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ABSTRACT

This report presents the plan for the Technology Integrated Educational Delivery System (TIEDS), which was developed for the Arizona State Department of Education in response to the "State Board Policy on the Development of a Plan for Technology" and the "GAITS Report," to establish the conceptual framework for educational change and technological advancement in Arizona's elementary and secondary schools. It is noted that the state TIEDS program is designed to accomplish a systematic change in cognitive and social environments resulting in the promotion of meaningful learning; restructuring of administrative and organizational offices; curricular reform; and an increase in quality, equity, accountability, and efficiency for all of Arizona's students. Divided into four sections, the plan discusses: (1) a rationale for TIEDS, including changing demographics, globalization, and costs; (2) issues and concerns, i.e., quality, equity, accountability, and productivity; (3) the ability of technology to meet educational needs; and (4) TIEDS educational environments, the use of work stations, and telecommunications networks. Copies of the Arizona State Board Policy, the GAITS ("Grow with Arizona Integrated Technology Systems") Report, and the goal and six objectives of TIEDS are appended. Also included are a glossary and listing of members of the TIEDS Work Group. (38 references) (DB)

TIEDS

Technology Integrated Educational Delivery System

A K-12 Master Plan for the Infusion of Technology into Arizona Schools in the [illegible]

TIEDS, the "Technology Integrated Educational Delivery System" is a dynamic Master Plan which calls for the infusion of technology in education. Like the waters of a tide . . . . the plan is fluid, ever-changing and responding to the teaching and learning environment.

IR

ARIZONA DEPARTMENT OF EDUCATION

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We also would like to thank those visionaries whose works provided insight, clarification and brought definition to TIEDS. We are grateful to each of you.

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FOREWORD

During the past 50 years, technology has changed our society and our lives, bringing us into a new age. Informational technologies have been an important and integral force in this change.

These technologies have dramatically changed the way business is conducted throughout the world and play a key role in the economic fortunes of nations. Additionally, these technologies have been largely instrumental in the enormous advances in medicine, transportation, architectural design, manufacturing, agriculture, science, banking, communications, space exploration, and on and on. There have been few instances of human endeavor which have not been impacted by technology.

Of all the efforts of any society, the most important is the educating of its populace. As we move into the next decade, the ability to rapidly and easily exchange all forms of information is absolutely essential to the development of our economy and the quality of our educational system. The challenge which confronts Arizona today is finding ways to enhance the depth and efficiency of our educational system and information exchange.

This State Plan For A Technology Integrated Educational Delivery System recognizes that challenge and proposes a way to enhance the depth and efficiency of our educational system through the infusion of technology into the K-12 teaching and learning environment. Though technology alone cannot decrease the drop-out rate or solve the ills related to under-education, it can play a critical role in a broad effort to address these issues. Technology can improve the efficiency of the education system, increase the productivity of teachers and administrators, provide all students with equal access to high quality instruction and educational resources and meet the continuing educational needs of adults in literacy, basic skills, occupational training and retraining and career and personal development.

This plan was developed in response to the "State Board Policy on the Development of a Plan for Technology" (Appendix A) and the "GAITS" report (Appendix B) which was submitted to the State Board at the July 25, 1989 meeting. It is my hope that this State Plan will create a new vision of learning, a vision which will transform all dimensions of schooling.

I appreciate the efforts of those individuals who worked so diligently this past year to make this plan a reality. I would also like to thank Salt River Project for their support and production of "Textbooks and Technology", a video describing the TIEDS vision. I look forward to the opportunity to implement this vision and thus, improve education for Arizona's children.

C Diane Bishop
State Superintendent of Public Instruction
July, 1990

STATE PLAN FOR A TECHNOLOGY INTEGRATED EDUCATIONAL DELIVERY SYSTEM (TIEDS)

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EXECUTIVE SUMMARY

Arizona is faced with the challenge and opportunity to create a new vision of learning, a vision which transforms all dimensions of schooling. The ultimate success determinant in realizing that vision will be a demonstrated change in the cognitive and social environments of our schools which clearly supports meaningful learning. This change in these environments will be visibly supported by changes in the physical environment and the administrative and organizational structure of our schools and classrooms.

This Plan for a Technology Integrated Educational Delivery System (TIEDS) establishes the conceptual framework for the realization of this vision. The plan plots a course to meet the multi-faceted needs of all learners from K-12, higher education, business, family and community. It calls for the infusion of technology in to the K-12 teaching and learning environments. The following statewide plan for a multi-level technology integrated educational delivery system provides for:

- an equitable, adequate and quality education,
- an efficient and accountable education system,
- an increase in the productivity of teachers and administrators,
- a continuous response to the educational needs of adults in literacy, the basic skills, job training and retraining, career and personal development.

The implementation of TIEDS will result in:

- a restructured teaching/learning environment which will enable and ennoble all Arizona learners,
- a systemic change in the cognitive and social environments of Arizona's schools which clearly supports meaningful learning,
- a systemic change in the physical environment and the administrative and organizational structure of Arizona's schools and classrooms,
- a systemic change in curricula that recognizes:
  - the changing classroom and workforce demographics,
  - the globalization of the economy,
  - changing workforce knowledge and skill requirements,
  - the role that technology plays in educational reform and restructuring,
  - the deficit of under-education.

The implementation of TIEDS will also provide for:

- quality - the best possible education for all Arizona's public school students,
- equity - financial equity and equal access,
- accountability - a system of standards and evaluation,
- efficiency - cost effective use of available resources,
- sufficiency - an appropriate level of support to meet educational needs,
- balance - a recognition of the value of local control and the need for statewide standards.

Though technology has great potential for education, it should not be viewed as an end in and of itself. Rather, technology should be used to achieve the goals of education and should be viewed as a tool to support teaching and learning. Technology will not answer all of our problems, but it can play a critical role.

STATE PLAN
FOR A
TECHNOLOGY INTEGRATED EDUCATIONAL DELIVERY SYSTEM
(TIEDS)

There are a variety of compelling reasons which support the adoption and implementation of this state plan for a "Technology Integrated Educational Delivery System" (TIEDS). These reasons include social and economic forces in the state and nation, legislative mandates, State Board actions, and the call from C. Diane Bishop, State Superintendent of Public Instruction, to fundamentally restructure our education system.

I. Rationale

Education is a major factor in productivity growth, even more so than increased capital or better use of resources. This education, however, must be responsive to the world of today. Much of the current educational environment resembles schools of the 19th century. We cannot continue to function in this manner nor can we continue to do business as we have in the past.

As a state we are increasingly locked in competition with other states and with other countries from around the world. This competitiveness will be heightened in 1992 when the European community sets in motion its internal market program. This will remove all physical, fiscal and technical barriers to trade between the 12 member countries and 320 million consumers. It remains to be seen what economic effect recent events in Warsaw Pact countries, the Soviet Union and South Africa will have on the United States.

We are faced with the challenge and opportunity to create a new vision of learning, a vision which transforms all dimensions of schooling. The ultimate success determinant in realizing that vision will be a demonstrated change in the cognitive and social environments of our schools which clearly supports meaningful learning. This change in the environment will be visibly supported by changes in the physical environment and the administrative and organizational structure of our schools and classrooms. That vision must recognize:

- changing classroom and workforce demographics,
- the globalization of the economy,
- changing workforce knowledge and skill requirements,
- the promise technology offers to educational reform and restructuring,
- the deficit of under-education.

A. Changing Classroom and Workforce Demographics

Arizona is embarking on a significant statewide effort to improve the state's student assessment program. The Goals for Educational Excellence project, a joint project of the Legislature, the state Board of Education, and the Department of Education, has required an analysis of the state's curriculum, testing programs and reporting of student progress. The new assessment and reporting system developed on the basis of this analysis will aid schools, districts, state educators and policy makers in making schools more accountable for and responsive to student needs.

While progress has been made in terms of establishing higher curriculum standards for all students K-12 and in the developing of a comprehensive pupil assessment process, the problems of high dropout rates, functional illiteracy and gaps in achievement levels of students continue to persist. Nationally, demographers predict that the number of minorities in schools will increase and traditional family structures and support systems will continue to demise. "Students who are black or Hispanic, or who come from single-parent families consistently have performed worse in school than others. The average reading proficiency of black and Hispanic 17-year old students is roughly at the seventh (7th) grade level." (Images of Potential, p. 4). There are indications that these conditions will accelerate unless we take action now.

These achievement gaps are not new, but are more urgent because the percentage of students who are at risk - predominantly poor and minority children - represent an increasing share of both the school population and our future workforce. This is verified in the recent **Ed. STAT** report "The 'At Risk' Status of Arizona School Districts". The report states "...a growing number of students are identifiable as being 'at risk' of failing to achieve in school and, ultimately failing to graduate. Furthermore, with the growing sophistication of workplace skills and the increasing competition for available jobs, dropping out puts a young person 'at risk' throughout the rest of his or her adult life." (p. 1). The study reported that the limited English proficiency (LEP) and socioeconomic status (SES) indicators most affect the percentage of students scoring at or below the 25th percentile on standardized tests within a given district.

In the coming decade, eighty (80) percent of new entries in the workforce will be women, immigrants, or minorities. These groups traditionally have been disadvantaged due to a number of factors - discrimination, language limitations, poverty and other economic reasons. Because of this they face an almost insurmountable situation when they enter the workforce. One of four members of the class of 2000, now in second grade, is living in poverty. In Arizona alone there are approximately 8,500 homeless children. These individuals are valuable assets. We can ill afford to cast them aside.

B. Economic Competitiveness and Globalization

"One of the major issues facing the U. S. economy is productivity growth. The projections for the 1988-2000 period highlight it as a continuing concern. Productivity has grown much more slowly in the past 10 to 15 years than in earlier periods. This has had an important effect on the rate of growth of real Gross National Product (GNP) and real disposable income.

Not only does productivity growth have important implications for future increases in our standard of living, but it also is an integral factor in America's remaining competitive or, in some cases, regaining competitiveness. Foreign trade is projected to continue to be the fastest growing category of GNP. The development of worldwide markets for goods and services means that we must remain competitive to sell products abroad or even at home, particularly high-tech goods and services where we still have an advantage in many instances.

The prospects for productivity growth depend on many things - such as spending on research and development, spending on capital equipment, utilization of our productive capacity, and the cost of energy - **but, clearly, the education and training of the laborforce are important.** We can only remain competitive through the participation of highly skilled and highly educated workers. Consequently, the potential imbalance between the educational preparation of those entering the labor force and industry's requirements raises an important concern." (Kutsher p. 39).

C. Changing Workforce Knowledge and Skill Requirements

The needs of the work place are changing drastically and dramatically. Informational technologies have been an important and integral force in this change. These technologies have changed the way business is conducted throughout the world and play a key role in the economic fortunes of nations. Additionally, these technologies are largely instrumental in the enormous advances in medicine, transportation, architectural design, manufacturing, agriculture, science, banking, communications, space exploration, and on and on. There have been few instances of human endeavor which have not been impacted by technology. Employers in these fields are demanding more highly-skilled workers, with over 90 percent of all jobs requiring some retrieval, assessment, and distribution of information. High school dropouts who once could learn unskilled or semi-skilled jobs will find that those jobs no longer exist in the twenty-first century.

"The United States continues to lead the world in new job creation. In the last two decades, we have generated about 35 million new types of jobs, and experts predict that we will generate between 12 and 15 million additional jobs before the turn of the century. This sounds encouraging until one considers that 75 to 85 percent of these new jobs require

cognitive, not manual, skills as well as post-secondary education." (Images, p.4).

Arizona, alone, has chalked up a 120% manufacturing employment increase over the past decade. It has been notably aggressive and successful in attracting high-tech industries; nearly half of manufacturing employment is in this sector compared to 15% nationwide. Predictions are that nearly 150,000 additional manufacturing jobs will be created in Arizona between now and the year 2000. (Arizona Now, p. 15) Approximately "41% of the new jobs in coming years will have requirements ranked at the highest level of proficiency in language, reasoning and mathematical skills, compared with only 25% of existing jobs that demand the same level of ability." (Perelman, p. 15).

These changes in the technological base of America's and Arizona's society will alter the knowledge, skills and values we need to be capable workers and citizens. Evolving information technologies will transform the nature of work, and this transformation will, in turn, affect the design and content of the school curriculum. Because of these technological advances, schools must shift in response. Data processing and information systems will be replaced by sophisticated devices for knowledge creation, capture, transfer, and use. Personal computers, videorecorders, fiber optic networks, intelligent telephones, videotex, digital discs, laser optics will change how we conduct business and how teachers and students function in the learning environment. Given the nature of employment in Arizona, it is critical that public education ensure that the learning needs of society and the continued enhancement and growth of our economic competitiveness be served by the most productive means possible.

D. The Promise Technology Offers to Educational Reform and Restructuring

Of all the efforts of any society, the most important is the educating of its populace. As we move into the next decade, the ability to rapidly and easily exchange all forms of information is absolutely essential to the development of our economy and the quality of our educational system. The challenge that confronts Arizona today is that of finding ways to enhance the depth and efficiency of our educational system and information exchange. In a word, systemic change of the K-12 education system must become a reality.

Technology is central to this systemic change. It is a powerful education tool to empower learners and assist teachers and administrators. The education arena currently lacks the in-depth exploration and empirical data to prescribe how technology should be used. "However, we do know that technology supports a variety of learning styles, contexts and curricula. It has the potential to expand teaching and learning beyond the four walls of the classroom. Technology suggests multiple teaching/learning patterns, challenging educators to pursue creative alternatives to the traditional lecture/worksheet structure. **Specifically, technology has the potential to:**

- **address the issues of educational equity, adequacy, and effectiveness,**
- **focus on students' characteristics and individual learning styles, e.g. self-directed, integrative, and collaborative learning styles,**
- **create learning environments which extend beyond the walls of the school involving members of the community, experts and scholars, other students studying the same issue or problem,**
- **focus on students applying their knowledge in purposeful activities, e.g. providing assistance to the community, working with other students on global issues, rendering relevance, practicality and societal value to their education,**
- **create inter-disciplinary approaches to curriculum often involving some form of teaming of teachers from different subject areas,**
- **enhance higher teacher expectations and a belief that students are capable of solving complex problems,**
- **establish a belief in the importance of utilizing existing and emerging technologies and researching their full potential for supporting education and creating new knowledge,**
- **increase students' responsibility for their own learning and the learning of others,**
- **develop the application of a mixture of technologies to the teaching/learning situation which extends beyond the classroom computer,**

- **establish flexible use of facilities, time and human resources,**
- **create a sensitivity to the development, health and wel-being of the whole learner rather than be limited to academic development. (Images of Potential, pp. 6 and 8)**

While we recognize that technology has great potential for education, we must also recognize that there are limitations as well. Technology should not be used as an end in and of itself. Rather, technology should be used to achieve the goals of education. It should be viewed as a tool to support teaching and learning. Technology will not answer all of our problems, but it can play an important part.

E. The Cost of Under-Education

There is little debate that the cost of dropouts to society, personally, economically and socially is monumental. The 193,000 dropouts from the nation's high schools in 1981 will lose $228 billion in personal earnings over their lifetime, while society will lose $68.4 billion in taxes. Today it would take a dropout over 48 years working 365 days a year at $4.00 per hour to make up the difference in the average lifetime earnings between a high school dropout and a graduate. The decision to drop out of high school could cost that individual a total of $562 308.70.

During FY87, the actual level of non-capital spending per student amounted to $3,544 per student in Arizona. The cost to incarcerate a juvenile offender was approximately $25,000 to $30,000 per year. Of all those incarcerated in Arizona, approximately 85% have no high school diploma or equivalent.

