sound software and lack of training in computer use and planning. (MSE)

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NATIONAL CLEARINGHOUSE FOR BILINGUAL EDUCATION

REVIEW OF THE STATE-OF-THE-ART OF EDUCATIONAL TECHNOLOGIES IMPLEMENTED IN PROGRAMS SERVING LEP STUDENTS FUNDED BY THE DEPARTMENT OF EDUCATION

FL014973

Part C

Research Agenda

Bilingual Education Act
U.S. Department of Education

REVIEW OF THE STATE-OF-THE-ART OF EDUCATIONAL TECHNOLOGIES IMPLEMENTED IN PROGRAMS SERVING LEP STUDENTS FUNDED BY THE DEPARTMENT OF EDUCATION

FINAL REPORT

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Part C

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EXECUTIVE SUMMARY

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In September 1983, the U.S. Department of Education's Office of Bilingual Education and Minority Languages Affairs (OBEMLA) asked the COMSIS Corporation to study the use of new technologies in bilingual programs funded by the Department. The objectives of this study were threefold: first, to provide information that would permit DoEd management to better evaluate future funding requests; second, to provide a base of experience upon which local school districts could build as they develop projects that use new technologies; and third, to provide information to those who manage, administer, and provide bilingual education about factors that have helped or hindered the use of new technology in the bilingual education environment.

COMSIS evaluated the funding request documents for 604 projects (544 Basic grants and 60 Demonstration grants). This evaluation identified 114 projects that used a new technology in their instructional methodology. From the 114 new technology projects, COMSIS selected a sample of nine projects for detailed analysis. The sample was selected to obtain a distribution of projects by funding year, technology, geographic location, grade levels, and native languages of students with limited English proficiency (LEP).

Two basic technologies were represented in the sample, video and computer technology. These two technologies comprised 80 percent of all projects funded by the department which involved technology. The other 20 percent involved the use of audio tape recorders or teaching machines such as the System 80. Review of project documents and preliminary discussions with grantees indicated that in these projects neither the audio tape nor teaching machine approach was considered e[illegible]ationally significant in terms of cost, time-on-task, or curricular impact. They were described as supplementary approaches to the instructional program. Further, no new projects were funded for the 1983-1984 school year that proposed the use of audio tape or teaching machines. This led to the decision to exclude any of these projects from the sample.

On the other hand, both computer and video technologies were identified as providing significant changes in the delivery of instruction to LEP students. In addition, these were the only technologies proposed in new projects funded for the 1983-1984 school year.

There were two variations of these two basic technologies. The video technologies studied were bidirectional or interactive television and videotape. The variations of computer assisted instruction were determined by the configuration of the computing equipment. The most common configuration used one independent computer for each student workstation. The other configuration linked computer workstations as a network to permit students to share computer resources.

COMSIS visited the selected projects and individual project sites. COMSIS personnel observed use of the technologies and discussed their impact with administrators, project staff, and teachers.

This study found that technology can have a significant positive effect on the LEP students. In the case of video, this effect was concentrated in two areas: bidirectional television can make scarce teaching resources available to students that are geographically dispersed; and videotape can bring the outside world into the classroom while giving the teacher a versatile tool that can play real life situations, stopping, starting and replaying as needed to clarify or reinforce specific issues.

While video technology can augment traditional teaching methods, computer technology can bring a revolution in teaching. Computers have the potential for permitting students to learn at their own speed in a highly motivating and non-threatening environment. To maximize the computer's potential, administrators and teachers need training. This training should be structured to teach how to apply computers to educational problems, not necessarily how to write computer programs.

The major impediment to using video technology in the schools is cost. Schools should not propose the use of bidirectional television unless a cable system with two-way capabilities is already in place. The cost of establishing such a network is extremely expensive. Development of videotape is also an expensive proposition. Videotape production is a personnel intensive operation that also requires use of expensive editing equipment. Schools should have access to such equipment on a no-cost or low-cost basis before proposing videotape production. Additionally, schools should have staff available who have video experience.

The major impediments to the effective use of computer aided instruction is the lack of instructionally and technologically sound software and the lack of training in the planning for and use of computers. Computer projects tend to focus on the use of computers rather than their application to meet a specific objective. Further, objectives for computer projects tended to be too broad to permit effective planning and evaluation. For example, "improving the educational opportunities for LEP students" is a laudable goal but too broad. "Teaching LEP students survival English" is a more precise objective and one that can be used as a criteria for software evaluation.

Technology has a role in education. That role is growing as the cost of technology decreases and its availability increases. In order to take advantage of technology, educators must understand its strengths and limitations. Further, there needs to be an understanding that technology does not supplant the teacher but instead provides teachers with new methods and teaching tools. Technology cannot make a poor teacher into a good teacher. Technology can increase the effect and effectiveness of a good teacher.

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CHAPTER 1

HISTORY

1.0 INTRODUCTION

The Department of Education (DoEd), under Title VII of the Elementary and Secondary Education Act, funds selected projects to assist limited English proficient (LEP) students acquire language skills necessary to effectively participate in all-English medium classrooms. During the past few years, a number of these projects have incorporated new technologies such as television, videotape, and especially, computers. The role of the new technology in Federally-funded projects has been varied and without a past history, thus, DoEd personnel charged with the responsibility of assisting grant applicants and deciding which projects to fund, have been at a disadvantage.

In September of 1983, the DoEd contracted with the COMSIS Corporation to study the use of new technologies in bilingual programs funded by the Department. The objective of this study was threefold: first, to provide information that will permit DoEd management to better evaluate the potential of future funding requests; second, to provide a base of experience upon which local school districts could build as they develop projects that use new technologies; and third, to provide information to those who manage, administer, and provide bilingual education about factors that have helped or hindered the use of new technology in the bilingual education environment. Although this study and its findings specifically address the use of technology in bilingual education, it has important lessons that are generic to all who would use technology as an educational aid.

To meet the three objectives of this study, the report is divided into three related but independent chapters. Chapter One details the history of each site visited. Chapter Two discusses the new technologies used by the selected sites and Chapter Three presents those factors, both positive and negative, that helped or hindered use of the new technology in bilingual education.

In conducting the study, COMSIS personnel visited nine projects that used new technology. The projects were not a random sample. They were selected based on an analysis of funding request documents maintained by the DoEd. The objective of the sample was to have a cross-section of projects relative to project duration, geographic location, and technology utilized. The table below provides the characteristics of the sample.

While the technologies used by the projects were dissimilar, the reasons for proposing a technology-based project were consistent among all sites. Three primary reasons were given by project personnel for selecting a specific technology: first, the local personnel involved in the grant proposal process were familiar with a particular technology, e.g., video or computers; second, the availability of equipment (especially true of projects using videotape or television); and third, the perception that a project proposal that used new technology, particularly computers, had a greater probability of being funded.

The nine projects studied, used four different technologies, two used video and two used computers.

DEMOGRAPHICS OF PROJECT SAMPLE

- **Project Duration**

First Year Demonstration Project	2
Second Year Demonstration Project	2
Third Year Demonstration Project	1
First Year Basic Project	2
Second Year Basic Project	2

- **Geographic Location**

Southern California	2
Pacific Northwest	1
Midwest	2
Northeast	3
Southeast	1

- **Technology***

Videotape	2
Bidirectional Cable Television	1
Single Station Microcomputer	6
Networked Microcomputer	3

*Will not add to nine due to some projects that used multiple technologies.

1.1 SUMMARY

The sites included in the study were chosen because they are representative of a cross view of projects funded by the U.S. Department of Education to apply technology in the instruction of limited English proficient (LEP) students. The nine study sites comprise a mix of geographical regions; include large, medium, and small, urban, suburban, and rural school systems and instructional levels K-12. Prior history, expertise, or experience in programs for LEP students were not included in the selection criteria. Given the selection criteria, it was surprising that so many similarities exist in the history of instructional programs for LEP students in the sites included in the study.

1.2 PRIOR TITLE VII FUNDING

With only one exception, all of the sites had a long history of Title VII funding. The districts knew how to write funding applications and how to target Title VII proposals to address the priorities and regulations established by the Office of Bilingual Education and Minority Languages Affairs (OBELMA). Four of the nine sites had other, non-technological, Title VII projects in operation concurrently with the project included in this review. With the exception of the one site, the majority of the personnel implementing the projects had previously worked on Title VII projects in the districts before the technological projects were funded.

This prior experience meant that the technological projects came into being within a fairly well defined administrative structure of programs for LEP students. The experience with Title VII rules and regulations also means that administrative staff felt that a technologically based project had a good chance of being funded. This feeling was based on the identification of educational technology as a priority area in demonstration grants for several years in a row.

1.3 LEP POPULATION

With the exception of two sites which served stable native American populations exclusively, each of the nine sites identified a recent change in the type of LEP students who had entered, or were entering the district. These new populations of LEP students were the central focus of the technological projects. In two cases the districts had received many Southeast Asian refugees. In one district the population was composed of recent Cuban and Haitian refugees. In one district the students were older refugees from the Lebanese civil war. In another Central American refugees were identified as the new population. One district looked not at the origin of the LEP population but their success in school. This district targeted the non-achievers within the existing program. In yet another district the LEP population was slowly switching from the children of migrant workers to the children of high-tech company employees.

Aside from the districts that served native American populations and the last case cited above, all of the projects involved new LEP populations composed of refugees from some social upheaval. They were generally undereducated and many times illiterate in their own languages.

This change in the LEP population was partly responsible for the districts' consideration of new approaches to the instruction of LEP students.

1.4 INSTRUCTIONAL FOCUS

In every project, English as a second language was the principal focus of the application of technology to the instruction of LEP students. In only one case was any attempt made to provide instruction through the medium of the students' native language in conjunction with the technology applied in the project. In one other case the students' native language was included for orientation and limited instructional support to what was otherwise taught in English. Aside from those two sites, use of the native language, if any such instruction was provided in the district, was separate from the technology of the project.

In several cases this concentration on English-only seemed to reflect the predominant philosophical or political view of the district. In other cases, particularly those using computer assisted instruction, the lack of courseware in the native language was the primary practical force precluding the use of students' language.

An interesting distinction occurred among the projects utilizing video technology. Some concentrated exclusively on English and used the video medium to reach more students. Others selected video technology because it was readily amenable to multiple language use.

The two native American projects focused exclusively on English language instruction. In both cases the majority of the students did not speak the native American languages, but, nonetheless, had been judged to have limited English proficiency. However, these were the only technical projects to include the culture and traditions of the students in specific units.

1.5 TECHNOLOGICAL MOTIVATION

Every site studied had some impetus other than the needs of LEP students to implement a technologically based program.

In the case of the video projects the motivating factor was the ready availability of technology, equipment, and training resulting from local requirements that cable companies provide capabilities and services to the schools. This led to a general interest in how these capabilities could be applied in instructional settings, especially among those responsible for LEP instructional programs.

Computers were generally the technology of choice when the local school district was moving towards widespread instructional computer applications. This ranged from highly organized and detailed district-wide "Computer Plans" to vaguely worded statewide mandates. In any event, the decision to use computers in the instruction of LEP students generally occurred within a context of general instructional interest and administrative encouragement. The availability of funding meant, in two cases, that the bilingual programs were the first in the district to actually implement CAI programs, making them forerunners in a district-wide movement toward computer aided instruction.

1.6 FIELD STUDY

1.6.1 Site Number One

Site One is a large-county school district located in the Southeast. The district primarily serves urban and suburban students. It has some rural areas and a number of children of migrant agricultural workers. In 1983-84 the total student population was 125,240. Of this total, approximately 8,500 were classified as LEP students.

The district provides English as a second language (ESL) instruction for all LEP students (K-12) in 19 transitional program instructional centers throughout the county. In addition to ESL instruction, 1,400 students receive bilingual instruction (Spanish/English or Haitian Creole/English) in six of these centers.

The first of these transitional centers for LEP students began operation in 1976. Since then additional centers have opened to serve the evolving demographic patterns of LEP students. Local and State funds account for more than 90 percent of all monies spent for LEP instruction. Staff development and curricular support is provided by a central county office. Individual building principals provide the direct administration of ESL instructional programs. Each principal who has a transitional center is assisted by a program coordinator. Bilingual programs receive additional administrative support from the central county office.

ESL and bilingual programs (Spanish/English) in the district predate 1976. The district used Title VII assistance to establish its first bilingual programs. In 1960, a wave of new immigrants, from Cuba and Haiti, inundated the county. At one point the district was registering 25 new LEP students per day. This large influx led to a rapid growth in the number of ESL and bilingual teachers and transitional program centers.

In 1982-83, the county received $135,036 for the first year of a three-year Title VII Basic project. The original request was for $250,000 to equip and support six of the transitional centers with microcomputers. The negotiated grant provided funds to establish three computer assisted programs at three sites. Each of the sites, one elementary, one middle, and one high school, has an operational Spanish/English bilingual program as well as an ESL program. Each site has a microcomputer laboratory equipped with Apple II microcomputers and is staffed by a bilingual instructional aide. The laboratory became operational in January, 1983.

Not all LEP students at each site participate in computer assisted instruction (CAI). Participation in CAI is reserved for students who need "remediation" and intensive practice in basic English skills. This focus, in part, is related to the limited number of microcomputers available at this time. The project administrators determined that, given limited resources, students most in need of English language reinforcement would receive supplementary CAI. In some cases LEP students are placed into CAI within one day of their arrival in the school. Of approximately 300 LEP students receiving CAI at the three sites (80 elementary, 125 middle, 95 high school), 200 are Spanish speaking and 100 come from 19 other language backgrounds.

Classroom teachers (either bilingual or ESL teachers) identify students in need of special assistance in basic English skills. Specific needs in mathematics, language arts, and reading are identified by the classroom teacher. The bilingual aide in the CAI laboratory selects the appropriate courseware for each student and schedules the students, in cooperation with the classroom teacher, on a pull-out basis. At the elementary level students receive 30 minutes of CAI three times a week. At the middle and high school level, students receive 45 minutes of CAI three times a week.

The program coordinator has the major responsibility for selecting of CAI courseware and training bilingual aides in the operation of the microcomputers. All of the current courseware is in English. The project's objectives focus specifically on supporting basic acquisition of English skills. The project is intended to support the district's English language acquisition objectives for all LEP students regardless of placement in bilingual instruction or ESL-only instruction. The aides are capable of providing native language directions (some in Spanish, others in Haitian Creole) and assistance to students with no English language ability.

The program coordinator is also responsible for organizing and providing staff training in computer applications. This training is provided to teachers at each of the three sites through a regular program using both in-house instructors and consultants.

1.6.2 Site Number Two

Site Two is a small-city school district located in the Northeast. The city serves an almost exclusively urban blue collar population. In 1983-84, the total student population was 2,400. Approximately one-third of the students (796) are from non-English speaking homes. Students who speak Spanish and Portuguese, as well as some who speak Cape Verdean account for the majority of the district's LEP students.

The district began bilingual and ESL instruction in 1971. In 1972, the district received its first Title VII bilingual grant. Since 1976, the district has used State and local funds to continue its bilingual (Spanish/English and Portuguese/English) and ESL instructional programs.

The district currently provides instruction for all LEP students. At the kindergarten level, LEP students receive ESL instruction in a daily pull-out program. LEP students in grades 1-3 receive a half-day of self-contained ESL instructional and a half-day of instruction in English language medium classrooms. Except at one school, where Spanish speaking LEP students receive bilingual instruction in a self-contained classroom. All LEP students in grades 4-6 are in full day self-contained ESL classrooms. In grades 7-12, Spanish and Portuguese LEP students are in a transitional bilingual program where they receive math, science, and social studies instruction in the native language and ESL instruction. All other LEP students .n grades 7-12 receive two or three periods of ESL instruction per day.

In October of 1983, the district received a Basic one-year Title VII grant of $119,000 to support three instructional components: a bilingual pre-school instructional program; development of a computerized model for the identification, assessment and instruction of bilingual special education students K through 12; and a computer assisted instruction (CAI) laboratory to provide enhanced vocational and other learning opportunities for low achieving and potential dropout bilingual students in grades 7 through 12.

The one-year Title VII grant award was received October 12. The timing of the grant award and its relatively short duration created problems in implementing the second and third technological components of the project. Staffing was inhibited by a union contract. Hardware (TRS-80, 64K, extended-color, network system) was not in place until January 30, 1984. CAI for secondary students did not begin until the second semester. Teacher and staff computer application training was impossible prior to the arrival of the hardware and software. Component 2 (computerized special education model) was abandoned because of time restrictions.

In component 3, two Vocational Training Specialists provide intensive language development, reading, and writing instruction to a group of low-achieving students. Additionally, they provide "life skills" instruction and monitor job placement and on-the-job training. They also identify skills that need CAI reinforcement and select the CAI courseware for the computer laboratory.

1.6.3 Site Number Three

Site Three is a medium-size city school district in the Northeast. The district serves an exclusively urban student population. In 1983-84 the total student population was 19,000. Approximately 5,000 students come from language backgrounds other than English. Of these, 3,500 limited English proficient (LEP) students receive bilingual or English-as-a-second-language (ESL) instruction.

The district has provided bilingual and ESL instruction since the early 1970's. The LEP population was 6.1 percent in 1976, when the instructional programs for LEP students began a period of rapid expansion as the number of LEP students dramatically increased every year.

Bilingual instruction is currently provided, K through 12, in Spanish/ English and Portuguese/English. Bilingual instructional aides provide Native language support is in Hmong, Khmer, Laotian, and Vietnamese. All LEP students receive ESL instruction as part of the bilingual program or as supplementary instruction to the regular curriculum. Approximately 50 percent of the LEP students receive assistance in their native language. At the elementary level, instruction is in self-contained classrooms. At the middle school and high school level, instruction is departmentalized. A total of 96 teachers districtwide provide ESL and bilingual instruction.

In October 1983, the district received $224,000 for the first year of a three-year Title VII Basic project. The project is designed to provide supplementary computer assisted instruction (CAI) in seven middle schools that serve LEP students in grades 5 through 8.

Eventually, each site will be equipped with a computer laboratory, each using 13 TRS-80 Model 4 microcomputers networked with a host microcomputer utilizing hard disk drive. Laboratories are being established one at a time to concentrate project resources on each site as it is established. One site was operational in January 1984. Four more sites were to become operational by the end of the 1983-84 school year. Two more sites will be established in September 1984.

The first year of the project was intended for gradual introduction of hardware and software and staff training. The project staff does not anticipate substantial instructional impact until the second year of operation when all sites are properly equipped and staff appropriately trained.

The ESL teacher uses the CAI laboratory at specific times during the day. The teacher brings students to the lab and selects CAI courseware for each student. The teacher, or the teacher's instructional aide, monitors and supervises students while they are in the computer lab. The teacher is solely responsible for matching students with specific courseware. This guarantees that the students will be working on objectives identified by their teacher. It also requires that the teacher be trained in computer use and knowledgeable about the CAI courseware available in the system.

Students spend an average of 45 minutes per day in the CAI laboratory. Since the CAI program focuses primarily on English reading skills, students with no English language ability spend less time in the laboratory. The project staff feels that a minimum of English language skill is necessary before students can benefit from the currently available CAI courseware.

Currently, all of the project's CAI courseware is in English and designed to support English language and reading objectives. Some mathematics courseware is available and is used at the teacher's discretion. The project staff plans to develop some CAI courseware of its own but primarily obtain courseware from other sources. They have no plans to develop or obtain CAI courseware to support bilingual instruction except for the ESL component of the program.

1.6.4 Site Number Four

Site Four is a community school district in a large city on the East Coast. In 1983-84 the district had a total student population of 20,330. Of those, 1,972 had limited English proficiency (LEP), 1,106 were Spanish speaking and 866 had a variety of other language backgrounds. Until 1973, LEP students had no organized instructional programs. In that year, and during the preceding year, LEP students began to have a noticeable impact on the school. In 1973, with Title VII assistance, the district began bilingual programs (Spanish/English and Greek/English) for the first time. The Spanish/English bilingual program is still in operation. The number of new arrivals from Spanish speaking countries increases every year. The Greek/English program was discontinued because the Greek-speaking LEP population in the district has not increased significantly during the past nine years. The district has also provided Portuguese/English, Farsi/English, and Russian/ English bilingual programs at the secondary level when the numbers of LEP students speaking those languages has made it practical to provide bilingual instruction.

All LEP students in the district receive English as a second language (ESL) instruction. Those in bilingual programs are in self-contained classrooms at the elementary level and in departmentalized programs at the secondary level. The district is under a set of court mandated regulations that govern the entry and exit of students in the bilingual program. The bilingual instructional staff at times feel that the court-ordered regulations are not in the best educational interest of the students.

In September 1931, the district received $293,897 to fund the first of a three-year Title VII Demonstration project to provide computer assisted instruction (CAI) in three schools. The district received $250,752 and $216,731 to continue the project in school years 1982-83 and 1983-84, respectively. The demonstration project was implemented in one public elementary school (1-6), one private parochial school (1-6), and one public junior high school (7-9).

At the elementary school, CAI was totally integrated into the bilingual instructional program. Six TRS-80 Model 4 micro-computers are arranged in a network configuration located in one classroom. The teacher is responsible for providing general instruction to the students and for supervising the use of the computers in CAI. Students spend an average of 120 to 150 minutes per week, or approximately half of their time, in CAI. The rest of their time is spent in other types of instruction.

At the junior high school, students use the computer laboratory on a shifting, pull-out schedule. That is, the students use the lab for one instructional period three times a week. The period varies so they are not pulled from the same class more than once each week. Teachers give priority for CAI in the laboratory to Students with lower skill levels. Teachers identify students weaknesses and the project staff select instructional courseware that address those deficiencies.

During school year 1983-84 the parochial elementary school did not appear to have any LEP students participating in the program. Students from other than English backgrounds (almost exclusively Hispanic) come to the laboratory on a pull-out basis to receive English reading, language arts, and mathematics reinforcement.

In addition to an extensive library of commercially developed software in English, the project uses courseware developed, with project assistance, by district teachers. While some of this courseware is in English the majority of the project-developed courseware is in Spanish, since few Spanish language programs are currently available. The teachers who developed the CAI materials used three approaches: first, they translated existing English language courseware into Spanish, leaving the original program untouched; second, they adapted existing English courseware to Spanish instructional use by translating the courseware and making necessary changes in the original software program. Third, they wrote original software for specific instructional purposes.

1.6.5 Site Number Five

Site Five is a medium-size school district in the western United States. Approximately 10 percent of the total student population of 12,000 is Lakota Sioux. Eighty percent of the Lakota Sioux in the elementary grades have limited English proficiency (LEP).

The district has provided special programs for Lakota Sioux students for the past 10 years. The major focus of these programs has been to strengthen the English language skills and to build positive self-concepts through instruction in the traditions and culture of the Lakota Sioux. The native language is used for instruction in only the early primary grades (K-2) where some children begin school as monolingual Lakota speakers. The district has had prior Title VII grants to support instruction for Lakota Sioux LEP students.

The Lakota students are concentrated in two geographic areas primarily enrolled in two elementary schools where a high percentage of students are native American.

In 1982-83 the district received a Title VII Demonstration grant for the first year of a three year project. It received one hundred sixty-two thousand dollars ($162,000) for the first year and $179,000 for the second year (1983-84). The demonstration project established computer assisted instruction (CAI) in four elementary schools to serve LEP students in grades 3 through 6. During the first year, the district started the program in two schools. It added an additional school in the second year and a fourth school is scheduled to be added during the third year of the project.

Each of the three elementary schools have computer laboratories where CAI is provided on a "pull-out" basis. The laboratories are equipped with from four to eight Apple II microcomputers. Each computer laboratory is run by a native American instructional aid. The project has an identified set of 47 instructional objectives that it can support with existing CAI courseware. Each student works on these objectives in a fixed sequence. Over time, some of the students move ahead and some lag behind. By the middle of the year students are working with a range of different courseware packages. At two schools the students are pulled from their regular classes on a shifting schedule basis. That is, they never come to the lab at the same time in any one week. At the other school students use the lab on a fixed schedule.

The CAI instruction uses only commercial courseware developed for native English-speaking students. The district's approach to instruction for Lakota Sioux students is one of remediation rather than English as a second language.

1.6.6 Site Number Six

Site Six is a rural school district in the far northwest United States. Eleven schools with a total student population of approximately 600 are spread across an area of 64,000 square miles. Eighty-nine percent of the students at the 11 schools are either Athabascan Indians (80%) or Inupiaq (9%). The school district was created in 1975 to give local residents control of the schools.

In October 1982, the district received $111,000 for the first year of a three-year Title VII Basic grant. It received another $111,000 for the second year of the project (1983-84). The project provides supplemental computer assisted instruction (CAI) in six of the district's eleven schools. At least 60 percent of the students in each school have limited English proficiency (LEP).

District funds were used to purchase Apple II and IIe microcomputers. The district used Title VII funds to purchase and develop instructional software and to train teachers and parents.

The six schools that provide CAI have microcomputers in individual classrooms. One other school, which has the largest number of students and the largest number of classrooms, plans to put computers in every classroom.

Classroom teachers have complete discretion in the use of CAI. Each teacher has been trained to use computers as instructional aids. They are also familiar with a variety of instructional software. To meet specific needs, teachers periodically request software from the central office. The locally funded media specialist then attempts to identify courseware that meet the teachers' needs. That software is evaluated by the district's media coordinator before being sent to teachers. However, teachers make the final decision to use or not to use individual instructional programs.

Classes tend to be small enough that one or two computers per classroom (one for every 10 students) provides a minimum level of CAI for each student during the school day.

The project's CAI primarily focuses on English language reading and writing, although other content areas and skills are also included. The project uses commercially developed software for both drill and practice and tutorials in reading and language arts. The most impressive aspect of the program is its use of the word processing capabilities of the microcomputers.

Students use the computers for writing activities in all content and skill areas. In two schools, the students produce their own weekly newspapers.

1.6.7 Site Number Seven

Site Seven is a medium-size school district near a large Midwestern city. The district has an urban/suburban student mix.

In 1983-84 the student population was slightly more than 12,000. Five thousand of those students have Arabic-speaking backgrounds. About 1,200 have limited English proficiency (LEP).

Prior to 1970 the schools had few LEP students. Most of the Arabic students are second or even third generation English speakers. In 1970, the district hired the first two English-as-a-second-language (ESL) teachers to work at the secondary level. At the elementary level, such instruction was handled by regular classroom teachers. When it had few LEP students, the schools were able to provide adequate instruction for these students. The situation changed radically in 1976, when the Lebanese civil war erupted. The district experienced a rapid increase in the number of LEP students who arrived as refugees from the war. Initially, the vast majority of these LEP students were young children. As the civil strife continued unabated in Lebanon, older children began to arrive. More and more of the school age refugees, some from the rural and mountain regions of Lebanon, arrived in the district with little prior formal education as contrasted with those who came at the beginning of the civil war.

Formerly, the district had received a five-year Title VII Basic grant funding through to establish an Arabic/ English bilingual program at the elementary and junior high school levels. A Title VII Demonstration grant helped the district prepare Arabic/English bilingual instructional modules for academic and vocational training. These modules were designed to help LEP students adapt to the curriculum in a large high school. In 1982-83, the district received a new Title VII Demonstration grant to establish Computer Assisted Instruction (CAI) and Instructional Television (ITV) in one high school.

The bilingual program at this high school (9-12) has three instructional levels. Level I provides bilingual classes in English, science, social studies, and mathematics. Arabic is used approximately 80 percent of the time in content area instruction and very little in ESL instruction. As students increase their proficiency in English, less of their time is spent in Arabic-based instructional. Level II instruction is approximately 50 percent Arabic and 50 percent English. Level III is 80 percent English and 20 percent Arabic. After Level III, students receive all of their instruction in English.

