LECTURES ON DEMAND IN ALN: ENHANCING THE ONLINE LEARNING EXPERIENCE

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ABSTRACT

It is now well known that asynchronous learning networks (ALNs) provide effective mechanisms for facilitating interaction within learning communities in which the learners are separated by distance or time constraints. However, despite the infrastructure and tools which make ALNs so successful, questions have been raised about the time and effort required on the part of instructors to generate effective ALN course materials. In this paper we address these and other concerns in the use of ALN and propose the use of a "*Lectures-on-Demand*" methodology to allow ALN students access to the actual classroom experience. The Lectures-on-Demand method incorporates the spoken word, spontaneously written material and other facets of natural human communication into the ALN infrastructure. This approach allows students to 'attend' regular classes in real time via the Internet, as well as to have asynchronous access to digitally stored video material with hyperlinks to online training resources at any time. The paper discusses the technical requirements from the user and provider perspectives and describes ongoing efforts at the University of Florida where an online MS degree in Electrical Engineering is now being offered using the Lectures on Demand approach and online courses toward a BS in Electrical Engineering are presently being developed with the same tools.

KEYWORDS

Online Education, Lectures on Demand, Streaming Media

I. INTRODUCTION

The traditional model of a learned instructor at the same *place* and at the same *time* with her eager students, is the model on which much of the modern educational systems are built — and it is not our intention to challenge the effectiveness of this age-old learning model. It is however an unfortunate fact that in many face-to-face learning environments instructors and almost all students have become comfortable with one-directional lectures and in this case the quality of the educational experience of a student watching a lecture remotely is almost identical to that of the student being physically present. Thus it is often up to the learned 'sage on the stage' to choose the material to be discussed, and to present it in such a manner that the various learning styles of

the students are accommodated as well as to ensure that the pace and level of sophistication of the presentation is adequate for typical intended audiences. With no feedback from, or interaction with the students, the instructor operates virtually in open-loop and often is not sure if effective learning is taking place until exams are administered

II. SYNCHRONOUS LEARNING NETWORKS: A NEOCLASSICAL CHARACTERIZATION OF TRADITIONAL LEARNING

On the other hand, many well-respected researchers and practitioners concur that effective learning takes place more readily in an active and collaborative environment in which the students learn by discovery and interaction with each other. In anticipation of the material to be discussed later, namely Lectures on Demand in Asynchronous Learning Networks, we characterize this traditional instructional model as an example of a *Synchronous Learning Network*. In this mode, the instructor is able to guide the students to learn new concepts using multi-way interactions, illustrating and connecting new ideas with examples and concepts, which are already known from common experience.

In this regard it is worth commenting that the things learned by active experimentation and discovery are known to be better retained and more useful than ideas simply taught in a straight lecture. This is well illustrated by the tremendous learning that takes place in the kindergarten settings where shapes and colors and other fundamental concepts are discovered and learned and retained for life. (Of course it may be argued that the rate of learning in the early years is highly influenced by the physical rate of growth of the brain at this stage of life, but the point still bears reflection – learning by doing and collaboration is more stimulating and enhances retention.)

It is not at all surprising then that the students consistently evaluate as being a superior learning experience classes in which they were involved in the learning experience, and in which instructors demonstrate the context and applications of the material, making careful connections with previously acquired facts, and presenting practical challenges. And though many students are initially resistant to class-time interactions, being much more comfortable simply to sit and be lectured to, once a congenial and relaxed atmosphere can be created, they actually do enjoy class-time participation. Initially, they enjoy other students asking questions since often these are the same questions that most students have and thus all benefit from the ensuing discussions. It takes delicate skill and balance for an instructor to gradually engage more and more students in class-time discussions. It is often woefully inadequate to simply ask, "Are there any questions?" since you are likely to get the easiest answer, "No!" On the contrary, experienced instructors find it beneficial to pose questions to the class and solicit direct responses and discussion of seeming paradoxes or controversial material.

The synchronous learning network is also manifested in effective strategies which allow collaboration among students in the classroom – small groups of students working together on a problem, coming to a consensus or discussing differences of views, and then reporting in a sort of 'show and tell' session back to the rest of the class. Those who have tried this approach in order to exploit the full benefit of the physical presence have found that it is remarkably effective in facilitating real learning and making the learning experience more enjoyable. On the other hand, some instructors are unwilling to invest the necessary time and effort to use this approach – they claim that there is no time in the curriculum for such activities and so they continue to give bland, one-directional lectures covering prodigious amounts of information in a sub-optimal learning environment.

Those courses in such disciplines as engineering in which there are required laboratory components provide a good example of having the students learn by doing in collaboration with their colleagues. In many cases students learn more from a 1-hour laboratory than from many

hours of formal lectures on a particular subject. In classes which do no have specific exercises like these, it is of tremendous value to bring to the classroom real-life examples which the students can discuss together and identify the direct application of the class material to practical situations.