On the other hand, the Committee for Economic Development found: "Every $1 spent on early prevention and intervention can save $4.74 in costs of remedial education, welfare, and crime further down the road. If we could raise the mean-tested skills of our nation's 19-23-year olds by one grade equivalent - a goal that would be considered within reach for any computer-assisted remediation program in the country in 50 hours - lifetime earnings would increase by 3.6% and the likelihood of births out of wedlock, welfare dependency, and arrests would decline by 6.5%, 5.2% and 6.2% respectively." (MDC, Inc., p.40).

Technology alone cannot decrease the dropout rate or solve the social ills related to under-education; single solutions do not exist for complex problems. Nevertheless, as a component in a broad effort to address these issues, **it can play a critical role by:**

- **providing all students with an equitable, adequate and quality education,**
- **improving the efficiency of the educational system,**
- **increasing the productivity of teachers and administrators,**
- **meeting the continuuous educational needs of adults in literacy, the basic skills, job training and retraining, career and personal development.**

II. Issues and Concerns

A. Quality Education

The mission of the Arizona Department of Education is to oversee the provision of the best possible education for the Arizona public school students within the philosopnical and fiscal mandates set by the Arizona Legislature and the State Board of Education. The strategic plan to accomplish this mission is embodied in the Educational Excellence in Arizona legislation Senate Bill 1442. The plan embraces several guiding principles, including:

- *equity* - financial equity and equal access,
- *accountability* - a system of standards and evaluation,
- *efficiency* - cost effective use of tax funds,
- *sufficiency* - an appropriate level of funding to meet educational goals,
- *balance* - between the value of both local control and the need for statewide standards.

* **Please Note Correction: Page 4 Sect. E.-The Cost of Under-Education, first paragraph, should read 973,000 dropouts**

These principles must not be simple platitudes but must be the very foundation for Educational Excellence in Arizona. Technology can serve as the mortar of that foundation.

Arizona's future well-being demands that we effectively educate all students and establish high expectations for their performance. From elementary school through high school and into higher education and job training, Arizona's young people of all backgrounds and abilities must be inspired to do their best. To this end, Arizona has established the following measurable goals:

- *individual student achievement* - to demonstrate mastery in mathematics, communications skills, science, social and economic studies, humanities and art, physical and health education, and to acquire broad employability skills and vocational/technical knowledge,
- *high school graduation rates* - to dramatically reduce the current drop-out rate of approximately one in three students who fail to graduate,
- *post-high school employment and college enrollment* - to ensure that high school graduates have the prerequisites skills necessary for success in higher education and in the workforce.

B. Equity

Equity for all Arizona's students demands that:

- every student should be able to receive quality instruction in every required course and in any additional appropriate course; the instruction should be effective and adequate, and coursework available in the state to one student should be available to all students,
- every student should have access to the data and primary resources that will empower him or her to accomplish his or her optimal level of achievement; the resources and information available to one student in the state should be available to all students.

Access to Instruction is Inequitable

State Board of Education rules for curriculum require instruction in specific content areas. For small, rural, isolated schools as well as urban isolated and urban declining enrollment schools, these requirements may present a burden and a challenge. These conditions often result in an inability to offer certain courses due to:

- lack of qualified teachers,
- inability to pay for qualified teachers,
- inadequate facilities and educational services and resources,
- insufficient numbers of students to warrant the required expenditure.

These conditions also contribute to:

- limited staffing,
- inflexible and narrow programming,
- few opportunities for program enrichment offerings for the gifted and talented,
- few opportunities for remediation.

These, along with inequities in the financial base of less wealthy school districts, make the delivery and access of balanced and quality education both costly and difficult.

Over the next ten years, these conditions will be exacerbated in Arizona. A recent study by Raymond I. Castillo, Director of Student Affairs, College of Education, Arizona State University, on Teacher Supply and Demand In Arizona indicates that the number of student teachers from all of the state recognized teacher preparation universities is in serious short fall of the state's demand. Specifically, the projected fall 1989 openings totaled 2,844. There was a total of 1,750 first year teachers available from the state's teacher preparation universities to fill these projected openings. These shortfalls showed up across the board including shortfalls in all of the content areas as well as in special education and elementary education. The new elementary foreign language requirement will solidify the need to

address the problem of the shortage of qualified education professionals.

Technology can address these burdens and challenges. Through the integration of technology into instructional strategies such as distance learning, computer conferencing, and electronic bulletin boards, all students can have the same educational opportunities. Through the use of facsimile machines, telephones, computers, modems and satellite or microwave receivers, educational opportunities are boundless.

Access to Information Is Inequitable

Information and the knowledge and wisdom that derive from it are the substance and the goal of education. Increasingly, information is the substance of the economy as well. By any measure, the United States is now an Information Society.

- At least 54 percent of the American workforce is composed of information workers.
- 63 percent of all equivalent working days in the United States are devoted to information work.
- Even non-information workers spend one-quarter of their time in information activities, while virtually none of information workers' time is spent handling goods or materials.
- Information work accounts for 67 percent of all labor costs in the United States because information workers receive wages and benefits that are 35 percent higher than those of noninformation workers.
- 70 percent of all work hours in the United States are devoted to information work because information workers put in an average of 10 to 20 percent more hours per week than do those engaged in other occupations. (Strassmann, "Information Payoff; The Transformation of Work in the Electronic Age". 1985, p. 56; cited in Rogers, p. 12).

In Workforce 2000, a study for the U. S. Labor Department, William Johnson and Arnold Parker, of the Hudson Institute, found that both the educational and skill requirements of U. S. jobs are rapidly increasing. According to their analysis 41% of the new jobs in coming years will have requirements ranked at the highest levels of proficiency in language, reasoning, and mathematical skills, compared with only 24% of existing jobs that demand the same level of ability. Anthony Carnevale, of the American Society for Training and Development, found that in addition to the traditional three "R's", American business now considers six other groups of basic skills to be essential for any kind of employment in the 1990's and beyond. These other skills are knowing how to learn, listening and oral communication, creative thinking and problem solving, personal management, and organizational effectiveness and leadership.

To deny Arizona's students access to information is to deny them their futures. Information is, indeed, power. It is the wealth of society and of its people. Failure to provide our students access to all sources of information is to confine them to a future without prospect.

Traditionally, information for students has been contained within textbooks, teacher presentations and libraries. Today, through on-line data bases, computer search and retrieval, electronic bulletin boards, compact disc-read only memory (CD-ROM), teleconferencing, distance learning, etc., information is widely available from many sources. It is a commodity that must be planned for, acquired, and dynamically maintained.

It is imperative that Arizona secure the future for its students by providing them access to information. Our students must have the opportunity to develop the knowledge and competencies required to succeed, to be productive and contributing members of our society and to experience quality life.

C. Accountability

Arizona's goals for Educational Excellence recognizes several elements essential to the development of accountability:

Assessment

- a broad-based data collection system of statewide educational performance indicators.
- a comprehensive assessment of student achievement, including both norm-referenced testing designed to provide national comparisons of a student's performance and criterion-referenced testing to provide specific information on a student's mastery of a given topic.
- the implementation of specific standards for grade level promotion and high school graduation.
- a system of local assessment, whereby each school board sets specific district standards of achievement and develops accountability measures based upon state goals.
- a system of accountability for school personnel, in which additional compensation is based in part upon student achievement performance.

Fiscal and Performance Accountability

- external fiscal management and performance audits to measure the achievement of program objectives in a cost-effective manner.
- joint utilization of personnel, services, and equipment to promote cost-effective use of resources and equal access to programs (e.g., multi-district vo-tech programs, special education, and telecommunications services).
- provision of incentives for consolidation of school districts.

System Accountability

- development of a system in which **all** educational levels - K through 12, community college, and university - coordinate their actions and facilitate the transition from one level to another.

In addition to their core teaching duties, teachers are expected to diagnose learning styles and rates of learning, measure acquisition of essential elements and track student achievement, maintain discipline records, and respond to a myriad of administrative details. Given these instructional and administrative requirements, all teachers (94 percent) agree that students need more help and support than they have needed in the past. Forty percent of teachers report "teaching" less than 75 percent of the time.

Administrators also report burdensome paperwork requirements because of the necessity to record and report financial and accounting information, student and personnel data, measurement results, and adherence to regulatory and legislative mandates.

Despite their importance for ensuring maintenance of records for accountability and student achievement, these tasks need not be burdensome. Through automation and rapid data transfer, technology-based management and expert systems can alleviate the tedium and time often associated with such reporting requirements. Relieving teachers of such labor-intensive record keeping allows them to concentrate on teaching; integrating technology into education will not necesssarily save teachers time, but it will allow them to devote their working time to teaching. Relieving administrators of the need to monitor the collection and transmission of such data allows them to support the educational functions of schools.

Technology has enormous implications for accountability. Computerization of mundane activities such as student attendance, grades, enrollment and financial data increases productivity and provides more time to spend on the instructional process. The use of technology also increases the availabiltiy of educational services, resources and information and creates different communication pathways for teachers, students and administrators alike. Although the paperless office is certainly an illusion, a much larger volume of information can be kept and organized without the investment of more time using technology.

D. Productivity

The teaching/learning environment made possible by the use of technology can lead to increased productivity for students, teachers and administrators. As Heinich (1984) suggests, teachers should consider the use of technology in education not only as a set of products but as a way to discover the *process* of planning, developing, selecting, implementing and revising instruction. This process insures that curriculum and instructional alignment occur and that individualized educational plans become a reality.

Using today's technology, teachers can more effectively manage classroom activities, measure individual student and group progress against curriculum goals, and revise the instructional materials to meet those goals. Educational technologies are now available so that teachers can develop instructional materials and activities that used to be reserved for only the most sophisticated media specialist. These technological developments have enabled teachers to create materials capable of enhancing the student's capacity and desire to learn as well as the teacher's capacity and enthusiasm to teach.

In the majority of today's classrooms, information that is required for administrative, classroom management and instructional purposes is dealt with manually or at best with meager technological support. This environment and lack of technological support requires that the teacher spend valuable instructional and professional time in completing laborious clerical duties. The productivity level of both teacher and student is stymied by this situation.

In a technology integrated educational system, however, productivity will be greatly enhanced. Taking attendance will simply be a matter of students logging in at their computers. This information will be electronically transferred to the administrative office to be aggregated, sent to the district office where it will be aggregated with other schools data in the district and eventually electronically transmitted to the state level. Student assessment will become more diagnostic with the results being integrated into instructional activities so that teacher and student receive immediate feedback on student progress. Student records will reflect past performance as well as current accomplishments. These profiles will be able to be transmitted to whomever has the authority and/or responsibility to have this information. The "guessing game" of where to place a student, how to motivate and challenge him or her, and maximize the student's full potential will no longer exist.

Once all instructional, administrative and communication systems among schools, districts and the Arizona Department of Education are fully integrated, information will be available instantaneously to students, teachers, administrators providing them with the resources to improve their productivity.

III. Technology Facilitates Meeting the Needs

A. Technology Works

Considerable research and evaluation have been conducted on the effectiveness of computers in instruction and learning. While some of the hopes and speculations regarding the utility of technology in meeting educational needs have not yet been realized, technology far less powerful than that currently available has already amassed a proven record of significantly improving the quality and efficiency of education. Furthermore, as newly emerging and blueprint technologies described below supersede those on which research has been conducted, the positive effects are likely to increase.

1. Basic Skills Can be Acquired More Thoroughly and More Quickly With the Aid of Technology

The use of technology, along with many other solutions, shows promise of improving students' basic skills, reducing the amount of time needed to learn these skills, and improving students' attitudes toward school.

Computer assisted instruction (CAI) generally produces small but significant increases in achievement test scores. The improvement rate varies according to the grade range studied and the application, but, at a minimum, achievement increases from the 50th to the 60th percentile on such tests (Bangert-Drowns, et al, p. 65). Other analyses find improvements from the 50th to the 61st percentile (Kulik and Kulik, p. 224), to the 63rd percentile (Samson, et al, p. 313), and to the 68th percentile (Kulik, et al, p. 59).

Furthermore, according to some analyses, "Computer-based teaching had its clearest effects in studies of disadvantaged and low aptitude students. This analysis provides the strongest evidence yet available that the computer has an especially positive contribution to make in the education of disadvantaged high school students." (Bangert-Drowns, et al, p. 66)

This finding is substantiated by another analyses that states "Six reviews at various grade levels found that slow learners and under-achievers seemed to make greater gains with computer-based methods than more able students." (Roblyer, et al, p. 30). The authors caution that "Many of the studies which yielded high effects with slow learners were of systems *designed* for this population." (Roblyer, et al, p. 30). More recent analyses, however, have "...found no evidence of differences between students on the basis of ability levels." (Roblyer, et al, p. 54).

Other relevant results indicate that students learned their lessons with less instructional time, the average reduction being 32 percent and that students liked both their classes and computers more when computers were used in instruction. (Kulik and Kulik, p. 224). A general conclusion of these analyses states that CAI: (1) has real potential as a tool in improving student involvement in precollege classes; (2) fosters positive attitudes toward the computer; and (3) can produce substantial savings in instructional time. A safe conclusion is that the computer can be used to help learners become better readers, calculators, writers, and problem solvers. (Kulik, p. 1)

In addition, commercial learning centers have shown success in increasing literacy and in assisting potential and actual dropouts to acquire certificates of high school equivalency through a computer-based program. The Comprehensive Competencies Program, for instance, provides individualized instruction pursued on a self-paced basis with attainment measured and tracked on computer. The program also provides the ability to diagnose learning pathologies and prescribe remedies. Data indicates that learners have gained an average of 1.1 grades in reading in 31 hours of reading instruction and of 1.6 grades in mathematics in 28 hours of mathematics instruction. (Taggart, p. 28). Participants in Adult Basic Literacy Education (ABLE) have increased reading and mathematics skills by an average of one grade level for every 40-50 hours of computer-based instruction combined with tutoring. (Mendel, p. 30). Another technology-based program that offers hope to adolescents and adults hampered by a low reading level is Principles of the Alphabet Literacy System (PALS) which uses interactive videodisc. During one ten-week summer session, the reading level of ninth- and tenth-grade students in Florida who were identified as low readers and who met eligibility requirements established by the Job Training Partnership Act (JTPA) rose an average of three grade levels. (McGraw, p. 21)

As a result of these successes, a report on workforce literacy, produced by the Sunbelt Institute, recommends that "Computer-assisted instruction, interactive video disks, television, and other modern technologies, must be incorporated more fully into literacy and adult education programs." (Mendel, p. 33). Similarly, a report by the Adult Literacy and Technology Project concludes, "It is imperative...to find ways to make technology, and through the technology, literacy instruction, accessible to everyone. (Turner, p. 3)

2. Higher-Order Skills Can Be Improved With the Aid of Technology

The higher-order skills that will be needed to support the economy of the state and the livelihood and welfare of the state's citizens can be significantly and demonstrably

enhanced with the aid of technology. For instance, the average achievement level of junior high school general mathematics students on a standardized test of problem solving rose from the 33rd to the 68th percentile over four years of television instruction. (Chu and Schramm, p. 2) The Higher Order Thinking Skills (HOTS) Program developed by Dr. Stanley Pogrow of the University of Arizona shows gains in thinking skills and social interaction that continue beyond the experimental experience. In the HOTS program, commercially available software is used to develop in at-risk students the thinking skills of metacognition, inference, decontectualization, and synthesis. As conceived by Pogrow, the HOTS program "...is an alternative to Chapter 1 programs in grades three through six that replaces all compensatory content instruction and drill and practice with thinking skills activities." (Pogrow, p. 11).

Results of the program, as reported by Pogrow, indicate that, "...in addition to gains in thinking skills and social interaction, schools are generating gains exceeding 15 percentile points (reaching as high as 25 percentile points) on standardized tests the first year. Gains continue in the second year. Standardized math scores are also up substantially without specific math activities the first year. Indeed, HOTS students have been outperforming students in computerized drill and practice programs." (Pogrow, p. 11).

