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ABSTRACT

This paper examines emerging information technologies and their implications for school library media centers. Because of the fluctuating situation regarding new innovations, only emerging technologies that specialists believe will occur within the next 5 to 10 years are discussed. For each technology mentioned, a brief description is given followed by its implications and possible applications for school library media centers. The following technologies are covered: (1) the digital electronic medium; (2) telecommunications; (3) cable and satellite resources; (4) integrated services digital network (ISDN); (5) telecomputer technologies; (6) computer hardware; (7) scanners; (8) CD-ROM technologies; (9) software developments; (10) specialized software; (11) hypertechnologies; (12) interactive media; (13) national and international networking; (14) Internet; (15) National Research and Education Network (NREN); (16) expert/knowledge systems; (17) neural networking; (18) virtual reality; and (19) virtual reality and education. (Contains 31 references.) (JLB)

Emerging Technologies: Applications and Implications for School Library Media Centers

by Dr. Kathleen W. Craver

EMERGING TECHNOLOGIES: APPLICATIONS AND IMPLICATIONS FOR SCHOOL LIBRARY MEDIA CENTERS

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Almost daily, school library media specialists are faced with emerging technologies that help to promote library services and concomitant pressure to utilize these new technologies to enhance programs and services.[1] The speed with which they appear on the market makes predictions of dominant electronic developments rather difficult. Given this rapidly fluctuating situation, the subsequent discussion of emerging technologies is confined to those which most specialists believe will occur within the next five to ten years.

Digital Electronic Medium

Before examining individual emerging technologies, it is important to understand and evaluate them within an overall framework. This integrated communications infrastructure is referred to as digital electronic medium (DEM).[2] Information, regardless of its original format, is stored as electronic charges in digital form. Once information is stored in this form, it becomes machine-readable, inexpensive and highly transmittable. Its universal effect is to permit the creation of an electronic database containing all of the print and nonprint materials in a particular library plus providing access to other electronic libraries via a wide-area network. Although DEM is not yet a reality, rapid advances in the following technologies will make it a salient characteristic of electronic systems by the year 2000.

Telecommunications

The major thrust for DEM will be precipitated by the nation-wide installation of fiber optic cabling (slender glass rods a fraction of the size of copper wire cables bundled together). " A single strand, for example, can transmit the contents of the entire Encyclopedia Britannica every second".[3] This telecommunications backbone will serve as the engine that will drive every type of information whether it be a book, recording or video to become digitized. Once digitized, information is no longer bound by time or place. It can be quickly and inexpensively transmitted through fiber optic networks to schools and homes.

Cable and Satellite Resources

As a result of the fiber optic networking of the country, SLMCs will also be deluged with an increase in cabling and satellite resources. Up to now, most schools have been restricted to

selecting from relatively few cable-supplied educational television programs such as Newsroom, the Discovery Channel, the Learning Channel and C-Span.[4] The potential for proliferation of educational channels is substantial. School library media centers will soon have greater selections at more competitive costs.

For SLMCs without access to fiber optic cabling, satellite technology will expand and improve. Hughes Communications, for example, is expected to introduce "Direc TV" which can transmit 150 television channels through a $700 rooftop disk the size of a large pizza pie.[5] With the predicted increase in programs and channels, various companies will specialize in educational programming. School library media centers will become the beneficiaries of this expansion.

Integrated Services Digital Network

Accelerating the digitalization of all forms of information is the development of an Integrated Services Digital Network (ISDN). Using the combined resources of AT&T, NCR, Siemiens, Hitachi, Telecom and all of the U.S. regional Bell Operating Companies, the ISDN program enables non-fiber optic telephone circuitry to convert analog signals to digital signals. Users can then connect their PC's or any digital hardware to a data wall outlet. ISDN is designed to facilitate the networking of computers and more importantly to further their electronic connection to larger computer systems such as minis and mainframes. The ability of SLMCs to utilize existing telephone circuitry to access databases, electronic mail and the collections of other libraries is unprecedented.[6] Advances in this area mean that SLMCs will no longer be excluded from the world of information because they lack the funds to pay for hardware once required for electronic access.