In summary, it is clear that though many instructors and students do not fully exploit the benefits of the physical presence in live face-to-face class sessions, the synchronous learning networks embodied in active learner-centric and collaborative model described above capture key elements of effective learning and it is pleasing to see attempts to promote this approach to modern learning environments.

In the rest of this paper we will turn our attention to the emerging paradigm of *Asynchronous* Learning Networks in which advanced communication and computer technologies play a major role. As we do so it is important to emphasize that we are not advocating a displacement of the tried and tested synchronous learning network mode – even if watered down to a mostly one-directional lecture. Rather we will show how traditional on campus learning can be enhanced in the sense that technology can be used to facilitate key mechanisms of effective learning, namely motivation, interaction between students and instructor and interaction among students as well as collaboration in the learning enterprise. In addition, major benefits also accrue to students who must participate in courses from a distance and out of synchronism with other students and the instructor.

In the next section we explain the use of Lectures on Demand in the context of ALN, by first discussing the concept of lectures on demand by itself, without the added advantage of being embedded in an ALN framework. Lectures on Demand using non-interactive streaming media is compared with the videotape distribution methods used in distance learning. It is argued that this approach constitutes an effective digital multimedia delivery technique, which facilitates asynchronous learning by sending the information rather than the media, but without the benefits of the vital interactions from the network of learners who are participating in the learning experience. We also explain the incorporation of high quality class materials synchronized with streaming video and audio to enhance the quality of the online learning experience. Section III then shows how the benefits of traditional lectures or lecture modules can be combined with ALN features to provide a powerful learning environment – Lectures on Demand in ALN. Our motivation is to capture to the extent possible the best features of an effective collaborative and active synchronous learning environment in the ALN context. The features described in this section represent initial steps to achieve these objectives, and suggestions are given for further developments in this general direction. Some preliminary evaluation results are presented in Section IV, and the paper concludes in Section V with some thoughts on further enhancements of the proposed Lectures on Demand in ALN learning environment.

III. LECTURES ON DEMAND: SENDING THE INFORMATION, NOT THE MEDIA

The notion of asynchronous learning has been around, in some form or fashion for some time in such embodiments as correspondence schools, videotapes, audiotapes and written material sent by postal or courier services.

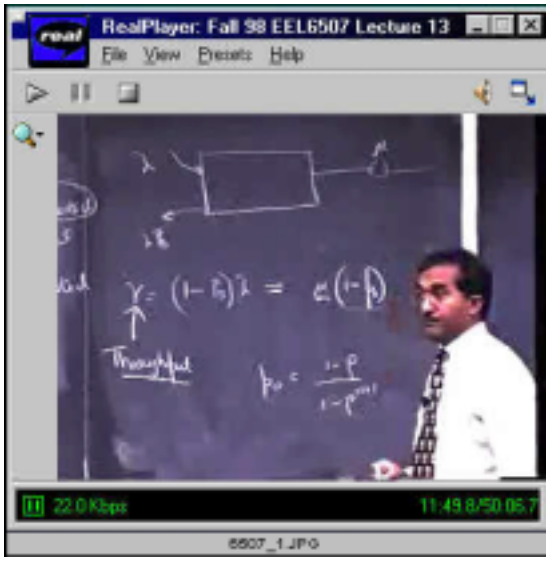
Indeed, at the University of Florida, for the past 16 years graduate level courses and degree programs have been offered asynchronously to students all over the State of Florida via the Florida Engineering Education Delivery System (FEEDS). This service essentially involved the establishment of special classrooms equipped with video and audio recording equipment in which regular on-campus classes were taught to a group of on-campus students. The recorded lectures were then sent via courier to off-campus students together with hardcopies of any class

materials provided to on-campus students. Typically, the Instructor would use a traditional textbook for the class and the students would cover various sections of the text, with homework assignments based on this material at regular intervals. There would often be a 1-way delay of 2 days in getting materials to and from the off campus students – very little interactivity – but the system somehow worked and survived for the past 16 years. Nonetheless, learners at different places and at different times were able to benefit from the traditional on campus lecture in this way - thus facilitating asynchronous learning.

The new and emerging computer and communication technologies now allow us to dispense with having to transmit physical media such as paper, audiotapes or videotapes – after all, it is the information on these media that needs to be transmitted effectively to the students. The World Wide Web now constitutes a unified delivery mechanism for multimedia information content – a revolution not dissimilar to the invention of the Gutenberg printing press 500 years ago. Video and audio can be digitized and compressed for online delivery and textual and graphical material can also be converted into digital formats appropriate for WWW delivery.

