Key Elements in Effective E-Learning – Examples in Engineering Education

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Abstract: The traditional lecture has endured for generations as the major teaching methodology for face-to-face learning and instructors and students alike have become accustomed to this format of teaching and learning. Though one-directional non-interactive lectures can be monotonous and of limited learning value, there is much that can be done by the instructor, to involve students in the learning process to facilitate greater learning and retention of the material being discussed. Indeed many educators have espoused an active and collaborative learning model for classroom instruction. In this paper we explore the mechanisms enabled by a multimedia Asynchronous Learning Networks (ALN) methodology to foster effective teaching and learning with the use of streaming or real-time 'lectures' as a major component. We show how traditional on campus classes can benefit from using multimedia ALNs as a complement to ongoing in class activities using online simulations as well as electronic discussion and conferencing tools. In addition we will also show how these same methods can be adapted for use in distance education while enabling a great degree of student to student and student to instructor interactivity.

Keywords: Education, Distance Learning, Online, Lectures on Demand, Asynchronous Learning Networks

1.0 Introduction and Motivation

Online courses and online degree programs are becoming more and more fashionable in this age when information technology permeates almost every aspect of human living. The convenience of being able to take courses at any time and from any place has proven to be very attractive for students who for a variety of very valid reasons cannot attend conventional classes. And even for those who participate in on-campus programs, it is convenient from time to time to be able to access online class material, which may have been missed due to unplanned conflicts.

With the advent of the world-wide-web (WWW) as a convenient and powerful repository of multimedia information of all types, both traditional on-campus education and distance learning now have modern mechanisms for conveying information in digital form, obviating the need to transmit actual paper or magnetic media, as was required in early forms of 'distance learning'. Now what needs to be done is to extract the information content and transmit this electronically to remote users in real-time or archived for asynchronous access, while at the same time enabling interactivity and communication among students and with the instructor.

A first step in this direction would be to put traditional textual and image-based learning materials online. However, while reading and self-study assignments may be completed as part of the online learning experience, we believe that an effective e-Leaning environment should also manifest the time-tested characteristics of traditional face-to-face learning. The physical presence can be exploited for almost infinite modes of communication if exploited to its maximal capacity in interactive and collaborative learning.

In this paper we advocate the use of a technique which we have called *"Lectures on Demand in Asynchronous Learning Networks (ALNs)"* [1] which represents an innovative use of multimedia technology for both traditional and distance education. We believe that this methodology captures and enhances the best facets of effective conventional learning environments using the communication facilities made possible by the Internet and the World Wide Web. A traditional classroom paradigm is used in this scheme to present the student with video and audio of a high quality classroom lecture or discussion with a cohort of on-campus student making up a live audience. The material which is presented to the students in the live classroom – whether written on chalk or white boards, or projected from transparencies or computer screens – is re-generated as high quality text, graphics and animation and

presented to the online student. A key feature is that the supporting class material are time and topic synchronized with the streaming audio and video so that as soon as new topic is being discussed the textual and graphical class materials are advanced automatically accordingly in the student's WWW browser. In addition the student can navigate the lecture in a non-linear fashion without the need to listen to or 'watch' the entire lecture. A particular student may wish for example to proceed directly to a certain module or topic to get answers to specific questions or to clarify a certain issue. In addition to the 'technology-enhanced' lecture or module, the student also has access to other online class resources as well as the ALN – a network of colleagues and learning facilitators who are immediately accessible via electronic communication links such as mailing lists or bulletin boards.

2.0 The Asynchronous Learning Networks (ALN) Framework

As suggested by the term **Asynchronous**, ALNs cater largely to learners who are not at the same place or at the same time as each other or with the instructor, yet effective **Learning** is facilitated by the ALN. While it is tempting to imagine that the **Network** in ALN has reference to the underlying communication network of interconnected computers, the important network in ALNs is rather the network or community of learners who interact at their our time and location. Of course the basic idea of learning asynchronously has been around for quite some time. Clearly learning is asynchronous when one learns from books, audiotapes and videotapes. However, the idea of coupling independent learners separated by distance and time constraints has been much more feasible in the past decade with the emergence of Internet-based communication technologies. Now instead of sending the physical media (such as printed material, magnetic or optical media) through regular mail or courier services, it is now merely necessary to send the digital content appropriately encoded to the user. In addition the learner can now have access to a network of fellow students via E-mail, mailing lists, bulletin boards and electronic conferencing systems. The World Wide Web has truly revolutionized student access from any place and at any time to a wealth of multimedia information sources, which can greatly enhance the learning process.