Telecomputer Technologies

Although the telepower revolution is going to blur the distinctions among televisions, computers, CD-ROMs, video disks and other forms of technological hardware, advancements are also occurring separately within these areas.

Computer Hardware

The capabilities of computers continue to expand almost exponentially each year. Computers initially designed to manipulate numbers, then text, symbols and graphics, have finally evolved into "information integrators".[7] Since the power of the computer is dependent upon its ability to store and process information, computer hardware specialists are competing to increase machine proficiencies in these two areas.[8]

The result of these achievements is the marketing of desktop microcomputers that are as powerful as mainframes. The most recent advancement is the development by Intel of the

Pentium chip. Described as "almost as fast as a supercomputer," the Pentium chip is available in PCs priced as low as $4,000.[9]

These hardware advancements complete another stage in the computer's evolution. They facilitate dramatic changes in the form and function of computers. The first change caused by more efficient chips is to permit computers to shrink in size so that they are truly portable. As such, they will replace the ubiquitous pencil and notebooks seen on all classroom desks.[10] Students will be using something similar to Apple's Newton PDA (Personal Digital Assistant) or Tandy's Zoomer. Both devices are digital notepads that employ a stylus for handwriting on a screen. The PDA then converts the handwritten notes into computer files which in turn can be transferred to networks, fax machines or cellular connections.[11]

Another portable advancement that will be in widespread use by the year 2000 is the notebook computer. Currently the best-selling notebook is Apple's, Powerbook. It contains an 85 mg hard-disk drive, a 386SL microprocessor and a color display and weighs only one pound. Powerbooks can be connected to desktop MacIntosh computers thus enabling students to obtain additional information and/or integrate their work with existing data.[12]

A second enhancement involves connectivity. The large storage and processing power contained in a portable computer means that students may use them to access the SLMCs online catalog, other networks, CD-ROM files and even commercial databases. While in the SLMC, they can download research from a database directly into their portable computers, slip them into backpacks and complete the rest of the assignment at home.[13]

It is this combination of portability in computers, coupled with advancements in telecommunications link ups, that will produce what is called the "telecomputer". This device will possess the attributes of a powerful palmtop computer and a cellular telephone in one. Recently the FCC approved experimental trial applications from three cable TV companies to test a wireless local area network. One of them, termed Altair, permits laptop and other portable computers independent movement within a building while accessing information from a central network.[14]

Scanners

Optical Character Readers (OCR's) or scanners are another form of hardware that will alter information search and retrieval and aid in the creation of full text databases in SLMCs. Prices for 24 bit, 300 dots-per-inch color scanners have dropped from approximately $8,000 in 1990 to about $900 today.[15]

Scanners are not difficult to use once software setups are selected. Basically the machine

reads in pages of hard copy and converts a document into either ASCI II files or into a field format used by wordprocessors or spreadsheets.[16] Once the text is in machine-readable form, it can be incorporated into a research assignment or added to a full text databasc.

Current advancements in the scanner and the software permit users to scan color images. One product called TWAIN (developed by Hewlett-Packard, Caere, Aldus, Logitech and Eastman Kodak) is designed to permit an image to be inserted directly into any DOS or MaC application, given TWAIN's compatibility with the program and hardware.[17]

OCRs are now cost effective and beneficial for SLMCs to purchase. As a means to construct specialized in-house full text databases or provide students with increased research and report presentation capabilities, they are a computer-related technology that will have important future applications.

CD-ROM Technologies

Of all the recent computer-related technologies to appear on the market, none has or will continue to affect SLMCs as much as CD-ROMs. The first improvement concerns storage capacity. With the increased storage capacity created by more efficient computer chips, the space for locally mounted CD-ROM databases will increase and the costs for CD-ROMs as the market expands should decrease. Increased storage capacity makes larger full text databases feasible. Software will also provide better methods for compressing the data, so that a larger database can be stored in the same amount of space. The faster processing speed expected with a new computer chip will facilitate the search and retrieval of lengthy articles on CD-ROM. A third trend concerns the networking of CD-ROMs. With the development of new networking software such as Novell 4.11, Optinet and stackable CD-ROM network players, the same database can be accessible from many terminals thus reducing a class queuing problem and permitting large group instruction.

