DOCUMENT RESUME

ED 352 517 CE 062 672

AUTHOR Damyanovich, Mike; And Others
TITLE Learning Technology: Enhancing Learning in New Designs for the Comprehensive High School.
INSTITUTION National Center for Research in Vocational Education, Berkeley, CA.
SPONS AGENCY Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE Dec 92
CONTRACT V051A80004-92A
NOTE 19p.; In "New Designs for the Comprehensive High School. Volume II--Working Papers"; see CE 062 664.
PUB TYPE Information Analyses (070)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Uses in Education; *Educational Change; Educational Development; *Educational Innovation; *Educational Media; Educational Principles; Educational Research; *Educational Technology; Guidelines; High Schools; *Information Technology; Integrated Curriculum; Multimedia Instruction; Relevance (Education); Role of Education; School Organization; School Role; *Technological Advancement; Telecommunications; Vocational Education

ABSTRACT

Technology, directed to each of the parts that collectively give shape and direction to the school, should provide the critical mass necessary to realize the specifications for the New Designs for the Comprehensive High School project. Learners should have access to personal productivity tools that increase effectiveness and efficiency in the workplace, home, and community as well as access to multimedia tools for information retrieval, manipulation, knowledge production, and presentation. The learning community should have: (1) an installed network providing access to almost any station on the network and to resources beyond the school through various means: telecommunications; network modems, printers, and other input/output devices; (2) telephone lines installed in every classroom, media center, and productivity center; and (3) electronic and/or voice mail accessible by students, staff, and community. Technology can catalyze the learning process by providing an interactive, distributed, open, instructional management system designed for monitoring alignment of curriculum, instruction and assessment, and student tracking. A management system helps students, parents, and teachers work together to develop and manage personalized learning plans. Technology can provide students flexibility in learning time, opportunity, and plans through an installed satellite, two-way interactive television, or computer-based instructional learning system. Access to and use of technology should be a common goal and shared responsibility of learning partners. (YLB)

ERIC

ED352517

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

LEARNING TECHNOLOGY: ENHANCING LEARNING IN NEW DESIGNS FOR THE COMPREHENSIVE HIGH SCHOOL

by
Mike Damyanovich
George H. Copa
Virginia H. Pease

This paper was developed pursuant to a grant with the Office of Vocational and Adult Education, U. S. Department of Education, for the National Center for Research in Vocational Education. While this paper has undergone review by project staff and the project's external Design Group, this document has not been reviewed using the customary NCRVE manuscript review procedures.

National Center for Research in Vocational Education
University of California-Berkeley
University of Minnesota Site

CE062672

BEST COPY AVAILABLE

LEARNING TECHNOLOGY: ENHANCING LEARNING IN NEW DESIGNS FOR THE COMPREHENSIVE HIGH SCHOOL

The high technology transformation of schools that many predicted a decade ago has not materialized. Looking around a typical high school today one would see little changed fROM the early 1980s. Educators are quick to point out the barriers to widespread use of technology (i.e., high costs of purchase and maintenance, dearth of appropriate software, lack of teacher training). Some observers believe problems with educational use of technology have as much to do with organizational politics as silicon chips (Sheingold and Tucker, 1990). There is ample evidence that the common practice of simply adding technology can not achieve changes without modification of the other dimensions of school. However, where stakeholders are redefining what goes on within classrooms and school, and rethinking the way teachers teach and students learn, new technology is demonstrating a key facilitative role in the transformation process (Pearlman, 1991).

If the design specifications for the new comprehensive high school are to be realized, the system needs to be viewed as an ecosystem of interrelated parts. Technology must be directed to each of the parts, which collectively give shape and direction to the school. The specifications for these key parts will define the specifications for technology.