A. Lectures on Demand at The University of Florida

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



At the University of Florida we used the videotape-based FEEDS infrastructure as a starting point to generate online lectures – both for real-time as well as for asynchronous access. As we shall see later, this was the first step in generating multimedia and contextual content for ALN courses. But for now we shall examine only the process of generating, storing and accessing streaming video and audio from traditional on-campus classes.

Instructors in graduate and undergraduate classes teach classes using traditional face-to-face methods and the lectures are recorded in one of the FEEDS TV studios. The studios are equipped to create videotapes of each lecture, as well as to digitize the audio and video signals in almost real-time and broadcast the lecture live (in reality there is an initial buffering and processing delay of about 10 seconds), via the Internet using streaming technologies. In this way, students at a distance can join the on-campus classes from any convenient location via a standard dial-up Internet connection. The lecture material is also stored online, so that students (both on-campus and off-campus), who could not attend the class in real-time, can benefit from the lecture at a later time. The archived digital video/audio may be generated in real-time, as the material is

being webcast live, although for optimal quality, the process is more often done off-line using VHS videotapes. Classes are offered online only when the class is also being offered on campus so that the online students essentially join a cohort of on-campus students. This approach also minimizes management demands since the existing student support infrastructure for the on-campus course can also be used for the online course.

Figure 1 shows a typical streaming video window as seen by a student joining a live class online or accessing simply the archived streaming video. This video window is of course accompanied by audio synchronized with the video frames. Thus when using only the basic lecture on demand, the student receives essentially a digital video and audio stream via the underlining network. But the student can now access this classroom lecture from any place and any time with no need to wait several days for courier delivery of video tapes.

Since the target will be for any student, anywhere and any time to have access to this material, it is interesting to consider what the remote student will need to benefit from these innovations. With videotapes, all that was needed was a VCR and a television, which most homes and even some offices now feature. For access to the lecture on demand, each student must have access to a multimedia, Internet-connected computer, specifically with audio playback capability.

It is useful at this point to consider some of the enabling technologies, which make lectures on demand feasible today.

B. Enabling Technologies

Computer technology has advanced to such an extent that now more than 50% of homes in the USA have a computer and some 30% have multiple computers. The power of these machines has increased dramatically while the costs have plummeted – it is now possible to buy a multimedia, modem equipped computer for under US $500.00. At the same time, digital signal processing has produced powerful encoding and compression techniques which make it possible to process high quality audio, video and image signals in real-time. In parallel with this increase in computational power, advances in digital communications have progressed from Plain Old Telephone Services (POTS) to Peculiar and Novel Services (PANs) such as X.25, Frame Relay Asynchronous Transfer Mode (ATM), Asymmetric Digital Subscriber Lines (ADSL), high speed cable and wireless modems as well as a variety of other digital signaling (DS-x) systems. These telecommunication facilities now provide effective links for Local Area Networks (LANs), Metropolitan Area Networks (MANs) and Wide Area Networks (WANs), the most well known of which is the worldwide Internet. Various communication protocols have emerged and continue to be developed to support an ever growing set of applications – the Transmission Control Protocol / Internet Protocol (TCP/IP) suite is most well known, and along with revisions such as IPv6, provide a wide range of enabling technologies.

C. The User Side

From the user perspective, each student will need to connect his or her multimedia computer to the global Internet in some fashion. Most academic institutions that provide network connectivity offer speeds up to 100 Mbps to laboratories and offices. On the other hand, home-based users must rely on Internet access via dial-up modems operating at speeds ranging from 33.6 kbps (V.34) up to 56 kbps (V.90). Alternatively, some geographical regions are now able to offer Integrated Services Digital Network (ISDN) connections at speeds from 64 kbps (1B channel) to 128 kbps (2 B channels), and ADSL services are beginning to appear with downlink speeds (to the user) of up to 1.5 Mbps and uplink speeds (from the user) of 256 kbps. Cable modem services are also available with “LAN” speeds of up to 10 Mbps depending on the load and operating in full-duplex mode or in conjunction with a dial-up uplink. The table below shows the relative

costs of typical Internet connections in Gainesville Florida, which the author believes to be typical of many cities in the US. It should be noted that most service providers now waive setup charges and even offer a 'free' multimedia computer in return for a long-term service contract, typically three years.

Table 1 Internet Connection Options

Service	Monthly Cost US$	Speeds	Nature of Link	Setup Charges
V.34 Dialup	10-20	33.6 kbps	Temporary	0-20
V.90	10-25	56 kbs	Temporary	
ISDN 1 B	20-30	64 kbps	Temporary	100
ISDN 2B	20-40	128 kbps	Temporary	100
ADSL	50-60	1.5Mbps/256 kbs	Full-time	400
DSL	50-60	128/128	Full-time	400
Cable Modem	40-60	Up to 10 Mbps	Full-time	100-400

D. The Content Provider

Once the user acquires a properly working Internet connection, she makes a connection to the lectures on demand site using the Internet browser appropriately equipped with the appropriate helper application to play the streaming media files.