A fourth trend relating to the increase in the number of databases corresponds to the demand that they be full text. For SLMCs whose users require almost instantaneous information gratification, these changes will be heartily welcomed. Many students in a structured situation such as school cannot always find the time or transportation to retrieve materials cited in other remote libraries. They need timely, local access to information that only full text databases can provide.

The last and most important trend regarding CD-ROM technology concerns its potential for interactivity. CD-ROM is considered by most technologists to be an inexpensive, multimedia medium. With the creation of CD-I (Compact Disk Interactive) by Sony and Philips, a special

purpose player enables the user to access a thousand video stills, six hours of high quality sound, ten thousand pages of text in conjunction with a computer software program that renders it totally interactive with the user.[18] In the case of CD-I, new developments in software are equally related to developments in hardware.

Software Developments

The developmental gap that usually exists between software and hardware is swiftly being closed by the design of new software operating systems. As more mainframes are replaced with personal computers comparable in storage capacity and microprocessing speed, they require software operating systems equal to the hardware power. To meet this challenge, several large technology companies such as Microsoft, IBM, Novell and Apple are racing to create software operating systems that can turn personal computers into supercomputers.

Microsoft's creation, Windows NT, claims to be the solution to harnessing the hardware power resident in new desktop computers. With Windows NT, users can work with specialized software only available on mainframes and minicomputers and with the click of a mouse, switch to writing a letter using Wordperfect. Windows NT is slated to sell for $300 to $500 thus making it affordable even for SLMCs facing financial constraints.[19] For Apple users, Taligent, an IBM-Apple cooperative project is also working on a similar operating system which is presently under the codename "Pink".[20]

Specialized Software

The creation of new operating software systems for PC's so that they can function as mainframes is an exciting development for SLMCs. They will become the heirs to new specialized software packages that permit greater individuation, easier access and more options. New online catalog software will allow more idiosyncratic access that is more likely to mimic the way children seek information. It will also permit access to materials via table of contents or chapter headings.[21]

Another form of specialized software called front end software will also permit more options. The emergence of super PCs will allow for more user-friendly menu and help screens that can be designed for an individual user or local SLMCs. Front end software will be particularly helpful to SLMCs as they access remote, fee-based or free commercial databases or libraries. Instructions, for example, can be simplified. Natural language queries could be translated into formal searches.[22]

The ability to load front-end software to interface with larger and more sophisticated software modules will make it possible to permanently integrate what are now termed user-

selected software options into larger options. Students, for example, will switch back and forth from accessing online databases to scanning and integrating paragraphs from reference books into their assignments via a wordprocessing format.[23]

Hypertechnologies

Striving to integrate multiple technologies continues to be an ongoing goal in software as well as hardware development. The increasing hypertechnologies (Hypercard, Hypertext and Hypermedia) in SLMCs are directly related to the hardware proliferation of CD-ROMs. Both will have a major impact on SLMC programs and services and will continue to do so in the coming years.

Current hypertechnologies empower computer users to organize and manage material without having to be fluent in the cryptic syntax of a computer programming language.[24] They permit users to connect pieces of information , to forge branches through a body of material and to edit or add to existing texts.[25]

The potential use of hypertechnologies in SLMCs is tremendous. School media specialists and school-library related businesses can design online systems, and bibliographic instruction units that cater to a user's level of knowledge or experience. Students may select the topic and information level to request information. At any point, they may stop when they have acquired sufficient information or gone beyond their level of expertise.

Future hypertechnology applications will be just as exciting for SLMCs as the currently emerging ones are. The first area concerns " published compilations of information" such as encyclopedias, census data and other reference works. In this scenario, all links or connections are created by the author, and students use the marketed product as they would a printed text. Candidates for this type of Hypertext use would be reference books with a great deal of indexing and cross references.