Pogrow emphasizes that it is not the computer alone which is responsible for these successes. The technology is a tool which must be used with the HOTS curriculum, teaching techniques employed by trained teachers, and instruction in the regular curriculum. He explains that "...the key to using computers to enhance learning in transferable ways is not the computers or programs themselves but the dialogue that ensues between teacher and students." (Pogrow, p. 13).

3. Technology Can Help Meet the Needs of Special Education Students

Special needs students, those with physical and mental handicaps, can in many cases be reached more effectively through technology than with only teacher-student contact. "Adaptive/assistive devices" can compensate for sensory communication, mobility, and manipulation deficits. Technological examples of such devices include braille writers and printers, speech synthesizers, reading machines, and eye movement detectors. Project A. I. (Activating Children Through Technology), for instance, integrates microcomputers with speech and music synthesizers, graphics tablets, and other devices, into educational programs for mildly to severely handicapped children to the age of eight years. **Preliminary results indicate that computer use increases attention span, retention, social interaction, and aspects of problem solving.** (Hutinger, p. 5)

A preliminary research project at the University of California at Los Angeles indicates that using speech synthesizers with adolescents with Down's syndrome increases the teenagers' speaking, reading, and writing abilities. Within 10 sessions, more than 80 percent of the students gained at least six months in mental age on at least one-half of the standard tests. (Kolata, p. 15)

Videodisc technology for instruction and management developed at Utah State University has been shown to be effective in teaching some content, such as telling time, and skills, such as social interaction skills, with children with mild intellectual handicaps. (Hofmeister and Friedman, pp. 360-361)

Technologies can be effectively used to assist management and diagnosis of special needs students as well as to support their instruction. Several programs exist, for instance, that periodically list children due for Individualized Education Program (IEP) review and automatically report necessary data to state and other agencies. (Bennett, p. 107) Preliminary evaluations of expert systems to diagnose handicapped students as learning disabled indicate that the expert system's conclusions "...were comparable to those of the 'better' human experts and more acceptable than those of the majority of human experts." (Parry and Hofmeister, p. 131). Similar studies of the use of expert systems to diagnose reading problems "...revealed that the

expert system provided more detailed information than human diagnostic reports." (*Ibid.*, p. 130).

4. Distance Learning is a Viable Means for Providing Effective Instruction and Inservice

Distance learning refers to instruction and inservice that are delivered over a distance via telecommunications or other means, or on-site via technology, and is comprised of at least one of the following characteristics: (1) the instruction supplements or comprises entire course content; and/or (2) the instruction is available from an instructor in real time; and/or (3) the instruction is interactive with the instructor and/or with courseware and data available on student workstations.

Telecommunications- and computer-based technologies offer the ability to deliver instruction to districts where it is currently unavailable in order to meet the needs of equity and quality cited above. Such instruction by distance can be provided—and, to some extent, already is offered—through a variety of means. Most notably, Arizona School Services Through Educational Technology (ASSET) offers supplemental instruction through public braodcasting to 131 districts and approximately 276,164 students. The wide array of programming delivered by public broadcasting stations enriches and broadens students' knowledge and experiences and informs teachers as well. Approximately four (4) districts in Arizona also deliver supplemental instruction, teacher inservice, and other school services over local cable or broadcast networks.

In addition to the supplemental instruction that is provided by public broadcasting, course work for credit is also offered through videotape, audio conferencing, telecommunications and computer-based technologies, and through combinations of these at the University and Community College level. Distance learning courses for credit at the K-12 level in Arizona currently include providers from other states and national consortia. These current and/or potential providers include:

- Oklahoma State University, as a member of the Midlands Consortium Star Schools Project,
- The Satellite Educational Resources Consortium (SERC), which is composed of public television groups and state departments of education,
- TI-IN Network, Inc. a provider of student and staff development services,
- The Education Satellite Network sponsored by the Missouri School Boards Association,
- The Satellite Telecommunications Education Program (STEP) produced by Educational Service District 101, Spokane, Washington.

Many additional efforts in other states and at the national and regional levels provide access to education-related information electronically. These include:

- The Software Communication Service, a 13-state consortium that offers to schools and colleges an extensive array of services, such as software and video preview, product procurement assistance and delivery, inservice training, and on-site technical support,
- Learning Link, an 11-member national information system that features databases, information resources, inservice teacher training, message centers and electronic mail, and gateways to remote educational databases.

The Office of Technology Assessment states: "In most instances, distance learning appears to be as effective as on-site, face-to-face instruction in the classroom. Extensive research indicates that distance learning is equally effective in applications for adult learners in nontraditional programs and for training of professionals in business, industry, and the military. Distance learning has proven to be a powerful delivery system for many subjects and through many media. Although the evidence is incomplete in K-12 settings, much must be learned about instructional design, teaching techniques, and various kinds of interaction that affect learner outcomes. Current distance learning efforts offer a rich source of data to be mined.

Distance learning affects the educational process in a number of ways. Students report having to take greater responsibility for their learning and that their experience helps them make the transition to higher education. Students also report that they benefit from exposure to a greater range of ideas, peers, and teachers made possible by the expanded educational community. At the same time, however, students report that distance learning is harder. When the distance learning group is large, students complain about difficulties in raising questions and obtaining help during class time.

Whether distance learning works equally well for all students is yet to be determined. Most applications to date have been with academically advanced high school students and independent adult learners - those who already possess strong study skills, high motivation, and discipline. Whether the medium of distance learning works as well with young or academically weak students - and under what conditions - needs further study.

Adult distance education is cost-effective when compared to traditional methods of instructional delivery, saving on travel and employee time. Experiences in adult learning and business and military applications have implications for teacher training and staff development. Few studies have examined cost effectiveness of K-12 projects. Where traditional instruction is simply not available, comparisons of the cost-effectiveness of distance education and traditional delivery is moot." (Linking for Learning: A New Course for Education, p. 11).

B. Emerging Technologies and Educational Practice Will Evolve

1. Technology Is Evolving

Technologies in use in schools today seem miraculous compared to those of just a decade ago. Those in use in the late 1990s will make those of the 1980s seem quaint.

Technologies in use in schools include:

- instructional television for supplemental instruction and inservice,
- computers for drill and practice, tutorials, simulations, programming, and problem solving exercises,
- electronic communications systems for educating geographically isolated students using one-way video signals, sometimes enhanced by two-way audio signals,
- communications networks for information and data exchange among education institutions,
- information utilities, which connect workstations to various information sources, such as radio, television, newspapers, journals, books, and magazines,
- teletext and videotext, which scan and retrieve information.

A broad current trend involves the synthesis of computers with telecommunications. The convergence and increased compatibility of many technologies is a current reality. In the future, the quality and capabilities of the technologies will increase, while costs are likely to decrease. Distance will no longer constrain the search for needed information. In practical terms, the new devices put the world of knowledge at the user's fingertips.

Emerging technologies offer enormous and unprecedented possibilities. Recent computer-related innovations greatly facilitate the entry, storage, and retrieval of very large amounts of information in multiple formats, including text, graphics, audio, and moving images. In the future, knowledge bases will be not only larger, but will be cross-referenced and linked to one another through public and other telecommunications networks, allowing users to browse through vast libraries of audio and video information.

Computer-based multimedia sometimes is referred to as "hypermedia". The technologies, in addition to the computer, that make multimedia possible are:

- CD-ROM, an optical storage device of immense capacity,
- the computer controlled interactive videodisc player.

Although the components above are the ones most likely to influence the delivery of education in the near future, other areas of research suggest additional long-term possibilities. These include:

- voice recognition and synthesis, which facilitate communication between the computer and the user,
- digitizing of print, audio, and video analog information, such as texts and videotapes,
- superconducting materials, which may greatly enhance the speed, memory, and efficiency of computers,
- vector and parallel processing, which use microprocessors to work simultaneously on different parts of a single large problem,
- expert systems and artificial intelligence, which emulate human higher-order reasoning abilities,
- neural networks, which allow machine learning and diagnosis of patterns and problems,
- vertical blanking interval (VBI) in television broadcast to deliver data simultaneously with the video/audio image.

As these technologies are developed and marketed, applications for education must be encouraged. Schools in 2000 must not be relying on the technologies of 1990; they must have access to and reason to use the technologies of 2000. Business, education, and government must work together to transform the technologies developed for the workplace and the military into those appropriate for the classroom. Such cooperative effort in regard to military schools' software is anticipated from the newly created Office of Technology Transfer within the U. S. Department of Education and other federal efforts. A product development consortium of business and education can move exciting training and applications technologies from the former to the latter. Furthermore, educators and taxpayers must be prepared to phase in new technologies and phase out or upgrade obsolete technologies on a cycle of approximately five years.

2. Education Will Evolve As Technology Is Implemented

The attributes that make the new technologies attractive for instruction and management also imply great social and organizational change in the education system. In the long run, the technologies promise to alter what is taught (curriculum), how it is taught (pedagogy), where it is taught (in schools, alternative educational settings, workplaces, homes, or elsewhere), when it is taught (during school hours, after school hours, weekends, or summers), and may induce debate on the whys of education (in terms of life skills, economic competitiveness, and personal enrichment). The extent of these changes has been described as a second frontier.

> Computing in education has a second frontier because an irreversible phenomenon of historic significance has been initiated that will deeply affect the potentialities and constraints of education. We can explore what lies beyond this frontier: we cannot return to a world in which the frontier does not exist. (McClintock, p. 349)

For technology to make a genuine contribution in education, it must be allowed to shape and be shaped by the school and classroom settings. Its effect will be minimal if it is simply "added on" to the existing curriculum. The relationship between education and technology must be holistic. Hardware alone cannot educate students. It remains for teachers, empowered by the technologies, to translate information into knowledge and wisdom on the part of the student; for students, similarly empowered, to formulate questions and to learn how to learn; and for administrators, also empowered by rapid data and information aggregation, to lead their institutions to ones characterized by diversity, efficiency, and achievement.

The two most common errors in technology planning assessment are to overestimate the speed of diffusion of an innovation and to underestimate its eventual consequences. (Dede, et al. p. 88) Integrating the new computing and communications technologies into education will require concerted effort. They will also provide teachers, students, and administrators with an array of rich alternatives to traditional teaching, learning, and managing.

Furthermore, while the emphasis of this plan is on the use of technology in school settings, technology will continue to have an impact on learning in the home and other settings. Television reaches over 90 percent of the homes in this country, and children and their parents have access to three major networks and public television. Nearly 50 percent of the homes in the country subscribe to cable television, providing an additional 20 to 150 channels for viewing. With this widespread coverage, it is possible to imagine a wide variety of information on parenting, careers, and other topics and courses offered both to adults and to students. This information could be broadcast as it is today; it could become interactive; it could be provided in the form of computer software and programs; and it could originate from a variety of sources.

a. Teaching Will Evolve

The technologies will bring the media laboratory and the library into each classroom. For the teacher, this combination will enable the authoring and presentation of lessons using materials drawn from multiple audiovisual sources. Currently, a single audiovisual presentation may require multiple, bulky pieces of equipment-film projector, slide projector, audio tape recorder, videocassette player, overhead projector, and screen. In contrast, **a teacher workstation that integrates the new technologies will make multimedia available to all teachers at all times.** The same is true of library resources, such as books and journals. Entire libraries of text, pictures, and even full-motion videos with sound will fit onto only a few optical disks.

The teacher's computer will be a super-workstation, capable not only of superior presentations to the class as a whole, but also monitoring student progress during individualized or small group sessions, thereby giving the teacher great flexibility in terms of instructional approach and classroom arrangement. The teacher's station will act as a file server that controls student access to a vast amount of software. The station also will assist the teacher with a myriad of administrative tasks, including attendance, lesson plan preparation, testing, grading, and report writing, thus freeing the teacher for planning and working with individual students.

In a student-centered classroom the teacher's role will be to enable students to assume greater responsibility for their own education. Teachers are more likely to facilitate learning, less likely to control it.

b. Learning Will Evolve

For the student, the technologies mean a variety of educational experiences ranging from directed interactive lessons to nondirected individual or cooperative exploration of diverse subjects. Directed lessons will use artificial intelligence or neural networks to diagnose and match the individual's unique learning style, providing feedback at appropriate intervals. Students will progress at their own pace, with some receiving intensive remedial assistance and others beginning advanced studies regardless of grade level. In general, students will learn more, faster.

In the long run, the new technologies could change assumptions about education. Under current practice, until test time, neither the teacher nor the students can be confident that students have acquired the knowledge or skills. With the new technologies, students and teachers can receive immediate feedback on a lesson's effectiveness. As a student works through an individualized lesson, he or she leaves an electronic "trail" that can be traced and

analyzed for information on how the student learns. The technologies may be the key that unlocks the mystery of how students learn. **Greater knowledge of student learning patterns, both individual and collective, promises to revolutionize the science of learning and the practice of teaching.**

c. Curricula Will Evolve

Changes in pedagogy and measurement, in the rates and methods by which students learn, and in the demands that will be placed on the citizenry and workforce of the future, suggest changes in curriculum as well. Some leaders urge a utilitarian curriculum that includes familiarity with computers for data searches, word processing, and other applications. (National Task Force on Educational Technology, p. 9) Others propose a "new literacy" that includes rhetoric to comply with voice recognition technologies (Compaine, pp. 156-59) or information analysis and evaluation, prediction and long-range planning, and aesthetics. (White, p. 7) The federal Office of Technology Assessment projects new job skills to include problem recognition and definition, handling of evidence, analytical skills, implementation skills, human relations, and learning skills. (U.S. Department of Labor, Office of Technology Assessment, 1988 p. 243) Former Secretary of Labor Marshall foresees a shift to higher-level skills, greater attention to language and international studies, and less concentration on textbooks. (Marshall, p. 54)

Regardless of the specific skills and knowledge which adults will need in the 21st century, the citizenry must be flexible as the world continues to change. Provisions for content and procedures in the curriculum must be similarly flexible. The Goals for Excellence and The Arizona Student Assessment Plan (ASAP) have laid the foundation for our response to these demands.

d. Management and Structure Will Evolve

For the administrator and other staff, **technologies offer communications within schools and districts, between schools and parents, and among education and other educational entities across the state.** The needs of students and families can be more productively met. **Records of mobile students can travel with them rather than behind them. Students at risk need not be lost.** Educational leadership can be thorough and consistent as local and state policymakers share information and guidance.

Developments might include alterations in the roles and relationships between instructional and administrative staff who will share technology hardware and networks to conduct their tasks. Governance of schools is likely to evolve.

e. Facilities Will Evolve

As electronic networks become wired and structural relationships within schools evolve, so will the buildings themselves. **The architecture that conveys the transmissions and houses the new teaching, learning, and managing must be planned for long-term flexibility and change.**

IV. The Vision - A Technology Integrated Educational Delivery System

Arizona's education system must have the ability and capacity to use and apply technology to the teaching and learning process. The following statewide plan for a multi-level technology integrated educational delivery system (TIEDS) plots a course to meet the multi-faceted needs of all learners from K-12, higher education, business, family and community. The system provides for:

- an equitable, adequate and quality education,
- an efficient and accountable education system,
- an increase in the productivity of teachers and administrators,
- a continual response to the educational needs of adults in literacy, the basic skills, job training and retraining, career and personal development.

Implementation of TIEDS will be accomplished in conjunction with the Arizona Educational Telecommunications Cooperative (AETC), which is currently developing a state-wide master plan for telecommunications network in Arizona.

It is anticipated that the network will provide the following services to participating members:

- delivery of instructional programming for the K-12 audience, both students and educational personnel,
- delivery of post-secondary instructional programming to university and community college level students, especially those in remote areas and at off-campus centers,
- delivery of instructional programming for adult basic education and General Education Development (GED) preparation for individuals in Arizona,
- delivery of instructional programming for continuing education or Arizona's workforce in education, business and industry, professional and government agencies,
- the provision of video teleconferencing for state and local agencies thus diminishing travel requirements,
- electronic transmittal of files and reports, electronic mail and electronic bulletin boards,
- access to an information-rich environment through on-line computerized catalogs, interlibrary loan, reference referral, and other library/media services,
- access to computerized test banks for K-12 teachers statewide to help assure greater consistency in competency testing in both academic and occupational programs and,
- exchange of information, courses and programs between and among public educational institutions through various means including data and audio teleconferencing.