Clearly the institution delivering lectures on demand must therefore operate and maintain in a high level of availability and reliability, information servers, WWW servers and video/audio servers. While WWW servers may be considered standard offerings in most institutions of higher learning, video and audio servers require special attention.

The preferred mechanism to deliver this video and audio content to the online student is a streaming service rather than a "download and play" option. In the former case a specialized server is required to interact with associated clients to detect the condition of the particular Internet link, and to buffer and store a small segment of the digital video and audio content, so that the client sees, after a short initial delay, a virtually continuous video stream as the buffers are replenished in the background. The advantage is that the user does not have to provide storage for large video and audio files since the streaming media is played directly via the multimedia speakers and video monitor. The video server (on the institution side) however, must provide large storage capacity as well as support for multiple simultaneous connections from users all over the Internet. The server should also be connected to a high-speed node on the Internet to ensure adequate bandwidth. Some organizations use shared 'virtual' servers on high speed Internet links for their multimedia servers, while maintaining their in house WWW servers.

Of course the quality of the streaming video and audio received by student at remote locations will depend on a variety of factors, some unpredictable and others subject to the provider or user choice. Variable congestion in the Internet is accommodated by initial and possible intermittent buffering – in the worst case collapsing to a 'download and play' mode, or effectively a slide show with audio. The user connection to an otherwise un-congested Internet should then match the desired streaming rate of the media file stored on the server. We have found that 20 kbps

encoding of video and audio provide very good audio response and acceptable video for users with Internet connections of 33.6 kbps and higher. Encoding at 40 – 80kbps gives roughly the same audio quality and a much improved video stream, but requires Internet connections of 45 kbps or higher.

Many users will be tempted to compare the reduced size (160x120 pixels), 5-15 frames per second (fps) compressed video from the streaming video with full NTSC 30 fps TV quality video. But it should be remembered that processing and courier delivery of the NTSC videotape would take some 2 days, while the streaming video and audio is available with quite usable quality almost instantaneously. Indeed many news media houses now feature "video on demand" using these same technologies.

The most popular multimedia encoders/players are (1) RealNetworks system, (2) Microsoft's MS Media Player system, and (3) the Quick Time streaming system, listed in an order which represents in the view of the author, current market share. The RealNetworks product was used in the initial developments at the University of Florida, but the other products are also being evaluated.

With the existing bandwidth constraints from the typical home based user (28.8 –50 kbps), some may argue that it would suffice to transmit only the audio at say 8 kbps or higher, and not include the video components of the lecture. While we agree with this point of view for the case of 'talking head' lectures, we maintain that dynamic lectures in which the body language of the instructor is relevant, or in which the instructor develops collaboratively with the in-class students a complex mathematical formula, the video is very important. To emphasize this fact, one need only to imagine sitting in an adjacent lecture room or at the other end of a phone link with audio only connections when the instructor is pointing and saying, "Looking now at equation number 1, we notice that this parameter is known, but this one must be computed from the initial conditions." It helps to see where the instructor is pointing, and the dynamic development of the set of equations, as opposed to a static image of the completed development. In short one of the main reasons for including the video is the same reason why most students try to attend regular lectures rather than listen to audio recordings. At least video recordings capture the dynamic effect and this is what we attempt to produce online also.

As desirable as it is to transmit and receive streaming video and audio from traditional classes, it is clear, based on our earlier discussions that, apart from the convenience in access from any place and any time, lectures on demand as presented above fail to provide some of the key features of an effective learning environment. In the next section we discuss how these issues may be addressed and present some first steps in integrating the Lectures on Demand into an ALN framework.

IV. LECTURES ON DEMAND IN ALN

Asynchronous Learning Networks (ALNs) provide a network of people who can interact with each other using electronic connectivity tools that can effectively simulate the interactivity of physical presence, especially the desirable collaborative mode of learning.

Despite the clear advantages of asynchronous learning networks for both distant and local education, the extensive preparation and planning required for the delivery of class material via multimedia asynchronous methods has been a major challenge. In some cases the estimated costs of preparing and making graphics intensive materials available via the worldwide web have been deemed to be so prohibitively expensive as to exclude large-scale deployment of such courses. Some ALN courses are purely text-based or provide outlines to textbook materials, which the

students study on their own and then collaborate online with colleagues on assignments or discussions.

We argue that the lectures on demand method, if used effectively, provides a cost effective alternative whereby experienced and effective instructors, some of whom may be strongly resistant to any attempts to force them to change their basic manner of teaching, can be encouraged to participate in the use of ALN methods for both on-campus and off-campus (online) students.