Assumption

The revolution in information technology and policy initiatives which grant school choice to consumers are changing both the process of education and the notion of school. Learning is no longer confined to school. Cable television networks (i.e., the Discovery and Learning channels) *how to* videos, and home computers are the beginning proliferation of learning sources made possible through technology. Whittle's Edison Project schools (Walsh, 1992), and other private vendors now on the drawing boards, pROMise a superior education at reduced cost through technology utilization. The new comprehensive high school, in order to survive, will need to consider the implications of a move fROM monopoly to marketplace. For the purpose of this paper educational technology refers to the new and emerging information technologies that connect people and institutions and provide easy access to multiple sources of information, in many forms, at disparate locations making learning accessible, flexible and portable, (e.g., computers, calculators,

electronic networks, telecommunications, database, graphics and publishing software, Videodisc, CD-ROM, interactive and satellite television).

The Keystone—Learner Outcomes

The adopted set of learner outcomes are the expressed mission of the new comprehensive high school. Mission provides direction and priorities for an organization. It legitimates what this school will pay attention to, provide opportunities for, and publicly value. These learner outcomes serve as a keystone for design of the other components of the new comprehensive high school. The design group established several specifications for selecting the outcomes (Pease, Pearce, Copa, & Beck, 1991). These same specifications are useful in selecting the technology. These specifications include

1. The learner is the key customer of public secondary schools—their wants and needs are the primary focus.

2. Striving for competency attainment; consistent with outcome based education.

3. Call for balanced attention to all areas of human talent and integrated learning—the academic and vocational outcomes should be integrated.

Implications for Use of Technology

In an outcome-based system students use technology tools (e.g., computers, CD-ROM, telecommunications, video camera) both to facilitate and to demonstrate their attainment of the learning objectives. Teachers use technology to create authentic learning environments. Learning outcomes directly represent the knowledge, skills, and attitudes needed by positive, contributing adults. To accomplish these outcomes, students must engage in worthwhile, significant, and meaningful learning in an environment that closely resembles the environment in which they will be expected to perform as adults. This suggests students will need access to the tools for knowing and tools for doing that are routinely used by adults in an increasingly complex and changing world. Today the tools of informational technology pervade virtually all aspects of our lives. Computers, calculators, electronic networks, telecommunications, data-bases, graphics and publication software, video, CD-ROM and many others are integral fixtures in the production of

information, solution to problems, and providing of service. The challenge is to teach use and engage students in the use of these tools as learning resources.

As in the workplace, home, and community much of what students do will be collaborative and project-based. To stimulate collaboration and help students acquire the necessary skills, teachers might employ groupware. Using *groupware* for writing-production, students would be encouraged to brainstorm across a network in a conferencing mode and then to write documents collaboratively. Students joining the network could participate in ongoing discussions about books, current events, environmental problems, or areas of mutual concern. Group tool technology creates a collaborative environment for shared thinking on projects. Collaborative, project oriented education quickly transgress formal academic boundaries. Integrated curriculum becomes the norm. Integrated courses might well begin by presenting a final exam project that requires demonstration of competency on challenging tasks than don't have a single solution. Involvement in multimedia productions (e.g., "Foxfire" on family, video almanacs of community, or international, interdisciplinary telecommunication projects with an Antarctic expedition) require performance activities that are authentic rather than contrived. Working together, vocational and academic teachers could develop projects around which to organize units and courses. Teachers would see their mission as joined. Further, combining classroom work with service or social action projects immerses students in consequential activity for which the proof of what they have learned is in what they produce. For these projects, students can rely on a repository of information and technology to match their information needs and presentation styles.

Educational Technology Specifications

In an outcome-based system students use technology tools to both facilitate and demonstrate their attainment of the learning. Specifying technology for such a system requires we ask these *smart* questions:

1. What technology can be utilized to increase the productivity of the student as they work toward attaining the learning outcomes?

2. What tools will foster student's multifarious exhibitions of competencies associated with the outcomes?

The recommended specifications include

(a) Access to the same personal productivity tools used to increase the effectiveness and efficiency of adults in the workplace, home and community (e.g., computers, printers, spreadsheets, databases, CAD systems); and

(b) Access to multimedia tools (e.g., computers, videodisc, CD-ROM, videocassette, recorders, video cameras) for information retrieval, manipulation, knowledge production and presentation.