DESCRIPTIONS OF FUNCTIONAL WORKSTATIONS/CENTERS

The needs and status of the use of technology in districts and schools will continue to vary. This undirected proliferation of educational technology could increase the polarization of educational opportunity in the state, allow inefficient allocation of scarce resources, and impose economic burdens on our schools.

Therefore, it is suggested that common objectives and requirements for the use of technology in the teaching and learning environment be adopted to ensure total system compatibility within the state. These elements are displayed in the following charts and graphic descriptions.

Student Workstations

The needs which technological tools address vary among districts and campuses in the state. This diversity will not diminish in the coming years. On the contrary, local flexibility—with accountability— and individualization will increase. In addition, some districts will be quicker to adopt emerging technologies than others. Thus, the extent to which technology will be implemented in the various districts will continue to vary. Nevertheless, regardless of local variety and currently unanticipated hardware and functions, minimum common expectations are held for technology use that will apply to all districts and campuses. These minimum attributes are displayed in the following charts by functional type.

Objectives:	**Requirements:**
Students receive and interact with instruction and information.	• computing ability • input devices • audio, video, color, and graphics capability • multimedia capability • expandability beyond the limitation of application software • upgradability • multisource video (cable)
Individual and group mastery of essential skills are continually monitored and remediated.	• tracking of mastery of essential skills • access to teacher workstation modules
Students' and teachers' stations interact for teacher-directed and peer learning.	• electronic mail • local area network (LAN)
Students search and retrieve bibliographic and other information.	• access to selected databases
Districts control access to student and teacher records.	• security of and access to external information
Students interact with much of the information and develop some skills that are linked to and exceed the essential skills.	• delivery of interactive courseware keyed to and exceeding the essential elements
Students prepare assignments, print reports, graphics, video tapes, etc.	• word processing and graphics production • printer/output devices • multimedia production • video production

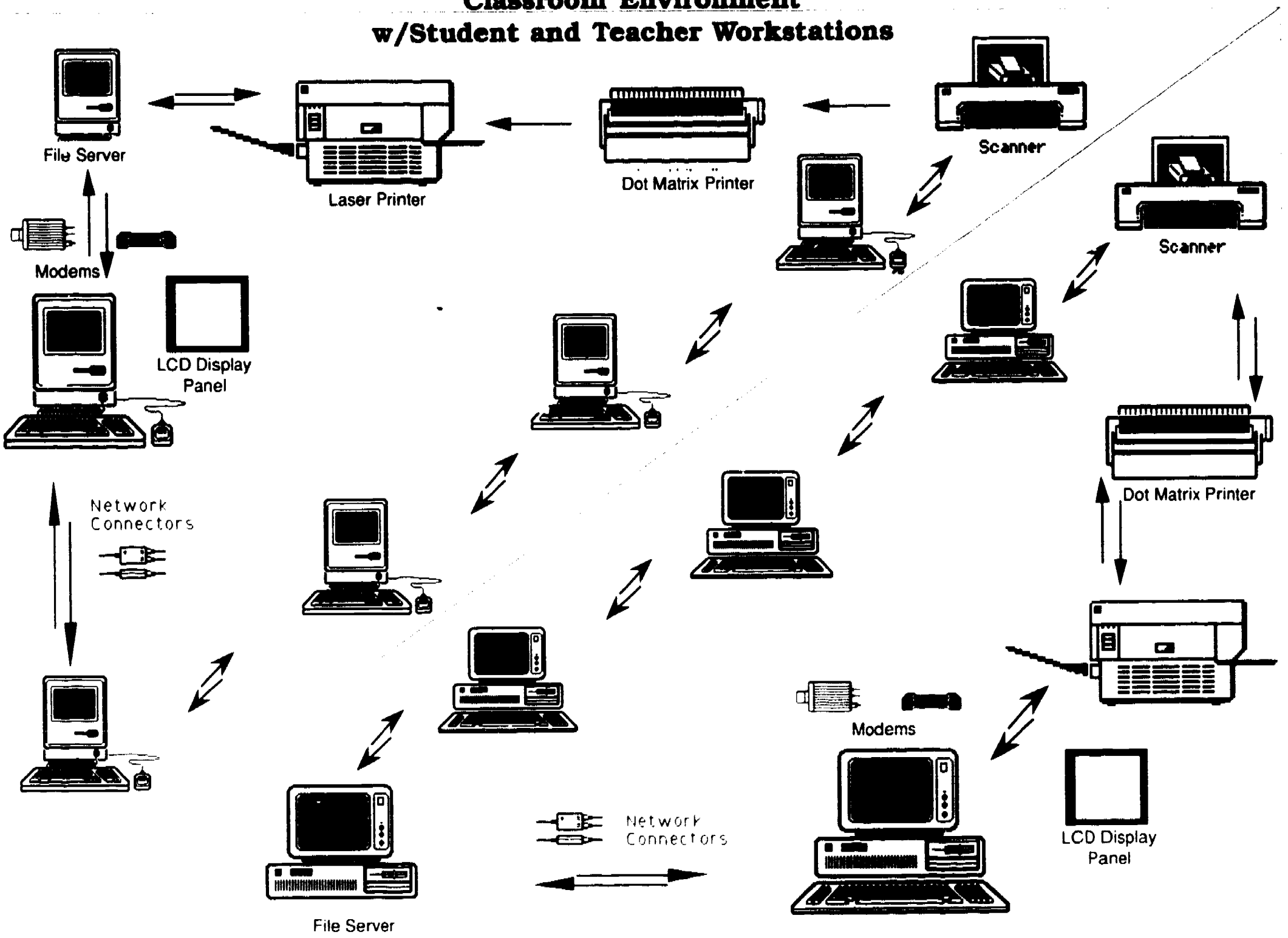
Teacher Workstations

Objectives:	Requirements:
Teachers conduct large group and/or individual instruction, demonstrating simulations, using graphics, sound and/or video-enhanced lectures, and illustrating trends and concepts.	• large screen projection • optical media, such as CD-ROM and videodisc • audio output • instructional television • recording and playback
Teachers prepare instruction, print reports, graphics, multimedia, video tapes, etc.	• word processing and graphics production • expandability beyond the limitation of application software
Teachers use stations to conduct routine instructional and administrative "paper" work.	• recording of attendance, program placement, disciplinary actions
Teachers send pre-instruction and post-instruction tests to students electronically.	• storage of and access to validated pre- and post-test item bank
Teachers use station to grade tests, display results for student and teacher, aggregate results, and send report(s) to appropriate location.	• local area network (LAN) • recording and aggregating of test results by specified factors (e.g. classroom and program) • transmission of results to campus, district, and state offices
Teachers monitor individual and group mastery of essential skills and progress through the curriculum and adjust instruction accordingly.	• tracking of learning, including the essential skills and the curriculum
Teachers analyze learning styles, diagnose learning problems, and adjust instruction accordingly.	• diagnostic and prescriptive software
Teachers notify staff and parents of students at-risk status.	• "early warning" indicators of at-risk students
Teachers search banks of pre-designed or teacher-made lesson plans for instructional suggestions.	• storage of and access to commercially available and teacher-generated lesson plans

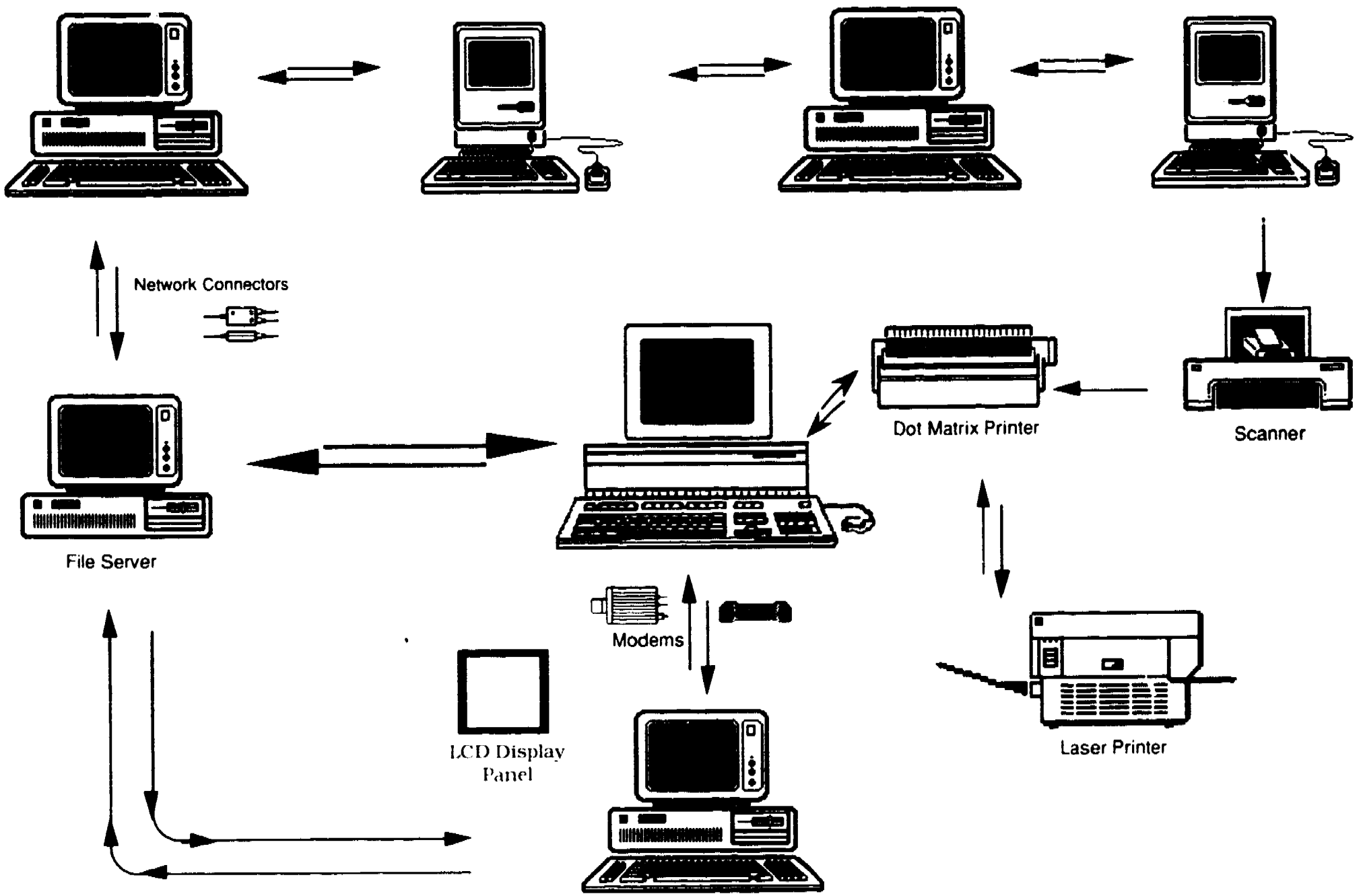
Teacher Workstation (continued)

Objectives:	Requirements:
Teachers download existing software written for dedicated machines.	• universal standard for various operating systems • video, color, and graphics capability • telecommunications reception
Teachers send messages and assignments, etc., to students, staff, parents, colleagues, and educational experts.	• electronic mail • routing of audio, data, and video signals through the same channel • interactivity
Teachers prepare lessons, check student achievement, and obtain information remotely, as well as at school.	• portable central processing unit (CPU), modem, and display screen for battery or plug-in use • retrieval of bibliographic and instructional information from databases
Teachers send attendance, grade, and other reports to district offices.	• wide area network (WAN)
Teachers send paper reports to students, parents, and administrative offices and create materials.	• printer/output devices
Teachers receive training on use of workstation modules.	• comprehensive and on-going staff development

Classroom Environment
w/Student and Teacher Workstations



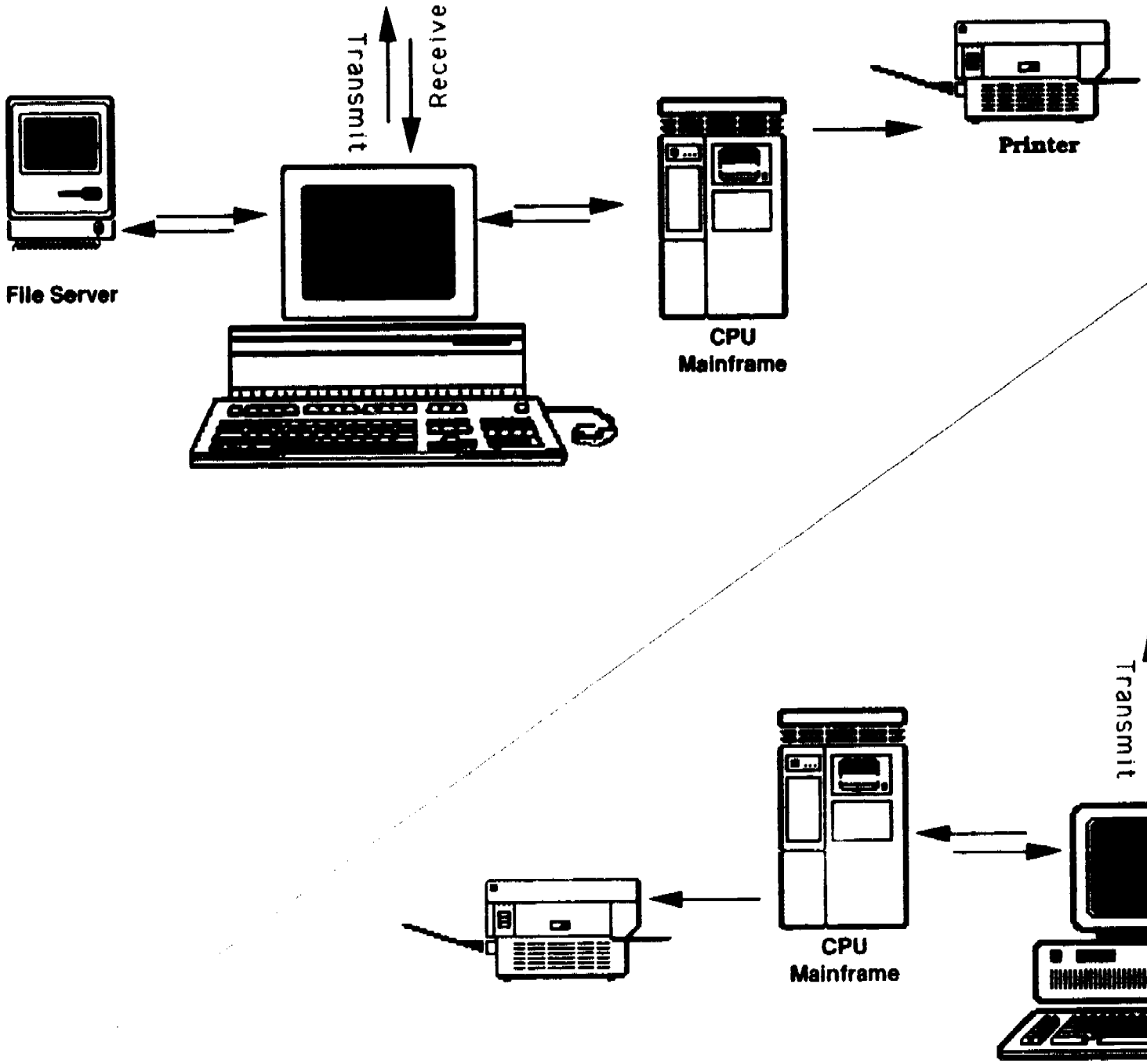
Classroom Environment
w/Student and Teacher Workstations



Administrator Workstations

Objectives:	Requirements:
Administrators increase time for instructional leadership.	• local area network (LAN)
Administrators retrieve and review data on achievement, course and bus schedules, student demographics, inventories, budget, attendance, and other instructional and administrative factors.	• aggregation of data on test results and student achievement, attendance, financial statements, inventories
Administrators write and send memoranda, etc. and record contacts with students and parents.	• word processing • electronic mail • printer/output devices
Administrators access electronic, optical, and other databases.	• CD-ROM and other mass data retrieval systems
Administrators send information to and receive information from ADE, other districts, and other buildings in the district.	• wide area network (WAN) • electronic mail • multisource video
Administrators record teacher assessment processes and results.	• software for teacher assessment

Administrator Workstation



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Telecommunication Centers
Interactive Learning Environment

The Telecommunications Center will be the locus for distance learning. Telecommunications Centers will be configured differently depending on local needs.