Our experience with the video quality associated with practical streaming multimedia content, suggested that it would be helpful to include high quality images of the material dynamically generated in class on chalk or white boards by the instructor. Figure 2 shows the incorporation of PowerPoint slides generated after the class by student assistants and verified by the instructor, or directly provided by the instructor.

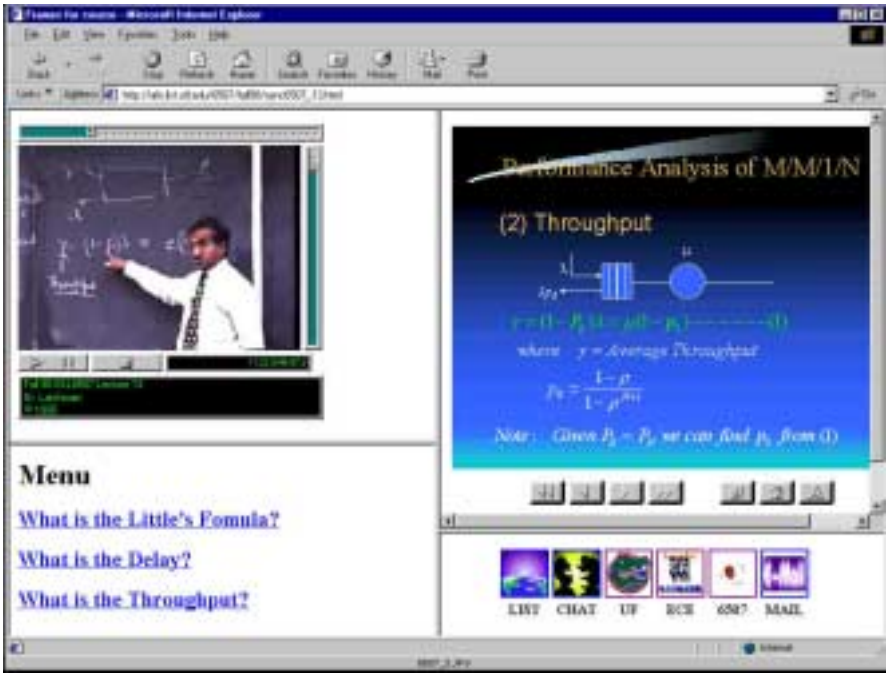
By post-processing the digitized video stream to insert time synchronized WWW pages with the relevant class materials, the Lectures on Demand method provides an enhanced service to both online and on-campus students. As illustrated in Figure 2, as the lecture is being played in the video window, the appropriate lecture notes appear in another widow and these notes are advanced automatically as the lecture progresses.

Figure 2 – Streaming Video Synchronized Power Point Slides

It should be noted that the student still has control over which slides are displayed by using the forward and reverse control buttons, but that the streaming media will override these controls at the instants of transition as commanded by the inserted time switches.

In the next section we examine how these synchronized streaming media presentations can be incorporated into an ALN environment to enhance learning.

Figure 3 Synchronized Streaming Media with Frames



V. INCORPORATING ALN FEATURES WITH LECTURES ON DEMAND

As indicated earlier, the proposed Lectures on Demand facility, which provides online streaming audio and video synchronized with the class materials, can be integrated as another component within an Asynchronous Learning Networks framework. Since ALNs essentially consist of spatially and temporarily separated groups of collaborating learners, in addition to enabling access to online learning materials (such as the online lecture), we must also provide students the ability to collaborate and interact with each other as a key ingredient in the learning process. Figure 3 illustrates a first step in this direction. Using the WebCT course management engine with some customization, we have provided the students access to a mailing list, which includes all students in the class (on campus and off-campus) as well as the Instructor and the teaching assistants. Thus, as a lecture is being followed or an exercise is being completed, online students can immediately send a question to the group – with answers coming back immediately, if someone online at that time is available or more commonly, some time later. There are also provisions for synchronous chat sessions during with the Instructor or TA's can moderate online question and answer sessions or groups of students can discuss projects or details of the material being considered in the class. WebCT also allows all students to create their own home page with a textual introduction with images or even video audio so that the students, instructors and TA's can get to know each other better to facilitate online interactions.

In Figure 3, the Lectures on Demand in ALN class is presented using a 'framed' presentation in which the class components are constrained in predefined sub-frames. Another interest feature shown in Figure 3 is a modular table of contents for each lecture so that the student does not need to follow the entire lecture but may select a particular topic of interest.