Bilingual aides provide special tutorial assistance to Arabic speaking students who have difficulties in any content area. In addition, bilingual aides provide special assistance in vocational classes where bilingual instruction is not routinely available.

The CAI and ITV technology in this project both require special materials.

In the case of CAI, the project uses Ar-Apple microcomputers (Apple II and Apple II+ microcomputers with an additional circuit board that allows the use of Arabic characters) are used in a computer laboratory. Teachers reserve the laboratory for specific times during the week and sent their students to work on specific courseware packages. These programs may be commercially-produced packages in English; teacher-developed programs in English, or bilingual (Arabic/English) project-developed courseware.

The project has trained teachers to author systems and computer programming enabling them to develop courseware geared to specific instructional objectives.

Students are assisted in the computer laboratory by a bilingual aide who has been trained to use the hardware and the instructional courseware. Teachers determine how long students are in the laboratory. Lab sessions may vary from 20 to 40 minutes.

The ITV project produces instructional telemodules. Telemodules are videotaped presentations that provide orientation and instruction in survival skills, academic subject, vocational training, and school orientation. The telemodules are produced in English and in Arabic.

The telemodules are used by classroom teachers, bilingual teachers, and community liaisons with LEP students and parents.

1.6.8 Site Number Eight

Site Eight is a medium-size school district on the West Coast. The district is an area of steady population growth. In 1971 the entire population of the area was approximately 16,000. In 1983-1984 the student population alone was slightly more than 16,000. The area is a "planned community" combining high-tech "clean" industries and residential areas. This development has transformed an exclusively agricultural area into a mix of agriculture, light industry, and suburban living.

During school year 1983-1984, slightly fewer than 700 of the district's 2,800 minority students were classified as limited English proficient (LEP). In 1974, the district began special programs for LEP students. At that time the vast majority of LEP students, the children of permanent and migrant farm workers, spoke Spanish. However, with the gradual reduction in the farming in the district, fewer children of agricultural workers are enrolling in the schools every year. The 1974 bilingual program was funded, in part, with a Title VII grant. Over the years the program has been developed and refined. The program now operates in three schools, one elementary, one middle, and one high school, where Spanish-speaking students are concentrated. Federal support to the Spanish/English bilingual program ceased in 1982. The program continues with local and state funding. Continuation of the bilingual programs depends on the number of students who need the program.

In the late 1970's, as the number of Spanish-speaking LEP students began to decrease, LEP students from other language and cultural backgrounds began to increase. While some of these students were Southeast Asian refugees, the majority were children of immigrants drawn to the growing technological industries in the area, and foreign nationals sent for tours-of duty with factories and research facilities located in the district.

The language mix, school and grade distribution of these LEP students makes bilingual instruction difficult. In 1980, the district received a three-year grant for a Title VII Basic program to take advantage of the instructional opportunities available through a cable television franchise.

The project teaches English as a second language (ESL) instruction with an interactive cable television link between the schools and the central office. The system provides ESL instruction to LEP students at all grades and at all levels of English proficiency. The cable instruction is conducted by a qualified, well trained ESL teacher. Instructional aides, located in each school, assist the instruction provided via television. This unique approach to overcome the problems inherent in a small number of students at one grade level with different language proficiency levels in widely separated schools was possible only because of the locally-mandated commitments of the cable television company to the school district.

In July 1983, the district received a Title VII Demonstration grant of $280,000 to build a five-school computer assisted instructional (CAI) program for LEP students. The original application had requested funds to support the interactive cable television program mentioned earlier. However, Federal assistance was limited to CAI.

CAI is offered to LEP students in four elementary schools (K-8) and in one middle school. It is a supplemental "pull-out" program designed to increase the students' English language proficiency. Some CAI courseware is available in substantive areas.

LEP students are pulled from their classrooms on a regular schedule established by the classroom teachers in consultation with the project staff. Students come to a microcomputer laboratory equipped with Apple IIe computers and staffed by a bilingual instructional aide. Students receive approximately 20 minutes of CAI instruction per day. Project staff select all of the CAI software. CAI is directed at LEP students who have reached some level of English language proficiency and literacy. Those with no English language proficiency receive oral language instruction through the cable TV. For a short time, some students may receive both CAI and TV instruction if their needs indicate such support.

1.6.9 Site Number Nine

Site Nine is a consolidated high school district serving four urban communities on the West Coast. In 1983-1984, the student population (9-12) was 18,000. Of that number, approximately 1,100 are classified as limited English proficient (LEP).

In 1974 the district began Spanish/English bilingual instruction at two schools. One school received Title VII Basic grants. The other school used state and local funds and added Vietnamese/English bilingual instruction to its bilingual Spanish program. These programs were relatively small because the numbers of LEP students were small. Hispanic LEP students tended to be English proficient by the time they entered high school.

By 1979, Asian LEP students, primarily Southeast Asian refugees, outnumbered Hispanic students 154 to 134. In that year the district received a Title VII basic grant to establish elementary school bilingual instruction in English and Vietnamese, Laotian, or Cambodian. By 1982 the district had become a center for Southeast Asian refugees. The district's LEP population consisted of 179 Hispanics, 841 Asians, and 93 from other language backgrounds. The dramatic increase in the LEP population was coupled with decreasing total school enrollments and corresponding budget cuts. This situation required the retraining of some teachers to instruct in English-as-a-second-language.

In July 1983, the district received a Title VII Demonstration grant of $179,051 to fund a video technology project to improve and support the acquisition of English language skills by LEP students.

The project is developing video materials based on the district's ESL curriculum. The videotapes teach English vocabulary, structures, and usage within a framework intended to foster academic and sociatal acculturation. The videotapes are accompanied by a teacher's guide that details the objectives of the lesson and activities, supplementary printed material, and an objective-based assessment.

The video tapes allow teachers to go beyond the walls of the classroom to provide language-related experiences that can be incorporated into their instruction. The videotape is transmitted to the classrooom through a centralized broadcast system housed at one school. The teacher or project staff supply the tape to the broadcast technician who transmits it on a designated channel at the time requested by the teacher. Students watch the program as they would any TV broadcast. After one tape is finished it is followed by another unit designed to build on the first video presentation.

The district is producing a set of video instructional materials, pilot testing these the materials, and training teachers to use the material. The district plans to develop a two-way interactive video instructional program. However, implementation of the interactive aspects of the program depends upon cable facilities that must be provided by a commercial cable operator.

Project staff were uncertain when, or even if, the local cable company would provide the necessary technical support.

CHAPTER TWO

2.0 Videotape

Two of the visited projects adopted an approach that used locally produced videotapes that were later replayed for the LEP students. Only a few tapes that had been produced before this study was conducted. This was due to the time required to produce a videotape. The steps involved are:

- Develop a concept related to a specific educational need that can be demonstrated/taught through the use of video,
- Write a script which converts the concept to a specific scenario,
- Lay out each scene in the script on a storyboard to facilitate taping in a logical sequence,
- Tape the scenes,
- Edit the taped material into a smooth flowing story, and
- Develop and produce tests and review guides to be used in conjunction with the taped story.

Of the six steps in videotape production, the most complex, time consuming, and expensive is editing. Editing's complexity lies in the skill needed to merge individual scenes into a cohesive story line and to simultaneously use multiple video playback and recording systems to achieve an effective result. It is time consuming because of the constant repetition and revision of the videotaping to achieve smooth results, and it is expensive because of the time involved, the requirement for a highly skilled specialist in videotape editing, and the need to use expensive equipment. Local media specialists estimated that editing represented more than 60 percent of videotape production costs.

Both visited projects developed similar solutions to the editing problem: first, project personnel established informal arrangements with local cable companies or with other schools in the area--e.g., high schools or colleges--for no cost or low cost access to videotape editing equipment; and second, video editors were hired on a part-time basis.

These solutions were not entirely satisfactory. Using equipment on an as available basis--generally after working hours--did not give project personnel the ability to effectively schedule their production time. Further, the use of part-time personnel, usually working away from the project site, sometimes resulted in communication problems between project management and the part-time person regarding the theme and presentation of the videotape.

The visited projects used professional quality video equipment. This equipment requires 3/4-inch videotape instead of the 1/2-inch videotape used in home video cassette recorders. The wider videotape equipment was selected for several reasons: first, the wider tape could be used with the recording, editing, and playback equipment provided by the cable companies; second, the wider tape provides greater flexibility when editing; and third, the wider tape permits re-recording tapes to 1/2-inch cassettes with no loss in quality, as would be the case when going from 1/2-inch to 3/4-inch.

Use of professional quality equipment significantly increased project costs. For example, a camera for 1/2-inch recording can be purchased for about $800 while a 3/4-inch camera costs more than $3,000.

The subject matter of the videotapes differed significantly between the two projects. One elected to use the technology to assist English language instruction. This was accomplished by taping typical situations such as student lunchtime conversations that had been staged using specific vocabulary words. After playing the tape for the LEP students, project personnel would discuss the scenario, taking care to emphasize the target vocabulary. Students were then tested to determine their level of comprehension of the selected words.

The second project elected to use video to teach students how to accomplish a specific goal, such as obtaining a Social Security card, or learning to use welding equipment. In this case, the action was taped both in English and in the student's native language. Students were given the option of which version they wanted to see. The project staff stated that LEP students generally elected to view the English version.

The effectiveness of project-produced videotape was difficult to evaluate. There appeared to be an increase in the skill levels of the LEP students which could be attributed to the project. There was, however, no methodology in place that would permit isolation of that portion of the improvement that could be attributed to the technology. For example, students were tested before and after viewing of the videotapes. The tests showed that the LEP students had acquired an understanding of the target vocabulary. However, the tests did not show whether that understanding was due to the video or to the reinforcemert discussions conducted before and after the students viewed the videotape.

The non-quantified benefits that could be attributed to the videotapes are:

- **Greater student interest:** Students seemed to have greater interest in the material that was televised. This was especially true when other students were the actors.

- **Improved instruction on technical subjects:** It is difficult to present technical subjects in "live" situations; examples can often be seen by only a few students and are difficult to repeat; small but important details may be overlooked when providing the same material repetitively; and critical points cannot be "replayed" when they concern examples or observed actions. Videotape permits the teacher to develop a "best case" presentation. This presentation can be replayed indefinitely with no details overlooked. Further, the teacher can stop/start or replay the action at any point depending on the needs or questions of the students.

The effectiveness of videotape can be altered by the manner in which it is played to the students. The visited projects used two playback methods that clearly illustrated the effects of video playback technology.

At one project videotapes were broadcast from a central facility. At a specified time the broadcast facility would play the videotape on an educational channel of the local cable network. This methodology di not permit project personnel or the classroom teacher to use the stop/start and "instant replay" capabilities of videotape.

At the second videotape project, playback equipment was located in the classroom. This permitted teachers and project personnel to stop the videotape to emphasize key points or replay examples in response to student questions. The instructional benefit was evident in the ability of the LEP students to more quickly learn the technical subjects presented.

Producing videotape instructional material is an expensive proposition. It should be attempted only if a school has personnel familiar with the technology and its use in an educational environment; and access to video equipment, particularly expensive editing equipment, on a no-cost or low-cost basis.

2.1 Bidirectional Cable Television

Bidirectional (two-way) cable television is a video system that allows all participants to concurrently broadcast and receive television transmissions. This technology is limited to those locations that are wired for cable television. While it is possible to utilize "over-the-air" broadcasts in this manner, the requirement for towers and broadcast frequencies (channels) makes general use of bidirectional television impractical and extremely costly.

One project that used bidirectional television had a bilingual teacher conduct a class with LEP students who were in several different schools. The teacher had two television monitors--one to monitor the picture being transmitted and one that permitted her to receive from one school at a time. All schools could receive the teacher's broadcast, and also had the capability to simultaneously receive broadcasts from one other school using the second channel.

The local cable company provided technical support to the project staff and equipment to the school district and the project.

The school district decided to utilize a bidirectional television system for two reasons: first, the bidirectional approach permitted one teacher, fluent in the LEP students' native language, to present material to a small number of students in several schools; and second, establishing a bidirectional television environment for bilingual education was a low cost option because a cable with two-way capability was in place and much of the needed equipment was already available. The system was used to teach English-as-a-Second-Language. The teacher was bilingual. Course material was presented in English.

The equipment used in this bidirectional approach included: a television camera (usually black and white) and monitor at each participating school and at the project site; microphones, both handheld and lavalier (small microphones either clipped on or suspended by a strap) at the project site, and handheld at the schools. Project staff considered multiple monitors so the teacher could receive from all participating schools simultaneously. However, they rejected this approach because of funding constraints. Staff felt they also needed color cameras at all locations and better sound equipment. Limited funding precluded purchase of the additional equipment.

This video methodology's impact on the students could not be measured. Any demonstrable impact of the technology could not be separated from the impact potentially attributable to the skill of the teacher and aides. into that due to the technology and that due to the Local personnel stated that students seemed enjoy the television sessions, especially seeing themselves, and they appeared more vocal than would be expected using traditional methods.

2.2 Comparison of Video Approaches

There is a tendency to compare videotape and bidirectional television because both approaches use video technology. Such a comparison, though possible, would not be meaningful. The two video projects shared a primary objective: increase educational opportunities for LEP students. Their secondary objectives were different. The secondary objective of the videotape project was to provide an instructional tool to a bilingual instructor, either an aide or a teacher, to use in an ESL or bilingual class. The secondary objective of the bidirectional project was to share a scarce resource, the bilingual teacher, among a number of LEP students in different geographic locations. Thus, with different secondary objectives, there is no basis for a "best method" evaluation.

2.3 Computers

2.3.1 Definitions

As the computer industry evolved, words were coined or new meanings were given to old words, creating a compact technical jargon. This jargon is extremely useful when communicating technical subjects between computer specialists but presents a barrier when attempting to discuss those same subjects with non-specialists. The approach generally used to describe technical concepts is to eliminate the jargon. Unfortunately, this is not possible with computer technology. Many computer concepts cannot easily or effectively be explained or presented without the use of computer jargon. This problem in working with computers is widely recognized. People are urged to become "computer literate," i.e., learn the computer jargon, rather than attempting to use non-technical terminology.

A computer system consists of a number of components that fall into one of two basic categories, **hardware** or **software**. Of these two categories, the easiest to understand is hardware.

Computer hardware is any physical component of the computer system. Computer hardware therefore has substance, occupies space, and can be touched. Typical hardware components of a computer system are:

- the computer,
- a **keyboard** to permit the user to provide data to the computer,
- a **monitor**, i.e., a television set with no mechanism for changing channels, to permit the computer to provide information the computer to the user,
- a **floppy disk** unit, a unit used by the computer to electronically record data on removable, flexible disks coated with magnetic recording material,
- a **hard disk**-unit, a unit used by the computer to electronically record data on non-removable, rigid (thus, it is hard) disks. A hard disk also may be called a Winchester disk, and
- a **printer**, a unit similar to a typewriter, used by the computer to present data and reports in printed form. Printers are generally classed as dot matrix or letter quality. Dot matrix printers form characters through a pattern of dots. Letter quality printers use a typewriter print mechanism where individual characters are stored on a type ball or Daisy Wheel.

Computer software is not as easily understood or visualized as hardware because it has no substance (thus, it is soft). Computer software is the most important component of a computer system. It directs the operations of the computer and all the associated hardware. Without software, a modern computer system cannot function.

If a computer system were compared to an automobile, hardware would be the engine, wheels, doors and all the car's physical components. Software would be the thoughts of the driver in directing the operations of the car. In this analogy, the driver's body would be classed as hardware.

Computer software is a collection of individual machine instructions, each telling the computer to perform a finite operation, e.g., to move data from one place to another. The machine's instructions are grouped into **programs** that perform specific functions or tasks, such as computing a payroll or printing a report.

There are three basic types of computer programs: **language**, **application**, and **operating systems**. Computer languages form the basis for all computer programs. Computer language is similar to human language in that it is designed for communication. The major difference between computer language and human language is that computer language is designed to permit one-way communication between humans and machines, i.e., the computer language permits a person to type instructions that are converted through the language into individual machine instructions to control the computer's operation.

The computer industry today has several hundred computer **languages**. Each language was designed for a specific user. The languages used by project personnel at the visited sites included:

- BASIC - Beginners All-purpose Symbolic Instruction Code, a computer language designed to be easy to learn by non-computer specialists.
- PILOT, Super PILOT - PILOT and Super PILOT are languages designed to permit users to quickly create computer programs for Computer Aided Instruction (CAI). These languages are generally called authoring systems. With the development of newer, more powerful authoring systems, e.g., DASHER, older systems such as PILOT and Super PILOT are occasionally considered educational programming languages.

An **application program** performs a user-directed operation such as computing a payroll, tabulating the number of LEP students in a specific school, or teaching mathematics. Application programs written for one computer system, e.g., APPLE, generally will not operate on another, e.g., TRS-80, without changes. This is due to differences in the capability and syntax of the computer languages available for the various machines.

The **operating program** is a master program or set of programs, that controls the operation of the application programs and their interrelation with the computer equipment. For example, to use one of the languages to convert a program into machine instructions a command must be provided to the operating system. In response to this command, the operating system searches the disk unit, locates the language program requested, loads the program into the computer, then instructs the language program to begin execution. The most common operating systems for microcomputers are CP/M, APPLE DOS, TRS DOS(used by the TRS-80), MS DOS, and UNIX.

Operating systems are supplied with the microcomputer. It is possible to install an operating system other than that provided by the equipment manufacturer, but this is generally not done was not done at any of the sites visited.

Computer languages can be provided by the manufacturer or acquired from other sources. The BASIC languages used at several of the projects visited was supplied by the equipment manufacturers, APPLE and Radio Shack (TRS-80). The PILOT or Super PILOT authoring language was acquired from a third party and was only used by projects with APPLE computers.

The final concept that should be defined before proceeding with a discussion of the sample projects is a **workstation**. A workstation is a grouping of computer equipment used by one person. A workstation has one keyboard and a monitor (also known as a CRT). Workstations may have other equipment such as printers, disks or magnetic tapes. A single workstation may be shared by multiple students, but to the computer they appear to be a single user, since only one keyboard is used to direct its operations.

2.3.2 Background

For years that computers have been thought to have a place in education. Government and industry have spent millions of dollars developing computer equipment and software, yet the use of computers in education has been restricted to special programs with limited success and applicability. Cost was one reason computers have been slow to move into the mainstream of education. Additionally, computers require both a highly trained technical operations staff and a programming staff to develop necessary computer instructions to make computers perform educational tasks.

In the past five years, the marketplace has experienced the introduction of the small, powerful, low-cost, easy-to-use **microcomputer.** The advent of the microcomputer brought the cost of acquiring not only a computer but multiple computers within the reach of local school districts. With the proliferation of the microcomputer came an explosive growth in the number and variety of computer programs (software) available for these computers. Development of software for the microcomputer became a cottage industry in the 1980's (See Figure 2.1). Computer software developed by one- or two-person operations and sold at prices generally under $1,000, permitted microcomputers to play games, perform business functions, and teach.

With the availability of competing low-cost hardware and software, school districts began to buy computers for use in the schools. These computers were generally used only in math ar . science classes or classes designed to teach computer literacy.

The U.S. Department of Education's Office of Bilingual Education and Minority Languages Affairs (OBEMLA) has also been impacted by the growth of microcomputers. From 1981 to 1983 the number of computer oriented projects funded by OBEMLA increased from six[1] to fifty-six[2].

OBEMLA personnel felt ill prepared to evaluate funding requests that featured computers as instructional aids.

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[1]Based on an analysis of third year continuations funded in 1983.
[2]Based on an analysis of projects newly funded in 1983.

FIGURE 2.1

SAMPLE OF PUBLISHERS OF EDUCATIONAL COMPUTER SOFTWARE

Avante Garde Creations
Bell & Howell
Brainbank, Inc.
Ceede
Computer Advanced Ideas
Data Command
Designware
DLM
Don't Ask Software
Educational Activities
Edutek
Fliptrack
Geometry
ICT
Kangaroo Inc.
MECC (Minnesota Educational Computer Consortium)
Milliken
Milton Bradley
Reader's Digest
Rhiannon
Sierra On-line
Soft Images
Spinnaker

Historically, computers had not been used in bilingual education. Thus, the Federal program managers had little context in which to judge the value of requests for funds. In other words, it was difficult for them to effectively analyze the potential of a proposed computer-based instructional methodology. In September 1983, OBEMLA contracted with the COMSIS Corporation to study the use of technology in programs it had funded.

2.3.3 Hardware

Two types of computers were used by the projects included in this study. The most prevalent was the APPLE, manufactured by the APPLE Corporation. The other was the TRS-80, manufactured by Radio Shack. The two computers, as purchased by the school districts, had approximately equal computing capability. The TRS-80, however, could be expanded to provide more capability than the APPLE. This difference appeared to have no impact. The programs used by the projects were written to use the capability available at the majority of computer installations. Thus, even if the TRS-80's had been expanded, the increased computing power would not have been utilized.

Several factors determined the choice of equipment:

- APPLE computers were the first low-cost computers available to the education community, thus, educators were generally more familiar with APPLE than with other computers.
- More educational software is available for APPLE computers than any other microcomputer, though this situation appears to be changing.
- The school districts had purchased APPLE's in bulk for use in courses in computer literacy, mathematics, science, etc. Therefore, to be compatible with mainstream curriculum, the bilingual project was required to use APPLE's.

- Existing hardware permitted APPLE modification to produce Arabic characters, a modification that is not currently available.

- The TRS-80 had the capability to link computers into a network of computers. The benefits of this arrangement are discussed in detail in section 2.4.4. The networking capability of the TRS-80 was especially important to one project that had proposed to use a minicomputer from a company that would provide all required software. Funding for the project was cut during negotiation and project staff had to locate equipment with equivalent capability but at a significantly lower cost.

Another significant difference existed between projects using APPLE's and those using the TRS-80. This difference was in the attitude toward maintenance of the computer equipment. Project personnel routinely performed first level maintenance on the APPLE's, i.e. rearranged connecting cables, ensured that circuit boards were properly seated, and even adjusted disk units. For example, at one project, each site was to be equipped with an APPLE repair kit (see Figure 2.2). Project personnel generally performed no maintenance on the TRS-80's. When a unit failed, specialists were called in or the unit was sent out for repair.

With significantly different maintenance approaches, one would expect a difference in the perception of system reliability if the failure rates were equal for APPLE and TRS-80 computers. This was not the case. Both the APPLE and TRS-80 were perceived to be highly reliable systems. Further, the frequency of outside maintenance for APPLE's and TRS-80's appeared to be equal. Thus, it appears that the APPLE has more minor problems, e.g., circuit board working loose and corroded/dirty electrical contacts, than the TRS-80 but because of the APPLE's ease of repair, users do

FIGURE 2.2

SUGGESTED CONTENTS OF APPLE REPAIR KIT
AT ONE VISITED PROJECT

- 1 head cleaning kit -- used to clean read/write heads on disk unit
- RAM and ROM chips -- RAM--random-access memory
  ROM--read-only memory
  Internal components of the APPLE located on the circuit boards
- Disk Drive
- Power Pack -- Device which converts standard electric current from a wall outlet into current useable within the APPLE. The power pack is an internal component of the APPLE.
- Connector Cables
- Power Cord
- Monitor

not perceive these minor problems as system failures. These perceptions could not be corroborated through objective data. None of the schools or school districts had maintenance records that included self-repair problems.

However, two observations made during the site visits tend to support this conclusion. The first concerns the susceptibility of the two types of computers to fluctuations in electricity and the second concerns replacing a fuse.

Most of the APPLE computers had an attachment called a "System Saver." This device protects the computer from equipment damage caused by minor fluctuations in electrical current and has a fan to cool the computer. The "System Saver" is generally needed when the capability of the APPLE is expended. The TRS-80 systems had no protection device like the "System Saver." The existence and frequent use of the "System Saver" seems to imply that the APPLE is more susceptible to failure caused by heat and electrical fluctuations.

The TRS-80's that were connected through a network of cables (see Section 2.3.4) use a power component in the cable network. At one school, this component was prone to "blow" an internal fuse. Instead of replacing the fuse themselves, project personnel either called for repair service or replaced the failed component. Project personnel did not consider the option of replacing the fuse themselves. The viability of self-maintenance in this instance was demonstrated at one site where service personnel rearranged the fuse so that it was on the outside of the component. Project personnel at this site replaced the fuse instead of calling for service.

In an urban or metropolitan location where repair facilities are relatively close, different maintenance approaches did not appear to affect system availability. In rural areas, however, maintenance could be a major decision factor. In the one rural school, the ease of user maintenance provided by the APPLE seemed to be a definite positive attribute. Project personnel were relatively self-sufficient, requiring little outside support for system maintenance or system upgrading (increasing or enhancing a computer system with the additional components). This self-sufficiency was consistent with the project's overall objective of a self-sufficient computer operation, an objective adopted to alleviate the cost and delays in obtaining outside support.

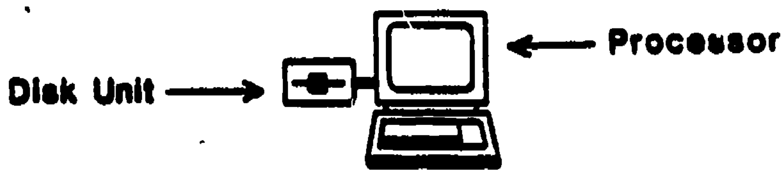
None of the funding documents that local school districts submitted to the DoEd included a justification for equipment selection. Thus, even if DoEd personnel had the expertise to evaluate the appropriateness of equipment selection, the data necessary for such an analysis were not provided.

2.3.4 System Configuration

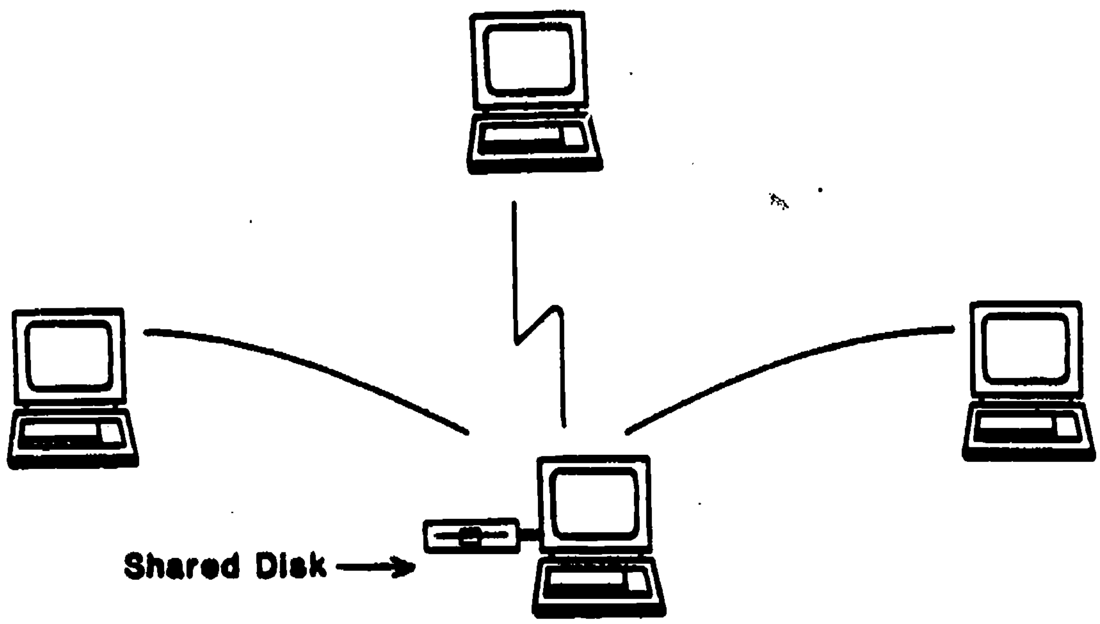
COMSIS personnel visited eight sites which specified the use of computers in their instructional approach. The eight sites used their computer hardware in two basic arrangements (configurations), stand-alone and networked (see Figure 2.3). In the

Figure 2.3

COMPUTER CONFIGURATIONS



STAND ALONE



NETWORKED

stand-alone approach, each workstation was an independent computer system with a single keyboard, monitor, and one or two disk units for storing both computer programs and data. The disk units used removable floppy disks generally 5 1/4 inches in diameter. Failure of a disk unit or any other single component would render only one of the workstations unusable.