The Signature—The Learning Community

In an effort to create a stronger sense of community in the high school, the design group proposed *the learning community* as its signature. The learning community was selected because it can bring to the new school, a sense of place, of individual identity and of group solidarity. It is worth noting that the design committee suggested the learning community have some *form of representation*, which would give it public status. These characteristics of the learning signature are also useful in defining the specifications for technologies in the new comprehensive high school.

Implications for Use of Technology

The most important benefits technology can bring to the learning community is venue and opportunity for interaction, collaboration, and information exchange. An electronic network would make it possible for students at different computers and in different locations to work at the same time, on the same projects. The merging of local area networks (LAN) and telecommunications can connect students to networks that span the globe. So, no matter where they are located, networking can give students instant access to virtually any information source anywhere in the world.

When local community is of primary concern, telecommunications can offer students valuable links with social, commercial, governmental, and educational resources. Students engaged in helping to resolve real problems in their community could have access to valuable community resources such as the science museum, a college reference library,

business marketing center, health clinic, art museum, Environmental Protection Agency, citizens watch group, or Department of Natural Resources. Students could initiate on-line forums of discussion about community issues or provide access to services for family or neighbors who don't otherwise have convenient or informed access. Through this technology the school becomes a vital meeting place for a host of community services. Additionally, students finding it difficult to meet face to face with out-of-school resource people (i.e., parents, business people, scientists, social workers or artists) can talk conveniently on line so they become an extended reference rather than a brief field trip acquaintance.

Within the school, telephones in the classroom can facilitate closer collaboration of teachers and parents. Local community cable channels can provide school outreach programs and town meetings. Voice mail can provide teachers an opportunity for leaving mail messages for parents and parents can leave questions and concerns for teachers. Using the local area network, Electronic mail (i.e., E-mail) can enhance student-to-student, teacher-to-student, and teacher-to-teacher communication.

Educational Technology Specifications

The learning community describes the signature of the new school. The *smart* question is, "How can technology establish community among teachers, students, parents and others?" Technology can provide venue and opportunity for local, regional, national, and global communications through local and wide area networks. The recommended technology specifications are as follows: (a) an installed "Backbone" network providing any user with access to almost any station on the network and to resources beyond the school through telecommunications; (b) network modems, printers, and other input/output devices strategically located so that fewer peripherals serve more users; (c) telephone lines installed in every classroom, media center, and productivity center; and (d) electronic and/or voice mail accessible by students, staff, and community.

Learning Process

The learning process describes the curriculum, instruction, and assessment needed to effectively address the learner outcomes. These three dimensions are interrelated and mutually dependent. The curriculum defines the areas of study students will encounter and

therefore the modes of thinking they will employ. Pedagogy provides the means through which the curriculum is made meaningful to the learner. Assessment tells students, administrators, teachers, and community what is paid attention to in school. The learner specifications which defines these three dimensions also delineates the technology to support them.

Educational Technology Implications

Technology can catalyze the learning process in several ways. The first is by providing an information system to manage information associated with the learning process; the second by enabling the conditions for authentic achievement. An instructional management system enables curriculum, instruction, and assessment to be developed and aligned with each other. Through design, analysis, and monitoring of curriculum and instructional programs practitioners can help assure the mission of the school is being expressed and operationalized in instruction and assessment of learner outcomes. The integrated, student-centered curriculum—suggested by the learning outcomes and specifications for the learning process in the new high school—present unique problems and opportunities for assessment. Learning outcomes focus attention on results. Assessing these results often requires more complex measures of performance than standardized, multiple choice tests. Authentic assessments require performance that produce richer and more meaningful results than grades but may not be communicated as easily.