Clearly much more could be done to embed the ALN features into the proposed approach as well as to ensure that the Lectures are presented using active and collaborative teaching and learning strategies which can then be emulated in the online mode. For example in an ongoing development at the University of Florida, use is being made in the Lectures on Demand in ALN

approach of the "one minute paper" as well as the change from a 50 minute lecture to three segments of lectures of about 10 minutes length, interspersed with class time exercises. Implementing this approach in traditional face to face classes is itself quite challenging; capturing these interactions and making these interactive facilities available to online students in an effective and user-friendly manner is even more so. Nonetheless the results thus far have been very encouraging.

VI. SOME PRELIMINARY EVALUATION RESULTS

While extensive evaluation studies of the effectiveness of the proposed Lectures Demand in ALN methodology is still underway, in this section we give a brief summary of the results of a simple evaluation exercise designed to test student response to this new online mode of learning and to make an initial assessment of the effectiveness in terms of key learning outcomes. For this exercise, a class of on-campus students was asked to take one lecture module entirely asynchronously using the Lectures on Demand in ALN method. This entirely on-campus class was being used for recording lectures for future online offerings and the process was discussed and explained to the students. In fact, at the time the exercise was given, the students had already been making use of archived classes to refine their knowledge and to review difficult developments. They were also using the discussion and collaborative tools described earlier to interact with colleagues and the instructor. Of the 34 students, 21 used the Lectures on Demand in ALN tools, and 13 simply read the assigned material or discussed it with colleagues.

The students who took the online class were asked to respond to the 14 questions shown in Table 2, designed to get some indication of their personal perceptions about this method of learning. Their responses are shown in Figure 4, which suggest that the students were overall quite positive about the learning in using Lectures on Demand in ALN. They felt that good audio quality was very important (more so than video), and that being able to have the lecture notes before hand as well as pausing and replaying parts of the lecture ("re-winding the professor") were unique benefits of this mode of learning. The also liked the synchronization of the PowerPoint files with the streaming video and audio and being able to ask questions of their classmates and the instructor at any time. The most negative response was to the suggestion that online classes could be comparable with the real live in class sessions. Only 42% agreed that the online class could be comparable to traditional classes and even fewer (40%) said that they would elect to take an online class if they could attend the regular class. On the other hand 58% agreed that the Lectures on Demand in ALN class was superior to a regular class in which there is little class interaction.

Table 2 – Evaluation of a Real Lecture on Demand

Question	ISSUE TO BE MEASURED
Question1	The overall class/lecture quality was acceptable.
Question2	I felt that I could learn using this mode of delivery.
Question3	Good audio quality is important for effective learning.
Question4	Good video quality is important for effective learning.
Question5	It helped to have copies of the lecture notes beforehand.
Question6	I liked this mode of learning since I could pause the lecture to make better notes or replay selected sections.
Question7	The synchronization of the streaming video with PPT files was useful.
Question8	If I have a question when participating in an online class, It helps to know I can send a question to the entire class and the instructor and TA at any time.
Question9	It would be very desirable to have access to online interactive simulations to illustrate key concepts.
Question10	Online classes in this mode can be comparable to traditional classes.
Question11	I would take online classes even if I could also attend the regular class.
Question12	I would be happy to take online classes like this if I could not attend regular classes.
Question13	I prefer to attend regular face-to-face classes when there is interaction in the class.
Question14	If there is little or no in class interactions, online classes are superior to traditional classes.

