Distance Learning Education Using the Web

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Abstract

This paper discusses the various distance learning techniques for the web. The fundamental concepts of distance learning and relevant technologies, such as videoconferencing, audio conferencing, online courses, web conferencing, and print media are discussed. Implementation examples using Internet for distance education are highlighted thru examples.

1. Introduction

Distance Education (DE) is instructional delivery that does not constrain the student to be physically present in the same location as the instructor. Historically, DE meant correspondence study. Today, audio, video, and computer technologies are more common delivery modes. DE may also be described as planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, instructional techniques, methods of communication by electronic and other technology, as well as organizational and administrative arrangements. It is an innovative development in higher education that uses technology to facilitate learning without the limitations of time or place. Many universities, schools and colleges offer courses online so that students around the world can complete a degree or certificate programs without stepping foot in a classroom. DE students use state-of-the-art technology to connect to faculty members, class fellows, and advisors. The great advantage of DE is that it gives students the flexibility to achieve an appropriate balance of work, family, community, and educational commitments.

Learning takes place in a variety of situations, not all of which are in a face-to-face setting with instructor and learner in the same physical location. DE represents a way for connecting and communicating with geographically dispersed individuals and groups. For example, how can the student who is not proficient in English are given an opportunity to succeed if English as Second Language is not available in the school? As another example, if a school cannot justify an instructor in Advanced Placement Biology for bright students, does that remove the possibility that a student can obtain this type of instruction? Similarly, if a school in a rural or remote area does not have the ability to attract an instructor for Foreign Languages, will the students be then unable to fulfill entry level requirements for a state university?

Some learners may find it difficult to pursue educational advancement in traditional ways. Students, due to special needs such as physical or social boundaries, may not be able to attend a “regular” classroom. Adult learners who face schedule conflicts from career and family responsibilities, or who feel uncomfortable with standard classroom environments, seek different avenues to learn. How do special need students find alternatives? How do adult learners pursue continuing education opportunities that will enrich their lives or open them to career opportunities that are unavailable to them today?

Research continues to highlight the benefit of ongoing professional development for educators and administrators. How can busy professionals continue to grow and develop in their fields without adequate access to the training that will facilitate this critical need? Also, how can instructors design materials to meet the needs of students outside the traditional face-to-face classroom setting?

One of the answers to the needs and questions outlined above lies in the ability to create connections through DE. By uniting instructor and learner with the use of educational media provided through a mixture of delivery modes, a connection can be established to provide a learning opportunity that would not exist otherwise. This connection can be created without the constraints of time or place, and can utilize a variety of modes that will make it accessible to the learner.

Often as a result of limited resources on the part of the educational provider or their remote locations, the learning process may be slower than the regular face-to-face classes, which may result in a frustration for many causing them to quit this type of education altogether. However, with the use of technology, multimedia tools, and carefully planned

study programs with identified learning outcomes prior to the start of course may provide a source of support.

2. DE Techniques

The main philosophy in DE is the flexibility of self-paced learning that is anytime, anywhere but challenging at the same time to keep the participants actively involved in the learning process. Many of the DE students are working professionals who seek opportunities for career advancement through professional development course and degree programs. They do not have much time to explore the technologies that support the learning system. Therefore one of the main requirements of any DE technique is to provide a quality education with simple but outstanding learner support systems including advising, online access to the university libraries, and technical support.

Success in a DE course depends upon students' self-discipline and the ability to learn without face-to-face interaction. Same rigor and high standards as classroom courses can only be maintained by frequent interaction between the students and faculty members either by writing or through videoconferencing. In general, the elements of a typical DE course are:

1) Asynchronous but frequent student and faculty participation
2) Lectures and assignments from textbook and other online resources
3) Individual and group assignments including case studies and discussions
4) Individual and group term papers
5) A comprehensive literature review, especially for graduate students
6) Online library access
7) Online exams, tests and quizzes

The absolute minimum for distant learning nowadays is an access to Internet and World Wide Web via a standard browser, and an active email account. The speed of connection may be important if the education provider rely mainly on videoconferencing. Otherwise, audio conference and written notes may also be sufficient.

It is noted that using one particular technology may provide only some of the DE elements. Thus a successful DE system must include a proper blend of technologies ensuring that most elements are covered. Most successful DE systems use more than one delivery method in a single course. For example, the instructor of an online course may wish to have students meet once a week via an audio conference to discuss an assignment; or a videoconference may be used to combine multiple media such as text and graphics that can be transmitted via a document camera; or Web sites and video tapes can be transmitted and viewed by all students. It has been noticed that blending different technologies together in one course provides an interesting and dynamic learning environment. Some example implementations are presented in this paper illustrating some successful DE systems.

