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The Internet-Based Lecture: Converging Teaching and Technology

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Abstract

Network-based distributed education is a reality today. At George Mason University, we have been pursuing a capability beyond the widespread practice of supporting courses with webpages: delivering lectures and seminars in real time, over the Internet. This paper describes the range of distributed education technologies available today, focusing on issues of instructor presentation, student participation, and temporal qualities of response to student questions. The analysis supports our selection of desktop audiographics for synchronous Internet-based course delivery. Courses that have been presented in this mode are described, along with factors influencing their success and factors in student participation.

1 Introduction

We stand at the beginning of a period of major growth in network-based teaching. Portions of the Internet now are capable of supporting synchronous, real-time communication between instructor and students or, better yet, among a group of students distributed over the network. Thus it is possible to project the most traditional function of university faculty to geographically dispersed students. In our region, ready availability of powerful Internet connections at home and office, combined with the increasing cost and frustration of commuting, imply that distributed education can, should, and will become one of the dominant modes of teaching.

I teach the technologies of computer networking and the distributed computer applications enabled by those networks. Moreover, I use computer networks and distributed applications to teach, so there is a very happy synergy between what I am teaching and the future of higher education. I have sought, with some success, to combine research in distributed teaching technologies with use of those technologies to pioneer Internet-based teaching. Many of my colleagues provide their students Web-based materials for self-study. I do this too, but my approach offers a richer learning opportunity beyond web pages. In its most effective form it involves a group of students at home or office participating in my class remotely via the Internet, able to hear my presentation, see supporting graphics as I present them, make their own presentations, ask questions, and receive immediate answers. These pilot distributed education classes are intended to meet the needs of my students while at the same time advancing the ability of my university and the teaching profession as a whole to function more effectively.

This paper is intended as a report to the Computer Science teaching community on recent advances in synchronous online teaching and their implications for course delivery. A fundamental assumption associated with our emphasis on the synchronous mode is that, to be most effective, teaching by humans requires real-time two-way communication between instructor and student. Other forms of Internet-based education with slower feedback, rightfully described as “distance learning,” may be quite valid educationally but do not provide the capabilities for lecture and seminar that can be obtained with real-time two-way communication.

2 Dimensions of Online Teaching

The area of synchronous Internet-based education is sufficiently new that no generally accepted framework for discussion exists. This section will therefore describe the range of alternatives to which the results described here might apply, in two different dimensions: presentation media, and the temporal dimension of response from students.

2.1 Context

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The basic context for these descriptions will be the online equivalent of lecture classes, where the instructor presents material and responds to questions. Often criticized as "the least effective form of teaching," lecturing remains a cornerstone of the educational establishment. Despite the criticisms, lecture remains an invaluable mechanism to provide students with an introductory understanding of a new discipline. It has the advantages that it focuses student attention, provides for delivery in the most current context and idiom, and represents an efficient use of student and teacher time.

For more advanced students, the online lecture context can be expanded to a seminar, an informal presentation with considerable student participation. When students are well prepared for a seminar, the role of the instructor can be limited to steering the discussion into the most fruitful avenues and serving as an expert to answer questions. Conducting online lectures and seminars effectively requires an environment that supports multiway communication.

2.2 Presentation and Participation Media

The online environment offers a significant range of media.

Text: This is the most basic form of computer communication. My colleague E. Norris has conducted several full courses in a Multi-User Virtual Environment or MUVE [7], groupware that offers a shared virtual space based entirely on shared text communication.

Audio: While text "chat" can facilitate discussion among a distributed group, we have not found it to be an acceptable substitute for the spoken word. Many students are auditory learners. An audio component is, therefore, a cornerstone of distributed education.

Static graphics: Other students are visual learners, and all can benefit from having information presented in more than one form. The ability to display graphics with diagrams and a variety of text fonts is essential to the teaching environment.