The network approach involved connecting several workstations together with cables. Each workstation had its own microcomputer for running programs, but was dependent on a master workstation for the disk or tape unit used to store programs and data. In two of the three sites with networked workstations, a hard disk was used w a the master workstation; at the third site, a floppy disk was used. Although there was no incidence of the failure of the master workstation or disk unit, such a failure could make all workstations unusable. For example, at one location that used networked workstations, a $12 power component in the connecting cables failed. Failure of this single component caused the total system to fail because the master workstation could not transfer programs from its disk unit to the subordinate workstations.

There are a number of differences between these approaches:

- As the number of workstations increases, a network of workstations becomes more economical than an equal number of stand-alone workstations. This cost advantage is due to the need for less computer equipment and software. The point at which the network arrangement becomes more economical will vary based on the specific equipment compared, e.g., the breakeven point could be as low as five workstations or more than ten. Further, the cost advantage of networked systems, however, may be lost if the expense of installing cables to connect the workstations is high.

- Control/Administration - In a network, the use of a single disk unit to store programs and data permits better control over the administration and use of computer programs. Also, it permits the integration of all programs into a single master control program. This would permit programs to be automatically transmitted to a student's workstation in response to a student-unique sign-in procedure.

- Record Keeping/Student Tracking - With a network, software can be developed or acquired that would automatically record a student's performance while using an instruction program. These data (e.g., number correct, number of attempts, time on task, and program used) could be used to track the student's progress and even automatically advance a student through a planned curriculum as specified goals were achieved. At one project, this capability to track students was a primary factor in the decision to use a network.

- Technical Support - Stand-alone workstations require a lower level of understanding of computer technology, thus, the requirement for technical support is reduced.

- Probability of Failure - All computer equipment can fail. In the case of the stand-alone workstation, only the failing workstation is affected. In the case of the network, if the master workstation fails, all workstations are affected. Also, a failure in the cable connections could affect one or more of the workstations in a network.

- Backup - Programs and data stored on a magnetic medium such as tape or disk may become unusable due to improper handling, static electricity, program failure, or other unpredictable occurrences. To deal with this problem, copies of the programs and data are made and stored separately. With floppy disks, this means making a copy of each disk. With the hard disk generally used in a network of workstations, backup is more complex because the hard disk can store considerably more information than the floppy disk, e.g., 4 million characters versus 250,000 characters.

The decision to use a stand-alone workstation approach was generally made by default by the projects visited. Projects using the stand-alone approach had decided to use microcomputers manufactured by the APPLE Company. Th APPLE Company does not offer a network capability for the APPLE systems used. To build a network with APPLE's, equipment manufactured by other companies would be required. This approach is complex and expensive. capability to be connected into a network.

The projects that used the network workstation approach generally had assessed the cost and capability of the stand-alone and network approaches and determined that the network approach was the best for their instructional environment.

The fact that the stand-alone approach tended to be made by default does not mean that the decision was inappropriate. It simply means that the decision-making process was different.

APPLE computers have made a significant impact on the educational community. There is a large body of educational software available for the APPLE. Further, several of the school districts used a large number of APPLE computers in other parts of the curriculum. It seemed a natural decision (and sometimes a mandated decision) to use APPLE computers for a new project. Further, the capability of networking APPLE computers is not widely known because it is not offered by the manufacturer. Thus, with APPLE computers, networking is an option that is less likely to be explored.

The school districts that had networked workstations used Radio Shack's TRS-80. Two of three network sites used a hard (fixed) disk, the third site used a floppy disk. The hard disk was preferred to the floppy disk because it can transfer programs from disk storage to the individual workstations at a significantly faster rate than the floppy disk and it can store all the programs and data used in the project on a single disk.

Other computers in the marketplace could support either the network or independent workstation arrangement. These systems were not available or were not being actively marketed when the school districts were selecting computer equipment to the educational marketplace.

2.3.5 Software

Software is possibly the most important component of a computer system. Software turns a seemingly random collection of electronics and electro-mechanical devices into a highly efficient machine, a tool that can be directed to perform many tasks, a tool that can even "learn" to tailor its operations to the needs of individual users.

Most personnel recognized the importance of software to the success or failure of the project. The manner in which the software was selected did not differ significantly from one project to another. All of the projects selected and acquired software in an on-going process consisting of five steps: definition of requirements; software identification; software screening; staff training; and software evaluation. The projects differed in the arrangement of these steps and the manner in which specific steps were taken.

Definition of Software Requirements: Software was selected based on its ability to address specific needs of LEP students. In most cases, teachers came to project personnel with a specific educational requirement and a request for software to satisfy that requirement. In other cases, project personnel defined requirements without teacher participation. Teachers were then presented with the software and project personnel's determination as to the educational potential of the program.

Identification of problem areas to be addressed by specific computer programs generally occurred after the project was funded and hardware acquired. This sometimes led to situations where the equipment acquisition decision appeared to be based solely on the volume of available software, but software actually used was available for both the APPLE and TRS-80.

Failure to define software requirements prior to project funding frequently resulted in underfunding for software acquisition. Software is expensive. Due to copyright restrictions, a project often must purchase more than one copy of a single computer program.

Software Identification: Before a project can acquire software, it must first identify and locate that product.

Project personnel use a variety of sources to locate software: referrals by other computer users; visits to computer stores; periodicals (generally educational periodicals) and advertising from educational software publishers. Of these sources, project personnel were unable to specify which was the best source. Generally, project staff continually reviewed material from all available sources to identify software which might have the potential for filling an educational need.

Project personnel repeatedly stressed the need for some method of acquiring information on computer software designed for the bilingual or ESL environment. It was felt that there should be some way to share software experience of other bilingual/ESL projects. Project personnel often suggested that OBLEMA establish an electronic "bulletin board." Under this arrangement, projects with computers would be able to connect through telephone lines to an OBLEMA computer. Projects would contribute information on their experience with bilingual software and retrieve such information stored on this computer by other projects.

Software Screening: A tremendous volume of software is available for microcomputers. A significant percentage of the available software purports to be designed for education. Project personnel, however, stated that 70 to 80 percent of the software reviewed was not suitable for their use because: the software did not meet their specific needs; the software did not address the educational need stated in the documentation; the software did not use a sound educational approach; the software was technologically deficient, i.e., the quality of programming was poor; or the software design was not thought to be sufficient to retain a student's attention. Further, there was relatively little native language software designed for a bilingual environment.

Each project had established its own screening procedures because of the high proportion of unsuitable software. Some projects use a formal software screening process with a questionnaire or form to rate the various attributes of the program. Figures 2.4 and 2.5 are examples of software screening documents.

Software Evaluation Form

Reviewer's Name________________ School__________ Subject/Grade__________

PROGRAM TITLE________________ Medium: ___5" disk; ___8" disk

___cartridge; ___tape

Microcomputer (brand, model, memory)________________

Hardware/Peripherals(necessary for execution)________________
" " " (to enhance execution)________________

PART 1

PROGRAM OVERVIEW AND DESCRIPTION

1. Subject area and specific topic________________
2. Prerequisite skills necessary________________
3. Appropriate grade level (circle) 1 2 3 4 5 6 7 8 9 10 11 12
4. Type of program (check all that are appropriate)

___Simulation ___Testing
___Educational Game ___Classroom Management
___Drill and Practice ___Other (specify)________
___Tutorial
___Problem Solving ___Remediation
___Authoring System ___Enrichment

5. Appropriate group instruction size:___individual ___small group___class
6. Program objectives:
   A. Are they clearly stated in program or documentation? ___yes ___no
   B. Are they educationally valuable? ___yes ___no
   C. Are objectives achieved? ___yes ___no

Briefly describe program if desired. Mention any special strengths or weaknesses.

____

PART 2

EVALUATION CHECKLIST

Check Yes, No, or Not Applicable for each question below. To add information, or to clarify an answer, use Comment section at the end.

Yes	No	N/A	Educational Content
___	___	___	1. Is the program content accurate?
___	___	___	2. Is the program content appropriate for intended users?
___	___	___	3. Is the difficulty level consistent for material, interest, and vocabulary?
___	___	___	4. Is the program content free of racial, sexual, or political t

Comments________________

Yes	No	N/A	PRESENTATION
___	___	___	1. Is the program free of technical problems?
___	___	___	2. Are the instructions clear?
___	___	___	3. Is the curriculum material logically presented and well orga
___	___	___	4. Do graphics, sound, and color, if used, enhance the instruct. presentation?
___	___	___	5. Is the frame display clear and easy to read?

Yes	No	N/A	INTERACTION
___	___	___	1. Is the feedback effective and appropriate?
___	___	___	2. Do cues and prompts help students to answer questions correc
___	___	___	3. Can students access the program "menu" for help or to change activities?
___	___	___	4. Can students control the pace and sequence of the program?
___	___	___	5. Is amount of typing appropriate for level of student?

Comments________________

Yes	No	N/A	TEACHER USE
___	___	___	1. Is record-keeping possible (within the program or through documentation worksheets?)
___	___	___	2. Does teacher have to monitor student use?
___	___	___	3. Can teacher modify the program?
___	___	___	4. Is the documentation clear and comprehensive?

Comments________________

PART 3

OVERALL EVALUATION

Check one.

___ Excellent program. Recommend without hesitation.
___ Pretty good program.(Consider purchase.)
___ Fair.(Might want to wait for somet better.)
___ Not useful.(Do not recommend purc

FOR LMS USE ONLY
Producer________________ Author(s)________________
Back-up Copy Policy________________ Cost________________
Review Policy ___yes ___no

FIGURE 2.4

EVALUATION

Title ____________________

Producer ____________________

Evaluator ____________________

Date of Evaluation ____________________

School ____________________

Subject ____________________

Level ____________________

Overall rating: Highly Recommended ______

Recommended ______

Not Recommended ______

Curriculum K-12 Department

COURSEWARE EVALUATION

PROGRAM

Program Title: ____________________

Producer: ____________________

Copyright Date: ______________ Price: ______________

Curriculum Area(s): ____________________

Content Topic(s): ____________________

User: Grade/Ability Level ____________________

Instructional Purpose: Standard Instruction ____ Enrichment ____ Remediation ____

Instructional Technique: Drill and Practice ____ Management ____

Tutorial ____ Problem Solving ____

Games ____ Other ____________

Simulation ____ ____________

HARDWARE REQUIREMENTS

MANUFACTURER	MEMORY	DRIVES	PERIPHERALS
Apple II ____	32K ____	Single Disk ____	Printer ____
Apple II Plus ____	48K ____	Double Disk ____	Color Monitor ____
Apple IIe ____	64K ____	Hard Disk ____	Cassette Player ____
Other ________			Speaker Circuit ____
________			Other ________
			________

PROGRAM COMPONENTS

Number of disks ____ Other ________________

Manual ____ ________________

Worksheets ____ ________________

FIGURE 2.5

FIGURE 2.5 (Continued)

DOCUMENTATION

Check and rate each item available in the computer program or in the accompanying materials (i.e., Teacher's Guide, Supplementary Materials.)

	COMPUTER PROGRAM RATINGS		ACCOMPANYING MATERIALS RATINGS	
	Approp.	Inapprop.	Approp.	Inapprop.
Suggested Grade/Ability Level	___	___	___	___
Instructional Objectives	___	___	___	___
User Entry Level Competencies	___	___	___	___
Program Operating Instructions	___	___	___	___
Resources/Reference Information	___	___	___	___
Pre-Test	___	___	___	___
Post Test	___	___	___	___
Follow-up Activities	___	___	___	___

RATING OF PROGRAM COMPONENTS

Circle the number which best reflects your evaluation (1 being the lowest rating - 5 the highest.)

1 - *Not Applicable*
2 - *Strongly Disagree*
3 - *Disagree*
4 - *Agree*
5 - *Strongly Agree*

CONTENT

1. The content is accurate	1 2 3 4 5
2. The content has educational value	1 2 3 4 5
3. The content is appropriate to the curriculum	1 2 3 4 5
4. The content is free of stereotypes (racial, sexrole, ethnic)	1 2 3 4 5
5. The content is free of spelling, punctuational, grammatical errors	1 2 3 4 5

INSTRUCTIONAL QUALITY

6. The purpose of the package is well-defined	1 2 3 4 5
7. The package achieves its defined purpose	1 2 3 4 5
8. The program is organized and presented sequentially in appropriate developmental steps	1 2 3 4 5
9. Presentation of content is clear and logical	1 2 3 4 5

10. The level of difficulty is appropriate for the intended users	1 2 3 4
11. Use of the package has motivational effect	1 2 3 4
12. The package effectively stimulates student creativity	1 2 3 4
13. Feedback on student responses is appropriate for intended users	1 2 3 4
14. The learner controls the rate and sequence of presentation and review	1 2 3 4
15. Instruction is integrated with previous student experience	1 2 3 4
16. Graphics/color/sound are used for appropriate instructional reasons	1 2 3 4
17. The user support materials are comprehensive	1 2 3 4
18. The user support materials are effective	1 2 3 4
19. Information displays are effective	1 2 3 4

TECHNICAL QUALITY

20. The user can exit the program at any time	1 2 3 4
21. Intended users can easily and independently operate the program	1 2 3 4
22. The program appropriately uses relevant computer capabilities	1 2 3 4
23. The program is reliable in normal use	1 2 3 4
24. Teachers can easily handle the logistics of managing the program	1 2 3 4
25. Teachers can make changes or add to the content	1 2 3 4
26. User's performance record is available	1 2 3 4

OVERALL RATING: *Highly Recommended* ________

Recommended ________

Not Recommended ________

COMMENTS:

6/83

Project personnel screened all software. However, teachers did not always participate in this process. The level of screening varied from project to project. The lowest level of screening consisted of simply not acquiring software thought to be inadequate by project personnel--thus the software never reached teachers who normally would perform detailed software testing/screening. The highest level of screening consisted of detailed analysis and testing by project personnel. In projects where the project staff performed this level of screening, the teaching staff performed no screening function, i.e., software adequacy and appropriateness decisions were the prerogative of project personnel.

A number of project personnel expressed the opinion that the teachers should play a role in screening software. The project staff felt that only the teachers themselves could effectively determine if a particular piece of software would fit into their educational environment. At the projects where the project staff implemented this approach, teachers seemed to have a better understanding about the role computers could play in education.

Software Training: It is not a productive exercise to acquire computer software, then put it into service without training the supporting staff, either teachers or aides. Every piece of software acquired addresses a specific educational need. Further, these programs have various features that must be understood to achieve maximum effectiveness.

Staff training at most of the projects was generally limited to increasing the level of computer literacy. Little training was given in the use of specific software products. This approach assumed that if the level of computer literacy was sufficiently high, the staff would be able to assimilate any new software product into the educational program.

The projects that stressed teacher involvement in program screening, appeared to have less need for staff training. It seemed that once the teachers knew what to look for in a good program--both technologically and in instructional content--they could incorporate new programs into the curriculum with little additional assistance.

Software Evaluation: The projects visited did not stop reviewing a particular piece of software after it had been purchased. The project staff had ongoing efforts to determine if the software products did meet the needs of the teaching staff. Generally, this type of evaluation was accomplished by questioning the teachers and teacher aides, observing the programs in use by the LEP students, and in some cases developing measurement tools. The measurement tools recorded the number of times a particular program was utilized. It was interesting to note that the software evaluation process for a computer based project was almost always a manual record-keeping operation.

2.3.6 Staff Training

At the projects visited, there was generally one person with prior computing experience, usually in the educational environment. It was this person who made decisions concerning hardware and software acquisitions and provided project continuity. The remainder of the project staff required computer training.

The training provided to the project staff was typically designed to raise their level of computer literacy. The training in effect was designed to teach the staff how to write computer programs. This left a gap in the project staff's training. Specifically, the staff received little or no formal training in how to use computers in an instructional mode.

The project staff, once they had learned how to write programs, became more valuable to industry. At one project, this affected operations because the more experienced aides left the project to take higher paying programming jobs.

Several of the projects provided training to teachers in an effort to raise their level of acceptance of computers as an educational tool. This training appeared to have the desired effect. Teachers began writing their own programs and integrating computers into their workplans. This increased the demand for computers beyond the available capacity.

Training in computers among the general teacher population has been recognized as a need by several of the LEA's. These LEA's have imposed a requirement that in order to advance, teachers must take computer courses. This type of mandated computer training in the view of members of the project staff is counter-productive. Teachers take computer courses, but are not motivated to include computers in their classes. Further, they tend to develop a fear that they will be displaced by computer technology.

2.3.7 Software Licenses

In the computer environment, one does not buy a computer program. What one buys is a limited license to use a computer program. This is similar to buying a book, i.e., the purchaser can use the book but is not permitted to reproduce it.

There is presently a great deal of confusion concerning the restrictions applicable to computer software. Software publishers state that purchasers may not copy the software in any form; Congress has enacted legislation permitting purchasers to copy software for backup; and software publishers in attempting to use technology to protect their products have spawned a new industry to produce technological methods to defeat those protections.

The LEA's visited recognized the problems associated with software licenses. As presently interpreted, an LEA would have to purchase a copy of a computer program for each workstation which is to have simultaneous use. This distinction is relatively clear in a stand-alone workstation environment, but is obscure when dealing with networked workstations.

The LEA's approach to the software license problem varied. The most restrictive interpretation assumed that absolutely no copies could be made of a computer program. If the floppy disk on which the program was stored was damaged or wore out, the LEA would purchase another copy.

This overly restrictive interpretation was not held by most of the projects visited. Most had acquired software which permitted them to copy protected software. Further, these projects had created more copies of copyrighted software than is generally considered acceptable, with the number of copies varying from project to project.

The most common reasons given for using a very liberal interpretation of the copyright restrictions were cost and overly restrictive interpretation of these restrictions. Cost because the LEA's simply do not have the funds to purchase a copy of a computer program for each workstation and overly restrictive interpretation because the project staff believes that there must be a reasonable compromise between one copy per workstation and unlimited copying.

The compromise suggested by a number of staff members of the projects visited consisted of purchasing one copy of a computer program for each school. This was also the most prevalent method of software distribution used at the LEA's included in the sample.

It should be noted that several LEA's, recognizing the problems of copyright infringement, had established guidelines which prohibited copying of copyrighted software. These guidelines were not always followed by the project aides (and sometimes the LEP student) who made copies as needed. For example, at one LEA where copying was prohibited, one floppy disk contained copyrighted computer programs from two publishers. This could only have occurred if someone had copied the software contrary to LEA policy.

2.3.8 Computer Security

Microcomputers present the LEA's with a new set of security problems; first, protection of the computing equipment; second, protection of the computing software; and third, protection of student data maintained in electronic form.

The demand for microcomputers is very high. This high demand has created a market for illegally acquired systems. The majority of the project sites visited had not been affected by theft or vandalism of computing equipment. This was primarily due to security precautions which had been taken at the LEA's. Rooms containing computing equipment were generally locked and alarmed. Computing equipment was indelibly marked and sometimes special locking equipment was used, e.g., equipment which locked the computer to a table or desk.

The seriousness of the physical security problem related to computing equipment can be exemplified by the experience of one of the projects in the sample. The LEA had located their computing equipment inside a locked room with a steel door. Thieves broke down the door and stole the equipment. The LEA attached special locking devices to replacement computers. This time when the thieves broke into the room they could not remove the computers. Since they could not remove the computers intact, the thieves disassembled the computers, stealing the critical components. No attempt has been made to steal the second set of replacement computers.

The complexity of the security problems associated with computers grows when software is considered. Like the physical hardware, the storage medium (magnetic tape or disk) must be protected from theft or damage. What adds to the complexity is that the magnetic images of the stored program must also be protected. This means that the disks must be stored in a location remote from any magnetic fields, e.g., placing a floppy disk on top of the monitor could adversely affect the stored programs. It also requires an environment where the temperature will not get too hot or too cold, e.g., floppy disks should never be placed in direct sunlight for an extended period.

The security problem again increases if student data is stored on tapes or disk. In this case, the data must also be protected against unauthorized access or alteration to ensure the privacy of student information.

Security procedures for protecting computer programs and data are not as obvious as the protection procedures for hardware. The security procedures for programs and data rely on proper handling by the users. For example, when a floppy disk is not in use, it should always be stored in its protective sleeve in a floppy disk box or other proper storage. Further, floppy disks should not be handled while eating and labels should be written before being affixed to the disk.

At the sites visited, it was apparent that some of the project personnel did not understand proper security/handling procedures for magnetic storage media. For example, floppy disks were left on desks or tables when not in use instead of being returned to storage. Further, at some of the sites eating was permitted in the computer area and desks on which floppy disks were placed were also used as lunch tables.

None of the projects visited were using project microcomputers to store or track sensitive student data. There were, however, plans to do such tracking at several projects. Those with networked workstations supported by hard disk had adopted automated procedures with student/teacher passwords for determining if persons attempting to use the system were authorized. These "logon" procedures would provide some data security. Those using stand-alone systems intended to store floppy disks containing student data in a secure location.

The problem of computer security will not go away. As the number of computer courses or computer-aided courses increases, the level of computer literacy of the student population will increase. This will increase the market for computer equipment and software, both legally and illegally acquired.

The growth in the level of computer literacy was apparent at several of the projects visited. A number of LEP students interviewed stated that they had more sophisticated equipment at home than they used in school. These students also expressed the desire to be able to take school software home to use on their own systems.

2.3.9 Instructional Software Used

As previously stated, there is a significant volume of educational software, much of which is not suited for use by the LEP student. Additionally, staff at the projects visited wrote or modified software (using the BASIC language or PILOT/Super PILOT authoring systems). Writing a complete library of educational computer software does not appear to be a viable alternative for an LEA. Designing and writing computer software is a time consuming exercise. One project director estimated that it required 300 staff-hours to develop a simple educational computer program using the BASIC programming language. While he believed this level of effort could be substantially reduced using a authoring system such as Pilot or Sym Pilot, he estimated that it would still require a minimum of 30 staff hours. While estimates as to the staff-time required for program development varied between projects, the basic conclusion was generally the same--LEA's will develop or modify software specific to their needs, but the majority of the software products in their library will be acquired from a software publisher.

Reviewing the software made available to the LEP student provided some interesting comparisons. Of the projects visited, only two used software which utilized a language other than English and only one used software which purported to be designed for ESL use. The two projects using other than English had elected to create their own computer programs. In one case, programs were totally designed and written by project staff to provide instructional mater[illegible]l to LEP students in Arabic. The programs were designed to permit LEP students to choose to read instructional material in English or Arabic. This approach, it was felt, would permit LEP students to move at their own speed from an Arabic environment to the mainstream English environment. One other comment must be made about the English/Arabic software. Specifically, Arabic uses a non-Latin character set and is written from right to left. To accommodate this software, the computers used had to be specially modified. The project is unable to obtain additional modified computers because the computer manufacturer has declined to continue to permit third-parties to provide the necessary hardware modifications.

The second project which used non-English educational software did not write their own programs as did the English/Arabic project. This project instead adopted a logical but novel approach. The project staff felt that LEP students would be able to enter the mainstream curriculum more quickly and better prepared if instructional material, other than English language instruction, could be presented in their native language, in this case Spanish. Lacking the staff to write the necessary programming, the staff decided to rewrite existing English based software into Spanish. This approach permits LEP students to learn subjects such as history using Spanish based software until they develop a minimum level of English competency at which time they switch to the English based version of the program.

No matter what language was used to present material to the LEP student, the instructional approach was generally the same. Computer software was geared to drill and practice and reinforcement of course material. The approaches used in these exercises often showed an imaginative use of graphics, but still presented course material using traditional techniques. The principle benefits derived from using this software were; one, motivating the LEP student; two, permitting teachers to individualize the level of drill and practice required by the LEP students; and three, providing the LEP student with a non-threatening learning environment, i.e., the computer doesn't get mad, never scolds, and has infinite patience.

One project did show a very innovative use of computer technology. This project instructed LEP students (kindergarten thru 12) in the use of word processing software, then gave the students the responsibility for producing a weekly school newsletter. This approach provided the LEP student with a number of benefits including:

- keyboard/typing skills,
- practice in expressing thoughts in written form,
- practice in English composition,
- practice in layout and design of newspapers,
- practice in the use of graphics to illustrate stories, and
- experience in planning tasks against a fixed deadline

Application software which is purchased has generally been acquired from small organizations which were spawned by the computer revolution. These firms have little or no experience in delivering educational materials to LEA's. Thus, they typically market their software as products with little emphasis given to establishing a long-term relationship with the LEA. To the LEA this means that as a general rule, the LEA cannot count on the publisher to correct programming errors, provide advice in the proper use of the program, advise the LEA on new versions of the purchased program, or even make LEA personnel aware of other products offered.

One LEA visited provided a good example of the lack of support or communication with the new software suppliers. This particular LEA had purchased several computer programs from a software publisher. This publisher then asked the LEA to serve as an advisor and provide critical reviews of new educational software products. The LEA agreed and reviewed the first computer program provided. The LEA's review was highly critical of the educational approach and technological adequacy of the program. After sending this report to the publisher, the LEA has not been asked to review any other programs. Nor has the LEA received any correspondence from the publisher concerning their critique.

The publishing houses such as McMillan, McGraw-Hill, Random House, and Britannica which have traditionally been suppliers of educational material have recently entered the educational software market. Personnel from the projects visited stated that they were disappointed in the initial product offerings of the traditional suppliers. Most of the publishers have apparently adopted a cautious approach to educational software to minimize the impact on their textbook market. A number of their educational computer programs simply consisted of automating existing textbooks; others were written to be used simultaneously with textbooks. Later offerings from the same suppliers have shown more imagination and preparation.

Almost all of the projects visited were using software products from one software publisher, the Minnesota Educational Computer Consortium (MECC). This is a non-profit organization which develops and distributes educational software. MECC has a large library of educational computer programs, the majority of which are limited to use on APPLE computers.

The primary reason projects used MECC software was its lower cost relative to the cost of commercial software. There was, however, a difference in the quality of MECC software when compared to commercial software. Projects rated commercial software from poor to excellent, with MECC software generally rated poor to good, i.e., no excellent ratings. The overall feeling was that commercial software was a better product in terms of imaginitive use of graphics, use of color, educational contents, and documentation than MECC software. One resource teacher explained the difference by stating that the best MECC software was "B" software. Previously, MECC programs would have rated an "A", but commercial software now being distributed has improved so much that the MECC software had to be downgraded.

Appendix B contains a list of some of the software used at the sites visited.

2.3.10 Relation to Curriculum

The placement of the computers appeared to have an effect on their use within the instructional curriculum. At most sites, the computers were placed in a computer lab. Students would attend the lab on a "pull-out" basis. This arrangement tended to make the use of computers a diversion from the normal classroom work. Further, it increased the need for close coordination between the teacher and the computer aide. Without this close coordination there was no assurance that the computer exercises selected by the aide would address the problem areas of specific LEP students.