3. Videoconferencing

In this section we focus on videoconferencing as the main technology to support DE system. However, as mentioned above, one technology alone is not sufficient for a successful DE system. Often a blend of technologies provide a more successful and dynamic learning environment for distant learners.

Videoconferencing allows groups of people in different places to see/hear each other and hold interactive meetings. With higher bandwidths available to access the Internet at cheaper prices, videoconference technology is probably the most exciting thing in newer communication systems that is likely to affect our daily life in near future. It is the most powerful tool for business, government, education, entertainment, and many other applications. An interactive multimedia videoconference system can provide a degree of interaction that offers the next best thing to being there.

Early videoconference system utilized large pieces of expensive equipment to provide "room-based" videoconference service. Participants at a site all gather together in a specially equipped conference room around a conference table and watch monitors displaying similar rooms at remote sites. The static nature of this equipment, combined with its cost, makes it a poor vehicle for casual or person-to-person conference.

Desktop videoconference is a newer kind of videoconference system, where participants sit at their own desks in their own offices and call up other participants using their personal computer in a manner much like a telephone. Based on the underlying communications channels, a videoconference system may be LAN-based, WAN-based or an analog telephone line based.

Bandwidth is always the limiting factor associated with communication. Sending video through a communications channel requires a lot of bandwidth. A typical 15" color monitor can display 1024x768 pixels that can be comfortably watched

by a single person. In contrast to computer monitors, a TV set usually has a resolution about 300×400. For a digital line drawing figure, one bit data for 0 and 1 representing light and dark would be enough. In order to display color or gray-scale images, about 256 different colors or gray-scale would be required, thus consuming 8 bit (1 byte) data for each single pixel. Generally speaking, larger number of available colors would be compensated, to some extend, by the inadequate resolution. Since each of the pixels in a frame is corresponding to a byte of information that describes the pixel's color, a frame of 300x200 pixels has 60 Kbytes (480 Kbits) of video information. These are for still pictures. In order to play video, many pictures, or frames, are needed.

Since the human eye is relatively slow with "persistence of vision", it perceives 20 or more sequential, but slightly different still pictures as continuous movement, provided these pictures are displayed in a short period of time (one second). A TV set displays 25 frames per second (fps) in most of Europe and China, and 30 fps in North America and Japan. Experience shows that a user's perception of the quality of video is strongly linked to the frame rate. Say we want to send video that consists of a series of 300x200 pixel frames. This means that in order to send 30 pictures through the communications channel each second, 1.8 Mbps data rate is required, which presents a bottleneck, especially in many WAN environments.

A standard ISDN connection, which is affordable for the desktop, can provide only 128 kilobits per second of data rate. Even though Ethernet can provide 10 Mbps raw speed, which makes Ethernet the popular choice of communications channel used for desktop videoconferencing. However, because of the packet assembling/disassembling, error checking, acknowledgment, and other overhead, the actual data rate in Ethernet is about 1.5 Mbps. Furthermore, Ethernet is a bandwidth sharing network protocol. Like packet-switched circuits, Ethernet has the disadvantage that data packets may not arrive in a timely manner. Typically there are other users who may consume about 70% of the bandwidth so that leaves around 450 Kbps for the videoconference, or less than 1 fps of video, which apparently still does not render good quality videoconference.

In order to make videoconference possible in such an environment, data compression is the only choice. The kinds of compression techniques used in most PC applications are called lossless, which means that if the original data are compressed, transmit/received, and then decompressed, it will end up with exactly the same data. Lossless compression may get a video image down to half its original size—a 2:1 compression ratio, which still isn't good enough.

Lossless compression is critical for software, documents, and critical data transmission and storage, but the compression ratio can hardly get to higher than 5:1. Using lossy compression, in which part (hopefully not critical) of the original data are changed or lost during the compression and decompression. Reasonably acceptable images can be obtained with compression ratios of 5:1 to 10:1 and even higher. Another form of compression is inter-frame compression, which sends a full frame then sends only information about how that frame has changed. Because many elements of the picture, like the background wall, do not change much from frame to frame, adding in inter-frame compression, compression ratios may reach 25:1 or more in typical situations and still maintain a pretty good image. Notice that the more motion in the picture, the harder it is to do inter-frame compression. Audio signal can comfortably be compressed by a factor of 5:1 to 10:1.