The student performance tracking feature of instructional management systems allows for development of learner profiles where individual data points can be examined and graphed against exit outcomes over any time period. These highly personalized learner profiles reflect student competencies and provide documentation of where, when, and with what success students encountered learning outcomes. Learner profiles can then become part of a computer-based, personalized management system designed to help students, parents, and teachers work together to develop and manage students personalized learning plans, goals and schedules. Student portfolios and exhibitions, both produced more effectively with technology, can also communicate achievement. For example, videotape portfolios provide an excellent tool for use in evaluation of speaking outcomes. Through video, multiple evaluations are possible with students, peers, teachers, parents, and community able to participate in the evaluation process.

Technology also enables some of the contextual conditions necessary for authentic achievement. The intellectual work of authentic achievement often involves tools. Many of the tools of technology are built into the lives of today's students (e.g., computers, video, television). These tools can provide a personal, active, and emancipative learning process. There are many technology-based products specifically designed to help disabled students operate computers using modified input devices like non-standard keyboard or voice activated switches. Others are designed to strengthen age and grade appropriate communication, academic and social skills. The multimedia tools of technology reach all the senses and can be matched to the learning styles of individuals. These tools encourage use of multiple intelligences and validate self expression through words, images, and sound. Using these tools allows the learner more control and more voice in the learning process. Students gain a sense of ownership since they actually create what they learn, and in the act of creating become active and experiential learners. As students create they often want to share what is being done with others. Authentic intellectual work is often collaborative. Microcomputer networks, groupware tools, and online data exchange through telecommunications provide place and opportunity for interaction, collaboration, and peer review; a community of learning.

Educational Technology Specifications

Technology can catalyze the learning process in two ways. First by providing an information system to manage information associated with the learning process and second by enabling the contextual conditions for authentic achievement. Although implementation of a student-centered instructional programs including outcome-based education have the potential to greatly increase the information load, the learning process specifications provide parameters for what is to be managed. The *smart question* for choosing an informational management systems is, "What information is necessary to gather and manage to realize these specifications?" Multimedia technology encompasses a range of possible applications as varied as it elements: full motion video, still images, animation, computer graphics, text, and audio. Since there is no one option specifications for multimedia tools must be decided based on, "What is to be accomplished and by whom?" This would include the following: (a) an open, interactive, distributed, instructional management system designed for monitoring alignment of curriculum, instruction and assessment and student performance tracking; (b) a management system that helps students, parents and teachers work together to develop and manage students personalized

learning plans; (c) access to multimedia tools; and (d) access to a local area network (LAN) merged to worldwide telecommunication networks.

The Learning Organization

Learning organization specifications address the organization of learners, learning setting, learning process, learning time, and learning staff. These specifications collectively define the structure of the new comprehensive high school. Structure defines the organizational framework within which the mission of the school is pursued. Eisner (1988) believes than when structure and mission are in conflict, it is structure rather than mission that is likely to dominate. Terry (1988) suggests that if one perceives a particular organizational problem to be at the root of a problem, its fundamental sources is the next level up. In his model, technology, viewed commonly as a resource difficulty, is actually a structure problem. Aligning technology with the specifications for the learning organization supports mission and by doing so prevents technology fROM simply being *added on.*

Implications for Use of Technology

Technology can provide students the flexibility of learning time, learning opportunity and learning plans called for in these specifications of the learning organization:

1. Flexible scheduling of learning time to encourage and support reaching leaner outcomes through a variety of learning strategies and to allow a concentrated effort when appropriate.

2. Maximum opportunity to change direction and focus as the student moves toward completion of high school.

3. Involvement in a planning process to reach learner outcomes in a way that is responsive to her/his needs and interests. This planning process should result in a flexible learning plan for each student which is reviewed periodically.