A second application concerns the ability to create active hypermedia. At Brown University's Institute for Research in Information and Scholarship, for example, a series of networked stations are used to provide sharable access to two sets of course materials. In English Literature and Plant Cell Biology courses, students can contribute their own additions and personal links to the original programs. Thus they become active participants in further developing the course materials by inputting their own ideas, findings and knowledge. Instructors report an improvement in student essays and class discussions through this type of Hypertext access.

The last application relates to the power of Hypercard as a user-friendly programming

language. School library media centers can use Hypercard to design interfaces to more complicated software systems such as large academic online systems or commercial databases. More importantly though, Hypercard can be used to retrieve text and pictures from large databases and systematically form them into suitable classroom units. For example, Harvard University's Perseus database contains five to ten thousand pictures and fifty million characters of text and commentary about the ancient Greek world. It is so large that it cannot be entirely viewed or read in a semester course. Hypercard is used as a tool to permit the user to access specific pictures, maps and commentary so that a cohesive presentation is available on a certain topic for use by students.[26]

Interactive Media

IM means the blending of hypermedia, videodiscs, and/or CD-ROMS or CDIs. A more apt term for this merging of broadcast telecommunications and processing communications has been termed "compunications."[27] Combining specialized software (Hypertext/Hypermedia) with videodiscs or CD-ROMs has created an interactive system with potential for revolutionizing current educational programs and methods. The individualization of instruction with the use of interactive media will finally become a reality not only in students' classrooms but also their homes.

Despite rapid progress in IM, it is still not synthesized into a seamlessly integrated technology. As such, it is somewhat defined by "levels of interactivity."[28] These levels relate to such things as the use of particular hardware, program software and design, and the information furnished to the user and instructor. The highest level of interactivity entails using the computer (with its specialized hypermedia software), and the videodisc to create teaching units by selecting portions of commentary/text or individual images. Interactivity increases appreciable at this level because the user is actually engaged in interpreting, analyzing, comparing synthesizing and evaluating the information. A final step permits users to impose their own voices and video images over the material and save their created programs onto floppy diskettes.[29]

National and International Networking

With the previously described advances in computer technologies and telecommunications, the installation of even one computer, a telephone line and a fax machine in a SLMC can substantially improve bibliographic access. Through locally integrated online systems, SLMCs can access a wide array of non-bibliographic and bibliographic databases throughout the world.

One of the most exciting new developments to occur in networking concerns the

generational advancements of online catalogs. Third generation online catalogs in addition to a full MARC record, boolean logic and keyword searching feature help screens, menus, abstracts and limited full text searching.[30] It is this generation of online or supercatalog that also extends networking beyond local and state boundaries to include the globe. Improved networking software has enabled this generation of online catalogs to serve as gateways to even more databases and networks.

Academic libraries are now loading commercial or proprietary databases such as ERIC, PSYCH Abstracts and Infotrac onto their online catalogs. These databases become part of the library's online catalog through a menu screen thus permitting students to search the local academic library database for materials and, when necessary , other subject specific commercial databases.[31]

Most of the technological advances predicted for electronic networks will be extremely advantageous for SLMCs. Overall they serve to increase access, streamline search commands, reduce the need for intermediary assistance and facilitate use by secondary school students. The first development concerns an increasing trend by large library systems to use similar software. Libraries in large regional consortia such as CARL (Colorado Alliance Research Libraries) and Melvyl (University of California Libraries) have a much easier time searching because the search commands are the same regardless of what database or library they are accessing.[32]

A second trend relates to the development of online systems that can manage numeric data and text of variable length. SPIRES (Stanford Public Information System), for example, has a component in their online catalog which supports a homework database consisting of lecture notes, answer sheets and practice exams.

A third trend concerns the ability of networks to put images online. At MIT, the library has succeeded in developing a collection of 7,000 slides that are used in conjunction with an architectural course. The last trend and one of the most important for SLMCs deals with the creation of full text online catalogs. Currently available full text databases are not for general reading. Their new features, however, will provide the foundation for future enhancements that will create full text online databases on a major scale. One of these as example is the Thesaurus Linguae Graecae (TLG), a Greek text database available through the University of california's Irvine campus to scholars in the humanities. Access is provided by keyword and line number.