Instead of placing the computers in a separate lab, some projects had elected to placed the computers in the classroom. This was accomplished in one of two ways; first, the computers were arranged as a computer lab within the classroom; and second, computers were placed in the classroom as another teaching tool available whenever the teacher felt its use was appropriate.

The primary difference between the use of a separate computer lab versus placement within the classroom was obvious. Where teachers had direct control of the computers they tended to become more familiar with their capabilities and thus more innovative in their application. For example, at separate computer labs, student use tended to be limited to drill and practice exercises as determined by the computer aides in discussions with the teachers. At those sites where computers were located in classrooms, LEP students used computers in more creative endeavors, such as writing stories complete with computer-produced illustrations.

The difference in teacher attitudes toward computer use depending on their placement was clearly illustrated by an accidental placement of computers within a classroom. At this project, the computers were generally located in a separate lab. In one school, however, due to space limitations, the computers were located in a classroom. The teacher at this site became involved in the students' use of the computers, working with the aide to ensure that software selection was appropriate and even coordinating some of the computer work with the classroom work. Teachers at the other schools, while supportive of the project, did not have the same level of involvement or appreciation of the use of computer technology in the educational environment.

Project personnel at all sites recognized the need to have computer use coordinated with classroom work. To encourage teachers to become more involved, projects sponsored in-service training and provided assistance to the teaching staff in using and evaluating computer software. At one site, the efforts to encourage teachers' involvement were counter productive. Project personnel conducted training during the summer, encouraging teachers to develop their own instructional software. The teachers became motivated and during the next semester they developed software and scheduled their students to use the computer lab. Unfortunately, there was insufficient equipment to meet the demand. This resulted in teachers who wanted to use the computers but were unable to reliably schedule their students. At the time of our visit during the second semester, the computer lab was virtually unused. Teachers stated that they had given up on the use of computers because of the scheduling conflicts experienced during the first semester. Project personnel stated that funding for equipment had been reduced during negotiations.

The experience of project personnel showed that the teachers who were best able to utilize computers were those who recognized that effective use required a change in their teaching methods. Computers permit teachers to individualize instruction to meet the needs of a specific student. Computers also change the way in which teachers interact with the student. Teachers at several of the projects learned how to use the computer as a teaching tool, a tool which took on the routine drill and practice and could also be used to motivate. This left the teacher better able to allocate time to teaching new material or helping students who had specific problems with the material.

2.3.11 Impact on the LEP Student

Children appeared to have no fear of computers. This was true no matter what the student's background. Students from rural areas of third-world countries were just as comfortable with computers as students from urban European countries. During one site visit, an LEP student had been placed on a computer his first day in school. The student was not afraid to push keys until the computer responded.

There was a difference of opinion as to whether a student with no English competency should be immediately placed on a computer. Some project personnel felt that students with no competency could benefit from computer use. At other sites, project personnel believed that a student must have a minimum level of English competency before computer assisted instruction can be effective.

Computers appeared to motivate students. This motivation affected student performance in areas other than computer instruction. LEP students in the computer based projects tended to have better attendance and showed improvement in other classwork. In some cases, this motivating factor was forced. Students with poor attendance or who fell behind in their classwork were not permitted to use the computers.

Educational software is designed to provide positive reinforcement. Generally this is through the use of graphics. Much of the software observed had extensive graphic displays such as smiling faces, whenever students responded correctly to a question. These graphic displays were obviously thought by the writers to be favorable attributes for a computer program. However, this was not always the case. In a number of instances, LEP students obviously became bored with the graphic displays, wanting only to know whether their response was correct or incorrect.

Student frustration with educational software was also apparent with computer programs which constantly wrote to/from the floppy disk. Input and output to the disk is a slow process. Students using such a program evidenced their frustration at the pauses in the program by drumming on the computer keyboard or doing unrelated homework assignments.

The interaction between the computer aides and the students had a significant effect on performance. The LEP student could quickly become confused if something happened which the aide had not explained. For example, at one site, a student entered a correct response, but the computer indicated an incorrect response. Instead of evaluating why this occurred, the computer aide restarted the program. This left the student confused because the machine did not respond correctly and he did not know why. An evaluation of the problem, an evaluation which the aide should have performed, showed that the student had entered the correct response followed by a blank. The computer program incorrectly treated this response as an error. Once this was explained to the student he could continue to use the program, making sure that responses were not followed by a blank space.

The impact of poor quality software on student performance was a major complaint of project personnel. The correct response followed by a blank was only one instance of programming problems which directly affected students. Other problems included:

- Incorrect examples used in instructional material, e.g., "Either apples, oranges, or pears were packed for the picnic."

- Questions asked, but all correct responses were not considered correct. This appeared to be a problem where the program author interpreted the question only one way while multiple interpretations were possible.

- Computer programs where the response was too slow, e.g., the student would type one letter of a word then was forced to wait for the computer to repeat the letter before continuing to enter the word.

- In some computer programs students were required to enter special control codes to direct program execution; in other programs, these same control codes terminated execution or caused the program to restart.

- Some instructional software was structured with extensive text. This software required students to read the text and isolate key points. Students had a tendency to want to refer back, as would be possible with written material, but could not as the programs did not provide for such a capability.

- Much of the educational software observed did not provide students with an explanation of why responses are wrong. While this is appropriate for testing, project personnel believed it was not appropriate for instructional software.

- There is a limited amount of native language instructional software. Further, special characters for non-English languages, but Latin based, cannot be displayed on the computer monitors without special modification.

Of potential significance concerning the use of computers is which students are permitted to use them. At the sites visited, computer use was generally limited to gifted and LEP students (due to the I›Ed funded projects). The general student population did not use computers as part of their curriculum.

The limitation of computer use has resulted in LEP students who are mainstreamed to the general population feeling like they are being punished. At several project sites, special exceptions had been made to permit LEP students to continue their computer work after being mainstreamed.

At one site, non-LEP students were occasionally permitted to fill out lab sessions where there were not enough LEP students. The aide responsible for this site teamed an LEP student with a non-LEP student. This approach appeared to have a positive effect on the LEP student. The LEP student knew how to use the computer and the instructional software, the non-LEP student did not. This resulted in the LEP student becoming the teacher to the non-LEP student, a situation which noticeably enhanced the LEP student's self-esteem.

There was some disagreement among project personnel as to the proper ratio of students to workstations during a class. Some projects preferred a 1 to 1 student workstation ratio while other preferred 2 students per workstation. There was a general consensus, however, that three students per workstation may be acceptable in some situations but never more than three. This means that a single workstation can service about 9 to 18 stude[illegible]er day assuming each student averages thirty minutes on task. If the 2 students per workstation ratio is exceeded, project personnel did not believe that students would have sufficient time on task to permit effective use of the teaching software. Further, three or more students per workstation would increase conflict as students decide who is to run the computer.

Students seemed to like using computers more than traditional teaching approaches. Part of this attitude can be attributed to the computer's novelty and the use of instructional games. But these components do not totally explain the level of acceptance of computers by the students. Questioning the students did not provide an answer, because they could not explain why they liked working with computers, they just did. Although undocumented by performance measures, students and staff consistently stated that LEP students did learn from the use of computers. With the development of better software and hardware, it can be expected that the role of computers will expand.

2.4 Summary

In the course of this study, four different applications of technology to educational problems were reviewed at nine sites. Though the technologies were dissimilar and their application varied between project sites, there were a number of parallels such that several statements can be made about the application of technology to education:

- Technology does have a place in education. All the sites visited showed that students do learn more effectively with the proper application of technological tools. What cannot be isolated is what portion of this learning can be attributed to the technology itself, to the changes in teaching that the use of technology imposes on a curriculum, and to the motivational aspects of using technology in a school environment.

- Application of technology to bilingual education is extremely limited. Only two of the projects visited had incorporated the use of bilingual approaches with the new technology. Instead, most projects had established an ESL approach or had adapted, or attempted to adapt, standard English teaching approaches to teaching English to LEP students.

- Projects tend to be dependent upon one key person. If that person leaves, the project would most likely fail. The schools do not yet have depth in personnel who understand how to use technology in educational programs for LEP students.

- Planning for the use of technology is generally not sufficient. This tends to result in under-funding of projects as LEA's cannot support cost estimates during negotiations. For example, one project visited has a computer lab which was virtually unused during the site visit. This was a direct result of not having sufficient equipment to meet teacher demand such that teachers became disillusioned with the project's ability to support their teaching curriculum.

- Staffing is a problem. Teacher aides with a background in the new technologies cannot be hired at the permitted salary levels. This requires LEA's to train the staff to meet the educational levels required. This approach has two major drawbacks. One, the aide is performing at less than an optimum level until training has been received; and two, as the aides are trained, their marketability to industry is increased, i.e., the aide is trained for higher paying jobs in industry.

- There needs to be a greater emphasis on measuring effectiveness. None of the projects visited had evaluation methodologies in place which would permit isolation of the effect of the technology on the LEP students. Elements such as time on task and response time to questions could have been captured to provide more information concerning the effectiveness of computer programs. Several of the projects visited anticipated using such measures to evaluate the effectiveness of specific computer programs.

- The video approaches tend to be staff intensive and have high equipment costs. The computer-based approaches appeared to have the greatest effect and applicability to other LEA's.

- At all projects it was clear that no matter what technology is used, the need for high quality teachers and aides is not reduced. Technology relieves educators of much of the routine teaching tasks but it also increases the level of training that a teacher or aide must have. Simply stated, technology can make a good educator better, but it cannot make a good teacher out of a poor teacher. Further, while it can multiply a teacher's effectiveness, it cannot properly be used as a substitute for quality staff.

The role of technology in education will continue to expand. Computers are certainly asserting their place and as more LEA's develop video capability, the approaches used in the video based projects studied will have greater applicability.

CHAPTER THREE

3.0 Problem Definition: What Do You Want to Do?

Technology is a tool. It is a means to an end. It is not an end in itself. For example, a hammer is a carpenter's tool to drive a nail. The carpenter's goal is not to use the hammer, it is to build a house. In order to build that house, the carpenter must follow a set of blueprints or plans. Technological tools are no different. Like the carpenter's hammer, technological tools must be used according to a plan (blueprint) to achieve a defined objective, e.g., build a house.

In education, the general objective of helping students to learn more quickly and effectively is often used as a program objective. With a new technology, such a broad objective is inappropriate. The objective must be stated clearly and concisely so that the proper technological tools can be selected and applied. For example, the objective of a project might be to make a bilingual teacher more accessible to Limited English Proficient (LEP) students in several scattered schools. This objective is sufficiently precise to determine that bidirectional television would be appropriate.

As part of this project, the funding documents for 544 grants were reviewed. Of those, 114 were identified that requested funds for new technology and their objectives analyzed. This analysis showed a lack of specificity in many of the project objectives. The desire to "improve the educational environment for the LEP student" was used most often to justify the instructional approach. This rationale is not sufficiently precise to evaluate the appropriateness of the new technology. This led to the funding of projects whose stated use of technology was not appropriate. In several instances, after receiving grant approval, the local school system significantly altered a project's approach because they discovered that the approach was unsuitable or unworkable.

The underlying or true rationale for electing to use technology fell into one of two categories: "reactive" and "need based."

Reactive rationales tend to meet needs or requirements not directly related to instructional needs. They also tend to be opportunistic. For example, the underlying rationale for establishing a new program could be to retain staff who have been working on other grants that are due to expire; or, the decision to use technology could be in response to a district or state directive to develop computer based projects.

"Need based" requirements are rooted in specific needs of LEP student populations. For example, one project targeted the writing deficiencies of its LEP students. It used word processing software to motivate student to develop and practice writing skills.

If a project is need based, objectives can be clearly defined and evaluation criteria can be developed to measure the project's success. On the other hand, evaluation criteria tend to be "soft" and imprecise if a project is motivated by a reaction to an imposed requirement or to take advantage of a non-instructional opportunity. The project tends to concentrate on the process rather than a goal, analogous to the carpenter concentrating on using the hammer rather than building the house. When the process, rather than results, become the focus, problems arise that range from the acquisition of unneeded or inadequate equipment to wasting resources on approaches whose effectiveness cannot be determined.

The need for clearly defined objectives is not unique to projects using technology. Any new or innovative educational approach should have a means to determine whether funding should be continued or if the approach should be, or could be, expanded to other locations. Without clear objectives, the ability to make this determination is severely hampered.

School systems should consider several factors when they define the objectives for a new technology project:

1. The needs of the LEP student population;
2. Whether existing programs meet student needs and if not, why not;
3. Whether existing programs can be modified to correct identified problems.
4. The problem areas that the proposed project will address.

3.1 What is Educational Technology--Does it Have a Role in Solving the Problem?

Once a school system has determined its goal or objective, it can turn its attention to developing a project methodology, i.e., how to reach those objectives. In developing this methodology, a local school system has the option to use a variety of traditional approaches or apply technology. A decision to use a technological approach should be based on a thorough understanding of the technology--its advantages, limitations, and operational problems. In several of the projects studied, decisions to use technology or a specific form of a technology were made by default. When the Department of Education identified educational technology as a funding priority, it created an incentive to propose projects that featured educational technology. Likewise, several school districts had already decided to purchase APPLE computers, therefore the LEP project used APPLE computers.

The technologies used at the projects studied included variations of computer or video approaches. Of the two, computers required a greater, or at least broader-based, understanding of the technology. The reason for this is relatively easy to understand. Video approaches tend to limit contact with the technology to the project staff. Students and teachers view the end product, i.e., the videotape or television session. Computers, however, require that teachers, students, and administrators learn something about the technology. They must become "computer literate." That is, people must, at least, learn the language of computers. Those sites that had project staff who understood computer technology were better able to apply the technology to their specific educational environment.

The principal advantages of technology are its ability to expand the availability of scarce resources, e.g., teachers with specialized teaching skills can reach more students, and to individualize instruction, e.g., students can progress at their own speed. The major drawbacks of technology are the cost of equipment and the need for technologically skilled staff. Technology is appropriate if the school district determines that the benefits of the instructional approach outweigh the cost of equipment and problems encountered when hiring and retaining skilled personnel.

3.2 Which Technology is Appropriate?

Once a school district decides that technology can benefit a program, the next question is which technology? This project studied two basic technologies, video and computer. Deciding whether the use of video is appropriate is relatively simple. The decision to use video technology is generally based on the availability of equipment. Video's primary benefit of expanding the availability of teachers with specialized skills frequently is outweighed by the high cost of trained technicians and video equipment.

Deciding whether computer technology is appropriate is more difficult. Webster defines a computer as "an automatic electronic machine for performing calculations." This is an accurate definition. It describes the methodology by which a computer performs its operation. It is, however, a misleading definition. This simplistic definition does not address the machine's multiple uses.

A computer is an extremely versatile machine. It can perform any number of tasks ranging from flying an airplane to teaching a student. It has this versatility because it can make decisions. Given a number of diverse stimuli, a computer can select the best or most logical alternative. This is not to say that computers can think (although there is ongoing research in this area). Computers are provided with a set of instructions, called software, which direct their operations. This software instructs the computer as to what action or response is appropriate when a specific condition occurs or stimuli is received.

The basic limitation of computers is that their decision-making process is deductive. Decisions or operations must proceed one at a time in a logical sequence. Computers must proceed from A to B to the result C. They cannot use inductive reasoning to determine that given A the result is C, skipping the intermediate step B. This limitation is largely offset by a computer's speed. Computers typically perform millions of operations per second.

Because today's computers operate deductively, the tasks to which they can be and have been applied have several common characteristics:

- The process can be described in discrete steps;
- The process is repetitive; and
- Often the process requires the manipulation or retention of large volumes of data.

In education, computers are generally appropriate for three situations. First, to teach students computer technology; second, as tools in performing the mathematical computations required in statistics or other scientific curricula; and third, as a tool in teaching other subject matter such a mathematics, history, or English. The applicability of computer technology in the first two situations is obvious. In the third, the school district must evaluate the instructional approach to determine if it fits the characteristics of a computer task. Specifically, can it be discretely described and is it repetitive? Typically, drill and practice exercises meet these criteria.

It should be remembered when comparing the capabilities and attributes of video and computer technology that one is not a substitute for the other, just as a screwdriver is not a substitute for a hammer. A decision to use a specific technology should be based on its applicability the instructional methodology and the availability of funding and personnel.

3.3 Pursuing the Computer Option

If a local school district determines that computer technology can make a positive contribution to a particular instructional approach, the next step is to decide which form of computer technology best suits the needs and goals. A computer is not a single entity. It is a collection of electronic and mechanical components combined into an integrated system. Direction and control of this system are accomplished through sets of computer instructions called software. The nature of the hardware and software define the capability and versatility of the computer system.

A computer system has the potential for a wide range of instructional and administrative applications. For example, one application could be monitoring students' daily attendance. In addition to simply recording and documenting student attendance, the computer could automatically call the absent student's home with a pre-recorded message in the student's native language requesting a written excuse.

Computer systems are capable of many other data management functions. While not as striking as calling parents in their native language, computers can be important for administration and program management. They can assemble demographic and performance information and manipulate that information to provide managers with precise, up-to-date information on student population, languages, location, and student performance. Such systems permit managers to access information that can improve instruction through easy periodic monitoring. Such monitoring could be performed at the school and classroom level as well as the program or district level.

Educators are most interested in the instructional applications in which students interact directly with computer systems. Computers can provide three broad types of support to student learning.

Instructional Support - The computer controls the conduct of the session. The student must respond to the computer in a specified way. Drill and practice exercises best exemplify this type of instructional support.

Collaborative Support - The computer provides situations that require the student to think and reason before providing responses. Adventure games and simulations are good examples of collaborative support.

Facilitative Support - The computer helps the student to perform tasks that are almost exclusively under the control of the student. The use of word processing to teach writing and critical thinking skills are excellent examples of facilitative support.

Selecting the appropriate mix of hardware and software is critical to the successful application of computer technology in an instructional program.

Computer hardware and software are inextricably linked. Software is useless without a computer. A computer is useless without software. A computer system may be functional without an appropriate mix of hardware and software, but it will not make the most effective contribution to solving a problem or completing a task.

Hardware

Computer systems can be tailored to the needs of a specific application. For example, if a computer system is to be used to teach a language, it may be useful if the computer could vocalize the language. In this case, a speech synthesizer might be added to permit the computer to "talk."

Picking the right computer system for a particular project requires an understanding of computer technology, project objectives, and the instructional environment. The task of selecting a computer system has never been simple, and is growing more complex. In the early years when computer instructional use first began, few computer manufacturers or computer service bureaus viewed secondary or elementary schools as viable sales opportunities. Now, however, most computer manufacturers are targeting the education market. Thus, in recent years the number of equipment choices has expanded significantly. The nine grant proposals reviewed during this study reveal that the local school districts proposed only three sources for computers or computer resources. They proposed purchase of:

- computing resources on a time-as-needed basis from a commercial computer service,
- computer systems based on equipment from the APPLE Company, or
- computer systems based on equipment from Radio Shack (TRS-80).

Since the local school districts in this study used only these three resources, the project sample was correspondingly limited. This report should in no way be considered an endorsement or criticism of the computer systems discussed. Such conclusions could not be drawn from a report of this nature. The superiority or inferiority of a computer system or resource must be determined relative to a given application and environment. Thus, such decisions regarding equipment selection can only be made at the local or user level.

Two of the grant submissions that were reviewed for this study proposed acquiring all computing resources, i.e., computer terminals, software, etc., from a single contractor. Computer resources were to be provided on an as-needed basis from a large, centrally located computer connected to the schools via telephone lines. This approach has been one of the more common methods of providing CAI to schools. Like any approach, this method has good and bad features. For example, due to cost considerations, this approach tends to be limited to large projects. One project visited during this study had considered the approach, but abandoned it for lack of funds. Since none of the projects visited was actually using this methodology, its features and characteristics are not discussed. Use of a contractor for total computer support is mentioned in this report to illustrate that a multitude of alternatives are available for developing a CAI program. The guidelines for planning and developing a CAI program included in this report do, however, apply to methodologies that are not discussed in this report.

Computer components at the sample sites were arranged or configured in one of two ways. Stand-alone configurations, consisting of one or more independent computer systems, were most prevalent. Each computer system had:

- a keyboard to provide information directly to the system,
- a video monitor, usually with color capability, to display information from the computer in either text or graphic form,
- a base unit containing the central processing unit, memory, a tone generator, and other supporting electronics, and
- one or two disk units capable of using 5 1/4 inch floppy diskettes.

Additionally, one system, generally used by project personnel, had a printer to produce hardcopy or printed information. The stand-alone systems were based on equipment manufactured by the APPLE Company.

The second equipment configuration used at project sites was a network. In this case, two or more computer systems were connected through the use of cables. Each of the systems or (workstations) had:

- a keyboard,
- a video monitor, generally black and white, and
- a base unit containing the central processing unit, etc.

Individual workstations were connected to a master workstation. In addition to a video monitor, base unit, and keyboard, the master workstation also had one or more disk units (a hard disk and floppy disk or a single floppy) and a printer. The network systems were based on equipment manufactured by Radio Shack.

The configuration of a computer system can have a significant effect on the operations of a CAI program. Each project in this study maintains a library of computer software. At sites using stand-alone systems, LEP students or project staff remove a floppy disk from the software library and load it into the disk unit of one of the computer systems. At sites using a network system, computer programs are loaded to individual workstations from the master workstation. If the master workstation has only a floppy disk, the process of loading different programs from the library to the individual workstations can be more time consuming than with stand-alone systems. However, if the master workstation has a hard disk, loading different programs to the workstations is extremely fast and could be an automatic process. For example, an LEP student could enter his name on his console. The computer would check to see what program the student is scheduled to use and automatically load the program from the hard disk.

With either the floppy disk or hard disk, the network does reduce the effort and problems associated with maintaining a software library. With a network, the library need only retain one copy of a software program. The stand-alone arrangement generally requires that the library retain one copy for each computer that needs to use the same program at the same time, i.e., if six students are to use the same program at the same time on different systems, six floppy disks with that program must be maintained in the software library.

The network arrangement also may have a cost advantage over stand-alone systems. Each stand-alone system requires one or two disk drives. A network system typically shares such resources. Thus, as the number of workstations increases, the network's cost per workstation decreases. At some number of workstations (a number that may be as low as 5 or greater than 10 depending upon specific equipment costs), the cost per workstation for the network will be less than the cost for a stand-alone system. The network's cost advantage may be increased by the reduced cost of software, i.e., a number of software publishers charge the same price for a copy of a program whether it is installed on a network with multiple users or on a single user stand-alone system.

It may appear that the computer network is the configuration of choice when planning a computer arrangement. This is not always the case. Networks have several drawbacks that may make the stand-alone system more appropriate for a particular application. The major drawbacks are:

- failure of the master workstation would render all workstations unusable;

- failure of the cable system (communications) could render all workstations (except the master) unusable,
- the cost of connecting workstations could be excessive if they are located a distance from the master unit,
- needed software may not be available for use in a network arrangement,
- it typically requires a better understanding of computer technology to establish, maintain, and effectively use a network than stand-alone systems, and
- if all students using the network attempt to use the disk at exactly the same time, it could overload the communication capacity of the system.

Given the differences between networks and stand-alone systems, the logical question is how to select the best arrangement. This question can only be answered in the context of each situation. Each local school district must weigh their specific objectives and environment. Based on the experience of sample projects, however, there are several guidelines that can assist the decision process:

- In a laboratory situation, where all workstations are located in one room, a network is generally more cost effective than stand-alone systems.
- In situations where workstations/computers are located in classrooms, stand-alone systems tend to be more cost effective.
- Where fewer than five workstations are required, the network does not have a significant cost advantage and is often more expensive.
- The system configuration is a secondary consideration to the availability of software that is appropriate to the instructional objective.
- Maintenance is more of a concern with a network than with stand-alone systems. Even though a network could have a lower frequency of failure than a stand-alone system, the failure of certain critical components could make the entire system unusable. Thus, LEA's considering a network system should have a stable

source of critical components and qualified maintenance personnel.

Both the stand-alone and network systems performed the tasks to which they were applied. However, the network system had greater potential for impacting a project's operations. Network systems have the capability to automatically capture and manage information concerning student performance on the CAI software. Such systems also could be used to better manage CAI software and develop simpler, but more secure methods for selecting specific computer programs for student use. One of the projects planned to use their network system in this manner. At the time of the site visit, the project staff was negotiating with a major software publisher to purchase software which would permit their computer system to perform these management and control functions.

Software that works on one computer system may not work on another, even if the other system is produced by the same manufacturer. For example, computer programs used on APPLE II computers cannot be used on TRS-80's produced by Radio Shack, nor can the APPLE II programs be used on APPLE's McIntosh.

Since software is not necessarily interchangeable, software availability should be a consideration in determining which computer is best for a specific application. This analysis, however, should be based upon the number of programs appropriate to address a defined objective and not on the total number of programs available for a particular computer. For example, one of the reasons given for selecting an APPLE over the Radio Shack TRS-80 was the larger volume of educational software written for the APPLE than for the TRS-80 (3,000+ for APPLE, 2,000+ for the TRS-80). Limiting the analysis to software appropriate to a project's objectives, however, tended to eliminate APPLE's numerical advantage. Further, in a number of cases the same software was available for both machines or successful software developed for one machine served as a model for software developed for other systems. In fact, the major difference in available and appropriate software between the APPLE and TRS-80, in the opinion of the site staff, was not numbers, but the greater use of color and graphics in software developed for the APPLE.

Software

Any software available for a particular computer can make the computer work. Making the computer work effectively, however, requires that the software be appropriate to the project objectives as well as being instructionally and technically sound. For example, if the objective is to teach English, software designed to teach math is not appropriate. If the software uses grammatically incorrect examples, it is not instructionally sound. If the software accepts incorrect responses or rejects correct responses it is not technically sound.

The number of educational programs that are not instructionally or technically sound is extremely high. Personnel at the project sites were remarkably consistent in rejecting 70 to 75 percent of the software they evaluated.

The absence of quality software is one of the greatest impediments to successful CAI programs for LEP students. The technical sophistication required to develop such quality software does not exist in the public schools. It does not appear to exist in the educational community in general. Further, in education generally and in bilingual education in particular, there seems to be a mistaken assumption that the subject matter expert must also write the software. This is not the case in the business world, where the expert on a subject or the end user establishes the objective for a computer program, i.e., tells the programmer what the software should do. The end user tests delivered software, evaluates its performance and either accepts it or sends it back for revision. This could, or should, work in the field of education.

Since the projects were funded under the auspices of bilingual education, it was surprising that only two projects used educational software in a language other than English. In both cases the software was developed locally. Project staff at one site developed software that provided simultaneous visual display of English and Arabic. At the other, project staff had obtained permission of software developers to translate and adapt the software from english to Spanish. In the former case, sophisticated technical skills were required to develop the software. In the latter, limited technical skills were required to adapt the software.

More surprising than the lack of software which supported instruction through languages other than English was the lack of software designed specifically for teaching English as a second language. Only one site had a software program that had been designed specifically for ESL instruction. The project staff rated that software product only "fair." The reasons given for the non-use of software to support ESL instruction ranged from a simple statement that it did not exist to the judgment that technically and instructionally sound software designed for English speakers was preferable to technically or instructionally poor software intended for LEP students.

The absence of appropriate software in projects funded to teach English to LEP students makes it difficult to use CAI for that purpose. The problem is not necessarily in the individual projects but rather in the software industry and in the educational network that supports bilingual programs.