Objectives:

Students receive the course work they need regardless of location or teacher availability.

Teachers receive on-site in-service in technology training and other areas.

Teachers and administrators confer from school-based sites.

Classroom instruction is enriched with master teacher presentations, video presentations, and interactive data communications.

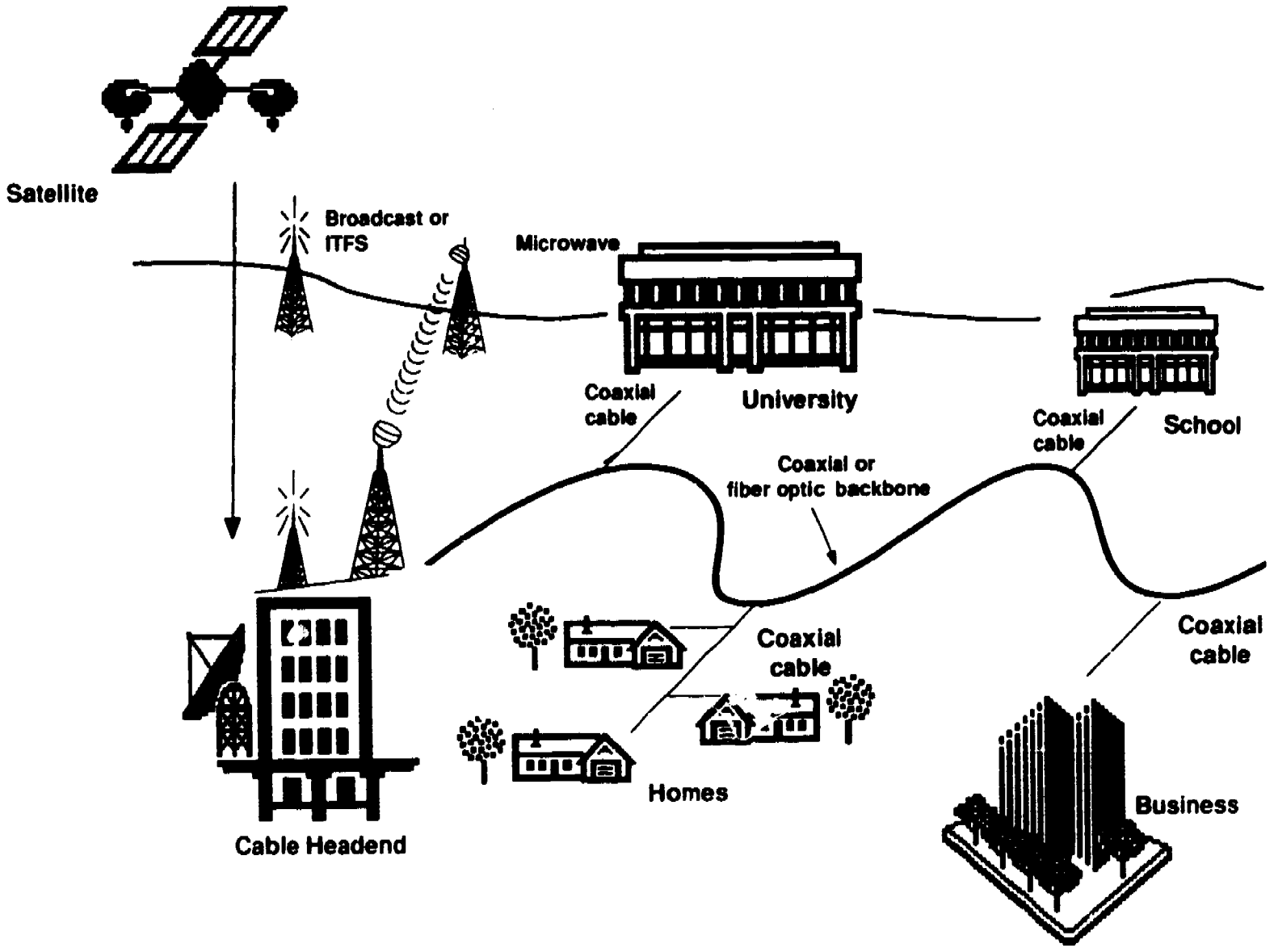
Communications among students and teachers at multiple sites are interactive and live.

Requirements:

- mechanism for delivery and receipt of courses, materials services and of teacher certification
- audio interactivity
- data transmission capability
- video capability (public broadcast, satellite, cable, ITFS, fiber optics)
- video and audio capability through receipt of distance instruction
- interactive mediaincreases

Sample Telecommunications Network System

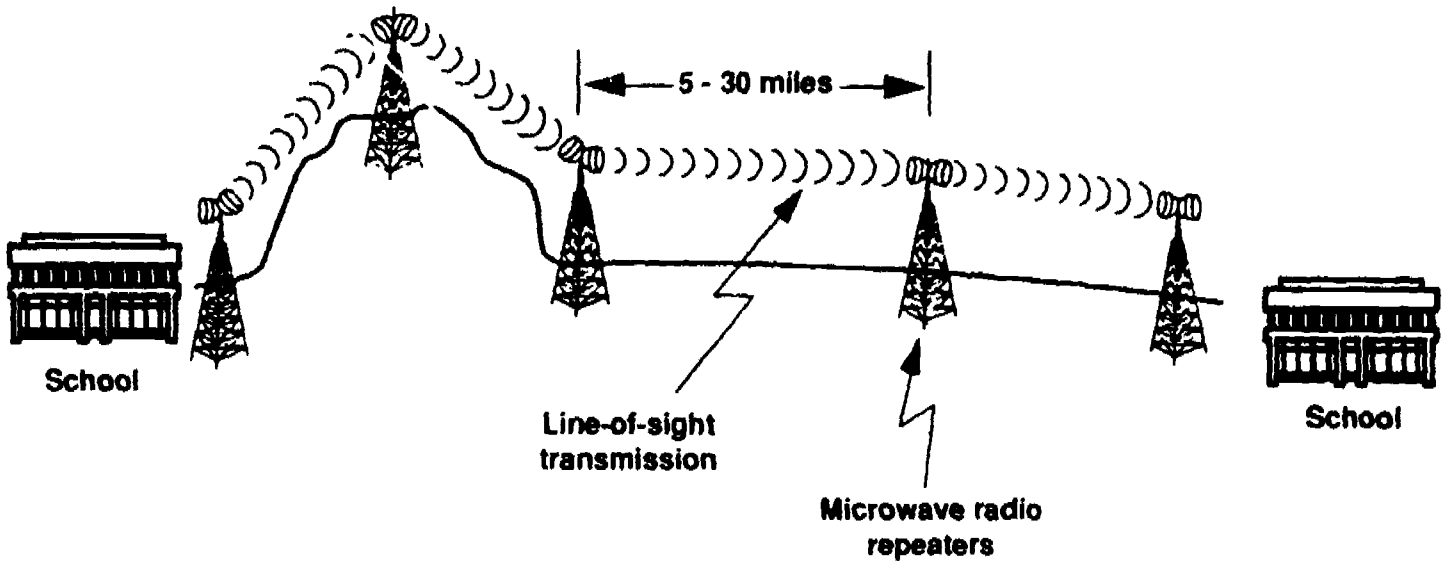
(Audio-Video-Data)
Multiple Transmission Modes



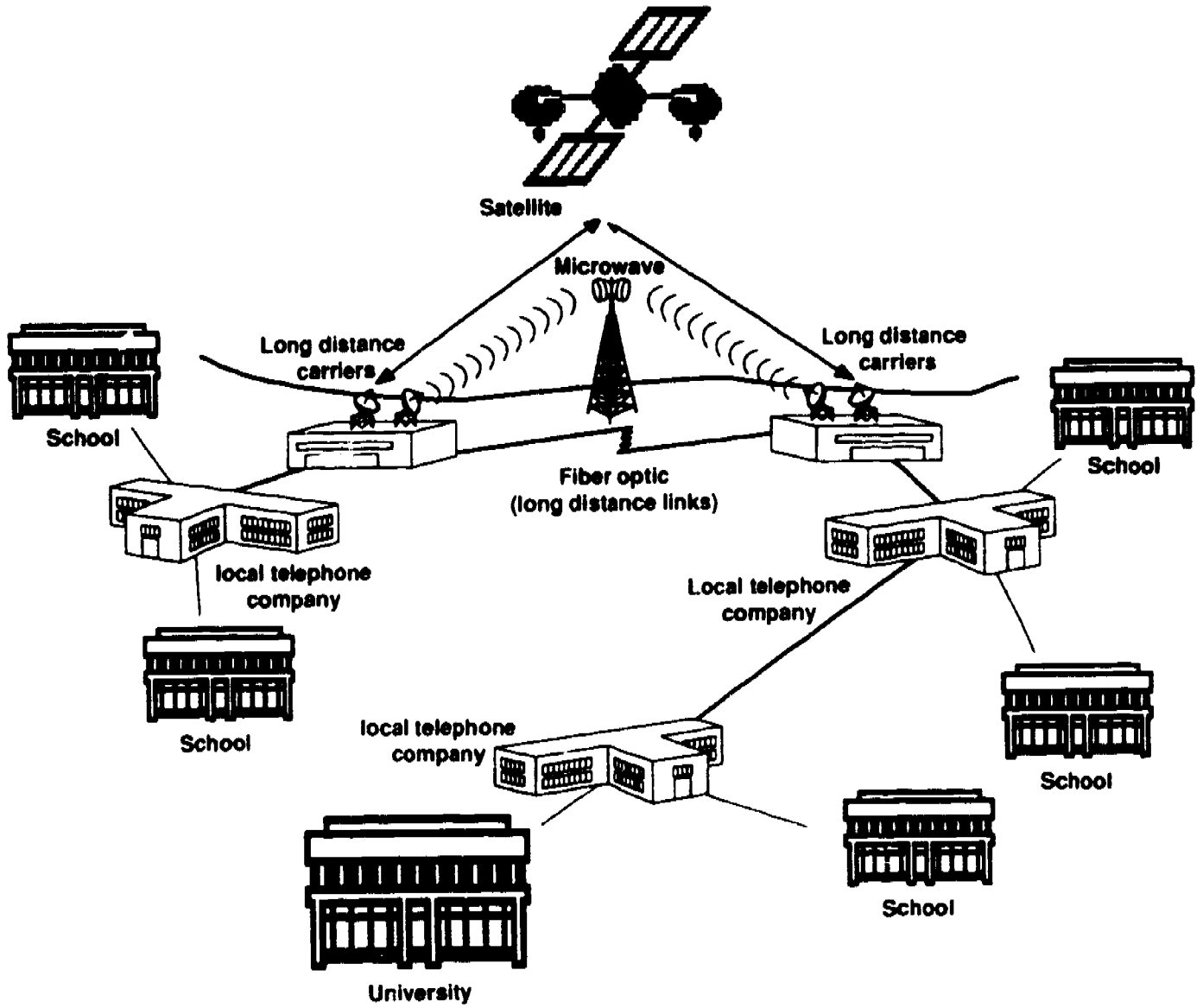
Figures on pages 28 - 33 are based on samples from "Linking for Learning"