Figure 4 – Questionnaire Results for Questions in Table 2

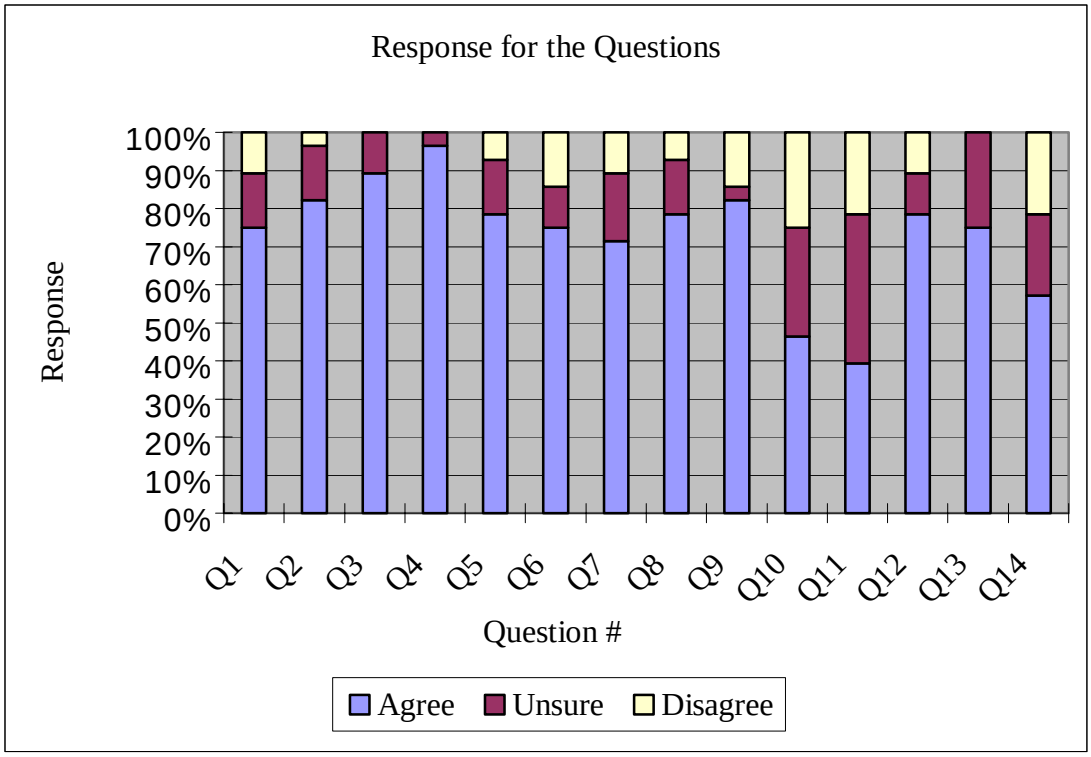


Figure 5a – Quiz Result with LoD (Average = 8.35/10)

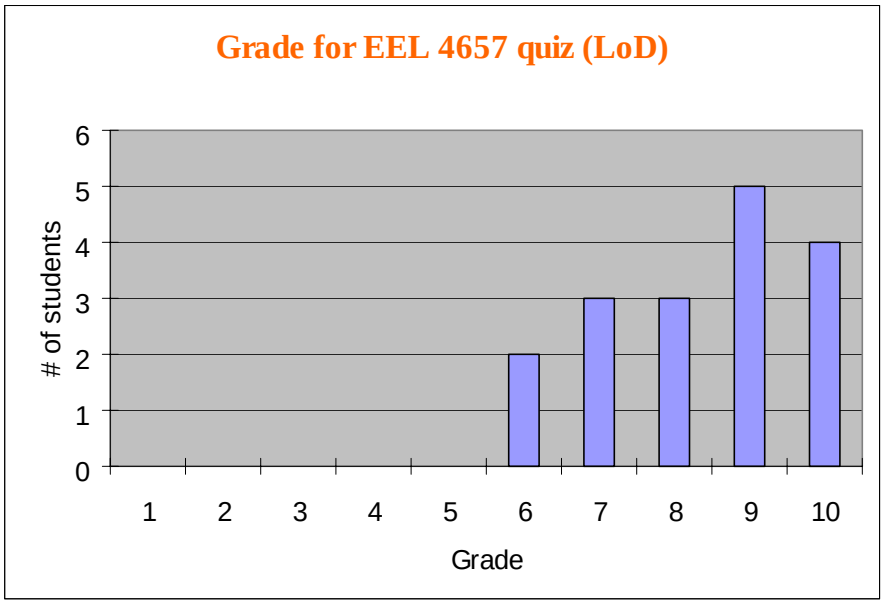
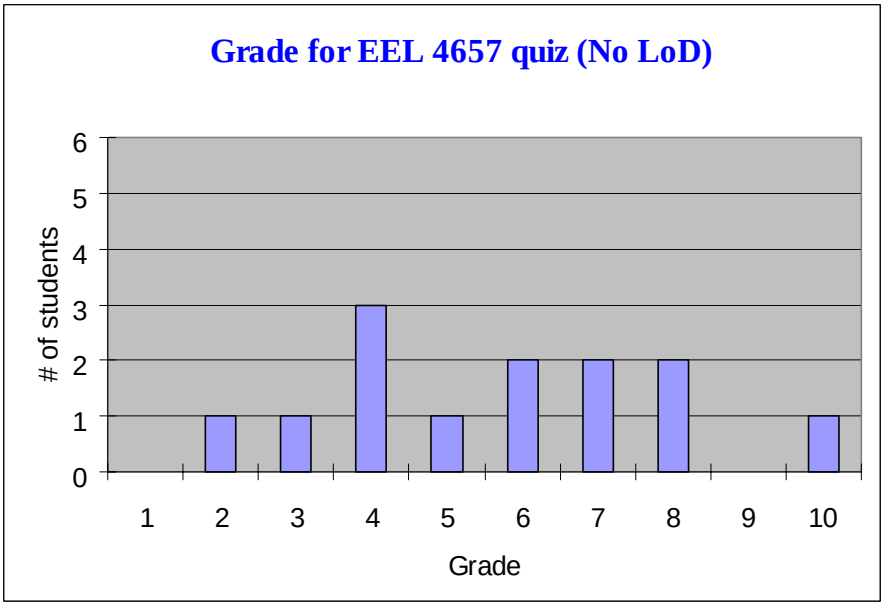