Commercial software developers have concentrated their efforts where they can expect the greatest financial return. As has happened in the general educational publishing area this means that specialized markets, such as English as a second language and bilingual programs, have not received the resource investment that other areas have received. Products for this market tend to be locally developed in a "cottage industry" fashion. As a result, the quality of available software is not consistently high. Nor is the software nationally advertised or distributed.

In order to use software a project must first know of its existence, be able to obtain a copy for evaluation, and evaluate its applicability to the project's goal.

Publications, such as "The Computing Teacher", try to reach the largest educational audience possible. Reviews of software contained in such publications rarely include software for LEP students. There is no single source of information on or reviews of software for LEP students. Each individual project is left to search among a variety of sources for appropriate software. Staff at every site visited voiced the same need to know what has been developed, where it is available, and what other users think about the product.

Several organizations have been established to serve as focal points for bilingual information. Personnel at the sites visited did not consider these organizations as sources of software information. Either project personnel did not know of the availability of software information or, after reviewing information, did not feel it was useful.

Each school district has an obligation to evaluate software for applicability to their particular population and educational environment. But, in case after case, projects had spent precious staff time reviewing and rejecting the same software. Without information flowing among educators concerning software quality, a lot of time is wasted at each project. If nine projects reject the same piece of software it is possible that a tenth would still find it useful. However, if that tenth project had access to the other evaluations, it could make more efficient decisions in the evaluation process.

Currently the only access projects have to such information is the result of their own initiative in contacting other projects and trading information.

Software evaluation is an important process that must be performed at the local level. Information from other projects would greatly increase the efficiency in locating and selecting software. Still, the educators must evaluate software based on the specific needs of students in their programs.

Software evaluation is composed of two basic parts, technical and instructional.

These technical components should be considered first:

- Is the software compatible with the computer system?
- Are the hardware requirements (memory and peripherals) of the software in the schools?
- Does the software perform as described?
- What manipulation is necessary to use the software?
- Can the software be used immediately or must the student be taught to use it?
- Are there weaknesses in the program? Does it recognize and correct for common keyboard mistakes by students, for example, leading or trailing spaces? How quickly does the program perform? Can students easily interrupt the program? Can information be lost through student actions? Is complete documentation available?

After the software passes the technical evaluation it should be evaluated for instructional merit.

- Are the stated objectives in consonance with established goals?
- Does the software actually teach or support the stated objectives?
- How are errors handled?
- Is the frustration level related to the instructional objectives or to the manner in which the program performs?

A final consideration in selecting software is cost. Projects can be ignorant of the specific restrictions of the copyright laws regarding the use and copying of educational software. This can be exacerbated by the failure of software suppliers to clearly define to the purchasers what rights they have when they purchase a piece of software. A software producer which allows wide copying and use of its software within a school or district may, in the long run, be cheaper than one which insists on the purchase of separate software for each computer or work station. At present there is no consistent policy among software producers nor among educational agencies which purchase the software.

LOCATION: WHERE DO YOU PUT THE COMPUTERS

The projects that were studied for this report use several different environments for teaching LEP students. The most common is a computer laboratory much like the audio-tape language laboratories found in schools. Students come to the computer lab at scheduled times for computer assisted instruction. In general, this requires that students leave other classes in some organized manner. It demands careful attention to the logistics and scheduling of the program in coordination with other school activities. The principal advantage of a computer lab is that it increases the number of students who can use CAI during the school day. With a lab, it is possible for equipment to be in full time operation and available to the entire school population during the entire school day.

Two staffing options are available for the computer labs. The most frequently used was the full time staff option. The staff operated the lab and were responsible for all activities while students were in the lab. This staffing option is especially attractive because only a few individuals need CAI training to initiate the program. The greatest disadvantage of this option is the separation of the computer lab from routine classroom instruction. The problems of physical separation can be compounded if the computer lab develops a secondary curriculum that has no direct relationship to primary classroom instruction.

The second staffing option is to have teachers bring their students to the lab at scheduled times. This ensures that the teachers responsible for primary instruction remain in control of the computer assistance their students receive. The disadvantage of this approach is that teachers need CAI training before they can make effective use of the laboratory. This approach also restricts teacher flexibility because of the constraints of scheduling the computer lab.

The second design option is to locate the computers in the classroom. With this option teachers are free to schedule and use the computers based on individual student needs and classroom organization. The advantages of this approach are that instruction can be individualized by the teacher, the person with primary responsibility. The major disadvantage is cost. Most school districts cannot afford to equip every classroom with three or four computers or workstations. Physical security for the equipment is also a problem. It is easier to secure equipment in one computer lab than in every individual classroom. In addition, this option requires that each and every teacher receive extensive CAI training before they can effectively use the equipment.

Decisions to locate computers in a laboratory or in the classroom will have a direct impact on the amount of time students can spend with CAI. With a lab design, students must follow a generally rigid schedule. As one group leaves the lab another enters. Students and teachers have very little flexibility. A student who needs a few more minutes to complete a task must stop to make room for the next group of students. Stopping a program short of completion generally means that the student must repeat the entire exercise because most programs do not have the capability to restart in the middle.

The scheduling problem has two solutions. The school can purchase software that has the capability to restart at any point in an exercise, or labs can be scheduled with sufficient time for all students to complete assigned tasks. The first solution is not entirely under a school's control. Publishers will only develop software with a restart capability if the market demonstrates that such a requirement is widespread and has a monetary value to offset the added cost of program development.

Guaranteeing sufficient time for students in a la environment is complicated by the basic concept of CAI and the rigidity inherent in lab scheduling. CAI's greatest strength is its ability to be individualized to the needs of each student. This means that students, even those using the same program, can and generally will complete tasks at different speeds.

Based on the experience of project staff at the sample sites, the best time interval for a lab session is thirty minutes (or longer) exclusive of movement between rooms. The software used at the sample sites could be completed by most LEP students in thirty minutes. Shorter time periods mean that a greater number of students would be unable to complete assigned tasks. Further, shorter lab time makes it more difficult for the lab teacher or aide to monitor each student's progress.

In lab situations, it is important to select software that can be restarted or is designed so the majority of students can complete the work during the established lab time. Where lab sessions are shorter than thirty minutes, the software selection process becomes extremely difficult.

Time is not a severe constraint when computers are located in the classroom. The teacher knows which students can most probably complete an assignment in the available time. Teachers can lengthen or shorten the CAI segment at their discretion.

There is no single estimate of the "average" time of educational software. Drill and practice and game format software tend to have shorter running times than simulations or adventure format software. The first can be as short as two or three minutes while some adventure software can take months to complete. Naturally, almost all adventure software can be interrupted and restarted at the point of interruption. Facilitative software, such as word processing, is totally time independent. The task and the student determine the time necessary. This software also allows the student to work, stop, and restart at any point.

The identification of 30 minutes as a minimum time period for a computer lab is not based on an average time. It is based on the longest time a student generally needs to complete common used non-interruptable software. Below-average students could complete a large selection of the reading comprehension programs in 20 to 25 minutes. Those who finish in less time can be given another assignment that corresponds to the remaining time.

Theoretically, a single workstation can support maximum of 13 students in one day, assuming a lab session of 30 minutes. All'wing 10 minutes for student movement between classes and set-up plus 20 minutes at the beginning and end of the school day for other activities reduces this number to 8. This estimate does not provide for lunch and teacher/aide planning periods or other occasions when the lab may not be scheduled for use. This assumption was made because multiple aides were assigned to each lab at the sites visited. This permitted the aides to alternate lunch and planning periods so labs were in constant use. Where workstations are installed in classrooms, the maximum number of students per workstation has greater variability than in lab situations. The teacher has greater scheduling flexibility and can adjust the time on the computer to better accommodate a student's speed. Also, less time is lost for student movement and set-up. For planning purposes, most locations visited assumed that the time-on-task for computers located in classrooms was equal to a 30-minute lab session.

Another method that can and has been used to increase the number of students served is to assign more than one student to a single workstation. Two students working as a team was appropriate for some software used at the sites visited. Teaming was carried one step further at one project site where the aide teamed an LEP student with a non-LEP student. The LEP student had prior CAI experience while the non-LEP student generally did not. This put the LEP student in an ego-building position of teacher to the non-LEP student. This appeared to motivate the LEP student to perform.

STAFFING

Staff requirements for CAI in a lab environment differ from those for classroom CAI. When computers are located in a self-contained classroom, it is not always necessary to add instructional staff if teachers have proper training and support.

Computer labs almost always require additional staff. In any computer lab situation, at least one individual needs instructional experience and skill equivalent to that of a teacher.

Regardless of the instructional setting, CAI projects require staff with computer-related skills. These skills may be spread among several staff members. Some of the skills may reside in other district staff who are available to work with the project. Some skills may require consultants to provide short-term expertise where it is not possible or not desirable to hire someone full-time.

Technical expertise in computer hardware is necessary in the selection and maintenance of the hardware. At a minimum someone needs to be able to identify a problem as hardware-related or software-related. School districts need technical expertise when they purchase or upgrade their computing equipment. Salesmen usually do not have the technical expertise, nor the motivation, to describe a piece of hardware's strengths and weaknesses or even the level of compatibility with existing hardware. For example, sales people frequently assume that any problem can be solved by equipment sold in their store. If not, the problem can be redefined to make their store's equipment the solution.

In addition, the project needs technical expertise in educational software. The selection and use of appropriate software is critical to the success of any CAI program. Any software evaluation should include both technical and instructional appraisals.

In fact, skill in classroom instruction and instructional design is essential to CAI success. CAI staff need the ability to identify the instructional objectives of individual pieces of software. In the excitement of establishing a CAI program, this is an important, often overlooked, skill. Without this skill, project personnel can become entranced by high-tech glamour and lose their focus, i.e., the process becomes more important than the objective.

None of these skill areas outweigh the other. They are all essential ingredients in the successful implementation of a CAI project.

The ability to program, that is, to write instructions in a computer language, is not a necessary skill for project staff. It is only necessary if the project is seeking to produce its own original software. One does not need to know how to construct an internal combustion engine to drive a car.

In most cases, contractors are the best option for a project that needs original educational software. If a project hires a programmer, it will have to pay a salary whether the program works the way it was intended or not. When a contract for programming services is written, it can include a guarantee. If the program needs to be fixed it will have to be fixed prior to final payment and at no extra cost.

The final necessary skill is the ability to train teachers to use and apply computers. Having a specific skill or technical expertise does not mean that an individual can train teachers to derive ben fit from the project.

TRAINING

Computer systems (hardware and software) can revolutionize instruction. However, the soldiers in this revolution must be trained. Properly-trained teachers and aides are essential to CAI success.

There is a minimum training threshold that must be crossed before CAI becomes an efficient teaching tool. This training needs to focus on the application of computers to instruction. The goal of the training should be to provide teachers and other instructional staff with sufficient knowledge to use existing educational software to enhance instruction.

Teachers, at least initially, do not need to know how to write computer programs. That level of training becomes necessary only if a project objective is to enable teachers to write educational software.

Too much concentration on the technical aspects of computers often leads to ignoring important questions of instructional application.

Staff training is important to the successful application of technology. There is often pressure to implement a CAI program as quickly as possible. That is, get students using the machines as soon as the system is operational. While the motivation is well intentioned, there is danger in starting a program before staff have been adequately trained. The danger lies in the tendency to limit the use of CAI to the initial level of competency of the staff. A CAI program that begins with inadequately trained staff likely will have difficulty, in the long run, reaching full potential.

Limitations of this nature were observed at several sites visited during the course of this study. In one case, computer lab staff had developed a procedure for manually recording student performance. The software they were using had a record keeping system that was more efficient than the paper and pencil records used by staff. Even after they became aware of the computerized record system, they preferred paper and pencil because that was "the way we started out."

In another case, staff members would consistently restart a program whenever a student encountered a problem without attempting to identify the source of the problem. For example, in one instance a student did not understand that he could not hit the space bar before pressing the "return" key. He had developed this habit using another program in which he was required to use the space bar to indicate his answer. In this new program, when he typed a correct response it was followed by a space. The courseware indicated that his answer was wrong. When the student asked for assistance, the staff response was to restart the program from the beginning. This occurred repeatedly. When questioned, the staff indicated that they had never been trained to analyze student-machine interactions.

In other cases, staff continued to use the same software even after the project had acquired more efficient replacements. They preferred to use familiar software rather than attempt to incorporate newer courseware into the curriculum.

In all these cases, project personnel had placed students in CAI as soon as the systems were operational. Staff received only on-the-job training. Since the personnel responsible for training often had multiple responsibilities, this meant that staff were often on their own when it came to learning about CAI. In this instance, as in most cases, a little knowledge can be dangerous.

The projects that delayed implementation until staff had received a minimum level of training had fewer implementation problems. They were able to use the technology to best advantage. Minor problems did not become major stumbling blocks. Most important, they seemed willing to accept and implement new approaches. In these projects the staff, less intimidated by the technology, could focus on student performance rather than machine and software manipulation.

PROGRAM TIMELINES

Early funding of CAI projects was a critical factor in their successful implementation. Projects that received their grant award in July were able to hire staff, procure equipment, and train staff before the school year started in September. They were often able to implement CAI with students as early as October of the first project year.

Other projects did not receive their grant award until October. In these cases, the projects started with serious handicaps. Staffing was a problem since the school year was well under way. This led directly to equipment procurement delays since no one was available to initiate the selection process. Space allocation and scheduling of students had already been made and, in some cases, were irreversible. Late funding meant that training programs could not be planned and initiated until as late in the school year as March.

In some cases these handicaps were made worse by local policies and procedures related to hiring personnel and procuring equipment. If the project manager wanted to hire a person who was already in the system, she had to first advertise the position, then wait until the selected individual could be replaced. Procurement procedures that required competitive bids also meant delays. Once purchase orders were approved vendors sometimes could not immediately supply the equipment.

It is doubtful that projects can do much to ensure that they receive a federal grant early enough to implement a project by

September of the first year. However, the projects can identify these constraints and plan for them.

Experienced project managers pointed out a potential conflict between preparing a realistic proposal for funding and winning a competitive grant award. This conflict could inhibit adequate planning and training. Some local project managers feel that they should not include an extended planning and training period in their applications for funding, no matter how beneficial. They fear that if their proposal includes this time they will lose points in the selection process and run the risk of not receiving a grant. If this is the case, it appears that some change in the selection criteria for technological projects might be warranted. If it is not the case, then the Department of Education should inform local project managers of its policy on this matter.

Pursuing the Video Option

Computers are a means by which instruction can be tailored to the needs of a specific individual. Video technology is a means to increase the availability of a scarce resource, in this case bilingual or ESL instruction or to bring real world situations into the classroom. This conceptual difference should make it apparent that television in the school is less threatening than computers in the school. Television is an extension of traditional teaching methods, computers are revolutionary.

Television in the classroom is not uncommon. What made the projects visited unique was: one, they were addressing the needs of LEP students, a traditionally underserved population in terms of television programming; two, the projects were developing their own course material; and three, one project was making use of bidirectional (two-way) television, a relatively rare approach in elementary or secondary education.

Like computers, video curricula for LEP students should be based on a clear understanding of the project objectives. Again like computers, it is easy to become infatuated with the process, i.e., the making of television shows can cause staff to lose sight of the project focus or emphasis and thereby fail to achieve desired student objectives.

The approach at the project using bi-directional television was the closest approximation of traditional teaching methods. In this case, television created an extended classroom. The teacher could conduct a class and interact with the LEP student almost as if they were in the same classroom and not scattered among several different schools.

The effectiveness of bi-directional television is directly related to the quality of the teacher using the system. The technology does have several motivational effects on the LEP students such as creating an environment in which students with lesser English speaking ability are not afraid to talk into a microphone. These motivational effects, however, would be overshadowed by the quality of the teacher, i.e., a teacher with good teaching skills would produce good evaluation results. Likewise, a poor teacher would be reflected by poor student performance. At the project visited, the LEA and the students were fortunate that the teacher had extremely good teaching skills.

LEA's that would like to use bi-directional television to create extended classrooms frequently cannot. The approach is only cost-effective if there is an existing cable system with two-way capability. Most school districts could easily afford the cameras and monitors necessary to establish a bi-directional television, but few if any school districts could afford to establish a cable network.

While it may appear that bi-directional television is a technology-based approach with no instructional drawbacks, this is not the case. The television class occupies only a portion of a student's school day. For the remainder of the day, instruction is provided on-site by aides or generally non-bilingual teachers. Matching the television class to instruction that is provided on-site is a task requiring close coordination. At the project visited, this coordination was achieved through frequent discussions, either telephone or in person, and on-site visits by the television instructor.

Videotape with monodirectional (one-way) television creates an extended classroom but in a different way than bi-directional television. Where bi-directional television brings the teacher to the student, video tape and television bring the world outside the classroom to the student. For example, through videotape, a student could be taken to Federal agencies and shown how to fill out the forms needed to obtain a Social Security card.

Videotape gives a teacher a unique teaching tool. Sessions can be stopped and started at any point to permit the teacher to reinforce, comment on, or clarify course material. This capability would permit students to more effectively and more quickly learn course material. One site visited had even demonstrated this effect with pre- and post-testing.

Videotapes can present material in a student's native language. This approach was used at one project to teach welding safety. Project staff and the welding instructor felt that a videotape in the students' native language would give LEP students a better appreciation and understanding of welding and welding safety.

Videotape playback units and television monitors even further enhance the effectiveness of videotape. The teacher or aide can preview the tape and incorporate instructional features into the lesson plan. The teacher/aide can use the start/stop capability of videotape to emphasize important points, clarify ambiguities, or request examples. If a videotape player is not available for individual classroom use, some of the benefits of videotape are lost. Stand-alone video units have an instructional impact slightly more favorable (due to the use of familiar actors and locations) than the educational offerings of public broadcasting.

Videotapes, like all technological approaches, have their drawbacks. There are few videotapes available with instructional material developed for LEP students. Thus, the projects visited developed their own. This is not an easy or inexpensive exercise. Producing videotape, even of marginal quality, requires expensive equipment and highly skilled staff. Any school proposing to develop its own video software should, as a minimum, have

- One 3/4 inch color camera with mobile tripod
- One 3/4 inch videotape player/recorder, and
- One boom microphone and/or a variety of hand-held and lavalier microphones.

This equipment would permit a school to produce a videotape, but not a good tape. A good videotape, one which can hold a student's attention while focusing on instructional objectives, requires extensive editing. Editing can only be performed with specially designed, expensive editing equipment. Project personnel at the sites visited felt that schools should only embark on videotape production after arrangements have been made for access to such equipment on a no-cost or low-cost basis. Project sites visited had made arrangements for such access with a technical high school, local college, or local cable company.

Videotape production is a people-intensive endeavor. It requires writers, actors, a director, technician, and an editor. All of these people require some degree of training:

- **Writers** - Projects required writers to create short stories that would hold an LEP student's attention and were directly related to specific project objectives. This generally meant that writers were part of the project staff.
- **Actors** - Projects can use students, teachers, aides, parents, or professional actors. The videotaped sessions observed during this study tended to have greater impact if the players were known to the LEP students. For example, one videotape using students as actors was taped at the school. The LEP students could better relate to the material because they knew the student actors and the location.
- **Director** - The director is responsible for laying-out the story produced by the writer for taping. This generally involves the use of a "storyboard" which outlines each scene. Scenes are then taped in an order, not necessarily the order of the story, which would minimize taping time and facilitate editing. The

director also ensures that the instructional focus is not lost during taping or editing.

- **Technician** - The technician is responsible for running the camera and tape equipment. Special training is required to ensure that the technician not only knows how to operate the equipment but also understands the need to maintain the instructional focus of the story. At the projects visited, the technician was generally an aide with some technical background but little training in how to maximize equipment use for specific taping situations. This resulted in wasted resources, principally staff time, as the technician learned these techniques on the job.

- **Editor** - Of all the persons involved in producing a videotape, the editor is the one who requires the most technical expertise. The editor must convert a collection of discrete scenes into a smooth-flowing story that is consistent with the script and without losing the instructional focus. Generally, the sites visited used part-time aides who had prior editing experience. One location had tried to contract the editing task. This, however, did not prove acceptable. The contractor, not having frequent direct contact with the project, delivered a product that was not considered satisfactory. The product had not retained the precise instructional intent.

Given the number of tasks and skills required, few schools can afford to hire and retain specialists in each area. Projects visited compensated for this problem by having staff perform multiple functions, e.g., the writer of a story is also the director. This approach also has drawbacks. Fewer staff to produce videotapes means that fewer tapes or poor quality tapes will be produced. Thus, LEA's electing to develop videotape instructional materials should not propose too aggressive a videotape objective.

APPENDIX A

ANALYSIS OF TECHNOLOGY FUNDING TRENDS

ANALYSIS OF TECHNOLOGY FUNDING TRENDS

The body of this research report is focused on information gained from the nine project study sites. These nine sites were selected from a total of 114 projects identified as implementing some form of instructional technology. In the process of identifying the nine sites to be studied in depth the grant applications and funding documents for all 114 Title VII projects were reviewed. The following analysis is based on documentation contained in the project files at the Office of Bilingual Education and Minority Languages Affairs (OBEMLA) in Washington, D.C. for these 114 technology projects.

Sampling Procedure

A total of 604 Basic and Demonstration Title VII Grants funded for school year 1983-1984 were reviewed to identify those grants which included some form of technology. Of those, 111 were identified as implementing some form of technology. In addition, three Demonstration Projects, which terminated in school year 1982-1983, were included for review at the suggestion of OBEMLA staff. Of this total of 114 projects, 35 were identified as potential sample candidates. Nine projects were selected for in-depth study and review. These nine projects are discussed in detail in the research report.

Figure A-1 presents the Sampling Procedure Summary and figure A-2 presents the breakdown of projects by type of funding, type of technology, and project year during school year 1983-1984.

FIGURE A-1

SAMPLING PROCEDURE - SUMMARY

- 604 FY 1983 FUNDED PROJECTS REVIEWED
  - 544 Basic
  - 60 Demo
- 114 TECHNOLOGY PROJECTS IDENTIFIED
- 35 PROJECTS SELECTED AS SAMPLE CANDIDATES
- 9 PROJECTS SELECTED FOR SITE VISITS

FIGURE A-2

SAMPLING PROCEDURE

• IDENTIFY PROJECTS PROPOSING THE USE OF TECHNOLOGY

	First Year Projects	Second Year Continuations	Third Year Continuations	Terminations
BASICS				
Computer Aided Ins.	43	13	2	
Video Tape	1	0	0	
Computer Literacy	4			
Computer Admin.	2			
Computer Record Keeping		1		
Audio-Visual		12	11	
Computer Assessment		1		
Teacher Training		1		
Computer Diagnostics			1	
Materials Development			1	
Computer-Unidentified	1	1		
Subtotal	51	29	15	
DEMOS				
Computer Assisted Ins.	6	2	3	1
TV	2			
Audio-Visual		1	1	2
Unidentified Technology	1			
Subtotal	9	3	4	3
TOTAL	60	32	19	3

CAI AS PERCENTAGE OF NEW PROJECTS FUNDED BY SCHOOL YEAR

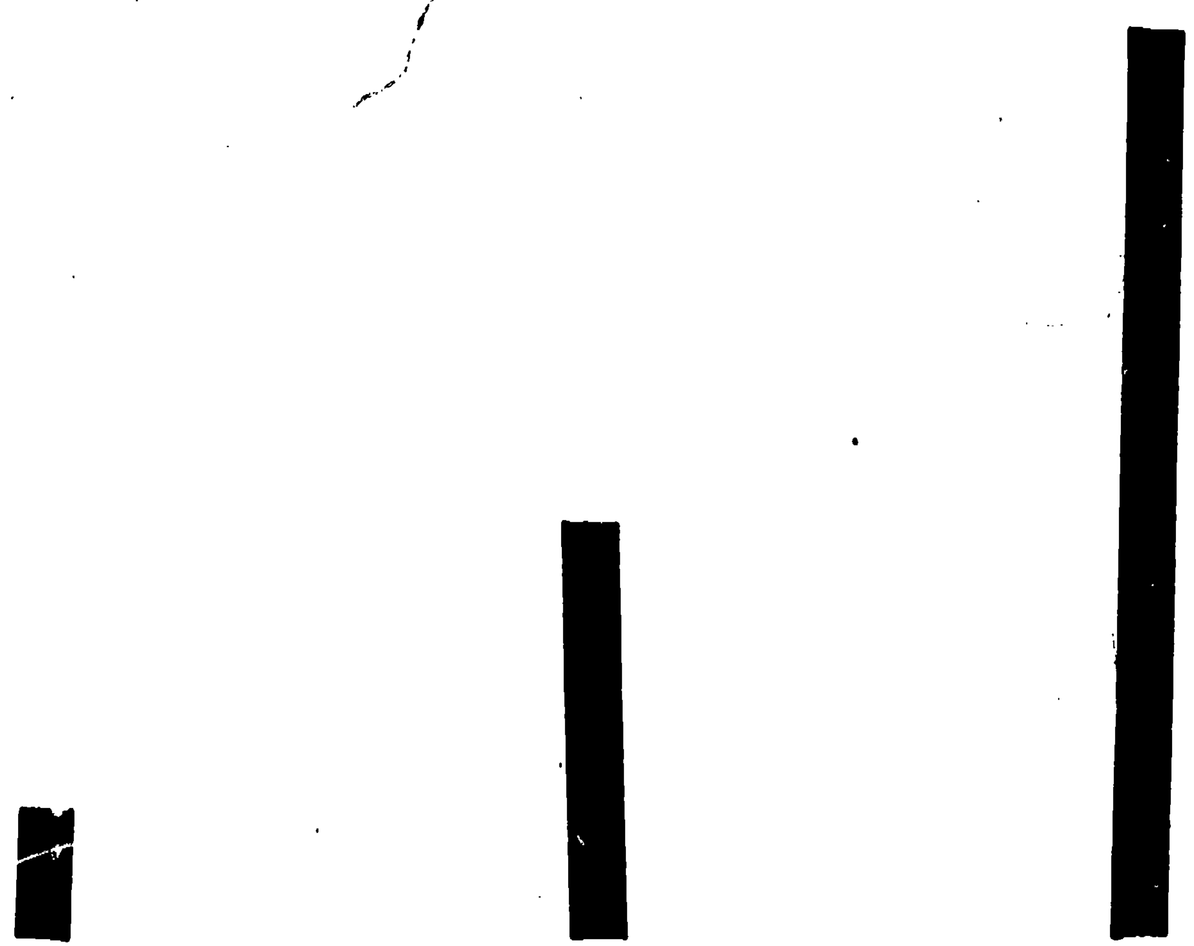


FIGURE A-3

VIDEO AS PERCENTAGE OF NEW PROJECTS FUNDED BY SCHOOL YEAR

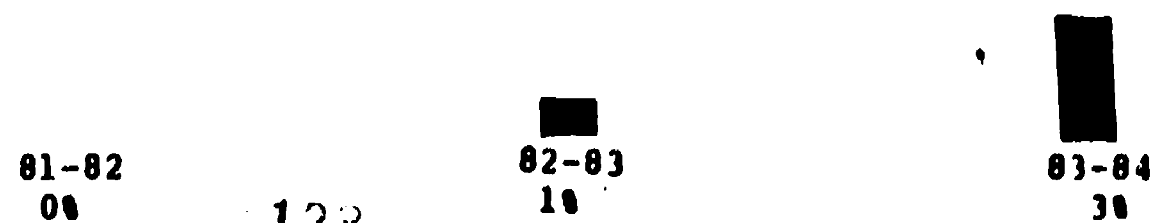


FIGURE A-4

Changes in Funding Patterns

The technologies were grouped into three major categories: Computer Assisted Instruction (CAI); Video based instruction (Video); and Audio-Visual based instruction (A-V).