The combination of convenient and appealing content delivery with seamless and easy to use interactive mechanisms for collaboration and mentoring using online communication tools, enable ALNs to mimic some important aspects of ideal learning environments – such as found for example in the early learning experiences of infants and kindergartners. We find that collaborative, active learning and discovery of new information – teaching yourself, and teaching as well as learning from others – are key characteristics of this very successful teaching/learning environment. It must however be admitted that both instructors and students alike have become very comfortable with the non-interactive one way transmission information transfer – with limited feedback, mostly in periodic written examinations. In these settings, the instructor appears to be a 'sage on the stage' expounding gospel truths to a passive audience. On the other hand, in an active learning environment, the teacher is more of a 'guide by the side' – encouraging and exciting the students with the thrill of discovery. Our intent is not to promote the replacement of conventional face-to-face teaching and learning with ALNs. Rather, we argue that that ALNs, when well designed, can in fact replicate many of the desirable features of effective face-to-face learning in promoting and facilitating interaction between students and with the instructor by more convenient and often more acceptable asynchronous means.

We firmly believe that the first choice for learning now and in the foreseeable future will be the traditional method: attending a great institution of learning, with erudite professors and dedicated graduate and undergraduate students studying and conducting research under the watchful eyes of these academic sages. Nonetheless, it is clear that ALNs can be used as an appropriate complement for such traditional on-campus classes. On the other hand for that significant segment of the population who cannot attend face-to-face lectures and on-campus programs, ALNs provide a vastly superior learning experience than study-it-yourself distance education. For example, ALNs provide for immediate feedback on online quizzes, online shared calendar of events, a WWW home page for each student, customized search and study tools, access to grades and progress reports, online assignment submissions. In addition, online WWW resources, course syllabi, class materials, assignments and problem solutions as well as access to an online community of peers and instructors make for a very desirable learning environment. Indeed such features in ALNs as bulletin boards and mailing lists which archive the discussion threads, or more sophisticated electronic conferencing systems and chat systems serve to build an interactive community of learners which looks very much like the active and collaborative learning scenario we painted earlier.

In the next section we describe various considerations in the integration under the ALN umbrella of audio and video from traditional lecture style classes, now repackaged for online course delivery.

3.0 Capturing the Lecture – Audio and Video considerations

At the University of Florida we benefited from the existence of the Florida Engineering Education Delivery System (FEEDS) [2], especially in the development of the MS online degree program. Many of our graduate courses were already being delivered to off-campus corporate sites via videotapes made specially instrumented classrooms. The Instructor teaches to a live class of 10-70 on-campus students using overhead slide projectors, computer-based PowerPoint slides, the chalk board or using a device that allows material written on a writing pad to be projected onto a screen. The instructor also has access to an Internet-connected multimedia computer in the FEEDS studio, which facilitates online demonstrations and the use of computer-based simulations. To facilitate video recording, the information from these multiple sources are integrated onto a single television channel which is projected onto multiple TV monitors in the studio (for in-class student viewing) and is recorded on high quality video tape recording equipment.

The instructor wears a wireless microphone to provide a high quality audio signal and there is also a set of microphones in the classroom to pickup student questions. A single control technician operates the equipment in each studio and is mainly responsible for switching video and audio inputs as needed during the lecture. It should be noted that in most of the studios, the main camera automatically tracks the Instructor by using a beacon associated with the microphone hardware. In other cases an operator must manually control the pan tilt and zoom of the camera as necessary. To avoid feedback the classroom microphones are turned off (or attenuated) when the Instructor is lecturing and the instructor's wireless microphone is attenuated when a student question is being asked. It is very important that both the audio and video which is captured on the camera and subsequently on video tape is of high enough quality to be useful when viewed on traditional video tape players. This criterion will assure a good baseline quality of the digitized and compressed video also. If one is only interested in audio (as is the case for quite effective streaming audio-only media presentations), then it is good to invest in a high quality microphone system to provide the best possible signal.