Graphic annotation: Graphics are made much more compelling if they can be annotated in real time in a way that is visible to all participants. This annotation might be used to add missing information, but often its function is simply to highlight the static graphic, drawing the student's attention to particular points.

Motion video: It seems there is an inevitable link in the minds of educators between video and teleteaching. In point of fact, a much better application for video in teaching is playback of recorded material to illustrate the lecture. Experience in my courses has shown little value in "talking head" video [5].

Immersion: Technology is available today to generate highly realistic virtual worlds that can be shared over the Internet [4]. High-resolution graphics, potentially in surround mode, can be coupled with computer graphics and networked virtual reality software to display the same views at multiple locations, where the actions of one participant are immediately evident to all others.

In principle, any of these media could be used to communicate among the students in addition to supporting communication between instructor and students. In practice, channels among students, and from student back to instructor, often are more limited than those from instructor to students. Also, most Internet service does not yet offer adequate quality of service (QoS) to deliver real-time motion video and immersion. Figure 1 shows the space defined by the media described above, when both instructor presentation and student participation are considered. The issues in choosing appropriate media for lectures and seminars are (1) whether the available media are rich enough to support effective teaching and learning, and (2) whether they are affordable in the Internet.

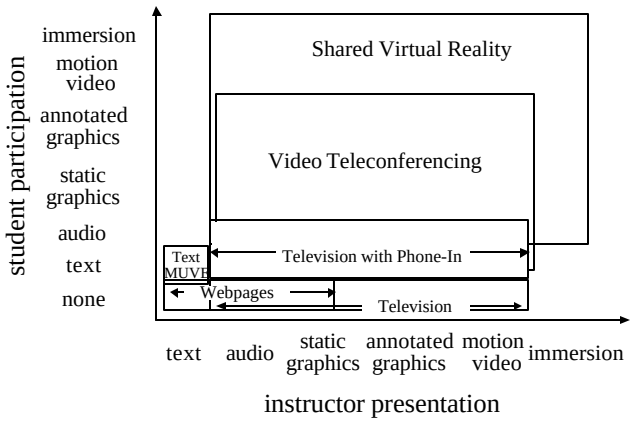

Figure 1. Tele-education Space

2.3 New Multimedia Systems for Teaching

The nature of Internet communication has led to two new systems that support distributed education online, as shown in Figure 2:

Webcasting: uses a World-Wide-Web (WWW) browser with custom "plug-in" software. The student can receive static graphics plus streaming audio and video. Major educational programs using webcasting are underway at institutions such as Stanford University (http://stanford-online.stanford.edu) and the University of California at Berkeley (http://bmrc.berkeley.edu). Streaming audio and video deal with the Internet QoS problem by buffering a significant amount of the data stream (typically at least 30

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seconds worth) to avoid gaps due to stalls in network delivery.

Desktop audiographics: also uses a Web browser and plug-in, but communicates audio using Internet telephony (real time audio) and provides real-time annotations over pre-loaded static graphics. It deals with the QoS problem by operating at a low data rate that can, if necessary, be supported by dialup connection to a facility with adequate network capacity. As a result it can support a truly synchronous lecture or seminar. Currently we are using the ClassWise™ desktop audiographic system [3], which has the additional feature that its classes can be recorded for asynchronous playback. It is being extended to provide the multi-user voice system described in [6], which will allow it to support online seminars as well as lectures.