To determine if there were any patterns emerging over the last three funding periods (school years 1981-1982, 1982-1983, and 1983-1984) the number of new grants for each category of technology was compared to the total number of new grants for each funding period.

Computer Assisted Instruction demonstrated a rapid rate of growth over the three funding periods. Three percent of all new projects in 1981-1982 involved CAI; 9.6 percent in 1982-1983; and 20.5 percent in 1983-1984. Figure A-3 provides a graphic representation of this growth.

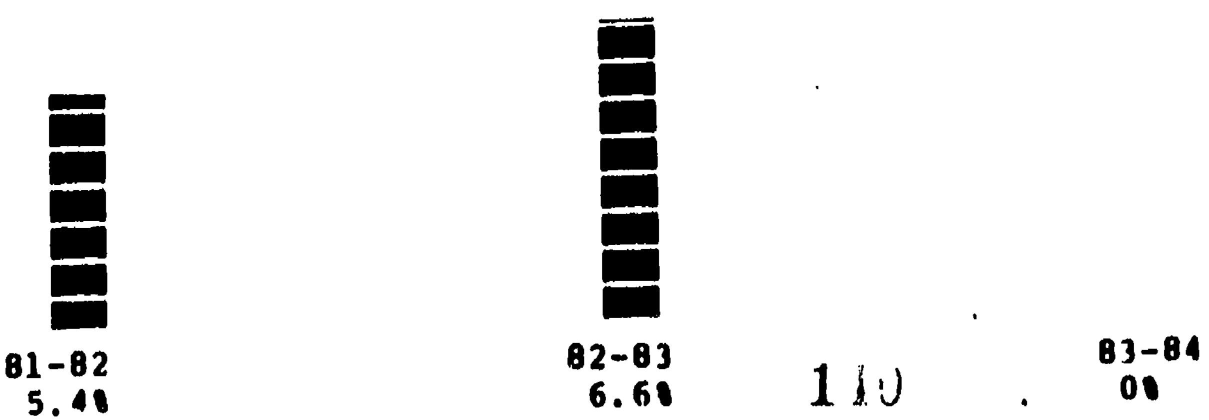
Video demonstrated a less rapid, but still significant rate of growth over the same time period. In 1981-1982 there were no video projects funded. In 1982-1983 one percent of all new projects involved video technology and in 1983-1984 three percent of all new projects implemented video technology. Figure A-4 provides a graphic representation of this growth.

Audio-visual technologies, primarily audio tape and teaching machines, demonstrated a totally different trend. In 1981-1982 5.4 percent of all new projects involved the use of A-V technologies. In 1982-1983 6.6 percent of new projects implemented A-V technologies. But, in 1983-1984 no new projects were funded that proposed the implementation of any A-V program. Figure A-5 provides a graphic representation of the A-V trend.

The pattern established by this analysis is the displacement of A-V technology in Title VII funded projects by CAI and Video technologies.

A-V AS PERCENTAGE OF NEW PROJECTS FUNDED BY SCHOOL YEAR

FIGURE A-5



Students Served in 1983-1984

During school year 1983-1984 a total of 30,478 students were served by both new and continuation Title VII grants which implemented some form of educational technology. 19,300 of these were in CAI projects; 3,900 in Video projects and 7,[illegible]0 in A-V projects. Figure A-6 provides a graphic representation of this distribution. The increasingly large number of students served by CAI and Video reinforces the conclusion that these two technologies are displacing the more traditional A-V technologies in Title VII funded projects.

Funding Levels in 1983-1984

During school year 1983-1984 a total of $15,800,000 was granted by Title VII to funded projects implementing educational technology. $11,000,000 went to support CAI projects; $1,100,000 for Video projects; and $3,700,000 for A-V projects. Figure A-7 provides a graphic representation of these funding levels.

Per Pupil Costs in 1983-1984

Comparing the funding levels of categories of technology with the number of students served by these projects produced average per pupil costs of $570 for CAI; $282 for Video; and $506 for A-V. Figure A-8 provides a graphic representation of these per pupil costs. It must be understood that this analysis is based on total grant amounts and total number of students served. Line by line budget summaries were not available. If such line items were to be analyzed a much more accurate and detailed description of actual technology costs could be produced.

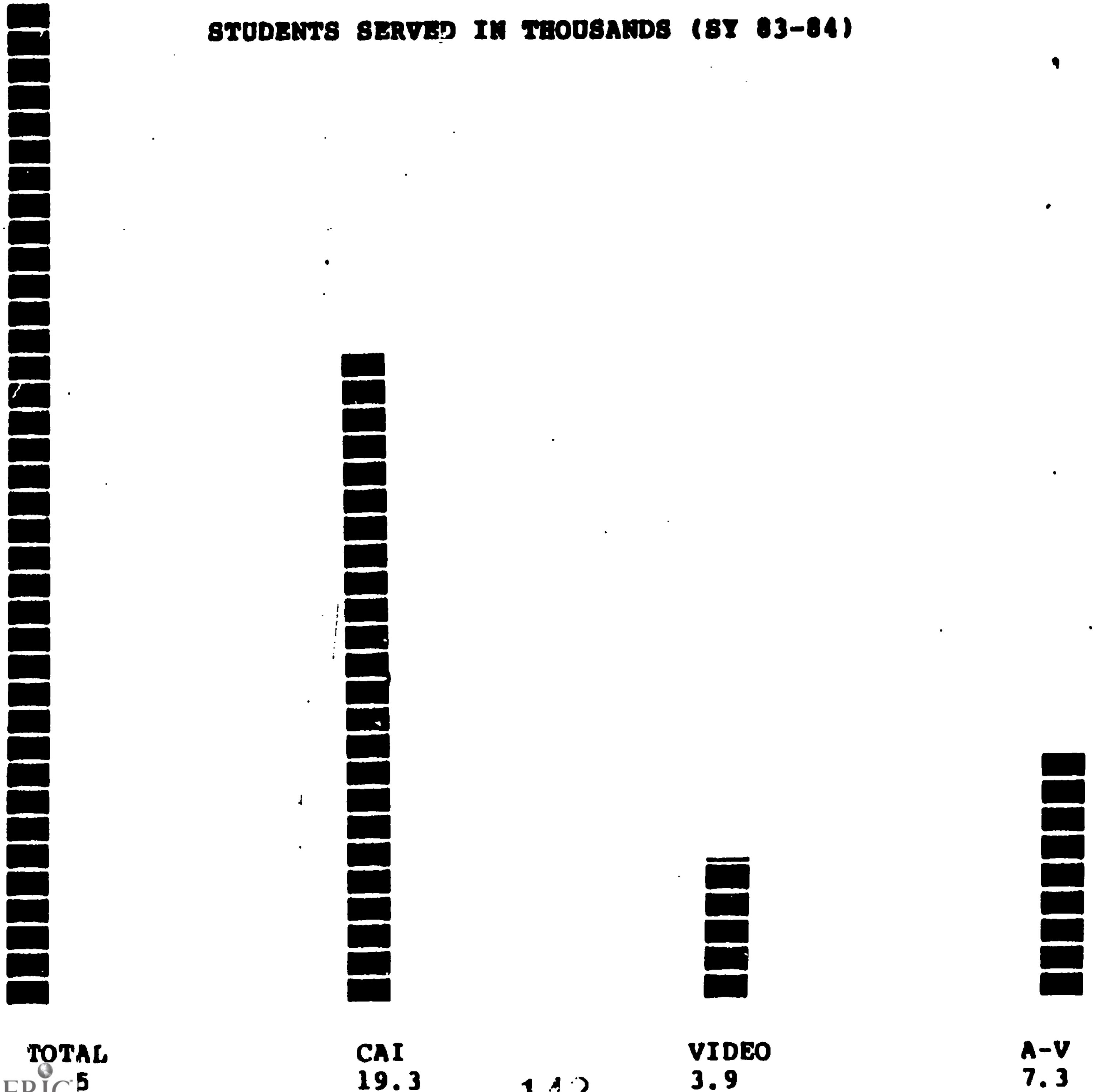

STUDENTS SERVED IN THOUSANDS (SY 83-84)
TOTAL
CAI
19.3
VIDEO
3.9
A-V
7.3

FIGURE A-6

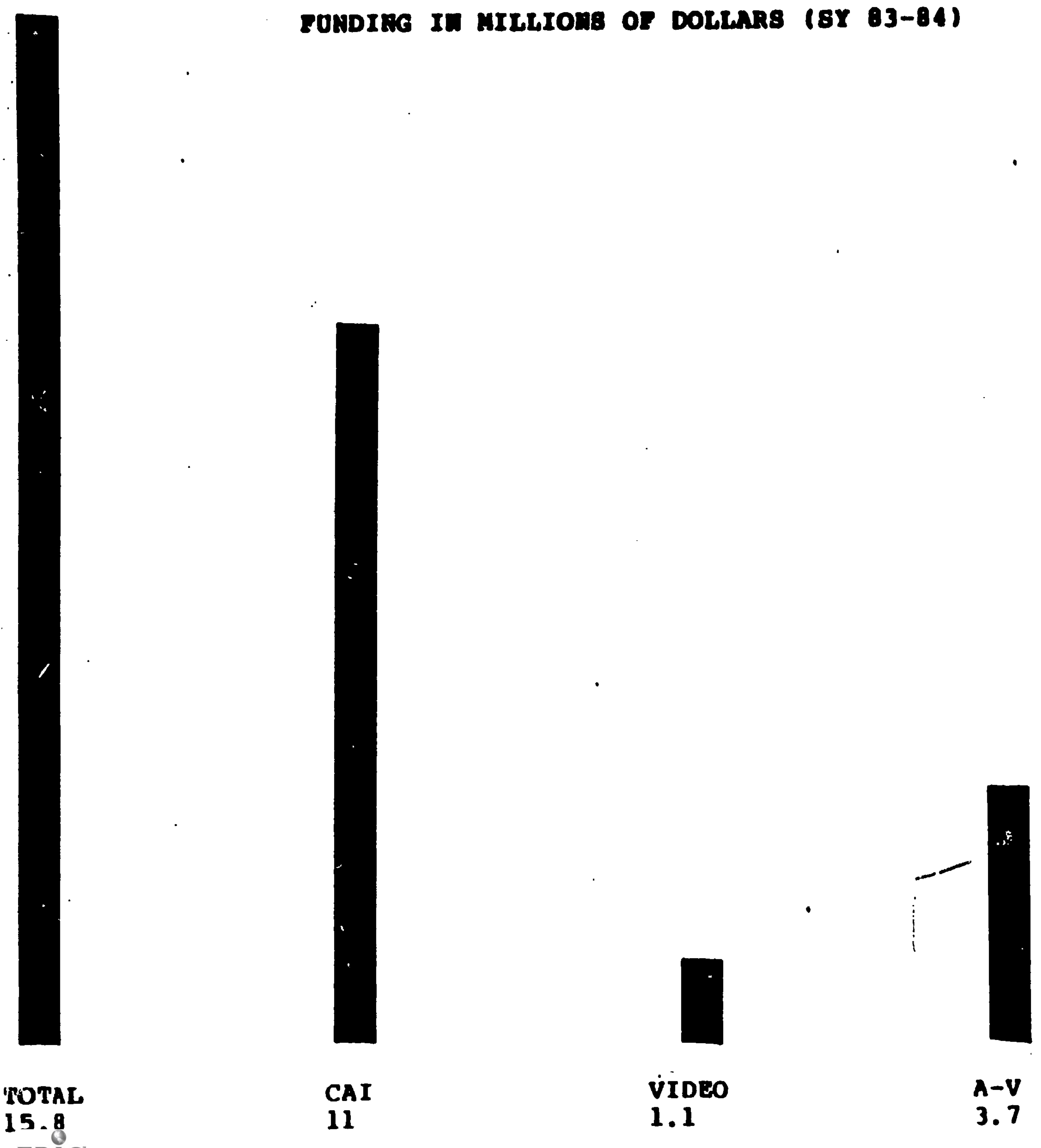
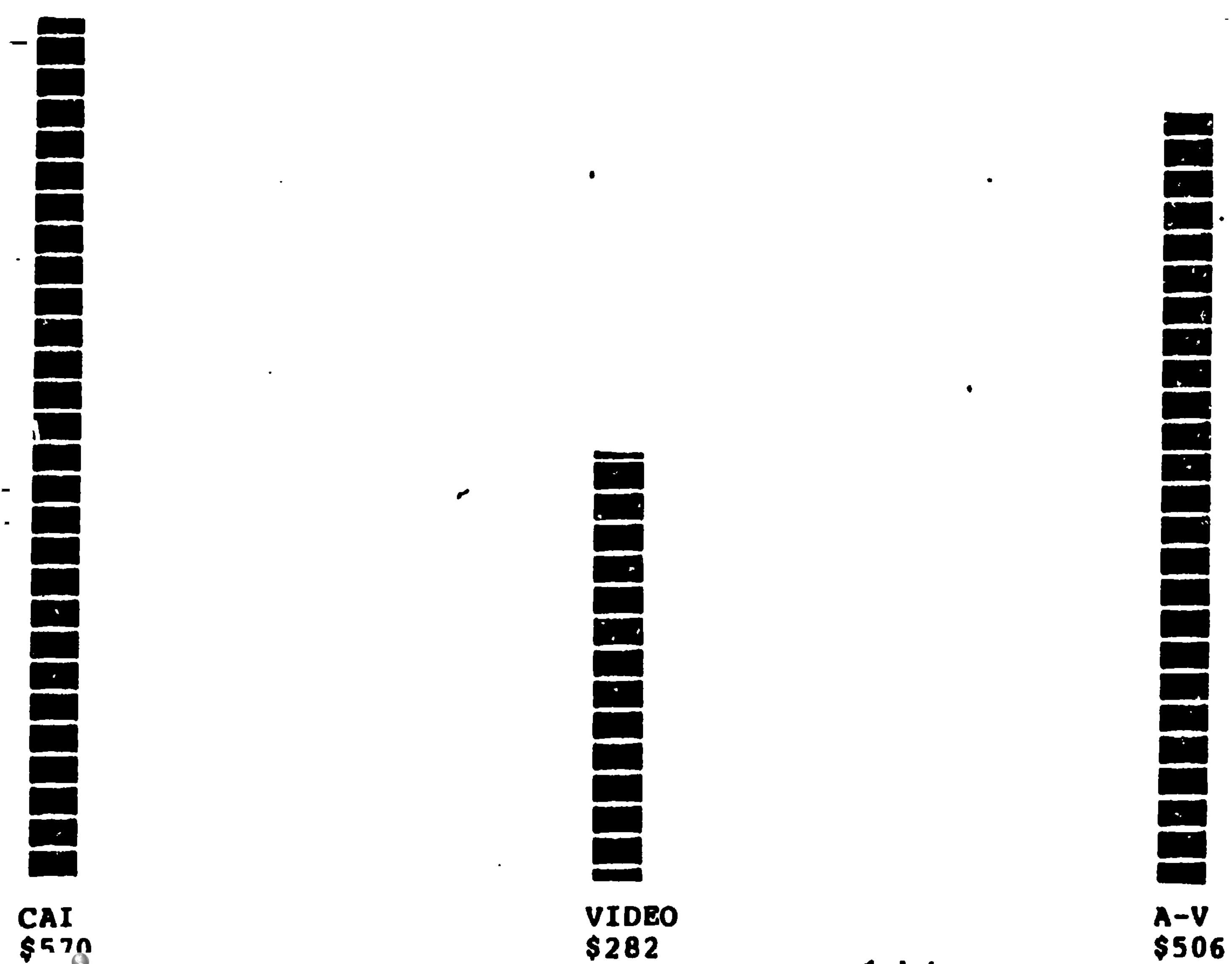

FUNDING IN MILLIONS OF DOLLARS (SY 83-84)
TOTAL
15.8
CAI
11
VIDEO
1.1
A-V
3.7

FIGURE A-7

FIGURE A-8

AVERAGE PER PUPIL COST FOR TYPES OF PROJECTS IN DOLLARS (SY 83-84)



APPENDIX B

EXAMPLES OF EDUCATIONAL SOFTWARE
USED AT PROJECTS VISITED

SOFTWARE LIST

Name	Publisher	Grade—Age	Level
Gertrude's Puzzles	Learning Co.	Excellent	K-6+
Gertrude's Secrets	Learning Co.	Excellent	K-6+
Juggles' Rainbow	Learning Co.	Excellent	K-6+
Bumple Plot	Learning Co.	Excellent	K-6+
Bumble Games	Learning Co.	Excellent	k-6+
Rocky's Boots	Learning Co.	Excellent	K-6+
Moptown	Apple	Excellent	K-6
Magic Spells	Apple	Excellent	1-6+
Microzine	Scholastic	Very Good	k-6+
Alien Addition	Dev. Learning Materials (DLM)	VG/Excl	K-6
Minus Mission	Dev. Learning Materials (DLM)	VG/Excl	K-6
Alligator Mix	Dev. Learning Materials (DLM)	VG/Excl	K-6
Mateor Multiplication	Dev. Learning Materials (DLM)	VG/Excl	K-6
Demolition Division	Dev. Learning Materials (DLM)	VG/Excl	K-6
Dragon Mix	Dev. Learning Materials (DLM)	VG/Excl	K-6
Bank Street Writer	Scholastic and Broderbund	Excellent	3-6+
Crossword Magic	Scholastic is on Distributor	Excellent	K-6+
How to Operate...		Excellent	
Apple 2+ or			
Apple 2E or			
Visicalc (Several others also available)		Excellent	Adult
Logo	Apple, Krell, and others	Excellent	4-Adl
Delta Drawing	Spinnaker	Very Good	1-6+
Story Machine	Spinnaker	Very Good	1-6+
Snooper Troops Case #1	Spinnaker	Very Good	1-6+
Snooper Troops Case #2	Spinnaker	Very Good	1-6+
Rhymes and Riddles	Spinnaker	Very Good	1-6+
Pik-Pek-Puk	Data Command	Very Good	3-6+
The Spelling Machine	Sev .al Vendors	Very Good	1-6+
Whole Brain Spelling	SubLogic Communications Corp.	Good	3-6+
Riddle Me This	Data Command	Very Good	3-6+
PAL (tracking system)	Univ. Sys. of Education	Very Good	2-6
Our Weird & Wacky World Critical Reading Programs	Ed. Activities	Gd.-VG	3-4
Our Weird & Wacky World Literal Comprehension	Ed. Activities	Gd.-VG	3-4
Dragon Game Series	Ed. Activities	Gd.-VG	3-4
BLS Series Reading Comp. #79	Random House	Fair-Gd.	3-4
BLS Series Reading Comp. #80	Random House	Fair-Gd.	5-6
Int. Rdg. Skills	Random House	Fair-Gd.	3-5
Homonyms	Hartley	Gd.-Vg	3+
Verbs	Hartley	Gd.-Vg.	3+
Antonyms/Synonyms	Hartley	Gd.-Vg.	3+
Nouns/Pronouns	Hartley	Gd.-Vg.	3+
Capitalization/ Capitalization Test Disc.	Hartley	Gd.-Vg.	3+
Word Search	Hartley	Gd.-Vg.	any age
Critical Reading Series	Borg-Warner	Gd.-Vg.	4-6+

Letter Recognition & Alphabetization	Milliken
Letter Recognition	Hartley
Using Phonics In Context	Ed. Activities
Consonants	Hartley Software (CED)
MECC Elementary	MECC
Vowell W/CDD MECC	Hartley
Intermediate Reading Skills	BLS
Grammar	Milliken
Tank Tactics	Data Command
Tennis Anyone?	Data Command
MECC	MECC
Intermediate Reading Skills	BLS
Vocabulary Skills	Milton Bradley
Grammar-(Searching)	Milliken
(Spell-it)	Hartley
MECC	MECC
Hartley Software (maybe)	Hartley
MECC	MECC
Vocabulary Skills	Milton-Bradley
Word Invasion	DLM
Word Viper	DLM
Computer-Reading	Edu-Ware
Antonyms/Synonyms	Hartley
Computer-Reading	Edu-Ware
Antonymns/Synonyms	Hartley
Vocabulary Skills	Milton Bradley
Word Invasion	DLM
Word Viper	DLM
Alpine Skier	Data Command
(Grammar)	Milliken
Vocabulary Skills	Milton Bradley
(Searching)	
Big Door Deal	Data Command
(Searching)	
Milliken Comprehension Power	Milliken
Reading Comprehension	Milton Bradley
Main Idea & Details	Brittanica
Comprehension Power	Milton Bradley
Big Door Deal	Data Command
Alpine Skier	Data Command
Intermediate Reading Skills	BLS
Intermediate Reading Skills	BLS
Alpine Skier	Data Command
Comprehension Power	Milliken
Intermediate Reading Skils	BLS
Comprehensive Power	Milliken
Big Door	Data Command
Letter Recognition & Alphabetizing	Milliken
006 Grammar Package	Micro Learningware
002 Math Package II	Micro Learningware

APPENDIX C

**Debugging CAI,
A Handbook For Planning Computer Assisted Instruction**

Debugging CAI

A Handbook for Planning
Computer Assisted Instruction

John B. Ippolito Ronald E. Saunders
Edited by Ralph W. Hoar, Jr.

Note: **Debugging CAI** is published by the Evaluation, Dissemination and Assessment Center for Bilingual Education (EDAC) in Cambridge, Massachusetts. Copies of the Handbook are available from the EDAC.

INTRODUCTION

This handbook provides step-by-step guidelines for planning and implementing a program of computer assisted instruction.

The book is based on research conducted by the COMSIS Corporation for the U.S. Department of Education. The research documented state-of-the-art educational technology used in federally funded projects to instruct students with limited English proficiency. It is intended to help teachers, administrators, and others involved in the education of students as they pick their way through the process of deciding whether and how to establish a program that uses computer assisted instruction (CAI).

Although this publication emerges from an assessment of computer use in bilingual instruction, the guidelines are applicable in any educational context.

Computers are no more than tools. They are one of many tools that can be used by the teachers and administrators. Computers are not the only tools available. They may be the most efficient tool for some purposes. However, they are not tools for all purposes. Your objectives must determine the tools you use, not the reverse.

A computer is analogous to a hammer. When a carpenter has to drive a nail he uses his hammer, not his screwdriver. The choice is obvious. His selection of tools is based on his judgment that one tool will achieve his objective while the other one will not. In education, the process should be similar: the tools should be suited to the objective.

As with the analogy, computers are appropriate tools for some jobs but not for others. First you determine the goal, then you choose the tool. The overriding consideration in education is to meet the instructional needs of students.

Before you can answer the question "Will the computer solve my problem?" you must know what the problem is. Without clearly defining the problem, there is no way of knowing that a computer is the appropriate tool to apply.

WHAT IS THE PROBLEM?

The prospect of success for computer assisted instruction is best if it is based on student needs rather than on a reaction to a funding opportunity, an external mandate, or the ready availability of a particular type of computer. A school district can be trapped if it focuses on the process rather than the goal. It can:

- acquire unneeded equipment;
- acquire inadequate equipment;
- waste resources on approaches whose effectiveness cannot be determined.

Poor rationales for a computer-based program include:

- Imposed requirements - The school board or a state agency has made CAI a "priori y."
- Funding opportunities - Staff cannot be hired--or must be cut unless new money is obtained.
- Non-instructional opportunity - A computer company will give the district microcomputers.

When these considerations precede an assessment of student needs, objectives tend to be imprecise, unmeasurable and perhaps misguided. Imprecise, unmeasurable objectives make it impossible to determine if the computer is the appropriate tool for the teacher to use.

Determine Your Needs, Define Your Objectives

If you first determine your needs, clear and precise objectives can be identified. The objectives can then be used to decide if technology is a cost efficient approach to meet those objectives. The desire to "improve the educational environment of the student" is laudable but it is too broad an objective to form the basis for deciding to implement computer assisted instruction.

Suppose students need to improve their listening and speaking skills in English. Should the school system initiate a CAI program for these students? **NO!**

Although they may in the future, computers that are currently available do not provide communication equivalent to the human voice and ear.

Improving the writing competency of students is a different case. If writing deficiencies are identified in testing, writing samples, or teacher observation, then a computer assisted instructional program could be developed to remedy those deficiencies. Software is currently available to assist students with vocabulary development, grammar and usage, sentence structure, and creative writing.

School systems must consider the following:

1. What do the students need? The needs must be specific, not global.

2. Do existing programs meet those needs? If yes. why are you considering a new program?

3. Can existing programs be modified and improved? A more traditional--non-technological--approach may be more cost effective.

4. Which learning needs are most important? They must be precisely stated.

These four questions must be answered before turning to the question of using computers. Real needs lead to realistic objectives which, in turn, provide the basis for a sound answer to the question: Can computers solve the problem?

CAN COMPUTERS SOLVE THE PROBLEM?

Once a school system has determined its students' needs and specified its objectives, it can turn its attention to reaching those objectives. A local school system has the option to use a variety of traditional approaches or to use computers or some other new technology.

A decision to use CAI must be based on a thorough understanding of the technology:

- its advantages,
- its disadvantages.

What Can Computers Do?

Webster defines a computer as "an electronic machine for performing calculations." This is an accurate definition of how a computer performs its operations. It is misleading because it does not address the machine's multiple uses.

A computer is an extremely versatile machine. It can perform any number of tasks. It has this versatility because it can make decisions. It makes decisions based on the instructions it is given. These instructions are called **software**.

Today's computers operate deductively. Decisions or operations must proceed one at a time in a logical sequence. Their major advantage is the speed with which they can perform these decisions or operations. Computers typically perform millions of operations per second.

The tasks to which computers can be effectively applied have several common characteristics.

- The process can be described in discrete steps.
- The process is repetitive.
- Often, the process requires the manipulation or retention of large volumes of data.

Not all instructional approaches and student objectives have these characteristics. In those cases a computer probably will not solve the problem.

In education computers are generally appropriate:

- as a tool to teach students computer technology.
- as a tool to perform mathematical calculations in statistics and data management.
- as a tool to teach subject matter.

The applicability of computer technology in the first two situations is obvious. The third application is the arena in which computers can revolutionize education. This application is the primary focus of this handbook.

What Are Their Strengths and Limitations?

Computers bring the following strengths to instruction:

- the ability to perform complex deductive operations;
- incredible speed of operation;
- the ability to store and use vast amounts of information;
- the ability to work effectively at multiple tasks;
- the ability to provide individualized instruction.

Their limitations include:

- They are relatively expensive.
- They cannot function inductively.
- They must be told precisely what to do.
- Their use requires a certain level of expertise.

Now to Decide

The decision to pursue computer assisted instruction should depend upon affirmative responses to the following:

- Student needs have been determined.
- Objectives based on those needs have been clearly stated.
- The instructional approach and objectives are appropriate to computer applications.
- Personnel with required expertise are available.
- Funds to purchase and maintain equipment are available.
- Funds for software and staff training are available.

PURSUING THE COMPUTER OPTION

Organizational Support

Innovation and change can cause problems in any organization. This is true of a school system. Adding a technology as new as computers can cause problems if everyone who is part of the educational organization is not given careful consideration. Failure to carefully coordinate with your school district's administration and management can seriously compromise the long-term potential of computer assisted instruction.

Naturally the organizational structure of each school system will vary. As a minimum, you should consider:

The School Board

- Does it have a stated policy on computer assisted instruction?
- Is a committee or task force already developing policy?
- Is the Board aware of the project's implications?
- What reports/information does the Board need?

The Superintendent

- Is computer assisted instruction a priority area for the superintendent?
- What information does the superintendent need to understand computer assisted instruction and the project.
- What are the superintendent's perceptions of the project?
- Where is the project on an organizational chart?
- What reports/information does the superintendent need?