Obviously access to the professional FEEDS studio was quite an advantage and contributed greatly to the initial success of our online programs. However, even in a traditional classroom, it is possible to use a consumer grade camcorder with an amateur operator, to capture adequate quality video and audio to facilitate the Lectures on Demand process. Our experience with this less sophisticated method has produced reasonable results, although caution has to be exercised in mitigating acoustic echo problems. An inexpensive wireless microphone with direct input to the audio input of the camcorder results in substantial improvements in audio quality. In addition most modern camcorders feature several attractive capabilities which can be used to good effect in video capture of the in class instructor presentation.

3.1 Live and Archived Streaming Media

An example of a RealNetworks [3] streaming video for a typical FEEDS originated lecture is shown in Figure 1. This is what a student who joins the live class would see – essentially a 'digital footage' of the in-class lecture. Note that while the audio is of superior quality when compared with toll-quality speech, the video operates at 1-5 fps (at a total data rate of about 20 kbps), and so motion is somewhat 'jerky'. Nonetheless, the online video is of usable quality for educational purposes in most cases.

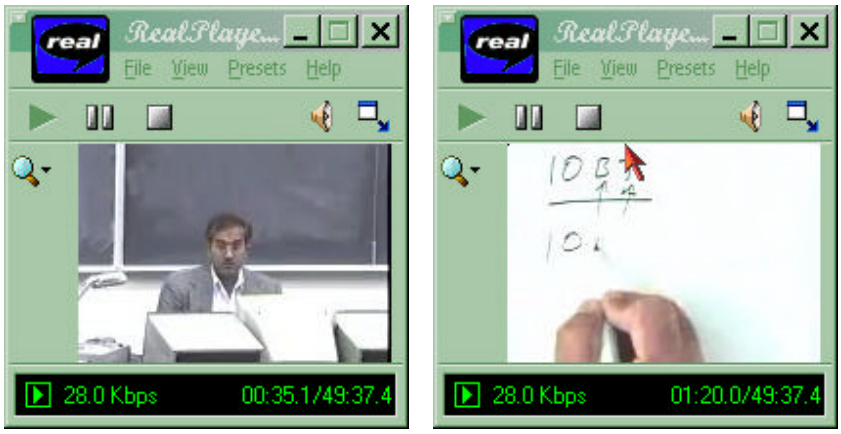

Figure 1 Online Lecture – as seen in real-time by remote students

In this next section we describe a post-processing step which converts the basic digital video stream into a synchronized multimedia presentation suitable for integration into the ALN paradigm.

Apart from the novelty factor, a digital video window on a computer screen on its own would be unlikely to fare in terms of educational value and impact than the use of television in education. The first step in generating a truly effective learning environment is to realize that the video content is supplemental to many other learning facilities in the ALN offering. There are course readings, WWW sites with lecture notes or other relevant material as well as online interactive forums for electronic conferencing. So it is desirable to integrate the streaming video and audio with these other ALN material. When taking together, the streaming video and audio – the lecture on demand – can be the focus of the ALN activities or it could be just one of several components to aid in asynchronous learning.

Figure 2 shows an example of an streaming audio and video window inset with synchronized PowerPoint slides in the larger window in the foreground, as well as an alternative format using frames. Note that while the slides advance automatically as the lecture progresses, the student still maintains control. Not only can he or she pause, advance, rewind, stop or restart the streaming presentation, but it is also possible to navigate among the slides by using the forward and reverse buttons. In addition having the streaming video as an independent window allows the student to move, resize or even minimize the video window at will. In particular if the video content at a certain point of the lecture is not particularly beneficial, the student can place the video window in the background and concentrate on other learning components – such as voice explanations or the PowerPoint slides.