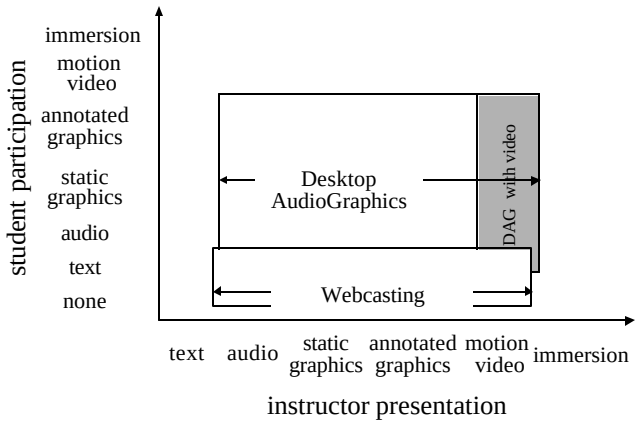

Figure 2.- New Multimedia Systems in Tele-Education

2.4 Temporal Aspects of Student Interaction

The need for effective interaction leads us to consider the temporal aspect communication among instructor and students. Feedback need not be prompt to be effective, however there is a qualitative difference between a response provided in 10 seconds and one provided in 10 minutes or 10 hours. In order to provide the quality of instruction associated with classroom lectures, it is important to support the immediate feedback associated with the lecture environment. Figure 3 compares the various systems available for distributed education on a scale of four possible response times:

- Real time: response in a conversational mode.
- Quick response: replies in less than one minute, typical of holding up a hand and waiting to be called on.
- Moderate response: replies within a few minutes, delayed due to queueing of phone calls or streaming media.
- Slow response: reply must wait on asynchronous participation, typical of electronic mail.

The range of response options shown for desktop audiographics in Figure 3 is associated with the range of media available: real time for spoken questions, quick response for text questions, and moderate response where streaming audio and video are in use. The use of streaming media causes a delay in delivery to the student which means questions will arrive up to a few minutes after the aspect of the presentation that elicited the question. This underscores the relative benefit of desktop audiographics for Internet-based lectures and seminars, and is one reason why we have selected this mode to support our classes.

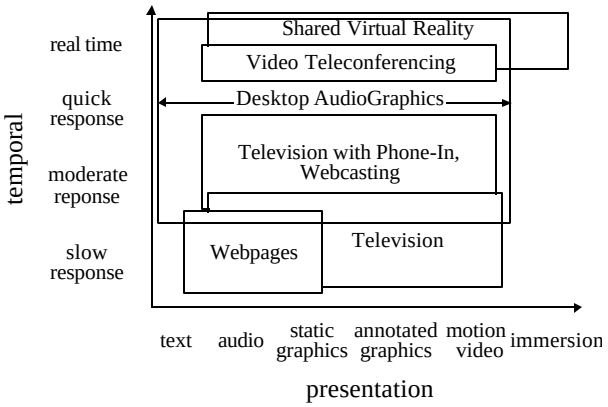

Figure 3.- Temporal Aspects of Presentation Systems

3 Experience With Online Lectures

At George Mason University we have employed Internet lectures and seminars in a variety of courses.

3.1 Internet Literacy Courses

Beginning with the MBone multimedia technology suite [2], we developed an approach to teaching Internet literacy over the Internet [1, 3]. The MBone suite consists of multi-site audio, video, and shared graphic whiteboard. Our initial experiments led to the conclusion that, in order to be practical, a system for synchronous Internet teaching must consume much less network capacity than the 100kbps (or more) required by the MBone tools. We also concluded that video offers low payoff as a medium for teaching technical subjects, because the important content is in the audio and graphics. These conclusions led to development of the ClassWise desktop audiographic teaching system, which is capable of operating at modem rates (under 28 kbps).

3.2 Introductory Networking Courses

I have taught by Internet lectures for a total of five semesters in Undergraduate and Master's level Computer Networking courses. These courses are presented to a live class (up to 30 students) using ClassWise on a Xerox

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LiveBoard, which is a 48-inch-diagonal rear-screen display with integrated sensor screen that supports drawing pens. They generally are well received by students. Typically one to three students will opt to attend from home or office, while several more will use the asynchronous playback during the semester to make up classes they miss due to work. The system is more popular with Master's students than it is with undergraduates. Details are provided in [3].