Figure 5b – Quiz Result without LoD (Average = 5.69/10)



A simple 10-minute quiz was administered during the class session following the session in which the students were assigned to take the online class module. The quiz required the students to use the material learned in the class material covered in the online class to do a short design problem. The results of the quiz for the 21 students who used the online lecture are shown in Figure 5a, showing a low score of 6/10 and high score of 10/10 with a mean of 8.35/10. For those 13 students who tried to learn the material by themselves, there was a much wider spread of scores from a low of 2 to a high of 10 with a mean of 5.69/10. The quiz and questionnaire results in this informal assessment were encouraging and further assessment design and implementation are underway.

VII. THE FUTURE OF LECTURES ON DEMAND IN ALN

The introduction of the lecture component in the context of ALNs provides another source of multimedia information for online courses as well for enhancing the on-campus learning experience. Students are already quite familiar and comfortable with lectures in the learning environment and the ALN structures provide for significant interactions between instructional staff and students as well as for communications and collaboration among students.

In the recent past, several institutions have begun to offer online courses using the lectures on demand approach. These include the pioneering efforts at the University of Florida [1] as well as early work at Stanford University [2]. Other institutions involved in lectures on demand using streaming media are Pennsylvania State University, Georgia Tech and the University of Maryland University College (UMUC) as well as the North Carolina State University. The experiences in these institutions in the use and evaluation of the Lectures on Demand in ALN methodology, were reported on at the 5th International ALN Conference held at UMUC in October 1999, and the results up to this point have been very interesting and encouraging [3]. Indeed the University of Florida now offers online courses towards MS and BS degrees using the Lectures on Demand in ALN approach. A University of Florida FlexMBA program is also available using similar technologies but is somewhat more dependent on multimedia content delivery via CDs.

One of the major benefits of using the Lectures on Demand method we have described in this paper to offer online ALN courses is the relative ease and reasonable costs involved in developing online course materials. Obviously a key requirement will be to have highly effective and organized instructors for the on-campus classes. Then the incremental technology efforts to make the class available online is no longer prohibitive. Although the capturing of the audio and video can be accomplished using consumer grade, personal recording devices, best results are obtained when more professional grade recording equipment is used – so it does help if a recording studio is available. On the other hand acceptable results can be obtained with audio only recording using low-cost microphones and tape recorders, and at the University of Florida, an entire course was videotaped and put online using a student operated home camcorder. On average it takes about 2.5 hours or student assistant effort to produce a synchronized streaming media online lecture for ALN delivery, starting from a traditional 1 hour "chalk and talk" class where the instructor lectures to an on-campus class.

It is appears that the lectures on demand methodology works quite well. However, from the remote user perspective, the data rates of the Internet links from residential locations is still an issue since even at 28.8 kbps, intermittent congestion sometimes causes long buffering times during which the streaming audio and video is interrupted. LAN, ADSL and ISDN connections work very well and even 33.6 kbps connections are usually acceptable. In some situations it is desirable for the students to download the video file to a temporary location and then to view the lectures "off-line" with the WWW pages being accessed over the Internet. In addition it is also possible to provide higher quality data rates – up to 200 kbps – providing almost full motion video, and distributing multimedia CD ROMs to students. This option is being investigated for a set of overseas students.

New versions of the streaming media systems are capable of encoding multiple data rates from 20 kbps to 200 kbps into a single video stream and then adapting the delivered data rate to the speed of the Internet connection.

Readers who are interested in further technical details on the functional operation of the lectures on demand system are referred to the companion article "*The Development and Use of Synchronized Streaming Media in Online Education*" which will appear in the ALN Magazine.

VIII. ACKNOWLEDGEMENTS

The authors wish to acknowledge the generous support of the Alfred P. Sloan Foundation, the National Science Foundation's Southeastern University and the College Coalition for Engineering Education (SUCCEED) program and the University of Florida Office of the Provost.

IX. REFERENCES

1. **Latchman, H., C. Salzman, D. Gillet and H. Bouzekri**, "Information Technology Enhanced Learning Networks for Distance and Local Education", *IEEE Transaction on Education*, Vol. 42, pp. 247-254, November 1999.
2. **Dale A. Harris and Andy DiPaolo**, "Institutional Policy for ALN", Journal of Asynchronous Learning Networks, Volume 3, Issue 1, May 1999.
3. The 5th International Conference on Asynchronous Learning Networks, http://www.aln.org/alnconf99/proceedings.
4. Computer Communication Networks Using a Lectures on Demand Approach, http://csc.list.ufl.edu/5718/courseware.

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