Flexibility of learning time entails exercising some control over the study topics, pace and procedures of learning. Instructional Learning Systems (ILS) can offer the

opportunity for independent learning apart fROM the classroom. An ILS is a hardware/software system in which students' computers are networked to a central server that has curriculum software and a management system to track student performance. Instructional Learning Systems are currently available fROM Computer System Research (CSR), WICAT System, Computer Curriculum Corporation (CCC), Josten Learning Corporation, International Business Machines (IBM), and WASATCH Education Systems. Choosing an ILS learning strategy, students would register for courses that cover up to several years worth of study. Once in a course the system adjusts difficulty of the materials based on the responses of the student. Difficulty increases as the student becomes more proficient until competency is reached. Students are able to select optional tutorial help selections at will. Many of the lessons require outside reading material and activities and emphasize a learning process of discovery rather than drill. Some lessons include engaging, interactive computer simulations, and a powerful set of on-screen tools including a notebook, scientific calculator, glossaries, mail, word processor, and graphing utilities. Place holders in the system allow students to exit the system and reenter where they left off independent of time and without being restricted by prerequisites or curriculum tracks.

Opportunity for the learner to change learning direction and focus is also afforded by the technology of *distance education*. Two of these technologies, satellite and two-way interactive television, provide instruction by teachers transported to the student. Two-way interactive television is suited for distance learning projects that span small geographic areas. Rural school districts are using two way television to transmit audio and video signals between participating classrooms located within instructional cooperatives. Depending on the location of each school, the signal may be sent via cable, microwave, fiber optic, or low power UHF transmission. Under this system every classroom is equipped with television monitors and video cameras are positioned to see all the students in that class. In effect every participant can hear and see every other participant just as they would if they were all in the same room. As an alternative to establishing and managing the facilities to produce and deliver high quality, two-way television programming, a number of schools have turned to a state wide or multi-state satellite networks for delivery of effective distance learning programming. In these systems a satellite dish or uplink beams live instruction over a wide geographic area. Students receive instruction via live video and interact with the teacher by toll free phone, facsimile, voice and E-mail. These technologies provide additional learning opportunities for students beyond the borders of the school building.

The organization and management of information collected about each student in the time independent, opportunity robust, learning organization specified for the new high school is impractical without the use of technology. Computer-based personnel learning plans (PLP) can be used to collect, organize and present student portfolio information. Portfolio information offers a richer understanding of students through identification of goals and aspirations and a clear and detailed picture of strengths and weakness. Portfolios allow recording of observations of a student, evaluations of her work, as well as actual samples of oral, written and graphic projects. Students can use the PLP to evaluate their own progress toward goals they have selected. Information in the PLP can be easily updated and shared with students, counselors, administrators and parents.

Educational Technology Specifications

Technology can provide students the flexibility of learning time, learning opportunity, and learning plans specified for the new comprehensive high school. Instructional Learning Systems (ILS), satellite, and two-way interactive television provide students with maximum learning opportunity and flexibility in learning time schedules. However, they are expensive. To keep fROM investing limited budget resources on inappropriate technologies, *smart* questions involve a needs assessment process to justify installation. The assessment process should focus on identifying the instructional, staff development, inservice and any community and adult education needs of stakeholders. They should also identify any local, university, vocational, or training center to which they could gain access to meet some of these needs. Since distance education is involved, participants may also identify local, regional or national expertise and resources that would help meet those needs. A school participating in this process would use the results to decide on which technologies, if any, to install. Technology specifications for the learning organization should include: (a) an installed satellite and/or two way interactive television if justified by a needs assessment process; (b) an installed computer-based instructional learning system (ILS) if justified by a needs assessment process; and (c) access to a computer-based, personal learning plan (PLP) management system.

Learning Partnerships

The learner outcomes, process, and organizations specifications make it necessary for learning to involve partnerships within the school and among the school and other

organizations. Access to and use of educational technology should be a common goal and shared responsibility of learning partners.

Implications for Use of Technology

The current work processes of U.S. and international corporations demand that students master basic skills, possess higher-order thinking competencies, have the ability to work collaboratively and use technology to solve work-related problems.

The design specifications for the new comprehensive high school support these goals. But, like other public schools, it may not have the financial resources to buy the latest educational technology equipment to attain them. Motivated by the need to help students acquire the needed skills for the workplace of the future, the school can form a partnership with local business that helps them gain access to educational technology tools they otherwise may not be able to afford. Both business and school could benefit through graduates who have been afforded an opportunity to gain the skills needed to make them contributing adults.