The most critical issue regarding compression is its interoperability with other videoconference facilities and how well it operates on a heavily loaded network. Compressed data bear no resemblance to its original form. Both conferencing parties must support the same compression algorithm for interoperability. The ITU/CCITT H.261 is a well-defined and widely recognized video compression algorithm. The device that performs Compression/Decompression is called a codec. A codec, which is an integral part of any videoconference system, also acts as an interface device between the videoconference device and the network.

Compression/decompression is very computation intensive operation. The better the desired compression ratio, the longer the calculation takes. When the compression becomes too complicated, codec, replacing the communications channels, often becomes the bottleneck of the videoconference systems. To achieve the required frame rates, an expensive codec will be needed to handle the task. Otherwise, the computer has to be very powerful to run the software compression/decompress algorithm. The H.261 standard uses a compression scheme that first sends very coarse image information across the channel then it successively refines the picture if enough bandwidth is left over to do so.

Videoconference Standards

Videoconference requires a synchronous deployment of voice, data, and video across a

network, which further requires substantial collaboration of standardization efforts. The following are the common ITU videoconference related standards:

- T.120 is a series of standards for common collaborative tools that regulate how whiteboarding and document sharing applications should interoperate. T.120 addresses a far-ranging set of user needs with a comprehensive set of standards for applications involving "collaborative computing" or "data conferencing". These standards are independent of hardware, network, operating system, and application details.
- H.320, also called Px64 meaning multiples of 64 Kbps, is the established standard for videoconferencing over circuit-switched channels. It provides a standard for the coding, transmission, decoding of audio and video over digital channels, typically over ISDN for videoconferencing-room setups. H.320 is a family of standards that includes H.261 video compression/decompression standard. Built into H.320 is the ability to translate between the NTSC video format used in the United States and Japan, and the PAL video format used in most countries in Europe and China.
- H.323 is the protocol suite that governs moving video and audio channels over a LAN connecting to the larger WAN and Internet environment. It is specifically designed so that H.323-compatible products will communicate with H.320-compatible products through a Gateway Unit—a hardware connection point.
- H.324 is officially titled as Multimedia terminal for low bit-rate visual telephone services over the General Switched Telephone Network (GSTN), or Public Switched Telephone Network (PSTN). H.324 is an ITU recommended standard family for modems designed to handle point-to-point multimedia data over analog telephone lines. H.324-compliant products are delivered in a range of formats, including standalone videophones and TV-based videophones, where the TV is used as a display device. Since H.324 is an umbrella of standards, it establishes standards for audio, video, and data communications, as well as procedures for call set-up and control by using other ITU Recommendations. On a desktop PC, meeting the H.324 specification requires at least a 28,800 bps V.34 modem that also meets the V.80 (video-ready) standard. Audio quality should meet telephone standards.

H.320 is the ITU-T standard for videoconferencing aimed to define the minimum requirements all videoconferencing systems must support in a wide area network (WAN) environment. This minimum requirement ensures that all the H.320 standard-compliant systems will communicate with each other. The differences in the systems are the optional requirements the systems support. These optional requirements affect the quality of the audio and video. How well and which ones are implemented are left to the system designers and manufacturers. Many videoconference operations involve calls with more than two parties. H.324 supports multipoint calls by having H.324 terminals connect through multipoint control units (MCUs). The H.324 recommendations specify methods for multipoint rate matching and synchronization. Figure 1 compares the major ITU conferencing standards.

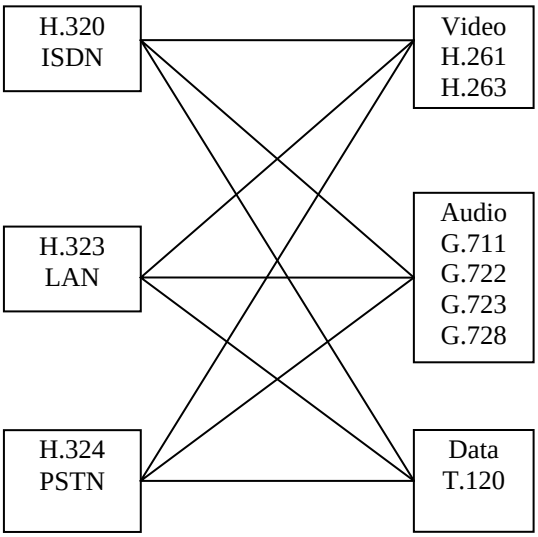

Figure 1: ITU Conferencing standards for video, audio, and data in WAN, LAN and public telephone network system.