As more of these specialized databases are developed and made available to a broader population, features such as structural browsing will be introduced that permit users to view an outline of the topic, appropriate chapter headings or paragraphs. OCLC has designed software

called GraphText that supports this type of full text searching. Other companies are expected to develop similar software.[33]

Internet

A fifth trend in networking which is unrelated to future software enhancements or database contents but is vital for SLMC participation concerns access to Internet. Internet is a constantly growing and mutating combination of approximately 280 academic and research center networks that permit users to search the catalogs of more than 60 research institutions. More than half a dozen international connections have been established with networks in Canada, Europe, Mexico and other parts of the world.

Local and regional library consortia, such as the CARL system in Colorado and the Melvyl system in California make their catalogs and even special in-house databases available through Internet. Some systems such as Melvyl limit searching to their catalog and restrict searching of commercial databases such as Medline to University of California patrons. Even though Internet consists of various networks administered by different institutions, it appears as an integrated entity to the user. Internet supports an increasing variety of other services such as electronic mail, file transfers among member Internet computers and linkage to remote computers that emulate direct connections. Full-text files may even be downloaded from Internet host computers. Examples include the Bible. Koran Shakespearean works, Peter Pan and Hardy's, Far from the Maddening Crowd. Song lyrics, news articles, recent Supreme Court opinions, census data, the CIA World Fact Book and a wealth of government information are searchable through Internet. The contents change regularly as more resources are added to the network. Equipment requirements are minimal. Users simply need a telephone line, a modem, a computer and communications software.

NREN (National Research and Education Network)

As a response to the increasing flow of data over Internet, plans are underway to upgrade the major network Internet backbone to a 3 gigabit per second level by 1996. This communication upgrade is part of the implementation of an even larger network called the National Research and education Network. NREN will establish fiber optic cabling and digital communications links in every U.S. school thus enabling the rapid transfer of textual information as well as video and audio. Each school will have a computer that performs as a local file distributor of NREN information to other terminals within the school's local area network.

Separate communications links can be established between different or like schools for such purposes as foreign language and cultural exchanges. Collaborative teaching units can be

designed among schools that permit them to share resources.[34] The SLMC will serve as an electronic navigator linking students and faculty to a truly global information network.

Expert/Knowledge Systems

Expert or knowledge systems are computer programs created to perform like a human expert in a defined area of knowledge. Most expert systems have four components. the knowledge base, the inference engine, the knowledge-acquisition interface, and the user interface. Once designed, the program functions as a "highly-informed insider" within its area of expertise. Users then interact with the knowledge to reach a conclusion. Expert systems, in addition to requiring the knowledge base of a subject expert, need to follow a complex set of rules involving decision trees, flow charts and inferential reasoning. They have many useful applications to school libraries and education.[35]

Most library expert systems have been designed to help users navigate through fairly complicated databases such as the National Agriculture Library's online catalog. Their expert system called Answerman assists users to find information in various agricultural reference books and guides them to more specific information by searching CD-ROM databases and remote online systems. CITE, an expert system at the National Library of Medicine, serves as an interface to the online catalog permitting the user to query the database in natural English.[36]

Both of these library-related expert systems improve the ability of a user to find information. The use of CIT, for example, which allows natural English to access the catalog would be very helpful in school online catalogs. Most students experience difficulty searching databases that require knowledge of Library of Congress or Sears subject headings.

While these types of knowledge systems are not yet available for SLMCs, these features will probably be incorporated into future generations of online catalogs. In the meantime, school library media specialists should become acquainted with other educational expert systems designed for various curriculum areas such as Dr. Know (Ventura Educational Systems, Newbury Park, CA), A.I.:An Experience with Artificial Intelligence (Scholastic, N.Y.), World Builder (Silicon Beach Software) and Course Builder (Telebotics Informational).[37]

Neural Networking

A.I.- An Experience with Artificial Intelligence is an expert system whereby the computer learns from student strategies and makes it more difficult for them to pose successful ones. It also illustrates a second type of "smart technology" called neural networking. Neural networks are considered another step in the development of artificial intelligence because they permit computers to solve problems rather than crunch information or data in their usual hierarchical

way. Neural networks employ a series of processors functioning in a fluid, parallel networking architecture that simulates the networks of neurons forming the human brain. Similar to the brain in function, they can recognize patterns of information and delegate various functions to other network parts. They can also "learn" from failure in some aspects of the network.