In addition to this long-term benefit more immediate gains are provided where business opens it training centers to student or schools, using financial support fROM business, develop multimedia training centers, which they run in the evenings for the benefit of employees. In this case schools acquire educational technology equipment and software for student use and business gets an opportunity to provide training for their employees. In such training centers one might find CAD systems, computer networks, engineering software, and multimedia equipment. Students would use this technology to work on *real* problems—some of them identified by the businesses that provided the technology. In other instances the school may purchase the equipment but maintain and upgrade it through fees charged to companies who send employees for training.

Educational technology also provides the opportunity to bring community into the school as a partner in improvement. Evening programs and classes that make computers, electronic networks, telecommunications, CD ROM, and interactive television available for community use piques interest and breaks traditional attitudes and misconceptions about school as well as offering people something in return. Through this partnership the community as a whole benefits fROM a closer tie to school. Similar partnerships of shared technology resources related to mutual goals and responsibilities can be made between the

school and universities, vocational schools, or regional and state educational cooperative units.

Educational Technology Specifications

Access to and use of educational technology should be a common goal and shared responsibility of learning partners.

Learning Staff

Experience has taught that technical innovation alone will not bring about educational transformation. An institution's capacity for change is dependent on the quality of its people. Although the learning staff specifications for the new high school have not yet been identified, technology integration suggests some of these qualities will be needed for successful membership:

1. Change agent: Serendipity and uncertainty play a role in the use of technology. Experience has taught us that real technology integration brings about dynamic changes in both instruction and learning.

2. Collaborator: The connections provided by technology can diminish the isolation of teaching and learning. Technology will provide opportunity for working with colleagues on-line as well as in person.

3. Coach, mentor, facilitator: The access, manipulation and production of information will be greatly facilitated by technology. Time will increasingly be used to ask the questions, pose the problems and provide the authentic learning environment which will help students convert this information to knowledge.

4. Researcher: Their part in the community of learners will require engagement in reflective practice. Some of this "action" research will involve identification of effective new technologies or technology mediated learning.

5. Information manager/decision maker: Technology will put information and information tools in the hands of learning staff. Empowering them as decision

makers as they plan, assess, deliver and analyze instruction and instructional programs.

Educational Technology Specifications

The following are identified as necessary educational technology specifications:

1. Access to the personal productivity tools would be used to increase effectiveness and efficiency in the workplace, home and community (e.g., computers, printers, spreadsheets, databases, CAD systems).

2. Access to multimedia tools (e.g., computers, videodisc, CD-ROM, videocassette, recorders, video cameras) would be used for information retrieval, manipulation, knowledge production, and presentation.

3. Access to a installed *backbone* network would provide any user with access to almost any station on the network and to resources beyond the school through telecommunications.

4. Telephone lines would be installed in every classroom, media center, and productivity center.

5. Electronic and/or voice mail would be accessible by students, staff, and community.

6. Access to an open, interactive, distributed, instructional management system would be designed for monitoring alignment of curriculum, instruction and assessment, and student performance tracking.

7. Access to a management system would help students, parents, and teachers work together to develop and manage students personalized learning plans.

Learning Environment

Schools are now organized around the work of adults. Specifications for the design of the new high schools suggest it will be organized around the work of students. Where will students work? The school, the home, and the rest of the community? Although design specifications for the learning environment of the new high school have not been identified, some space plus technology relationships are suggested by its keystone and signature.