The performance of a videoconferencing product is judged by the quality, speed, and continuity of the video and audio it presents. The factors that affect the system quality are:

- **Picture Resolution**, which is critical to the quality of the picture. There are two types of resolutions: Common Intermediate Format (CIF) with resolution 352x288 and Quarter Common Intermediate Format (QCIF) with a quarter the resolution of CIF (176 x 144). CIF is also occasionally referred to as FCIF -- Full CIF.
- **Frame Rate**, also referred to as the Number of Frames Per Second (fps), is the number of times the picture image is refreshed. H.320 systems

can support frame rates of 7.5, 10, 15, or 30 fps. A low frame rate causes the motion to appear flickering. The higher the frame rate, the smoother the motion will be.

- **Pre-processing** is a complex process that reduces the amount of re-coding the background. If pre-processing is not used the video encoder may spend lengthy time encoding noise caused by the poor lighting of the camera, fooling the system to think that there is motion in the background when in fact there is none. Pre-processing ensures that only real motion gets encoded.
- **Post-processing** can compensate for picture degradation caused by fast motion. It may reduce the blocking and noisy effects caused by H.320 video codecs. Post-processing can also be used to enhance the frame rate and reduce the flickering motion effect caused by low frame rates.
- **Motion Compensation** is performed at both the encoder and the decoder. Essentially, motion compensation only encodes the moving block rather than encoding the entire video area for every frame. This is especially important at lower bit rates. Motion estimation is performed at the encoder to determine what the motion vector should be. All H.320 systems must have the ability to decode a motion compensation signal. The encode ability is where video quality improvements are made, which is optional.
- **Audio quality**: H.320 specifies three types of audio:
  1 48 - 64 Kbps Narrowband
  2 48 - 64 Kbps Wideband
  3 16 Kbps Narrowband

4. Some DE Implementations

We discuss three DE implementations as examples in this section. The first is a CMS, typical examples of which include Blackboard and WebCT.

Course Management Systems

These commercial products are available to the universities and usually require some training before their usage, especially if it is desirable to utilize the full potentials of these tools. One such product, Blackboard (http://blackboard.com), also called as "The Blackboard Learning System" features:

- Curriculum-driven content management and content sharing
- Assessment management system including Gradebook maintenance
- Electronic management of the collection and organization of assignments via the integrated Gradebook interface
- Discussion boards and Virtual Classroom tool enabling collaboration and communication in the learning environment
- Data management for integration with student information, identity management and authentication systems

A typical course screen in Blackboard can be used to manage a course via buttons. The students' and teachers' screen are similar except the "Control Panel" does not appear in students' screen. The control panel allows the instructor(s) to manage the contents, the gradebook, assessment, course tools and options, using an interface with a variety of choices. The course tools allow the collaboration of students in teams to work on a project, for example. In addition, discussion boards and message postings facilities are available. Among other interesting features are chalk board discussions with instantaneous screen capture to be shared among the participants, email tool for sending group emails, and announcements for broadcasting the timely and relevant messages to the class.

Course Online System

The Course Online (CoL) system is a modification of CMS tailored to include some special features related to the institution where it is implemented (for instance Depaul University). Most of the features are similar to the Blackboard system except that most frequently accessed features are made available thru a drop down menu on the main screen. In addition, there is an option on the left menu bar to view the video recording of lectures with synchronized PowerPoint presentations and whiteboard display. While this feature is bandwidth intensive but given a high speed Internet connection provides a true classroom environment.

The control panel works very much similar to Blackboard, which provides tools for course administration, content management, grading, discussion, email and group management.

WebTycho System

This system implemented at University of Maryland University College (UMUC) highlights a complete DE system that can be used successfully by the students with a low bandwidth connection. However, it requires strong self discipline for interacting regularly via the non-interactive web conferences. So the users do not logon

simultaneously to chat with each other rather they participate in the conference by posting messages in different sections of the course.

While the menu in WebTycho system is quite similar to the CoL system described above except that it does not have bandwidth intensive "View Lectures" portion. Each one of the item on the menu may be expanded to see the details, which include postings by the instructor, responses by the students and follow on discussions on the topic. In this approach instructor has an important responsibility to manage the contents and focus the discussions. For instance, he/she will discourage students to do any discussions in the "Reserved Readings" sections since it is meant to include a list of references for the course. While specific focus groups may discuss their views in one specific area, most course related discussions and class topic presentations are done only in the Conferences section.

5. Conclusions

We have investigated the DE technologies available to conduct a successful online teaching. Video, audio, web and other types of online conferencing technologies have been discussed and contrasted with traditional print media or correspondence courses. The positive impact of technology to provide education anytime anywhere is discussed with emphasis on available videoconferencing technologies and standards.

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