The rapid development of neural networks has exciting applications for not only artificial intelligence but also for increased use of expert systems, computer-assisted-instruction, and simplifying software. All of these improvements can be expected to positively affect the future programs and services of SLMCs. Nippon Electric, for example, is designing a four-processor neural network PC capable of solving problems, reading text and voice inputs, using expert systems and learning from use patterns.[38] Researchers at Johns Hopkins University, for example, have constructed a neural network that learned to read English by decoding series of printed symbols into words and sentences. The process is similar to the method a human would use to learn to read. Although neural networks are still considered somewhat on the cutting edge, software has already been produced that permits users to install a primitive neural network on a PC for less than $200.[39]

The promise that neural networks hold for capturing visual images, sound and recognizing complex patterns cause some computer experts to envision them as "smart" interfaces for other computers or complicated online systems. Termed "knowledge assistants" or "intellectual robots", they will be stored in portable student PCs and will learn student information-seeking behavior patterns. Once learned, they will shortcut routine tasks and respond to queries and search for information.[40]

Virtual Reality

As researchers continue to search for the "holy grail" of artificial intelligence--namely the ability to simulate the human brain in a computer--they discover other valid learning technologies that are relevant to SLMCs and the educational process. The most futuristic of these is virtual reality.

Virtual reality involves one or more users experiencing a computer-generated simulation. Usually participants don a head-mounted display system that is equipped with stereo LCD video goggles and headphones. The system simulates a three-dimensional visual and aural sensory experience. A tiny transmitter attached to the headgear permits sensors to determine the location of the participant. These signals are relayed to the computer which correspondingly alters the user's point-of-view. Looking in different directions, for example, participants might see a main street in Birmingham, Alabama or in another direction see policemen moving towards them as

protestors did during the 1960's civil rights struggles.

In place of a keyboard that interfaces with the computer, participants move throughout the space by using a dataglove. The glove is attached through fiber optic cable to the computer and is equipped with sensors that react to hand and finger manipulation. Using the glove, users can grasp objects, turn down streets, and by pointing the glove move forward within the computer-generated environment.[41]

Currently virtual reality systems are in a developmental phase for technologies. The MIT (Massachusetts Institute of Technology) Media Lab, the Human Interface Technology Lab at the University of Washington and the Computer Science department at the University of North Carolina are the most frequently cited educational institutions conducting research in this area. AutoDesk and VPL Research, Inc. are two private companies also pursuing work in this field.[42]

Virtual Reality and Education

Researchers in this area envision three main applications for virtual reality in education. The first is "visualization." Virtual reality enables a student to literally see "connections and relationships" that are difficult to picture either as a concept or in a dimensional capacity.

A second application of virtual reality concerns its improved capacity as a simulator of processes, procedures and environments. For years, inflight simulators have been used to train pilots to fly before actually operating expensive airplanes. Virtual reality systems can improve on simulators by increasing sensation and dimensions through a more sophisticated technological approach.

The third application lies with its constructive qualities. At this level, SLMCs house virtual library workstations that enable users to move through a knowledge database comprised of text, sound, diagrams, moving images and three dimensional datafields and objects. Using an electronic tutor or personal digital assistant device to select and save information from the workstations, the students can construct their own virtual reality programs or use the information from the virtual library workstation to solve problems, finish homework or complete research assignments.[43]

Conclusions

School library media centers are at a crossroad. Over the next decade, our institutions will face fundamental technological changes. In an increasingly competitive global economy, it will border on negligence if SLMCs fail to provide electronic information technologies. With improvements in telecommunications, access to multitype networks, declining costs in computers and the availability of fax machines, school media specialists in even the smallest SLMCs should

be able to provide users with some form of expanded access and document delivery.

Never before have SLMCs been so essential to their parent institutions. Our media center programs and service are educationally imperative if schools are to supply students with the skills, training and knowledge they must have to prosper in an electronic world environment.

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