4.0 Lectures on Demand in ALN – Putting it All Together

It must be recalled that the synchronized streaming video and audio constitute only one component of the ALN course delivery environment. Indeed depending on the focus of the instructor and the instructional designer, the synchronized online lecture may not even be the central element of the course as is the case with a traditional face to face class. Rather the lectures on the demand feature provides a connection to the on campus experience in a way hitherto not possible for online students or for students at a distance.

With this in mind it is now possible to integrate the lecture and synchronized class materials with the ALN resources that have been designed to facilitate a community of online collaborating learners. At the University of Florida we initially experimented with a home grown ALN interface to provide conferencing and discussion lists. We used a *majordomo* mailing list server to which each class member would subscribe at the beginning of the class (with no further instructor intervention) as well as a *hypermail* interface which archives the mailing list and sorts the discussion by subject and date. We also used a *perl* script-based tool, *webchat,* for online ‘ live’ discussions.

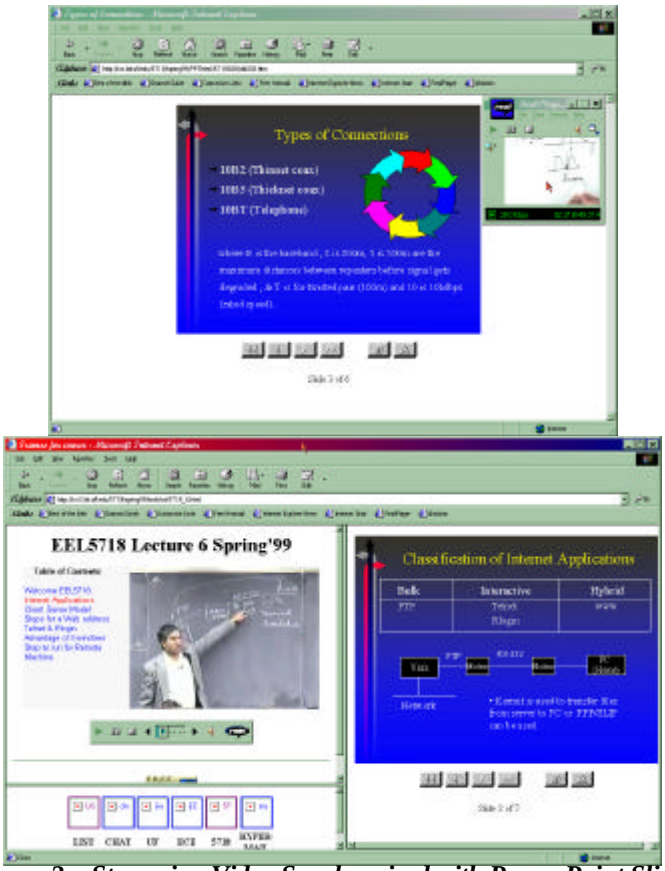

Figure 2 – Streaming Video Synchronized with Power Point Slides

In recent times, commercial off-the-shelf products provide these capabilities and we have elected to use the WebCT [4] course management system in our program, with good success.

7.0 Conclusion

Our online educational program is still in its infancy. However, we have learned a great deal about the complex technological, administrative and stakeholder issues involved in this endeavor. Our experience thus far has been very positive. The Lectures on Demand approach is being used to deliver complete MS degrees in Electrical and Computer Engineering (ECE) Several courses are currently available online and others are presently being developed. Students must satisfy all regular UF MS admission requirements and then they can take the online Lectures on Demand courses during the semester that the courses are being offered on campus. The online students have a well-defined window (1-2 weeks) within which to complete segments of the course including assignments and reports. Students may also obtain certificates in certain specified areas such as in Networks or Database Systems or Operating Systems

We have also begun to explore the possibility of developing and offering courses towards a BSEE degree. Of course in this latter case the challenges are even more difficult since the BS degree requires hands-on laboratory experience as well as some courses not offered in the ECE department. Another major concern that is the topic of current investigation is evaluation and assessment of this online teaching/learning environment. We have some encouraging initial results, but much more work remains to be done in this area.

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