3.3 Graduate-Level Seminar Course

The LiveBoard arrangement described above also was used for a graduate seminar course that I taught in Performance Evaluation of Computer Networks. The sessions in this course involved more interaction between the instructor and students, and among the students. Two students participated at a remote campus and others used remote desktop systems occasionally. All students were required to make presentations to the class twice during the course. They used ClassWise just as the instructor did, with equal success. One negative factor arose from the fact that the remote students could hear the instructor but could not hear discussions among the local students. As a result they expressed significantly lower satisfaction with the course than the local students. (We have since provided microphones for the local students.)

3.4 Internet-Delivered Professional Education

We have developed a professional education course consisting of eight modules, each with four lessons two hours long (see http://netlab.gmu.edu/nec). We presented the initial pilot for this course synchronously. The instructor sat at a workstation and annotated the slides using a graphics tablet. Following the synchronous pilot course, it proved impossible to attract a full class of synchronous students due to the fact that our target student population all work long hours. They preferred to take the course asynchronously from a server, underscoring the value of the recording option.

3.5 Role of Asynchronous Media

Please note also that the enthusiasm for synchronous distributed education reflected here does not mean that we shun asynchronous media. Each of our synchronous Internet-based courses was supported with Web pages and electronic mail.

3.6 Student Personality Issues

We have not completely come to grips with the issue of why some students prefer synchronous delivery, others prefer asynchronous delivery, and many prefer to attend class in person when possible. Clearly, part of the phenomenon is due to the busy schedules associated with hectic life in high-technology Northern Virginia. Some students deal with work demands (including travel) by using asynchronous delivery to time-shift classes. Others save commuting time, which can be up to two hours round-trip, by receiving classes on their home or office desktops. However, my observation is that there is also an issue of learning style involved. One our first MBone students reported that he saved no time or travel by not attending class in person, but he found he was more comfortable at the workstation because it delivered class without the distractions he experienced in the classroom. Our sample population of students is still too small to allow generalization. However, it is clear that a small fraction of students actually prefer Internet class delivery to in-person attendance. I suspect that these are students who are easily distracted and therefore find the desktop class environment beneficial.

4 The Future of Internet-Based Lecture

Whether due to avoiding commuting, time-shifting classes, or student preference, there is little doubt that demand for distributed education will continue to grow. The generation of students now in high school has grown up online. As they reach college and beyond, we can expect more telestudents in our curriculum. At a minimum, this will involve more telementoring, principally via email. However, the same reasons that see lecture in widespread use today can be expected to fuel demand for telelectures in the future. The viability of audiographic desktop distance education has been demonstrated. I believe the Computer Science education community should be among the first to embrace the potential of this new approach.

References

[1] Bordeaux, A., D. Sprague, J. M. Pullen and D. Sterling, "Taming the Electronic Frontier: A Distance Education Course for Defense Dependents School Teachers," *The Journal of Computing in Teacher Education*, Vol. 14 No. 3, Spring 1998

[2] Macedonia, M. and D. Brutzman, 'Mbone Provides Audio and Video Across the Internet," *IEEE Computer*, April 1994

[3] Pullen, J.M. and M. Benson, "ClassWise: Synchronous Internet Desktop Education," *IEEE Transactions on Education* multimedia CDROM issue, November 1999

[4] Pullen, J. M., "Networking for Distributed Virtual Simulation," *Computer Networks and ISDN Systems Journal*, Vol. 27, 1994, Elsevier North-Holland

[5] Pullen, J. M., "Synchronous Distance Education and the Internet," Internet Society Annual Conference 1998, Geneva, Switzerland, July 1998

[6] Pullen, J. M. and H. Nah, "A Multi-User Virtual Environment With Extensible User-Friendly Web-

Based Interfaces," *Proceedings of the 1999 Western Simulation Multi-Conference*, Society for Computer Simulation, San Diego, CA, Vol. 31, January 1999

[7] Pullen, J. M. and E. Norris, "Using A Multi-User Virtual Environment As A Synchronous Teaching Tool," *Proceedings of the 1998 Western Simulation Multi-Conference*, Society for Computer Simulation San Diego, CA, Vol 30, January 1998