Otner Administrative Offices

- Which divisions, branches or individuals will be affected?

  - area or regional superintendents?
  - instructional supervisors in elementary and secondary schools?
  - curriculum supervisors in reading, language arts, math, etc.?
  - the personnel office for hiring new staff and writing new job descriptions?
  - the staff development office to coordinate training schedules?
  - the purchasing office to procure hardware and software?
  - the accounting office for expenditures of funds?
  - buildings and grounds for wiring, remodeling, maintenance, etc.?

- Who will or can make decisions that will affect the project?

- How much training and information do those individuals need to understand computer assisted instruction and the project itself?

The Schools

- The principal and assistants

  - Does the principal understand the program?
  - How does the principal perceive the project?
  - What decisions will the principal make?
  - What information does the principal need to understand computer assisted instruction?
  - Does the annual plan include the project?

- Teachers

  - Do teachers understand the project?
  - How do they perceive the project?
  - Do they want the project?
  - How will time or compensation be provided so teachers can receive training, evaluate software, revise lessons, and all the other changes required to implement computer assisted instruction?

Administrative support and understanding are critical to the success of any innovative program. It is especially import nt when a project requires extensive, long range staff training.

Teachers in the school system are more likely to support the project if they are involved in its planning and implementation.

Capability and Versatility of Computers

Once a school system decides to pursue the computer option, the next step is to decide which form of computer technology best suits the identified needs and goals.

Computers are not single entities. They are a collection of electronic and mechanical components combined into an integrated system. Direction and control of this system are accomplished through sets of instructions called software. Without software computers are useless. Different sets of software allow a single computer to perform multiple tasks. In an educational environment this could range from managing student files to providing direct instructional support.

An appropriate mix of hardware and software is critical to the successful application of computer technology in an instructional program. The hardware and software, in combination, define the capability and versatility of the computer.

Theoretically, an appropriate mix of hardware and software can perform almost any task. In reality, not all imaginable hardware and software have been developed. School districts may prepare themselves for future developments, but they can only use what is available today to implement their program.

Data Management

Discussions of computers in education often overlook the importance of data management. Computers are perfect for many of the laborious and time consuming tasks that require the manipulation of information. They can:

- Assemble and manipulate demographic and performance data.
- Provide managers with immediate, up-to-date information needed to evaluate and improve programs.
- Monitor student attendance and automatically call parents in the language spoken in the home.
- Compile, produce, and score tests for student assessment.
- Answer "What if ...?" questions concerning population shifts, school closings, budget changes, etc.

The Computer in Instructional Applications

Of greater potential than data management, are the instructional applications in which students interact directly with computers. They can support student learning in three ways.

Instructional Support. In this use the system is in control and dictates to the student. Students respond to the computer in a predetermined manner. Drill and practice exercises best exemplify this type of instructional support.

Collaborative Support. In this type of support students do much more thinking and cognitive interaction with the system. Adventure games and simulations are good examples of collaborative support.

Facilitative Support. In this application the system helps students perform tasks that are almost exclusively under their control. Word processing, used to teach writing and critical thinking skills, is an excellent example of facilitative support.

Which Type Should You Use?

Each of these types of support depend upon the system having the appropriate mix of hardware and software.

The determination of which type of support will be most advantageous depends upon:

- objectives that have been set for the students;
- instructional approach used in the school;
- availability of appropriate software;
- capability of the computer to use the software.

DESIGNING A SYSTEM

Computer hardware should be tailored to specific needs. Matching hardware to a particular project requires a thorough understanding of computer technology and how it can support project objectives. Specifically, you have to understand both the physical and the methodological aspects of the instructional environment. That understanding should precede an assessment of available hardware and software vendors.

Selecting a hardware system has never been a simple task. In recent years most microcomputer manufacturers have targeted the educational market. The equipment choices have grown significantly. (See page ????? for a sample of currently available microcomputers.) The superiority or inferiority of a computer system or resource can only be determined relative to its intended use. This means that decisions regarding equipment are best made only at the local or user level.

Where Should You Put Them and How Should You Arrange Them?

Where you put the computers often determines the appropriate configuration of the system. Their location is also important to the overall planning of the instructional program.

Two basic options exist. They can be located in a designated computer laboratory or they can be located in individual classrooms.

Whatever the arrangement, their location should be harmonious with the instructional approach of the total curriculum. Each location offers its own advantages and disadvantages.

Classroom Location

Advantages

- The teacher has full control over computer use.
- Computer support is directly related to classroom teaching.
- Flexibility in individualized instruction is increased.
- Student access is guaranteed.
- The program can be phased in classroom-by-classroom.
- Few extra staff are necessary.

Disadvantages

- Computer equipment in classrooms may be more vulnerable to theft, vandalism and accidental damaged.
- Equipping each classroom may be more expensive.
- Multiple copies of software are required.
- Each teacher must be fully trained prior to implementation.
- Machines generally are not in continuous use.

Laboratory Location

Advantages

- Only lab teachers need computer instruction training prior to implementation.
- Computer equipment can be more easily protected against theft, vandalism, and accidental damage.
- Multiple copies of software may not be necessary.
- Machines can be in continuous use.

Disadvantages

- Laboratory staff must be hired.
- Classroom teachers have minimal control over computer assisted instructional support.
- "Pull-out" is the usual scheduling option.
- Less flexibility exists for individualized instruction.
- They require a room of their own.
- They complicate student scheduling.

What Are Time-On-Task Capabilities?

If computers are located in the classroom, under the control of the teacher, the amount of time each student spends on a particular piece of instructional software depends entirely on each student's own ability and the teacher's instructional objectives. The teacher is present and can adapt the schedule to the student's progress or select software appropriate to the student's ability and to the time available.

In the laboratory situation, it is absolutely essential that time be planned so lab teachers can tailor their computer instruction programs to complement classroom instruction. This involves regular consultation with classroom teachers. Time becomes a driving force in planning and scheduling laboratory use. For a laboratory to function effectively, the minimum time for actual computer use is 30 minutes. That is 30 minutes exclusive of the time needed for students to move from classrooms to lab and to prepare for instruction. Any shorter time will not allow students to complete assigned tasks. Longer periods allow greater time to use instructional software that is more comprehensive. Longer periods also allow staff to help students with problems.

How Many Students and How Many Machines?

If computer assisted instruction is to be effective, students must have access to the machines on a regular basis. In the classroom, one machine should serve no more than 10 students. The logistics of laboratory operations reduces that ratio. Each workstation in a laboratory can provide effective access to no **more than seven students per six-hour day.**

Which Location to Choose?

Choosing a location depends upon the situation in the individual school. Both locations offer advantages, limitations, and problems. Picking the location will always involve trade-offs.

The choice should include the following considerations.

- What are the objectives of the program?
- What are teacher and administrator perceptions and attitudes?
- How many students will participate?
- Can the school hire new staff?
- Can existing staff be trained?
- How much space is available in the school?
- How much will construction or wiring cost?
- What are the school's security risks?

How Should the Systems be Arranged?

After selecting the most practical and beneficial location for the computers, the question of how to configure the computers must be considered.

Whether they are located in classrooms or labs, two basic configurations are possible. With stand-alone systems, each student works at an independent computer. In a network system, each student works at a station that has a video display and a keyboard but all the stations are tied directly to a master computer. In a stand-alone system, computer programs are loaded manually on each machine. In a network system, computer programs are loaded at the master computer to serve one or more workstation.

Each system configuration presents a set of advantages and disadvantages.

Stand-Alone System

Advantages

- Allows flexibility of location
- Permits independent operation

Disadvantages

- Cost is high per unit
- Requires multiple copies of software
- Involves greater risk of theft
- Requires physical manipulation of individual floppy disks
- Requires "paper and pencil" records of student performance
- Requires more first-level maintenance

Network System

Advantages

- Lower cost per unit
- Easier loading of software (with hard disk drive)
- Computerized capability to keep records of student performance
- Minimal first-level maintenance

Disadvantages

- Immobile
- Failure of master workstations makes all workstations inoperable
- Requires more highly-trained staff with sophisticated understanding of computer technology
- Cable systems that connect workstations can be complex and costly
- System might not be able to handle the workload if all students attempt to access the master workstation at the same time

Which Configuration Is Best for You?

Given the differences between networks and stand-alone systems, you must decide in favor of one or the other. The selection may have already been made by default, dictated by decisions concerning student objectives and the location of the computers. It may also be a moot point if no reliable source of network oriented equipment is readily available. Where a choice has not already been forced by other factors, the following guidelines may be helpful:

- In a laboratory situation, where all computers are located in one room, a network is generally more cost effective.
- In situations where computers are located in classrooms, stand-alone systems tend to be more cost effective.
- Where fewer than five workstations are required, the network does not have a significant cost advantage.
- Maintenance is more critical in a network. The failure of one component can make the entire system inoperable.

What Hardware Will You Need?

The minimum hardware you need depends upon the configuration of the equipment. Stand-alone systems consisting of one or more completely independent computers and networked systems consisting of several workstations connected by cables to a master workstation, each require different types of equipment.

In **stand-alone** systems, each computer system requires:

- a keyboard;
- a video monitor;
- a base unit containing the central processing unit and other supporting electronics; and
- one or two disk units capable of using floppy disks.

In **networked** systems, the master workstation requires:

- a keyboard;
- a video monitor;
- a base unit containing the central processing unit and other supporting electronics;
- one or two disk units capable of using floppy disks; and
- cables and communications systems to connect master and slave workstations.

Each slave workstation requires:

- a keyboard;
- a video monitor; and
- a base unit containing the central processing unit and other supporting electronics.

Will All the Pieces Work Together?

Of critical importance in selecting hardware is the question of system compatibility. Not all pieces of hardware will work together. Most important, **different hardware may require different software.**

The same manufacturer may even produce different lines of products that are not compatible. Radio Shack's TRS-80 Model II and Model 4 microcomputers may have software compatibility but they each use different size disks. Software designed to run on the Apple III will not work on the Apple][. The term "IBM compatible" has no standard definition. Because an "IBM compatible" computer can run one piece of IBM software does not mean it will run all IBM software. You must carefully examine equipment specifications and you may need technical assistance from someone who is not affiliated with a vendor.

What About Software?

One of the major factors in selecting hardware should be the availability of software that is appropriate for both the proposed objectives and the computer system. The selection of software is more complex than looking at the total number of educational computer programs available for a particular machine. Existing computer assisted education projects consistently reject between 70 and 75 percent of all software they evaluate. The programs that are judged effective tend to be available in formats for several different machines.

The program's objectives, instructional approach, and the location and configuration of the computers will have major impact on software and hardware decisions.

Appropriate software can be acquired in four ways:

- Purchase or obtain existing software that is either commercially developed or otherwise available in the public domain;
- Adapt existing software;
- Tailor-make software with a commercially developed authoring system; or
- Develop original software.

Whichever way, or ways, you use, software must be carefully evaluated to determine its usefulness. In the case of commercially developed software this evaluation should occur prior to purchase. In the case of original software, the evaluation is an integral part of the on-going development process.

Software evaluation is composed of three basic elements, technical, instructional, and cost.

Technical Considerations

- Is the software compatible with the computer system?
- Is the necessary hardware (computer, input and output devices) already in the schools?
- Are the publisher's instructions (documentation) for using the software complete and understandable?
- Does the software perform as described?
- What manipulation is necessary to use the software?
- Can the software be used immediately or must the students be taught to use it?
- Are there weaknesses in the program?
- How does it handle keyboard errors?
- How quickly does the program load? Read to the disk? Perform generally?
- Is the program vulnerable to student tampering?
- Can the program be interrupted and restarted at the point of interruption?
- Can information be lost?

Instructional Considerations

- Do the stated objectives meet student needs?
- Is the instruction appropriate to the age, grade, language, culture, etc., of the students?
- Does the software actually teach or support the stated objectives?
- How are errors handled?
- Do either the instructional objectives or the manner in which the software performs frustrate students?

Cost Considerations

- What is the cost per copy?
- What are the stated or copyright restrictions on making copies and backups?
- What stated restrictions does the software producer place on networking?
- What guarantees apply?
- What is the software producer's policy on damaged or worn disks?
- What training or support services are available? Are they free or do they cost?
- What is the software producer's policy on translation and adaptation of the software?
- Where is the producer located?
- How long has the producer been in business?
- How is the software distributed?
- What is the vendor's relationship to the producer?

While each school district should evaluate software for its applicability to their particular population and educational environment, information from other sources can help weed out poor software.

Currently there is no organized software review forum that focuses on the instructional needs of students with limited English proficiency. Most publications tend to concentrate on the largest audience, composed of mainstream English speaking students.

You should consider:

- Obtaining lists of other computer assisted instruction projects from federal and state agencies;
- Requesting information and services from federally funded service centers and clearinghouses;

- Subscribing to magazines and journals that review software;
- Contacting local, regional, and national organizations or clubs of people who use particular computers.

Commercially Developed Software

The absence of quality software is one of the greatest impediments to successful computer programs for students with limited English proficiency. The technical sophistication required to develop quality software does not exist in the public schools. In fact, the ability does not appear to exist in the educational community. In education generally, and particularly in bilingual education, there seems to be a mistaken assumption that the expert on a subject must also write the software. This is not the case in the business world. The expert on a subject establishes the objectives for a computer program, that is, tells the programmer what the software should do. The user tests the software, evaluates its performance and either accepts it or sends it back for revision. This could, or should, work in the field of education as well.

The demand for bilingual software has not yet stimulated private sector development. There are indications that more software designed for English-as-a-second-language will be available in the future.

Nevertheless, software developed commercially for English speaking students can be used to assist students with limited English proficiency. Again, it must be evaluated on its technical merits and on its appropriateness to the objectives and to the students in the program.

Commercially Developed Software

Advantages

- technical sophistication
- wide range of age/grade levels
- can often be reviewed before purchase
- often available for different machines
- often comes with supplementary materials

Disadvantages

- expensive
- often has restrictive copying policies
- rarely has a guarantee
- not designed for linguistically and culturally different student groups
- may not address real student needs
- may not work in network configuration
- detailed planning necessary to fit existing curriculum

Public Domain Software

The best sources of useful public domain software are federally funded projects that have already developed original software. You will have to take the initiative to find projects with programs similar to yours.

Advantages

- may better address special needs
- free or minimal cost

Disadvantages

- may not present a full range of instruction
- may be technically less sophisticated than commercial products
- may be hard to find

Adapting Existing Software

Commercially developed or public domain software always can be modified to better meet student needs and the instructional approach of your program. Often adaptation requires minimal technical skills. For example, software programs that present material in English can be translated into other languages. The computer program itself is not basically altered. Only the language used and the acceptable responses are changed. Naturally, translation of copyrighted material requires permission from the copyright owner.

Adaptations that require changes in the program itself, will require sophisticated programming skills. School staff may or may not have those skills.

Advantages

- ability to target specific student needs
- does not necessarily require sophisticated technical skills
- much cheaper than developing original software

Disadvantages

- final product depends largely upon the quality of the original
- requires specific content knowledge, instructional design skills and some programming knowledge
- need permission and cooperation of original software developers
- requires creation or adaptation of supplementary materials
- requires staff time

Authoring Systems

One of the quickest ways to tailor software to specific needs is to use authoring systems. An authoring system is a computer program designed to create educational courseware within a format already specified by the system. These systems can produce usable educational software without sophisticated computer programming knowledge. Authoring systems should be evaluated in much the same way any other instructional software is evaluated.

Advantages

- ease of operation
- relatively low long-term cost
- specific student needs can be targeted
- software can be tailored to existing curriculum

Disadvantages

- staff must be trained
- technical sophistication among systems varies greatly
- instruction must fit approach used by the system
- requires staff time for training, development, evaluation
- final product may operate more slowly than other software

Original Software

Developing original software is costly, time consuming, and demands sophisticated skills in:

- instructional methodology
- instructional systems design
- computer technology
- computer programming

Local school systems should undertake the task only if they have all the necessary financial and human resources.

The development of original software should not be considered as merely a sideline to, or a by-product of, an instructional program. It requires the full time commitment of staff and resources over an extended period of time.

A school system or project may feel that the development of original software is the only viable option. In that case, careful consideration of the high technical skills necessary must be given in the hiring of staff. It may be necessary to depend upon hiring, or contracting, outside consultant to do the actual programming and software coding.

FIGURE 1

Sequence For Original Software Development

- identify instructional objectives
- design an instructional approach compatible with computer assisted instruction
- write detailed instructional lessons
- translate instructional lessons into discrete steps
- select an appropriate programming language
- design a program approach
- design a software program
- code the program in appropriate language
- evaluate technical performance of software
- field test software with students
- debug and revise the program based on field testing
- revise instructional elements based on field testing
- develop supplementary materials

Advantages

- Software is targeted at student needs.
- Native language and culture can be incorporated into software.
- Software can target specific age, grade and subject.
- Software can be made to fit existing curriculum.

Disadvantages

- Cost is high.
- Requires highly sophisticated staff skills that are rare and expensive.
- Technical sophistication will depend on staff skills.
- Requires lengthy period from start to final product.

Which Machine Do You Buy?

Possibly one of the most traumatic tasks when establishing a computer assisted instruction program is purchasing the machines. The easy way out is to buy a computer that is popular or readily available. However, that is not necessarily the best computer or the most cost effective for your specific needs. The nearest computer store is always ready to sell the "perfect" computer for every requirement (even if the salesman has to slightly redefine your objectives). Even a "free" computer may not be a good deal if it doesn't meet your needs. If no appropriate software is available or if the "free" computer has been discontinued, developing a software library or maintaining the system could be expensive.

A number of factors should be considered before you decide what system to buy. The level of detail and applicability of these factors will depend upon your specific project objectives and purchasing procedures. For example, your district may require competitive bidding. That process might not allow you to designate a specific computer system.

The factors that should be considered in a purchasing decision include:

- <u>Software availability</u>

  Is there software appropriate to project objectives, if so, how much software?

  Is softwa e being developed by a number of publishers or only one publisher?

  What software, useful to the project, is provided with the computer?

- <u>Hardware</u>

  Is the hardware powerful enough to support the equired software, e.g., does the computer have sufficient memory for the available software?

  Can the hardware be enhanced to meet changing needs, e.g., if publishers begin writing softwar requiring more memory, can be system be expanded?

  Can devices, e.g., input/output devices, manufactured by other manufacturers be attached to reduce cost or enhance system capability?

  Does the hardware require any special attachments to protect against excessive heat build-up or electrical fluctuations?

  Is documentation complete and easy to use?

  Is the manufacturer stable?

  Can the hardware survive the rigors of an educational environment?

- **Maintenance**

  What is the repair history of the computer and its components?

  What is the average time to repair the computer and its components?

  Is the equipment guaranteed and if so, for how long and what does the guarantee cover?

  Are repair facilities local or must sy tems be returned to the manufacturer?

  Are spare parts readily available?

Is a maintenance contract available?

What is the stability of local suppliers?

Is installation part of the purchase price?

- Technical Support

  Is staff training part of the purchase price?

  Does the equipment supplier provide technical support as part of the purchase price? If so, how much and what kind?

- Cost

  What is the true cost of the computer system including purchase price, installation, training maintenance, etc.?

  Does the "low bidder" provide the best terms for the life of the project?

  Have all bidder costs, such as construction, wiring, cables, etc., been included in the true cost of the computer system?

- Legal

  Have all terms and conditions been included in the proposed contract?

STARTING YOUR PROGRAM

By now you have determined:

- student needs
- instructional objectives
- viability of computer support for the objectives
- type of compute. support desired
- location of equipment in the school
- configuration of equipment
- hardware requirements for options selected
- software appropriateness and availability
- brand of equipment

Now you're ready to start your program.

Timing

Funding for the project might come from a combination of local, state, and federal sources. Each of these will have different fiscal constraints and requirements for obligating and spending money. Delay or differences in when money is available can influence when a program can become operational.

Local procurement policies and procedures need to be carefully examined. You should consider how they will affect implementation.

Often there is substantial pressure to get computers into the schools and students sitting in front of the computers as quickly as possible. Resist it! It can be dangerous if:

- appropriate staff is not hired;
- existing staff is not trained;
- equipment installation is incomplete;
- appropriate software is not in the schools; and if
- the objectives are not clear to all staff.

What About Staffing and Training?

Staffing needs depend upon whether the program will be in a laboratory or classroom, networked or stand-alone. For example, a laboratory with a network configuration requires more staff than stand-alone computers in the classroom. Nonetheless, a minimum threshold of computer competency is necessary if the program is to be successful. In most situations existing personnel can be trained rather than hiring all new staff.

Staff training must focus first on instructional applications. Computer literacy will be a part of understanding these applications, but, unless the creation of programmers is the objective, teachers do not need sophisticated programming skills.

At a minimum, one person should have sufficient technical and instructional knowledge and experience to guide the program through its initial implementation.

Computer Literacy

"Computer literacy" is a term frequently used but seldom defined. Ask five people--even five who conduct computer training--for a definition, and you generally get five different opinions. To some, computer literacy is being able to write a computer program. To others, it means comfort with computer jargon.

Computer literacy, for the purposes of this handbook, is defined as the knowledge and skills necessary to understand the capabilities, strengths, and weaknesses of applied computer technology. One can be computer literate without being able to write a computer program. Conversely, a computer programmer can be a computer illiterate; i.e., the programmer can write programs but not really understand how to apply computer technology to solve a problem. One does not have to know how an internal combustion engine works in order to use a car.

The training needed for computer literacy involves two factors, language and computer capability. Language skills are needed to facilitate communication. Thus, a person who is computer literate must have a basic understanding of computer terminology. For example, one who is computer literate should understand the difference between storage and memory, but need not know the difference between core and semi-conductor memory.

A person who is computer literate should be able to understand the characteristics of tasks to which computer technology could be applied.

Computer literacy training should include:

- **Understanding Computerese** - This training should explain the derivation of "computerese" to help break down the mystery of computer technology. For example, the computer term "debugging" (locating and correcting errors in software or hardware) originated when technicians had to remove a moth from a large physical switch in an early computer.
- **Making Your Computer Work for You** - This training should teach how computers have been successfully applied, concentrating on the areas directly related to project objectives, e.g., when instructing teachers use educational applications as examples.
- **How to Pick Good Software** - This training should enable teachers to define requirements clearly enough to determine if a specific computer program is appropriate or to develop specifications that a programmer could use to write an acceptable computer program. This course should include hands-on experience to break down the "fear of computers."
- **Care and Feeding of Your Computer** - This training should concentrate on topics such as the need for backup, the proper handling of data storage media, heat and electrical problems, concerns about theft, vandalism and accidental damage.

How Do You Overcome Fear and Learn to Love the Computer?

Technology generally, and computers particularly, can be threatening to many people. This is as much a reality in education as it is elsewhere. The objectives and limitations of a computer project must be made clear to and understood by all involved.

A supportive environment is one that understands what the program can and cannot do. A lack of information and understanding leads to distrust and fear, misuse and disuse, and eventually abandonment and demise. Each level in your school's hierarchy needs to be considered.

School Board

- What is the potential cost effectiveness?
- How does the program relate to the total curriculum?
- What new demands will the program create?
- What needs will it meet?

Superintendent and Central Administration

- How will the program be monitored?
- What is its relationship to the school bureaucracy?
- What is its impact on other programs?
- What are its budget implications?

Principals

- What will the program do to the organization of the school?
- Where will it be located?
- How will it affect scheduling?
- How will it relate to existing instructional programs?
- Who will direct the staff?
- What is the staffing pattern?
- What benefits will there be for those not in the program?
- How does it meet instructional needs?

Parents and Advisory Committees

- What role will they have in the design and conduct of the program?
- How does it meet their needs?
- Whose children will participate?

Teachers

- How will teachers be involved in planning and decision-making?
- How will training be organized and scheduled?
- How will anxieties be relieved?
- How will realistic expectations be communicated?
- How will the union or professional groups be involved?

Students

- What expectations do they have?
- How will they communicate their needs and perceptions?

MAINTAINING AND IMPROVING YOUR PROGRAM

Once the program has started, it's time to focus on maintaining and improving the program. Developments occur so rapidly in computer technology that what was considered impossible yesterday is commonplace today. Instructional environments change too. The very introduction of a computer based program of instruction will affect the needs of students as well as the perceptions of staff and parents.

Evaluation

A strong, coherent evaluation design is the best way to assure that the project is appropriately implemented, maintained, and improved. As situations change, the project must change. Documenting the changes and providing information on which to base decisions is the chief role of the evaluation design.

It is always difficult to identify causal relationships in the real world of schools. The introduction of a new technology, such as computer assisted instruction, adds another complicating variable. An evaluation of computer uses should focus on their effectiveness and be directly related to student achievement.

Effective evaluation requires an investment of time and money. It must begin in the initial planning and design phases of the project and be an integral part of the ongoing implementation of the project. If it is only an afterthought, the results of the evaluation will be vague and useless.

Technological Advances in Hardware and Software

Computer technology is advancing at such a rapid rate that it is impossible to predict the capabilities that will be available to the educational community tomorrow. This means that a project that is implementing computer assisted instruction may find that its current approach has been overtaken by new developments.

Computer-student voice interaction is technically feasible but financially impractical. That may no longer be the case within a very short time.

Computer controlled laser disk technology is just beginning to find its way into education. Potential developments in this area could mean a radical change in the way instructional courseware is conceived and developed.

The number and quality of commercially developed educational software are increasing every day. Adaptation and original development of software may be the only options for certain student populations today. As education receives more attention from commercial software developers, the need to invest school resources on such efforts will decrease.

Project staff must stay abreast of hardware and software developments if they are to maintain the most cost effective approach to computer assisted instruction.

Staff Development

Computers must be used by trained, qualified teac
Otherwise, they will become sources of waste and inefficiency.

Too often staff development occurs only during the initial implementation. While it is true that motivation is higher at the start of a new project, staff development must continue on a planned, regular basis. Without an ongoing staff training program, three dangers loom.

- The departure of trained staff can interrupt instruction.
- Staff get into a "rut" of routine activity and lose sight of student learning objectives.
- New hardware and software developments do not reach teachers.

A computer assisted instruction project should:

- increase the pool of threshold-level trained staff within the school system;
- raise the level of technical sophistication of previously trained staff;
- inform teachers of new developments in hardware and software and provide training appropriate to those developments;
- inform and train parents and community members of current programs and future plans.

CONCLUSION

Many educators are reluctant to apply computer technology to teaching. This reluctance is due to several factors.

- The mystique that envelopes computer technology isolates potential users from day-to-day problems but it also limits their knowledge of computer capability.
- The jargon associated with computer technology makes simple concepts seem complex.
- The belief that in order to use a computer effectively, one must know how to write computer programs, and
- The complex, difficult, and expensive process of buying a computer.

Hopefully, this handbook has clarified these issues so that using computers is not threatening or forbidding. Computers are not the exclusive purview of data processing professionals. They are tools that can be adapted to many different tasks, the complexity and variety of which is only now beginning to be explored. With today's computer software, there is no need to know how to write computer programs and the cost of computing has dropped dramatically.

The process for planning and implementing a computer assisted instruction project is not more difficult than planning other projects, only different. The process requires that a number of factors be considered in the decision process, but many of these decisions become self-evident as the project objectives and educational environment are defined.

The only new requirement placed on educators is that they must become computer literate in order to use the technology effectively. But here again, the knowledge required is minimal. Being computer literate simply requires sufficient knowledge to determine when or if computer technology can be effective and to be able to communicate the problem in terms that can be understood by computing professionals. It is the responsibility of the computing professionals, e.g. computer manufacturers and software publishers, to explain the benefits, functions and instructions for using their machines and software in terms that can be understood by educators.