The signature of *learning community* brings to the new school a sense of place, of individual identity, and of group solidarity. It suggests the adult and student workers in this system will need a multiplicity of spaces such as open areas, small cubicles designed for up to ten participants, larger gathering places and a number of individual and independent learning places. These areas could be zoned to provide schools within a school a sense of identity and connected through electronic networks for a feeling of community. The keystone is represented by results-oriented learner outcomes. Students would use technology tools to both facilitate and demonstrate their attainment of these outcomes and teachers would use them to create authentic learning environments. Because there is no one best way to enable this work, several space plus technology zones could be provided. These zones might include: (a) seminar rooms for small group interaction in which technology is limited to whiteboards for sketching ideas and concepts; (b) production areas containing networked computers with shared peripherals; (c) large workrooms with several multimedia production stations and desktop publishing workstations; and (d) a learner bank stocked with high technology tools and equipment, which can be loaned but is otherwise not available. Classrooms should be designed for teacher and student to maximize technology for knowledge presentations. In these classrooms lighting and equipment would be controllable fROM one central point allowing optimum viewing for each student. Integration of a variety of media (e.g., telephone, CD-ROM, videodisc, data line, videotape, computer projection equipment), would be possible through a computer driven console programmed to allow presenters to control these applications. Video distribution would be fROM a centrally-located source to the classroom via coaxial cable. In conjunction with these spaces would be a presentation area with the same capabilities of the classroom plus data links to access information in real time. These links would include telecommunication systems for distance learning, two-way interactive television and a down link for satellite distribution.

Educational Technology Specifications

Adult and student workers in this system will need a multiplicity of spaces such as open areas, small cubicles designed for up to five participants, larger gatherings places and a number of individual and independent learning places. These areas could be zoned to provide schools within a school for a sense of identity and connected through electronic networks for a feeling of community.

Summary

The specifications for the New Designs for the Comprehensive High School offer an opportunity for successful transformation by removing or lowering many of the previous barriers. Technology, directed to each of the parts that collectively give shape and direction to the school, will provide the critical mass necessary to realize these specifications. This educational technology should include:

1. Access to personal productivity tools used to increase the effectiveness and efficiency in the workplace, home and community (e.g., computers, printers, spreadsheets, databases, CAD systems).

2. Access to multimedia tools (e.g., computers, videodisc, CD-ROM, videocassette, recorders, video cameras) for information retrieval, manipulation, knowledge production and presentation.

3. An installed *backbone* network providing any user with access to almost any station on the network and to resources beyond the school through telecommunications.

4. Network modems, printers, and other input/output devices strategically located so that fewer peripherals serve more users.

5. Telephone lines installed in every classroom, media center, and productivity center.

6. Electronic and/or voice mail accessible by students, staff, and community.

7. An interactive, distributed, open, instructional management system designed for monitoring alignment of curriculum, instruction and assessment, and student performance tracking.

8. A management system that helps students, parents and teachers work together to develop and manage students personalized learning plans (PLP).

9. An installed satellite and/or two way interactive television if justified by a needs assessment process.

10. An installed computer-based instructional learning system (ILS) if justified by a needs assessment process.

11. Access to and use of high technology as a common goal and shared responsibility of learning partners.

12. A multiplicity of spaces such as open areas, small cubicles, larger gathering places and a number of individual and independent learning places. These areas could be zoned to provide schools within a school for a sense of identity and connected through electronic networks for a feeling of community.

References

Eisner, E. W. (1988, February). The ecology of school improvement. *Educational Leadership, 45*(5), 24-29.

Pearlman, R. (1991, January). Restructuring with technology: A tour of schools where it's happening. *Technology and Learning, 11*(4), 30-36.

Pease, V. H., Copa, G. H., Beck, R. H., & Pearce, K. (1991). *Design specifications and selected learner outcomes for the comprehensive high school of the future: Choosing the keystone.* St. Paul: University of Minnesota, National Center for Research in Vocational Education, St. Paul.

Perelman, L. W. (1987). *Technology and transformation of schools.* Alexandria, VA: National School Board Association Special Report.

Sheingold, K., & Tucker, M. S. (1990). *Restructuring For learning with technology.* A collection of papers prepared for the Center For Technology in Education and the National Center on Education and the Economy.

Terry, R. W. (1988). *Human framing action tool.* Unpublished notes, Reflective Leadership Seminar, Hubert H. Humphrey Center For Public Affairs, University of Minnesota, Minneapolis.

Walsh, M. (1992, March 4). Whittle unveils team to design new schools. *Education Week, 9*(24), 1, 13.