Sample Telecommunications Mode

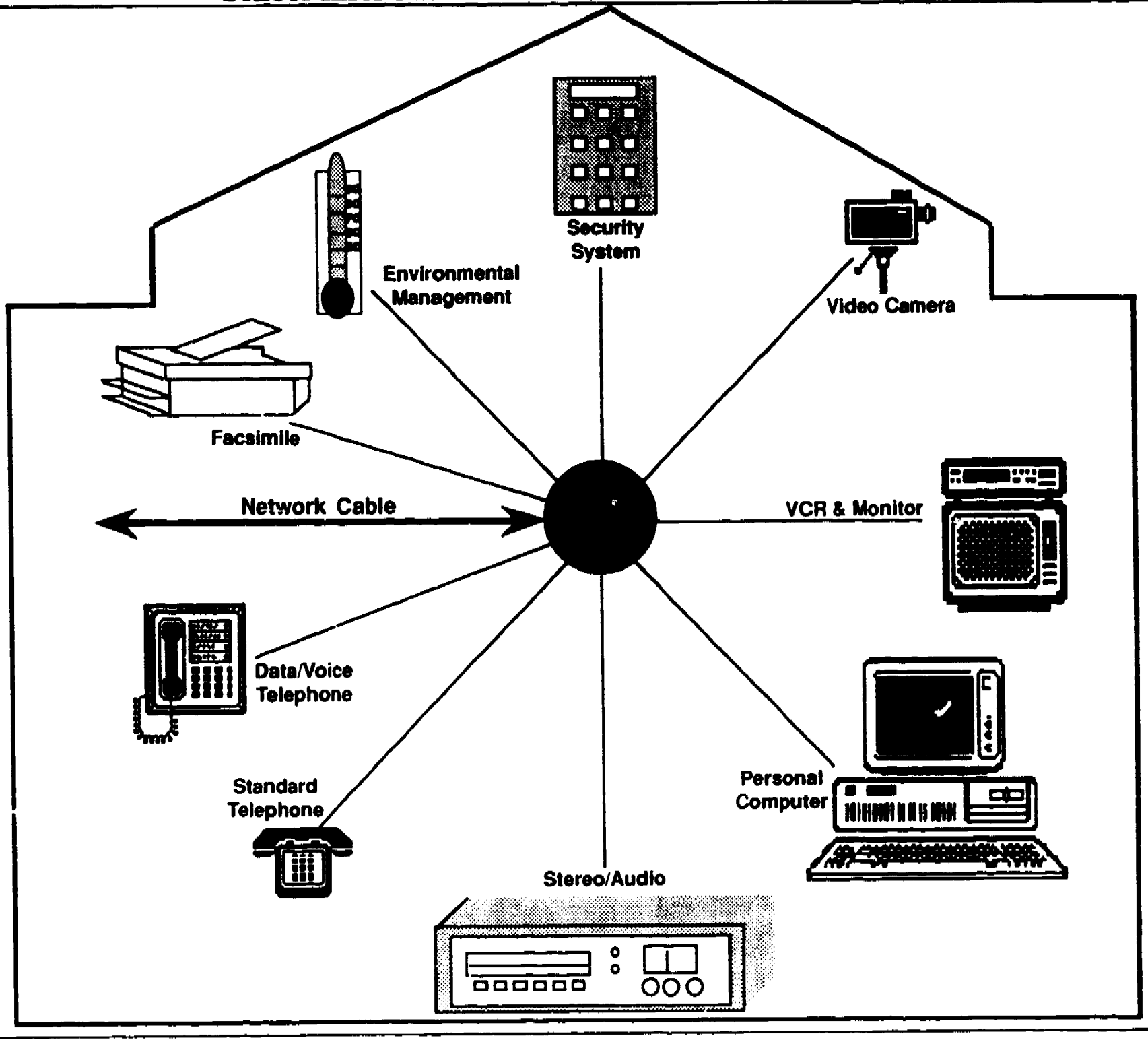
Microwave

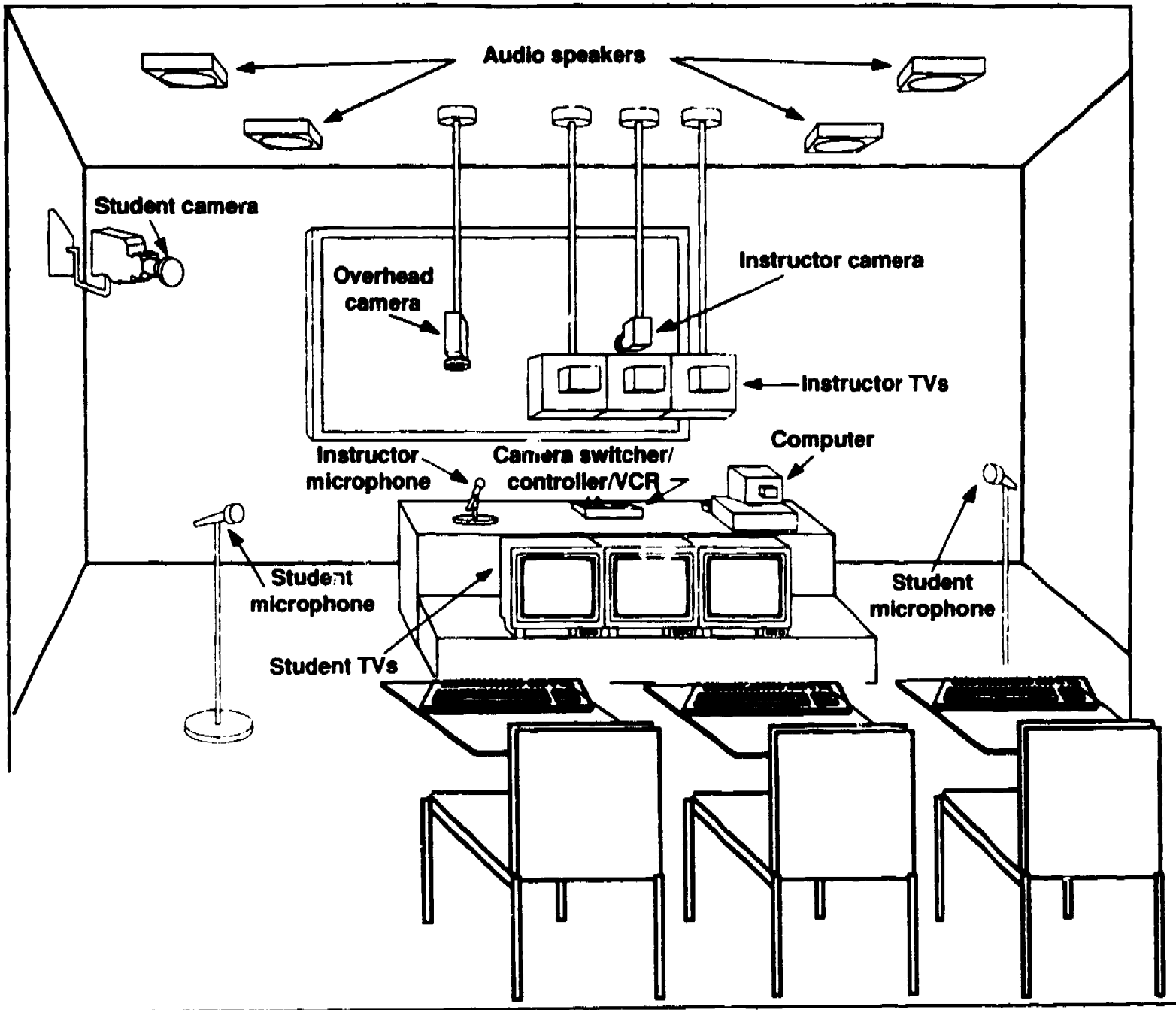


Sample Public Switched Telephone Network

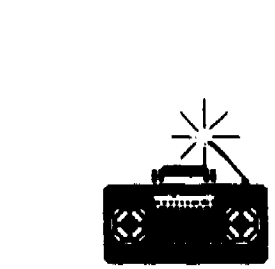


School Information and Communication Environment

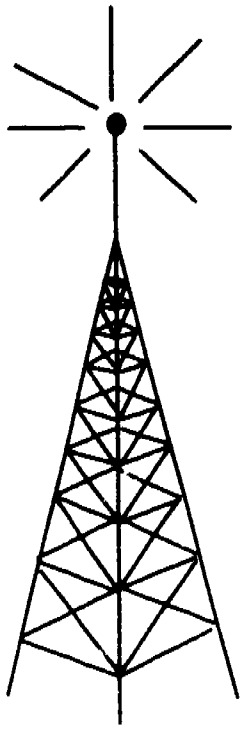



Audio speakers
Student camera
Overhead camera
Instructor camera
Instructor TVs
Computer
Instructor microphone
Camera switcher/ controller/VCR
Student microphone
Student microphone
Student TVs

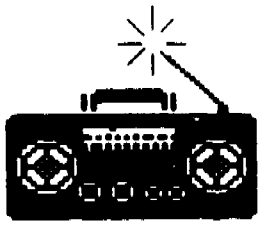
Sample Distance Learning Environment
Audio and Data Transmission Mode

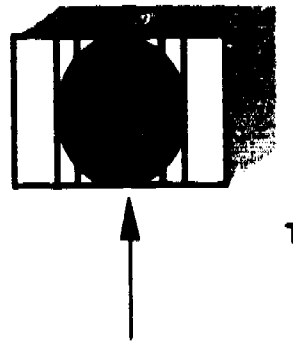


Radio Broadcast

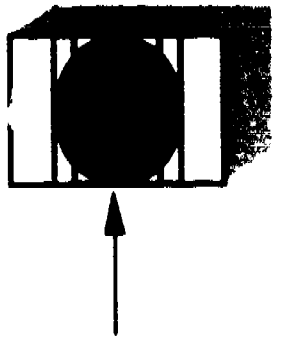


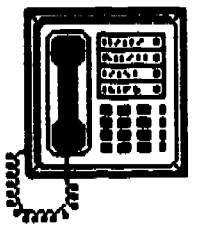
One-Way Audio

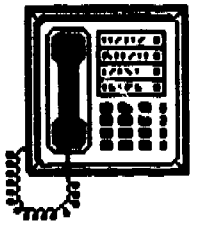




Two-Way Audio



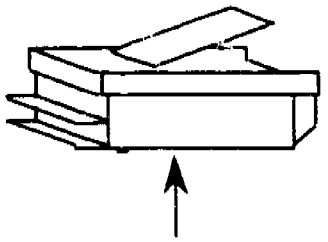


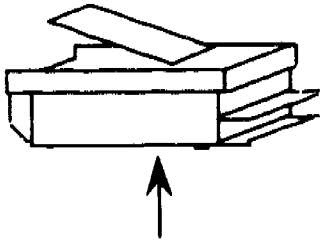


Audio Conference

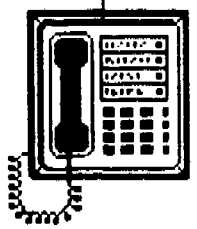
33

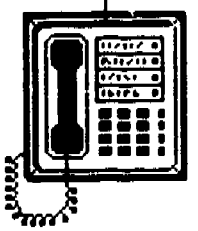
Two-Way Audio
Two-Way Image

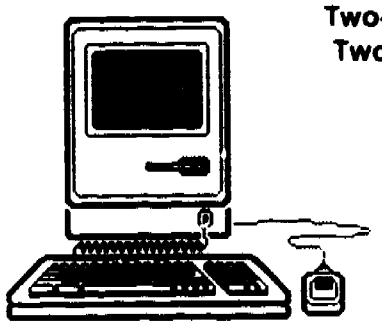




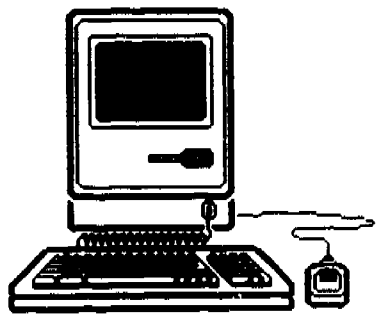
Audio Conference with Facsimile

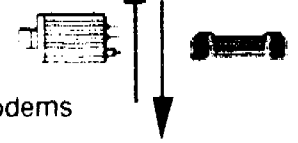




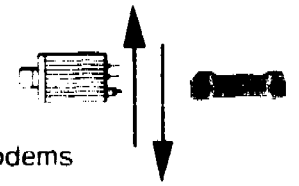


Two-Way Audio
Two-Way Data

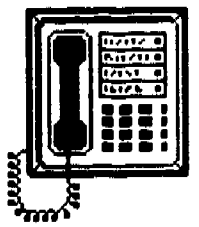


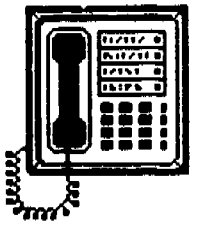


Modems



Modems





Audiographics

Community Access Learning Centers

Community-Access Learning Centers will contain sophisticated workstations and other technologies. The Center will be available for use by all community members and will access a wide variety of informational resources. The goal of Community Access Learning Centers is to enhance the opportunities for life-long learning.

Objectives:	**Requirements:**
All community members receive training in technology use and applications.	• training software
All community members investigate subjects in depth.	• access to bibliographic and other information from a variety of databases
All community members obtain course content and evaluation in subjects for which courseware is prepared.	• instructional television • video, color, graphics capabilities (satellite, cable, ITFS, fiber optics) • interactive capability • knowledge-based courseware • audio capability • evaluation capability
All community members produce high quality materials.	• compatibility with student and teacher stations • printer/output devices
All community members receive and interact with literacy training, job-related training, and on-going technology training and course work in a wide variety of fields.	• electronic mail • local area network (LAN) • input devices • computing ability
Community-Access Learning Centers provide recreation as well as a variety of learning materials.	• access to databases • diverse courseware and instructional materials

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
Quality Education **Equity** **Accountability** **Productivity**	Establish a statewide Technology Integrated Educational Delivery System (TIEDS).	Establish a statewide electronic information transfer system so that all districts, schools, other educational entities and the Arizona Department of Education will improve communications and reduce paperwork.	An integrated distributed student services information and management database will be in place to support schools, districts, other educational entities and the Arizona Department of Education, including but not limited to: Arizona Student Assessment Plan (ASAP) Individualized Education Plan (IEP) Student Followup/Tracking System Career Counseling and Guidance Information i.e. post-secondary education and employment Information Graduation Rate Standardized Testing	State
			An integrated distributed business and administrative services database will be in place to support districts, other educational entities and the Arizona Department of Education, including, but not limited to: Student Demographics Attendance Staffing Information Special Program Information, e.g. Special Education, Vocational Education, Gifted Education, Chapter I, Child Nutrition, Adult	State

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Education Financial Summary Data, e.g. Transportation Monitoring and Compliance Data Library Resources Current and Planned Legislation Attorney General's Opinions State Board Rules and Regulations State Board Policies and Actions	
			An integrated distributed instructional services database will be in place to support districts, other educational entities and the Arizona Department of Education, including, but not limited to: Essential Skills Listings Instructional Resource Banks Community Resources and Services Broadcast Television Services (e.g. ASSET) Cable Television Services Satellite Services Interactive Compressed Video Services Instructional Television Fixed Services Satellite Services Computer and Telephone Conferencing Services	State

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Library and Multimedia Services An integrated distributed information services system will be in place to support schools, districts, other educational entities and the Arizona Department of Education in communications activities including but not limited to: Electronic Mail Electronic Bulletin Board Gateways to National and other States' Data Bases, e. g. Ednet, CompuServe, SpecialNet, Genie, TEAnet (Texas Education Network), etc.	State
			Online library networks will facilitate equitable sharing of instructional materials and maximize the use of all available library resources and services.	State Districts Other Educational Entities
Quality Education Equity	Establish a statewide Technology Integrated Educational Delivery System (TIEDS). (continued)	Continue to cooperate with the institutions of higher education and other appropriate state agencies in the development and implementation of a statewide public education telecommunications network.	Telecommunications centers, as appropriate, will be established for both the delivery and receipt of instruction and training. Students, staff (certified and non-certified), administration, parents and other community members will be able to receive instruction and training at these centers.	State Districts Other Educational Entities Business/Industry State Districts Schools Other Educational Entities

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			The delivery of instruction and training to homes, alternative educational settings and cooperating business and industry sites will be available.	State
			State telecommunications activities will continue to complement and cooperate efficiently and effectively with those in other states and at the national and international level.	State
			The telecommunications centers will be equipped with up-to-date broadcast quality production equipment with audio and computer conferencing interactivity, data transmission capability, video capability with multimedia and graphics integration.	State
			Each classroom in which courses originate will be equipped with appropriate specialized equipment and materials for lesson design, preparation, and communication.	State
			Instructional support equipment and materials such as software, video clips, and computers will be available to originating electronic classrooms.	State
			Program design workshops will be provided for teachers and production staffs in the existing sites on an annual basis.	State

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Adaptive and instructional technology in programs designed for special education, vocational education, and for students who need resources beyond those used in traditional settings will be provided.	State Districts Schools
			Interactive teleconferences for students will be available to provide current information that is not included in textbooks, to meet Board of Education mandates, to share new developments in education including science and technology, and to provide equity in the availability of selected courses.	State Districts Schools
Equity **Accountability** **Productivity**	Establish a statewide Technology Integrated Educational Delivery System (TIEDS). (continued)	Develop guidelines for educational technology acquisition to serve as a standard for development, utilization and enhancement of an integrated and compatible education delivery system.	Guidelines will establish quality, technical, functional, security, service and other design specifications.	State
			Guidelines will establish a uniform instructional, management, and communications system that is efficient, integrated and compatible.	State
		Establish a mechanism by which districts, other educational entities and the state can select and procure equipment and services which meet guidelines.	Districts, other educational entities and the state will acquire technologies at the lowest available cost and thus maximize economies of scale.	State Districts Other Educational Entities
			Equipment to access TIEDS will be equitably available throughout the state.	State Districts Other Educational Entities

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
		In cooperation with business and industry and the community establish and maintain Technology Preview Centers.	Operational assessments will determine the appropriateness and effectiveness of technology innovations.	State Districts Business/Industry Communities
			Districts and other educational entities will be able to investigate and select technologies appropriate to meet local needs.	State Districts Other Educational Entities Business/Industry
			Districts, other educational entities, the state, business, industry and the community, will benefit from the mutual application of resources.	State Districts Other Educational Entities Business/Industry
Accountability	Establish a statewide Technology Integrated Educational Delivery System (TIEDS). (continued)	Prepare, review, revise and implement annual district and campus plans for technology acquisition and integration.	Districts will have "structured for success" in incorporating technology into the educational system.	Districts Schools
			Districts will acquire technologies appropriate to meet local needs.	Districts Schools
			Districts will acquire technologies which will be integrative and compatible with TIEDS.	Districts Schools
Equity Accountability	Establish a statewide Technology Integrated Educational Delivery System (TIEDS). (continued)	Procure and integrate equipment according to plans.	Student Workstations, Teacher Workstations, Administrator Workstations, Community-Access Learning Centers, and Telecommunications Centers will be established according to requirements as described on pages 17 - 33.	State Districts Schools

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Each school will have appropriate specialized software and peripheral computer hardware and adaptive devices for Vocational Education, Special Education, Math Education and other content areas as appropriate.	State Districts Schools
			Students will use computers and other related multimedia to enhance classroom activities through easy access to information, educational resources, databases, and experts in the field.	Schools
			The "classroom" will become a community resource for research, economic development, literacy development, and workplace training and retraining.	Districts Schools Community Business/Industry
Accountability	Provide leadership in the development and implementation of a statewide Technology Integrated Educational Delivery System (TIEDS).	Establish a TIEDS Board of Directors.	The Board of Directors will provide direction and coordination in the development of an effective governance, management and planning and accountability system for the implementation of TIEDS and will report to the State Board annually on progress and results.	State Board
			The Board of Directors will establish, develop and maintain a **TIEDS Development and Opportunity Fund** to provide for the financing of TIEDS.	TIEDS' Board of Directors Advisory Groups