The success of a computer related project depends more upon the quality and dedication of the staff than the sophistication of the computing equipment, i.e. good software and computers can make a good teacher better, but can never make a poor teacher a good teacher. If a trade-off must be made regarding the skill levels of the project staff versus adding more equipment, generally it is better to forego the equipment and keep competent staff.

Finally, if project staff feel that they need more technical skills to plan, implement, or to provide ongoing support, consultants can be used very effectively. Tasks that require technical skills tend to be one-time or to occur at irregular intervals. Such situations suggest the use of consultants who can be more cost effective than permanent staff.

A TOURIST'S GUIDE TO COMPUTERESE

It is not our purpose to present a complete dictionary of "computerese." Others have already done this. One reliable source is the glossary of computer terminology produced by the National Bureau of Standards.

This discussion is intended to clarify terms used in this handbook.

Computer technology has evolved a language of its own. Command of the terminology must precede intelligent use of the technology. Some words like "bit" (<u>bi</u>nary digi<u>t</u>), were coined to fit the technology. Other words like "memory" and "storage" were adapted to the technology because their traditional definitions fit computer components or functions.

Hardware is the general term that describes the physical components of a computer system. Numerous physical components may be installed in, or attached to, a computer system. These components tailor the capability of the computer system to accomplish a given task.

The **central processing unit** is the heart of a computer system. It is this component that performs all the computations and data manipulation. The other hardware components are designed to support the operations of the central processing unit.

Memory is the component that most affects the capability of the central processing unit. Data and computer instructions are placed in memory as they are used by the central processing unit. The more memory available to the central processing unit, the greater the complexity of operations that can be performed.

Memory is vulnerable to occurrences such as power outages when instructions and data in memory can be lost.

Storage is frequently confused with memory. Storage is where data and instructions are placed when not required immediately by the central processing unit. Storage is a non-vulnerable medium, i.e., when power is off, data and instructions are not lost. Typical storage media for small computers are cassette tapes, flexible (floppy) diskettes, and hard (fixed, Winchester) disks.

The amount of storage required of a computer system is directly related to the volume of data. The amount of memory required is directly related to task complexity.

Information must be entered into the computer system to be processed. Several hardware components may be used to perform this function. Disks, cassette tapes, or other storage devices can provide the computer system with previously stored data. Equipment such as optical scanners and typewriter-like keyboards can conduct data to a machine readable form to provide information directly into a computer system or to place information on a storage device.

Information is not useful unless it can be converted from machine readable form to a form that the user can understand. Computers can convert information into printed form (hardcopy) through the use of a printer, display text or graphics on video monitors, produce sound through tone generators or speech synthesizers.

Collectively, devices that provide information to a computer system are called **input devices**; those that receive information from a computer are called **output devices**; and devices that perform both functions, i.e., storage devices, are called **input/output units**.

A computer can do only what it is told and will do what it is told even if the instructions are humanly illogical. Instrucions are grouped in **computer programs** that direct the computer to perform a specific task. The generic term for computer programs is **software.**

Software is difficult to conceptualize. It has no physical substahce. Software may be reproduced and distributed on a variety of physical storage media. Floppy disks, audio cassettes, and printed documents are commonly used to store or distribute educational software. It is important to distinguish the software from the storage medium. The software tells the machine what to do and when to do it. The storage medium is only a phase to retain data. When a program is purchased, what is purchased and subject to copyright protection, is the software, not the medium used for distribution. The computer program must be transferred to the central processing unit and computer memory before it can direct the computer's operations.

The term **courseware** is often applied in instructional settings. Courseware is software that has been developed for instructional environments. In addition to computer software, courseware typically includes teacher guides, written supplements, student tests, and other instructional material.

Computer Assisted Instruction (CAI) is a use of computer-based educational methodology. The computer--like books, pencils and paper--is secondary to the instructional content. For example, the computer is used in a program to teach English, not computer programming. Computer Assisted Language Learning (CALL) is a specialized form of CAI. The term is used to describe the application of computer technology to language teaching.

Instructional software may be grouped into three categories:

- Instructional Support Software

In institutional support software, most of the direction and control resides in the computer. Tutorials, drills and practice, or games are good examples. Tutorials reinforce specific skills taught elsewhere in the curriculum. One common format is for the student to answer questions that determine reading comprehension.

Drill and practice software is primarily intended to improve two aspects of student response, speed and accuracy. In the majority of cases this means that all a student must do is remember a previously displayed response and feed it back to the computer by hitting the correct keys on the keyboard. Drill and practice software is extremely effective for instructional situations where visual memory is important. This software successfully reinforces spelling, arithmatic operations, and discrimination and classification skills.

Software that uses a game format generally has the same instructional objectives as tutorials or drill and practice. Game software simply adds external motivation to the learning process. A typical example is the identification of vocabulary by word class. In a tutorial program a student might be asked to underline the nouns in a passage or write an appropriate noun to complete a sentence. In a drill and practice program the student might be asked to respond "yes" or "no" to the question "Is X a noun?" In a game format the student's task might be to defend a planet by shooting down attacking spaceships that have a noun word written on them. Shooting correctly scores points while shooting incorrectly allows the enemy to destroy areas of the planet.

Regardless of the particular format, the critical point is relating the skills or information to an instructional objective. The danger of this type of software is that it can easily become an exercise in eye-hand coordination with no relationship to the student's instructional needs. This danger can be avoided by careful evaluation of the software prior to use and continuous monitoring of students while they are using the software.

- <u>Collaborative Support Software</u>

In collaborative support software the student is required to think and reason in order to direct or analyze a scenario presented by the computer. Collaborative software uses several approaches to encourage the students to apply thinking skills in the learning process. In "discovery programs" students must ask the correct questions and then answer them to learn the concept being taught. Variations on this approach are "simulations" that build on discovery software by having students simulate an activity by applying existing knowledge. In the process they gain new knowledge. Simulations may involve exercises in managing personal finances or crossing the country by wagon in the 19th century.

- <u>Facilitative Support Software</u>

Facilitative support software requires the user to provide almost all of the thinking, decision making, and control of the process. Facilitative support software has not been widely used in programs for students with limited English proficiency.

APPENDIX A

SAMPLE OF MICROCOMPUTERS CURRENTLY AVAILABLE

MODEL	CRT	MEM	STRG	HD	OS	PRICE
NEC PC-8201	40x8	16K	OPT	N/A	NEC-DOS	449
COMMODORE 64	OPT	64K	FLOPPY	-	DOS	490
EPSON HX-20	4 LINE DISPLAY	16K	OPT	N/A	ROM OS	604
APPLE IIe	OPT	64K	OPT	-	APPLE	686
IBM PC JR	OPT	120K	1/360K	N/A	PC-DOS	729
TELXON 787	2 LINES	16K	16K	-	CMOS	755
TELXON 790	2 LINES	16K	16K	-	CMOS	785
TRS-80 MODEL 100	40x8	24K	OPT	-	CMOS	799
SONY SMC-70	OPT	64K	OPT	OPT	CP/M,CMOS	830
TELXON 790	2 LINES	32K	32K	-	-	870
ALSPA P4001	OPT	64K	OPT	OPT	TURBODOS	953
NEC 8801	80x25	64K	OPT	OPT	CP/M,MS-DOS	953
APPLE IIc	OPT	128K	1/143K	-	APPLE	992
KAYPRO II	9	64K	2/191K	N/A	CP/M	1088
MORROW MD-2	OPT	64K	2/186K	-	CPM 2.2	1104
HP 86B	OPT	128K	OPT	OPT	OPT	1212
TELERAM 3100	-	64K	128K	-	CP/M	1276
MORROW MD-3	OPT	64K	2/384K	-	CPM 2.2	1359
IBM PC	OPT	250K	1/360K	N/A	PC-DOS	1397
TELEVIDEO PC	80x24	64K	2/256K	N/A	CPM 2.2	1419
TELERAM 3000	-	64K	128K	-	CP/M	1436
INTERTEC VPU 128	12	128K	OPT	OPT	MSDOS/CPM	1497
CROMENCO C-10SP	80x25	64K	1/390	N/A	CPM	1499
XEROX 16/8	80x24	64K	OPT	OPT	CPM or MS-DOS	1590
ALSPA ACI-1/SS	OPT	64K	1/596	OPT	CPM	1592
TRS 80 MODEL 4	80x24	64K	1/184K	-	TRS-DOS	1599
COMMODORE 8032	12	32K	8050 DD	-	DOS	1604
MICRO ROADRUNNER (PORTABLE)	80x8	64K	64K	N/A	MS-DOS	1658
KAYPRO 484	9	64K	2/384K	N/A	CPM	1676
TELERAM 4100	-	64K	128K	-	CPM	1676
TIPC 110M	80x25	128K	1/360	OPT	MS-DOS	1711
SHARP PC-5000	8x80	128-256K	BUBBLE 128K	N/A	MS-DOS 2.0	1735
CHAMELEON	9	128K	1/320K	-	MSDOS	1745
VISUAL TECH. 1050	640x300	128K	2/240	N/A	CP/M+	1779
EAGLE PC PLUS 2	OPT	128K	2/360K	OPT	MS-DOS	1780
COMMODORE 8096	12	96K	8050 DD	-	DOS	1854
T.I. PORTABLE	9	128K	1/360	N/A	MS-DOS	1856
NEC APC III	80x25	128K	2/320K	OPT	UNIX,MS-DOS	1904
APPLE MACINTOSH	9	128K	1/400K	N/A	APPLE	1911
COLBY PC 3.1	9	128K	1/360K	N/A	OPT	1996
TELEVIDEO TS1605	80x25	128K	2/360K	OPT	TELE DOS	2126
TRS 80 MODEL 2000	80x25	128K	2/720	OPT	MS-DOS	2200
MORROW MD-11	OPT	128K	384K	10.75MB	CPM 3.0	2206
UNISYSTEM PC	12	256K	2/360K	N/A	PC-DOS	2218
COLBY PC 3.2	9	128K	2/360K	N/A	OPT	2236
FUJITSU PM 00105	OPT	128K	2/320K	OPT	CP/M 86	2236
EPSON QX-10	12	256K	2/340K	OPT	CP/M & VALDOCS	2276

SAMPLE OF MICROCOMPUTERS CURRENTLY AVAILABLE

MODEL	CRT	MEM	STRG	HD	OS	PRICE
SPECTRAL SPECDAT	OPT	96K	OPT	OPT	CDOS/CPM	2280
IMS 518-2DH	12	64K	2/320K	OPT	TURBODOS	2325
KAYPRO 10	9	64K	1/382K	10MB	CPM	2348
JONOS C2150-1	9	128K	2/322K	-	CP/M PLUS	2377
OTRONA 2001	7 or 12	256K	2/360K	OPT	MS-DOS	2426
WANG PC-003B	12	256K	2/720	N/A	MS-DOS	2444
LEADING EDGE PC	80x25	128K	2/320K	OPT	MS-DOS	2490
COLUMBIA 1600-VP	1	128K	2/320	N/A	MS-DOS	2515
OLIVETTI M-18	12	128K	320	10MB	MS-DOS	2519
CHAMELEON PLUS	9	256K	2/320	N/A	MS-DOS	2533
LANIER LBP-1/S	12	192K	1/650	-	LEXUS,MS/DOS,CP/M	2546
GAVILAN SC	80x8	64K	360K	N/A	MS-DOS GAVILAN	2621
SPERRY	11	128K	2/360K	OPT	MS-DOS	2641
COLUMBIA 1600-IV	OPT	128K	2/320	N/A	MS-DOS	2663
ABLE	9	128K	2/360K	N/A	PC-DOS	2663
APPLE LISA	12	1MB	1/400K	OPT	OPT	2677
WORDPLEX 12-100	9	256K	2/320K	-	MS-DOS	2707
HYPERION 3031	7	256K	1/320	OPT	MS-DOS	2716
NEC APC-H02	80x25	128K	2/1.2MB	OPT	MS-DOS CPM	2742
WORDPLEX 12-200	12	256K	2/320K	-	MS-DOS	2750
INTERTEC VPU-512	12	512	.5MB	OPT	MS-DOS CPM	2761
TRS 80 MODEL 12	80x24	64K	1.25MB	OPT	TRSDOS	2799
FACIT 6520	15	64K	2/640K	N/A	CPM	2850
OLIVETTI M-20	80x25	64K	2/1.2MB	OPT	MS-DOS PCOS	2867
IBM PC-XT	OPT	256K	1/360K	10MB	PC-DOS	2999
OLYMPIA PEOPLE	12	128K	2/655	10M	CPM	3038
EAGLE PC PLUS XL	OPT	128K	1/360K	10MB	MS-DOS	3070
FACIT 6520-S	15	64K	2/640K	-	CPM	3070
HYPERION 3032	7	256K	2/320K	OPT	MS-DOS	3137
TELEVIDEO TS-804	80x24	320K	737	OPT	MS DOS/OASIS	3191
FUJITSU PM 00100	OPT	128K	2/320K	OPT	CP/M	3196
VECTOR GRAPH. V4/20	80x25	128K	2/630	OPT	MS-DOS	3196
LANIER LBP-1/D	12	192K	2/650	-	LEXUS,MS-DOS,CP/M	3226
FACIT 6528	15	160K	2/640K	N/A	CPM	3243
DG 91290	12 MONO	128K	1 DSKTE	OPT	RDOS	3310
COLBY PC 3.3	9	123K	1/360K	1/10MB	OPT	3320
IMS 8x8-2DH	OPT	64K	2/1.2MB	OPT	TURBODOS	3356
UNISYSTEM XT	12	256K	1/360	1/10MB	PC-DOS	3371
EAGLE SPIRIT XL	9	128K	360K	10MB	MS-DOS	3425
APPLE III+ BUS.	80x24	256K	1/143K	5MB	APPLE	3443
INTERTEC VPU 1000	12	1MB	1MB	OPT	MS-DOS/CPM	3551
SPERRY	12	128K	1/360K	10MB	MS-DOS	3569
OTRONA 2001	7 or 12	256K	1/360K	10MB	MS-DOS	3641
TRS-80 MODEL 16B	80x24	256K	2/1.25K	OPT	TRS-XENIX	3759
STEARNS 0920007	15	128K	2/320K	-	MULTI	3801
WANG PC 005A	12	256K	2/720	10MB	MS-DOS	3802
JONOS C2600	9	128K	1/322	1/10MB	CP/M PLUS	3986
COLUMBIA 4V	OPT	128K	1/320	10MB	MS-DOS	4007
WORDPLEX 12-200	12	256K	1/320K	10MB	MS-DOS	4025

SAMPLE OF MICR[illegible]MPUTERS CURRENTLY AVAILABLE

MODEL	CRT	MEM	STRG	HD	OS	PRICE
SPERRY	11	128K	1/360K	10MB	MS-DOS	4027
JONOS C2550	9	128K	-	2/5MB	CP/M PLUS	4197
IMS 858-2DH	OPT	64K	2/1.2MB	OPT	TURBODOS	4200
DURANGO POPPY	14	256K	1/800K	10MB	MS-DOS	4246
MICROLINK APPROACH I	19	64K	2/320K	N/A	CPM	4455
COMPUCORP SIMPLIFIER PC	12	128K	2/315K	-	CPM	4549
DG 91295	12 MONO	256KB	2 DSKTE	OPT	MS-DOS	4610
GRID 1100	6	256K	384K	OPT	GRID COS	4676
SPECTRAL VIP	13	156K	OPT	OPT	CPM	4865
MICRO-LINK APPROACH II	19	64K	2/320	OPT	CPM	4930
CORVUS CONCEPT	15	256K	OPT	6MB	PASCAL	4989
LANIER - 1/R	12	192K	1/650	10MB	LEXUS,MS/DOS,CP/M	5092
MOMENTUM 32/4	15	512K	2/5MB	N/A	UNIX	5197
MICRO-LINK APPROACH III	19	64K	2/320	N/A	FORTH	5215
GRID 1101	6	256K	384	OPT	GRID COS	5300
STEARNS 0920005	15	128K	1/320 or 1/10MB	OPT	MULTI	5571
WANG PC-006	12	256K	360	30MB	MS-DOS	5810
GRID 1109	6	512K	10MB	OPT	GRID COS	6236
CORVUS CONCEPT	15	512K	-	11MB	PASCAL	6306
STEARNS 09200018	15	128K	1/20MB	OPT	MULTI	6456
MOMENTUM 32/410G	15	512K	10MB	25MB	UNIX	6497
AUTOMATED SYSTEMS RX-50	OPT	128K	128K	128K	MP/M 86	6525
ITC PC-XT	11.5	128K	1/360K	10MB	PC-DOS	6543
CROMENCO CSIHD2	OPT	256K	1/390	21MB	UNIX	6716
MOMENTUM 32E/10F	12	512K	10MB	YES	UNIX&C	6890
COMPUCORP 775	12	256K	2/655K	-	CPM	7112
ALTOS 586-20	132x15	512K	1/1MB	22MB	UNIX	7192
DURANGO POPPY	14	384K	1/800	20MB	CCPM	7782
OTRONA ATTACHE	5.5	256K	2/360K	NONE	MS-DOS	7851
CROMENCO CS2HD2	OPT	256K	2/390K	21MB	UNIX	7976
TI 300	80x25	128K	1/1.2MB	5MB	PROP	8196
FORTUNE PS-20	12	512K	720K	20MB	FOS (UNIX)	8296
DG 91305	12MONO	256K	1 DSKTE	15MB	RPAOS	8520
MOMENTUM	12	512K	20MB	TAPE	UNIX&C	8528
ALTOS 586-40	132x25	512K	1/1MB	42MB	UNIX	8792
ITC PC-XT	11.5	128K	1/360K	5MB	PC-DOS	9141
MOMENTUM 32E-40	OPT	512K	20MB	40MB	UNIX	9152
TELEVIDEO TS 816/40	N/A	128K	33.2MB	OPT	CPM	9226
COMPUCORP 785	12	256K	1/655K	1/5MB	CPM	9585
INFOTECS CC3	OPT	650K	OPT	5MB	DOS	9995
ITC PC-XT	11.5	128K	1/360K	2/5MB	PC-DOS	10184
ALTOS 986-40	132x25	1MB	1/1MB	42MB	UNIX	10392
DURANGO POPPY II	14	640K	1/800K	20MB	XENIX	10604

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SAMPLE OF MICROCOMPUTERS CURRENTLY AVAILABLE

MODEL	CRT	MEM	STRG	HD	OS	PRICE
FORTUNE XP-20	12	512K	720K	20MB	FOS (UNIX)	10786
WICAT S150-6	12	512K	1/616K	10MB	WMCS	11467
CALLAN CD100123	12	2MB	616K	28MB	UNIX	11738
WICAT S155	OPT	512K	1/616K	10MB	WMCS	12172
FORTUNE XP-30	.12	512K	720KB	30MB	FOS (UNIX)	12446
SPECTRAL RIPS	13	156K	2/1200K	OPT	CDOS/CPM	12950
WICAT S160	OPT	512K	1/616K	10MB	WMCS	13158
AUTOMATED SYSTEMS RX-200	OPT	128K	128K	28MB	MPM-86	13662
CHARLES RIVER UV68/35F-B	OPT	512K	1.26MB	35MB	UNIX	15036
PIXEL 20	OPT	512K	1/10MB	42MB	UNIX	15293
CALLAN CD100245	12	2MB	616K	43MB	UNIX	15863
CENTURION 5300	80x24	128K	-	32MB	PROP	17984
AUTOMATED SYSTEMS RX-400	OPT	128K	128K	56MB	MPM 86	18882
AUTOGRAPHIX AGX 100	13	64K	2/140	N/A	GUIDELINES	19500
CALLAN CD100384	OPT	2MB	616K	43MB	UNIX	19838
AUTOGRAPHIX AGX 110	13	64K	2/140	N/A	GUIDELINES	22500
CHARLES RIVER UV68/67-TC	OPT	1MB	45MB	60MB	UNIX	25746
CHARLES RIVER UV68/137-TC	OPT	1MB	45MB	120MB	UNIX	27426
AUTOGRAPHIX AGX 200	13	256K	1/320	10MB	GUIDELINES	35500
WICAT S200-0	OPT	512K	9 TRACK	474MB	UNIX	42743

APPENDIX B

HINTS FOR ESTIMATING SOFTWARE COSTS

Estimating software costs is not an easy task. Software is an intangible with no direct or constant relationship between quality and price. Good software can be inexpensive and poor software can be extremely expensive. The task of making budget estimates can be simplified by considering several factors.

- **The number of programs to be purchased:** A CAI project can assimilate only a finite number of computer programs during a school year. The limitation is imposed by the time required for students to learn and to use the program, a time significantly affected by the length and number of CAI sessions a student attends. For example, if it takes a typical student an average of three hours to learn and use a computer program and students spend one hour per week using the computer, then the maximum number of computer programs that can be assimilated during a 36 week school year is 12 (36 weeks / 1 hour per week x 3 hours to learn and use). This assumes that all students are to use the same programs.

- **The number of copies needed:** Even though computer programs can be copied, copyright restrictions limit the circumstances under which such copies may be made. For estimating purposes, assume that <u>no</u> copies can be made and that additional copies must be purchased. With this assumption, the next decision is to determine if one copy of a program is to be purchased for each school or one for each workstation. The factor that will best help answer this question is the number of students that will need to use the program at the same time, i.e., if there are five workstations that must use the same program at the same time, then five copies of the program must be purchased.

- **The average cost of a computer program**: In reality, there is no average cost for a computer program. The price for computer software varies from nothing, e.g., public domain software, to several thousand dollars. For estimation purposes, past purchases are the best gauge of an average cost. Without that historical experience, the next best method is to review the prices of software relevant to project objectives. Finally, if no historical data are available and a review of software prices is not practical, then a "comfortable" price should be assumed to be the average, i.e., given the nature of software, people often feel uncomfortable paying more than "X" dollars for any one software product. Thus $300 is a number that could be used in a "comfort factor" approach.

Assuming that a project has 10 workstations and elects to purchase copies for each workstation, the estimate for software costs for one year would be $36,000 (12 software products x $300 x 10 copies).

It is clear from this example that software does represent a significant cost. Further, software tends to be a "lumpy" or "up front" cost. As a project builds its software library, the budget requirements for software should decrease as the project requires fewer new programs (assuming that the project does not alter its initial educational objectives).

There are a several actions that project staff could take to maximize the use of their software budget. These actions include:

- Establish and maintain a different software library for each school or project site. The libraries would rotate among the schools on a regular basis. This library rotation arrangement would permit a project to purchase wider varieties of computer programs instead of many copies of the same program.

- Limit the number of workstations that can have simultaneous use of the same program. CAI permits individualized instruction individualized. Thus, there is no absolute requirement that all students must use the same computer program at the same time. Limitations on simultaneous use would reduce the number of copies required for each program.

APPENDIX C

A PROCEDURE FOR DETERMINING THE NUMBER OF COMPUTERS FOR A CAI PROJECT

Determining the minimum number of computer workstations needed to support a program of computer assisted instruction is possibly one of the easiest aspects of implementing a CAI program. It is easy, because the problem can be expressed as a single equation:

$$N = \frac{T \times S}{A}$$

where

N = the minimum number of machines required rounded up to the nearest whole number, e.g. 1.1 becomes 2

T = the desired time-on-task for a student plus any time needed for set-up and movement between classes

S = the number of students to be included in the program

and

A = the number of hours available in the time period during which every student is expected to have access to a a workstation; e.g. a day or a week

For example, assume that 30 students in a classroom are each expected to spend 30 minutes on a CAI task once per day. Since the computers are in a classroom, there is no requirement for movement between classes, only five minutes for setup. The computers are available five hours per school day. In this example,

A = 5 hours (5 hours x 1 day),

T = 35 minutes or .58 hours (30 minutes + 5 minutes),

and S = 30 students.

APPENDIX D

EDAC/COMSIS COURSEWARE EVALUATION PROTOCOL

PART I - DESCRIPTION

1. Program Title ______________________________
2. Author and copyright date ______________________________
3. Producer (publisher/manufacturer) ______________________________
4. Subject area ______________________________
5. Program Cost

   Single Copy ______________________________

   Multiple Copies ______________________________

   Multi-User System Cost ______________________________
6. For what grade level(s) or target audience?

   Producer's opinion ______________________________

   Your opinion ______________________________
7. Is instructional type specified by producer? Yes___ No___
8. Under which category would youy classify the type of instruction? (Check as many as apply)

   Drill & Practice_____ Other (please specify):

   Tutorial _____

   Simulation _____

   Game _____
9. What kind of microcomputer is required by the program?

   Brand____________ Model____________ Memory____________

   Storage____________
10. The minimum requirement for the monitor should be:

    Color__________ Black & White__________
11. Back-Up/Copying Policy

    No Copier_____ One Copy_____ Unlimited Copies_____

PART II - TECHNICAL QUALITY

N.A.*	Yes	No	
____	____	____	1. Program runs effectively.
____	____	____	2. Program can be exited at any time.
____	____	____	3. Program can be restarted at point last exited.
____	____	____	4. Instructions can be reviewed at any time.
____	____	____	5. Cues are provided to request learner input.
____	____	____	6. Indicator on monitor to show where input will appear.
____	____	____	7. Indication of correct/acceptable or incorrect response is provided quickly.
____	____	____	8. Random reinforcement.
____	____	____	9. Random generation of items.
____	____	____	10. Adequate time given to read each screen page.
____	____	____	11. No more than 10 lines of text on each screen.
____	____	____	12. Program collects and stores performance data, e.g., right, wrong, attempts, skill level, time on task.
____	____	____	13. Diagnoses learner's status based on performance.
____	____	____	14. Adjusts level of difficulty and/or permitted learner response time based on learner's diagnosed status.
____	____	____	15. Branching is based on student input and does not always follow a set pattern.
____	____	____	16. Instructions for operation are complete and easy to use.
____	____	____	17. Comprehensive support materials are available.
____	____	____	18. Program is reliable, e.g., does not

terminate incorrectly or "hang".

_____ _____ _____ 19. Use of control characters such as "RETURN" is consistent.

*N.A. - not available or non-applicable.

PART III - CONTENT QUALITY

N.A.*	Yes	No	
______	______	______	1. Program is relevant to subject matter.
______	______	______	2. Content challenges learner.
______	______	______	3. Content is free of stereotypes.
______	______	______	4. Level of difficulty is appropriate for learner.
______	______	______	5. Content is accurate and error-free.
______	______	______	6. Content matches each objective.
______	______	______	7. Content designed to be altered to fit learner needs.
______	______	______	8. Tests are congruent with lesson objectives.
______	______	______	9. Test alternatives available.
______	______	______	10. Content is motivating.

*N.A. - not available or non-applicable.

PART IV - INSTRUCTIONAL QUALITY

N.A.*	Yes	No	
____	____	____	1. Attracts learner's attention.
____	____	____	2. Learner is informed of lesson.
____	____	____	3. Reminds learner of previous learning.
____	____	____	4. Content is supported by examples.
____	____	____	5. Learner is guided by examples followed by counterexamples.
____	____	____	6. Practice opportunities available.
____	____	____	7. Corrective, non-threatening feedback is provided immediately.
____	____	____	8. Assessment of overall performance is provided.
____	____	____	9. Retention and transfer are encouraged.
____	____	____	10. Remediation activities are provided when necessary.
____	____	____	11. Special effects are embedded in content.
____	____	____	12. Graphics enhance content.
____	____	____	13. High degree of learner participation.

PART V - SUMMARY COMMENTS

1. In your opinion, what are the major strengths and weaknesses of the program?

____

____

____

____

____

*N.A. - not available or non-applicable.