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			The Board of Directors will receive input from TIEDS advisory groups which will be representative of all sectors of the education community, interested business leaders and interested leaders of civic organizations.	TIEDS' Board of Directors
			The representative advisory groups will assure the evaluation, acquisition, and integration of appropriate hardware, software, multimedia and other educational resources for the TIEDS information base.	Advisory Groups
			The Board of Directors will conduct applied research and development activities to ensure the effectiveness and future development of TIEDS.	TIEDS' Board of Directors
			The Board of Directors will collaborate with districts, other educational entities, business and industry, and other organizations in the development and implementation of TIEDS.	TIEDS' Board of Directors
Equity	Finance the system (TIEDS).	Establish a **TIEDS Development and Opportunity Fund** to support the development, administration, operation, maintenance, expansion and enhancement of a statewide technology integrated educational delivery system.	A system to identify funding sources will be developed and implemented.	State TIEDS' Board of Directors
			Monies will be available for grants and contracts for the development of the technology integrated educational delivery system's function, design and	State TIEDS' Board of Directors

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			engineering specifications and for payment to secure appropriate licenses.	State TIEDS' Board of Directors
			Monies will be available for grants to public school districts and other public education entities for the purchase of equipment, materials and services necessary to access TIEDS.	State TIEDS' Board of Directors
			Monies will be available for grants to public school districts and other public education entities for the development, transmission and reception of instructional programs and supporting materials and services.	State TIEDS' Board of Directors
			Monies will be available for the purpose of establishing projects which demonstrate or develop advanced technologies as solutions to both educational and telecommunications problems.	State TIEDS' Board of Directors
			Monies will be available for the development, administration, operation, maintenance and expansion of the technology integrated education delivery system.	State TIEDS' Board of Directors
			Equipment and other in-kind contributions will be available to districts, schools and other educational entities and the Arizona Department of Education.	State TIEDS' Board of Directors

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Technologies will be distributed equitably throughout the state so that technology acquisition will not vary according to district wealth.	State TIEDS' Board of Directors
			Districts will have access to information to plan for and acquire technologies and technology related goods and services, including alterations in facilities necessitated by integration of technology on a long-range and cyclical basis.	State TIEDS' Board of Directors
Quality Education Equity	Finance the system (TIEDS). (continued)	Provide educational technology planning and implementation grants and other incentives to encourage the use of technology.	The uses of technology by districts and schools will have been encouraged through project grants and other incentives for special programs.	State TIEDS' Board of Directors
			Incentives and grants will have been awarded to local school divisions for exemplary programs using technology, especially those meriting "Distinction" in the School Recognition Program	State TIEDS' Board of Directors
Quality Education Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System.	Review and revise essential skills, in light of implications of current and emerging requirements, post-secondary education and/or employment.	Provisions for curriculum content and for delivery, promotion, and graduation, postsecondary education and/or employment will continue to be revised to emphasize the knowledge and skills needed by citizens in the next century and to encourage individual student progress and maximum achievement.	State

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
Quality Education Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Evaluate and incorporate electronic media materials into textbook development and adoption.	Textbooks will incorporate or constitute electronic media as appropriate.	State
			Software, courseware and/or multimedia that takes full advantage for education of the capabilities of current or emerging technologies will be developed and made available to schools.	State TIEDS' Board of Directors
Quality Education Productivity	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Investigate and, as appropriate, implement state licensing and electronic delivery of software, courseware and multimedia to districts for preview and instructional use.	Districts will be able to review and procure software, courseware and multimedia appropriate to essential skill requirements and to local needs at the lowest cost available.	State TIEDS' Board of Directors
Quality Education Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Continue to assist districts in software, courseware and multimedia selection and use by demonstrating courseware considered for adoption in the Technology Preview Centers and by training district staff.	Software, courseware and multimedia will continue to be evaluated by practitioners and districts will acquire and use software and courseware appropriate to meet essential skill requirements and local needs.	State Districts Schools
Quality Education	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Develop and implement at-home technology integrated educational delivery programs which encourage students and parents to engage in child/parent home learning.	Pilot at-home technology integrated educational delivery programs will be developed and implemented by Local Education Agencies.	State Districts Schools

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
Quality Education Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Involve higher education, business and industry, and research institutes and agencies in planning and implementing pilot programs to test the effectiveness of educational technology, especially with students considered to be educationally at-risk and those considered to be gifted and talented.	Hardware, courseware, and other products supportive of TIEDS will meet Arizona's students' educational needs, standards and specifications through cooperation among the state, school districts, institutions of higher education, other public sector representatives, and the private sector.	State, Higher Education, Business/Industry
		Review and support ongoing research to evaluate the emerging role of the teacher in a classroom influenced by technological developments.	Emerging technologies and applications will be tested in public school settings.	State Higher Education
			Research on the effects and effectiveness of technology-infused education will be conducted and disseminated so that products and practice will improve.	TIEDS' Board of Directors Business/Industry
			The quality, diversity, and competitiveness of educational technology products and applications will be increased through the value added by cooperative ventures with local, state, national study groups and business and industry.	TIEDS' Board of Directors Business/Industry
			Disseminate results of demonstration programs to districts, other educational entities, other states and the public.	State TIEDS' Board of Directors
			Successful uses of technology in education will be expanded to multiple districts and statewide use.	State TIEDS' Board of Directors

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Unproductive uses of technology will be reduced.	State TIEDS' Board of Directors
			Districts will receive research results and technical assistance on effective uses of integrated educational technologies.	State TIEDS' Board of Directors
Accountability Productivity	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Develop a "Technology Planning Guide" to be used by districts and schools.	Districts will receive technical assistance in technology planning.	State
			Criteria will be established to gather data for planning and decision making.	State TIEDS' Board of Directors
			TIEDS will be evaluated and a report of progress submitted to the State Board of Education annually.	State TIEDS' Board of Directors
Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Review TIEDS, the K-12 master Plan for the Infusion of Technology in Arizona Schools and provide a progress report to the State Board of Education on an annual basis.	TIEDS will be monitored and regularly revised based on progress and research results.	State TIEDS' Board of Directors
Quality Education Accountability	Conduct research and development related to the Technology Integrated Educational Delivery System. (continued)	Conduct correlations of the Essential Skills in each required content area to instructional television (ASSET), satellite course offerings, computer software lessons/programs and other multimedia educational resources.	Correlations will provide districts with a resource for curriculum analysis and alignment with the Essential Skills.	State
			Correlations will provide a basis for technology integrated curriculum development, application and evaluation.	State

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
Quality Education Equity Accountability Productivity	Use technology to assist in the restructuring of the teaching and learning process thus empowering educators and learners to achieve their maximum potential. (continued)	Provide a basic level of educational technology training for all staff in the Department of Education to promote leadership in the use of technology.	A basic level of "hands-on" training will have been provided for Program Officers and Content Specialists New staff will receive "hands ..." training as appropriate.	State Districts Schools
Quality Education	Use technology to assist in the restructuring of the teaching and learning process thus empowering educators and learners to achieve their maximum potential. (continued)	Provide guidelines, models and training for supervisory, administrative and instructional staff in the use of technologies in the curriculum in elementary and secondary schools.	Entering and continuing supervisory, administrative and instructional staffs in elementary, middle and secondary schools will have received standards, models and training in the appropriate uses of technology and telecommunications in curriculum development and in classroom instruction and management through conferences, seminars, workshops, special sessions.	State Districts Schools
			School-based models of instruction involving technology will have been identified and/or developed for replication in other schools.	State TIEDS' Board of Directors
Quality Education	Use technology to assist in the restructuring of the teaching and learning process thus empowering educators and learners to achieve their maximum potential. (continued)	Continue to provide training for teachers and administrators through statewide workshops, seminars, conferences, telecourses and teleconferences to promote the use of technology in all classrooms.	Teachers and Administrators will increasingly integrate technology into instruction, classroom management and administrative tasks and duties.	State Districts Schools

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
Quality Education	Use technology to assist in the restructuring of the teaching and learning process thus empowering educators and learners to achieve their maximum potential. (continued)	Through the Technology Certification requirements ensure the integration of technology into the content and delivery of current teacher preparation and graduate programs.	Teacher preparation and graduate program providers through technology certification requirements will have integrated appropriate technoiogies into all pregraduate and inservice teacher education preparatory courses.	State Higher Education
			Newer technology pilots involving teacher preparation, graduate and inservice programs will have been implemented for the planning and training for instructional currentness, appropriateness and improvement.	State Districts Higher Education
Quality Education **Equity** **Accountability** **Productivity**	Deliver the TIEDS information base.	Maximize the full potential rather than the acceptable levels of performance in the teaching and learning environment.	Students will receive and interact with instruction and information thus providing for self-paced learning.	State District Schools
			Individual and group mastery of the essential skills will be continually monitored and remediated.	State Districts Schools
			Instruction and educational resources will be available to enhance the development of basic skills in problem solving and critical thinking.	State Districts Schools
			Students will develop additional skills that are linked to, and exceed the essential skill requirements, thus achieving their maximum potential.	State Districts Schools

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Students will receive instruction they need regardless of location and/or teacher availability.	State Districts Schools
			Teacher's role will be refocused from instructor-disciplinarian to coach-strategist-counselor-instructional facilitator.	State Districts Schools Higher Education
			Teachers will conduct large group and/or individual instruction demonstrating simulations, using graphics, sound and/or video-enhanced presentations.	Districts Schools
			Teachers will monitor individual and group achievement of essential skills and progress through the curriculum and adjust instruction accordingly.	Districts Schools
			Teachers will use the technology to conduct administrative, management and communication activities.	Districts Schools
			Administrators will retrieve and review data on student demographics, achievement, attendance, budget, inventories, transportation and other instructional and administrative factors.	State Districts Schools
			Administrators will send information and communications to and receive same within district, to and from the Arizona Department of Education, other districts locally, other states, and other educational entities.	State Districts Schools

TIEDS IMPLEMENTATION RECOMMENDATIONS AND OUTCOMES

ISSUE	OBJECTIVE	RECOMMENDATION	OUTCOME	RESPONSIBLE ENTITY
			Parents and other community members will receive and interact with literacy development, job-related training, technology training and other course work as appropriate.	State Districts Schools Communities Business/Industry
Quality Education **Equity** **Accountability** **Productivity**	Deliver the TIEDS information base. (continued)	Provide a variety of course offerings and access to information through the statewide telecommunications network from local, district or other Arizona education entity and from national and/or international distance learning programs and information resources.	Every student will be able to receive quality instruction in every required course and will have access to any additional appropriate courses.	State Higher Education Districts Schools
			Every student will have access to the data and primary resources that will empower him or her to accomplish his or her optimum level of achievement.	State Districts Schools
			Every special and vocational education student, and every student in need of additional resources for remediation, supplement or enrichment will have access to them.	State Districts Schools

Appendix A

STATE BOARD POLICY

ON THE DEVELOPMENT OF A PLAN FOR TECHNOLOGY

The State Board of Education empowers the State Superintendent of Public Instruction to develop a plan for the use of technology in the K-12 educational system. Recognizing that technology and the field of education are fluid; applying advances in the former to the latter can help achieve a vision of education in Arizona that has been, as yet, unattainable.

Therefore the plan shall address but not be limited to:

1) improving the cost effectiveness of the delivery of instruction using technology,

2) ensuring the connectivity among and standards for the implementation of technology for administrative, instructional and communication purposes,

3) assisting educational institutions in the development and implementation of plans infusing technology into the K-12 educational system,

4) improving public education's use of telecommunications for administrative, instructional and communications purposes,

5) supporting the professional development of education personnel in the use of a telecommunications system.

Technology alone cannot decrease the drop-out rate or solve the social ills related to under-education. Single solutions do not exist for complex problems. Nevertheless, as a component in a broad effort to address these issues, it can play a critical role – by improving the efficiency of the educational system, by increasing the productivity of teachers and administrators, by providing all students with equal access to high quality instruction, and by meeting the continuing educational needs of adults in literacy, basic skills, occupational training and retraining, and career and personal development.

In the absence of a long range plan for technology, undirected proliferation of educational technology could increase the polarization of educational opportunity in the state, allow inefficient allocation of scarce public resources, and impose grave economic burdens on public schools. In the absence of a state plan, technology used in the K-12 public education system would expand in those districts wealthy enough to implement programs through local initiative. Those districts characterized by high-cost needs and insufficient local resources and awareness could continue to be isolated from the benefits of educational technology and, therefore, exhibit increasing disparity in student achievement and administrative efficiency. This potential expansion and polarization of educational opportunity would have severe economic consequences on the state.

Adopted by the State Board of Education - July 25, 1989.

Appendix B

"GROW WITH ARIZONA INTEGRATED TECHNOLOGY SYSTEMS"

A Report to

C. DIANE BISHOP, SUPERINTENDENT OF PUBLIC INSTRUCTION

"We must take bold steps to fundamentally restructure our education system. We must ensure that our educational institutions have the ability and the capacity to use and apply technology to the teaching and learning process We must take bold steps to empower ourselves and responsibly determine our destiny."
C. Diane Bishop, "Opening Remarks - Education Utility Symposium", December 7, 1988.

This report recommends the innovative restructuring of education in Arizona together with the supportive premises and strategic considerations as outlined below.

The Arizona Education Telecommunications Cooperative (AETC) is recognized as an existing entity established by institutional boards representing public education in the State of Arizona. AETC's defined mission and goals statement is supported by "Grow With Arizona Integrated Technology Systems" (GAITS). GAITS supports the position of AETC as a leader and its role as the "strategic planner" in the proposed technologically integrated restructuring of education.

In an attempt to unify the planning efforts to restructure education in Arizona, GAITS also supports the AETC in its effort to:

1. design, develop, and establish a state-wide, multi-level technology-integrated educational delivery system to be implemented and directed by a board of directors;
2. develop financing strategies for the new proposed system;
3. design and develop the system's information base;
4. design and develop supportive mechanisms for the system's use;
5. develop procedures for the selection and governance of advisory groups;
6. ensure total system compatibility within and without the state; and,
7. ensure that after the AETC has completed the strategic planning process for this delivery system, the implementation responsibility of the plan will be with the system's new, representative board of directors.

Additionally, GAITS' support is reflected in its own effort to:

1. present a unified and collaborative leadership support of education and business;
2. eliminate the wasteful and competitive use of limited educational resources;
3. extend and support the strategic impact of a state-wide, multi-level technology-integrated educational delivery system that incorporates the needs of Arizona's education, businesses, families, and communities;
4. integrate its own report and recommendations with those of AETC;
5. support AETC's efforts to fund the system through legislative action and other reasonable means; and,
6. support the implementation of the strategically developed plans of AETC by the system's new Board of Directors.

Therefore, GAITS submits the following major goal with relevant objectives. Each objective delineates its individual premises, issues, implementation procedures, and benefits which are recommended to be used as guidelines for the future designing, planning, development, and implementation of Arizona's new technology-integrated educational delivery system.

INTRODUCTION

Current and future applications of integrated technologies will provide the framework for resolving today's crisis in the organization and delivery of education.

The Office of Technology Assessment (OTA) examined recent research on educational uses of computers in a wide range of applications in many different settings. Although the results build an incomplete and somewhat impressionistic picture, they do suggest that certain configurations of hardware and software, used with particular populations of children and under the supervision of competent teachers, contribute to meeting specific instructional objectives. OTA found that the varied capabilities of the technologies are key to their power. Educators, using interactive technologies for many purposes find that there is no single best use. The use of technologies for instructional purposes do, however, contribute positively to the following activities: drill and practice to master basic skills, the development of writing skills, problem solving, understanding abstract mathematics and science concepts, simulation in science, mathematics, social studies and vocational education, manipulation of data, acquisition of computer skills for general purposes and for business and vocational training. Technologies also contribute positively to the issues of: access to and communication with traditionally underserved populations of students, access and communications for teachers and students in remote locations and instructional and administrative management.

This paper was prepared by the membership of the "Grow with Arizona's Integrated Technology System" Ad Hoc Committee with the above as a collective mind-set. The paper was prepared in response to C. Diane Bishop's, Superintendent of Public Instruction, request to consider the use and application of technology to the teaching and learning process.

GOAL

ESTABLISH A STATE-WIDE MULTI-LEVEL TECHNOLOGY-INTEGRATED EDUCATIONAL DELIVERY SYSTEM (TIEDS) THAT MEETS THE MULTI-FACETED NEEDS OF ALL LEARNERS WITHIN THE EDUCATION SYSTEM, BUSINESS, FAMILY, AND COMMUNITY.

OBJECTIVE # 1: ESTABLISH A BOARD OF DIRECTORS FOR THE STATE-WIDE, MULTI-LEVEL, TECHNOLOGY-INTEGRATED EDUCATIONAL DELIVERY SYSTEM.

A Board of Directors for a state-wide multi-level, technology-integrated educational delivery system (TIEDS) will be established by the Fall of 1990 to deliver education and public services.

Premise:

The implementation of the Arizona Education Telecommunications Cooperative (AETC) developed strategic plan for this technology-integrated educational delivery system (TIEDS) will be the responsibility of a new, representative Board of Directors beginning in the Fall of 1990.

Recommended Implementation:

Establish a **new, representative Board of Directors** to implement and manage the system.

Issues:

- Barriers to restructuring education
- Planning and accountability
- Equitable distribution of resources
- Compatibility, connectivity
- Information and technology updating

Benefits:

- Ability to secure funds from multiple sources
- Checks and balances to ensure accountability
- Early integration and collaboration of restructuring effort
- Positive contribution to the economic development of Arizona
- Accessible and equitable Board of Directors

OBJECTIVE #2: FINANCE THE SYSTEM (TIEDS)

This technology-integrated educational delivery system will be managed by a **representative Board of Directors** who will have the **fiduciary responsibility** for the system's operations.

Premise:

A Board of Directors with fiduciary responsibilities can ensure the **flexibility, accountability, adaptability** and **accessibility** of a technology-integrated educational delivery system which will provide equity for all learners/users in Arizona.

Recommended Implementation:

Direct the Board to secure and be accountable for the financial resources of the TIEDS.

Issues:

- Financing options/sources for the system
- Marketing the concep
- Creative approaches to the financing of technology in schools
- Stakeholder investment and protection of entrepreneurial and entrepreneurial contributions to the system
- Planning and implementation priorities
- Capital funding alternatives within limited resources

Benefits:

- Flexibility of combining of private, public, and corporate resources
- Potential for financial independence
- Assures public accountability
- Equal accessibility and local affordability

OBJECTIVE #3: APPOINT ADVISORY GROUPS

The Board of Directors shall appoint the educational delivery system's advisory groups which will be **representative** of all sectors of the **education community**, interested business leaders and interested leaders of **civic organizations**.

Premise:

Representative advisory groups will assure the evaluation, acquisition, and integration of appropriate materials for the educational delivery system information base.

Recommended Implementation:

The Board of Directors will **gather information** from all advisory groups to address and resolve the above issues.

Issues:

- Community input, accountability
- Outreach and community involvement
- Criteria for the selection, use, implementation of technology

Benefits:

- Everybody has ownership in the process
- Synergy of collaborative efforts
- Holistic planning producing systemic change
- Broader representation
- State-wide coordination responsive to local needs

OBJECTIVE #4: DEVELOP TIEDS INFORMATION BASE

The TIEDS information base will contain all appropriate educational materials for **reference and instruction**, classroom/school/district/organization **management information** and **data**, education-related **research**, electronic networking **communications** and all other information and **components** deemed desirable and necessary to meet the needs of the system's users.

Premises:

The potential for **self-paced learning** will be maximized and facilitated by this delivery system and information base.

The development and sharing of instruction and training between education and business will enhance and accelerate the **holistic development** of Arizona's life-long learners.

Uniform data definition and collection formats for purposes of **planning, research**, and **evaluation** will be efficiently obtained through a compatible technology-integrated system.

Technology-integrated telecommunications provides an efficient **method to share** information and educational resource materials.

Recommended Implementation:

Develop the TIEDS' information base to **integrate** all instructional, management and research resources and **make** it **available to all learners/users.**

Issues:

- Local control of appropriateness of information base content
- The assessment and reassessment of the needs of life-long learners
- Equal access for all learners and community segments
- Computer facilitated self-paced education
- Standardization of information formats

Benefits:

- Information availability is unlimited
- Information is current, shared, affordable, and easily accessible
- Flexibility to integrate and utilize all information bases

OBJECTIVE #5: DELIVER THE TIEDS' INFORMATION BASE

TIEDS will deliver the information base within an integrated, compatible, hardware system.

Premises:

Planning, research, and evaluation require uniform data definition and collection formats which are obtained most efficiently through a **compatible computer system**.

The Board of Directors will **proactively represent Arizona** in appropriate activities for purposes of insuring the TIEDS compatibility with a technology-integrated educational delivery system.

A technology-integrated educational delivery system at this time would place Arizona in a **position to share** leadership in the establishment of a national network.

Recommended Implementation:

Develop the specifications and standards for the integration and compatibility of TIEDS.

Issues:

- Maintaining equal access to information for all learners and community segments
- Selection, use, implementation of technology
- Transition from current technology to future technology as it becomes available
- Developing regional, national and international system standards
- Concurrent national liaisons

Benefits:

- Equity of access to all learners/users
- Information availability is unlimited
- Economy of scale of purchase
- Elimination of duplication of effort
- Potential for national/international technology leadership

OBJECTIVE #6: FUNDAMENTALLY RESTRUCTURE THE LEARNING ENVIRONMENT

Utilize technology to assist in the restructuring of the **teaching** and **learning process** thus empowering educators and learners to achieve their **maximum potential.**

Premises:

The restructuring of the teaching/learning environment will require that the role of the teacher be refocused from instructor-monitor-disciplinarian to **coach-strategist-counselor-instructional facilitator.**

The systemic development of a program for learner growth will provide for **flexible learning calendars and environments.**

A restructured teaching/learning environment will **enable and ennoble all Arizona learners.**

Self-paced learning will be maximized and facilitated by TIEDS.

The "classroom" will become a **community resource** for research, training, entrepreneurs, and home-based education.

Recommended Implementation:

Ensure the **timely** and **efficient implementation** of TIEDS to assist in the restructuring of the teaching and learning environment.

Issues:

- Maximization of potential rather than acceptable performance levels
- Curriculum development, application and evaluation through TIEDS
- Assessment and re-assessment of the needs of the life-long learner
- Provide opportunity for holistic-inter-disciplinary content
- Re-define "school" concept
- Pre- and in-service training

Benefits:

- Empower learner facilitators to create an individualized educational environment
- Maximize learners' potentials
- Empower learner facilitators to achieve personal fulfillment
- Equal opportunity to access all available informational materials, programs, equipment and peripheral components
- Equal and adequate training and instruction in the use of TIEDS

GLOSSARY

Analog communication: A communication format in which informa-tion is transmitted by modulating a continuous signal, such as a radio wave. *See also* Digital communication.

Asynchronous communication: Two-way communication in which there is a time delay between when a message is sent and when it is received. Examples include electronic mail and voice mail systems.

Audio bridges: Electronic devices that connect and control multiple telephone lines for audio and data applications, allowing many callers to be connected as a group simultaneously. Used for audio-conferencing.

Audioconferencing: An electronic meeting in which participants in different locations use telephones to communicate simultaneously with each other.

Audiographics: An advanced computer application in which computer interaction is augmented by two-way, real-time audio communication. Audio, data, and graphics are shared over regular telephone lines, allowing users in different locations to work on the same application simultaneously.

Bandwidth: The width of frequencies required to transmit a communications signal without undue distortion. The more information a signal contains, the more bandwidth it will need to be transmitted. Television signals, for example, require a bandwidth of 3 million-hertz (cycles per second), while telephone conversation needs only 3,000 hertz.

Bit (BInary digiT): The smallest unit of information a computer can use. A bit is represented as a "O" or a "I" (also "on" or "off"). A group of 8 bits is called a byte. Bits are often used to measure the speed of digital transmission systems.

Bulletin board service (BBS): A computer service that allows remote users to access a central "host" computer to read and post electronic messages. Communication is usually asynchronous.

C-band: The designation for satellite communications operating at 6 GHz (billion cycles per second) uplink and 4 GHz downlink. These frequencies are also used for terrestrial microwave transmission.

Coaxial cable: Shielded wire cable that connects communications components together. It is commonly used in cable television systems because of its ability to carry multiple video (or other broadband) signals.

Codecs: The abbreviated form of "coder-decoder." Electronic devices that convert and compress analog video signals into digital form for transmission, and convert them back again on reaching their destination.

Compact disc-read only memory (CD-ROM): An optical storage system for computers that only allows data to be read off the disc. New data cannot be stored and the disc cannot be erased for reuse.

Compressed video: A video signal requiring less information to transmit than broadcast quality or full-motion video. Digital technology is used to encode and compress the signal. Picture quality is generally not as good as full-motion: quick movements often appear blurred. Compressed video requires transmission speeds between 56 kbps and 2.0 Mbps.

Computer conferencing: Allows individuals at different locations to communicate directly with each other through computers. Communication may be in real time or delayed.

Digital communications: A communications format used with both electronic and light-based systems that transmits audio, video, and data as bits ("1s" and "0s") of information (*see* Bit). Codecs are used to convert traditional analog signals to digital format and back again. Digital technology also allows communications signals to be compressed for more efficient transmission.

Digital video interactive (DV-I): A system that combines audio, data, and limited-motion video on an optical disc. DV-I will run on a personal computer, allowing the user to control interactive programs.

Downlink: An antenna shaped like a dish that receives signals from a satellite. Often referred to as a dish, terminal, Earth station, TVRO (television receive only).

Downstream: The direction a signal travels as it moves from the transmitting (origination) site to the receiving sites.

Electronic blackboard: A computer application that allows graphics to be shared among many computers simultaneously. Each user can see and annotate the graphics as needed. The results will be visible to all users.

Electronic Mail: Electronic networking system that allows users to send and retrieve messages on computers. Users may communicate within a building, a school district, or across the country.

Facsimile machine (fax): A telecopying device that electronically transmits written or graphic material over telephone lines to produce a "hard copy" at a remote location.

Fiber optics: Hair thin, flexible glass rods that use light signals to transmit audio, video, and data signals. Signals can be sent in either analog or digital format. Fiber optic cable has much higher capacity than traditional copper or coaxial cable, and is not as subject to interference and noise.

Footprint: The area on the Earth's surface to which a satellite can transmit. Different satellites cover different areas and have different footprints. Satellite footprints generally cover all the continental United States (full conus) or only half of it (half conus coverage).

Freeze frame: One method of transmitting still images over standard telephone lines. A single image is transmitted every 8 to 30 seconds. Also referred to as slow scan.

Frequency: The number of times per second an electromagnetic wave completes a complete cycle. A single hertz (Hz) is equivalent to one cycle per second.

Full-motion video: A standard video signal that can be transmitted by a variety of means including television broadcast, microwave, fiber optics, and satellite. Full-motion video traditionally requires 6 MHz in analog format and 45 Mbps when encoded digitally.

Gbps: Giga (billion) bits per second. *See* Bit.

GHz: One billion hertz (cycles per second). *See* Frequency.

Graphics tablet: A computer device resembling a normal pad of paper that users draw or write on. The graphics tablet converts hand-drawn images into digital information that can be used and displayed by a computer.

Headend: In a cable television system, the headend is the central transmission office from which programming is distributed to subscribers.

High definition television (HDTV): An advanced television system that produces video images as clear as high-quality photography. HDTV is still experimental in the United States.

Instructional Television Fixed Service (ITFS): A band of microwave frequencies set aside by FCC exclusively for the transmission of educational programming. Allows broadcast of audio, video, and data to receive sites located within 20 miles. Receive sites require a converter that changes signals to those used by a standard television set.

Integrated Services Digital Network (ISDN): An end-to-end digital network that will allow users to send voice, data, and video signals over the same line simultaneously. Narrowband services now in operation give users up to 24 channels to send voice and data information, with a combined capacity of up to 1.544 Mbps. In the future, broadband services available over a public ISDN are expected to offer full-motion video services as well.

Ka-band: Satellite communications frequencies operating at 30 GHz uplink and 20 GHz downlink.

Kbps: Kilo (thousand) bits per second. *See* Bit.

KHz: Kilohertz; thousand cycles per second. *See* Frequency.

Ku-band: Satellite communications frequencies operating at 14 GHz uplink and 12 GHz downlink.

Light emitting diodes (LEDs): Used as transmitters in some fiber optic systems. They transmit digital bits as pulses of light along a fiber optic strand.

Limited-motion video: *See* Compressed video.

Mbps: Mega (million) bits per second. *See* Bit.

MHz: Megahertz; million cycles per second. *See* Frequency.

Microwave: High-frequency radio waves used for point-to-point and omnidirectional communication of audio, data, and video signals. Microwave frequencies require direct line-of-sight to operate; obstructions such as trees or buildings distort the signal.

Modem (modulator/demodulator): A device that converts digital computer signals into analog format for transmission.

Modulation: The process of encoding audio and video signals onto a radio wave (carrier frequency) for transmission.

Multiplexer: A device that combines multiple signals for simultaneous transmission over a single channel.

Public Switched Telephone Network (PSTN): The public telephone network.

Real-time communication: Two-way simultaneous communication, as opposed to asynchronous.

Repeater: A device used to extend the range of a communication signal.

Reverse flow amplifier: In two-way cable television systems, these devices move video and audio signals from the receive sites back to the cable headend.

Slow scan: *See* freeze frame.

Steerable dish: A satellite receive dish that uses motors to rotate the dish to receive signals from many satellites. "Fixed" dishes are stationary, always pointed at the same satellite, unless realmed by hand.

Switched network: A type of system where each user has a unique address (such as a phone number), which allows the network to connect any two points directly.

T1 rate: A digital transmission speed of 1.544 Mbps.

Technology: For purposes of this paper, technolgy is defined as the application of audio, video and data technolgies in the educational environment. E.g. computers, telecommunications, multimedia,CD-ROM, laser discs, etc.

Teleconferencing: A general term for any conferencing system using telecommunications links to connect remote sites. There are many types of teleconferencing including: videoconferencing, computer conferencing, and audioconferencing.

Television receive only (TVRO): Satellite dishes only capable of reception.

Touch screen: A computer screen that allows data to be entered by using a specialized pen to write on the screen, or by making direct physical contact with the computer screen.

Transponder: The electronic equipment on a satellite that receives signals from an uplink, converts the signals to a new frequency, amplifies the signal, and sends it back to Earth. Satellites are usually equipped with 12 to 24 transponders.

Uplink: A satellite dish that transmits signals up to a satellite.

Upstream: The direction a signal travels as it moves from a receive site back to the site of original transmission. Used especially in two-way cable television systems.

Vertical blanking interval (VBI): The unused lines in a standard television signal. The VBI appears as a black band at the top or bottom of a television picture. Often used for closed captioning.

Very small aperture terminals (VSATs): Satellite receive dishes, approximately 1.8 to 2.4 meters in diameter, that are capable of sending and receiving voice, data, and/or video signals.

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Please Note Correction: Page 4
Sect. E.-The Cost of Under-
Education, first paragraph,
should read 973,000 dropouts