

AC 2007-1317: MANAGING A DISTANCE-LEARNING EET LABORATORY COURSE USING COLLABORATION SOFTWARE

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Managing a Distance-Learning EET Laboratory Course Using Collaboration Software

Abstract

Methods of managing various distance learning EET laboratory courses using collaboration software are detailed. Particular emphasis is given to different types of collaboration software, advantages and disadvantages of each, and student and faculty feedback on the effectiveness of each.

Introduction

As part of Old Dominion University's distance education program, the Electrical Engineering Technology program offers several on-line (web-based) laboratory courses. In an effort to give the distance education students an equitable educational experience and facilitate course assessment, the on-line laboratory courses are structured so that students perform the same experiments and submit the same deliverables as their on-campus counterparts.

However, although the ODU EET faculty attempt to make the on-campus and off-campus laboratory courses as equivalent as possible, because of logistical differences, the courses simply cannot be made identical.¹ The on-campus student has an apparent advantage over the distance education student in that he/she is part of a physical community with ready access to the university laboratory facilities, the instructor, and fellow students. Similarly, the instructor has easy access to the circuitry designed by the student, thereby apparently making the correction of any mistake, evaluation of student performance, and grading relatively easy. Providing a similar environment to a distance education student is more of a challenge. It is the purpose of this paper to concentrate on the evolution of methods implemented at Old Dominion University that help to "level the playing field" for both the distance education student and the instructor in an e-learning community,¹¹ so that the educational experience and student assessment are identical or at least as similar as possible to that for the on-campus student.

In this paper, particular attention is given to collaboration software. Many variations of collaboration software (both free and licensed) are currently available such as Blackboard Virtual Classroom (Blackboard, Inc.), NetMeeting (Microsoft Corporation), Messenger (Yahoo!, Inc.), Skype (Skype Limited), and Acrobat Connect Professional (Adobe Systems Incorporated, formerly named Macromedia Breeze). In this particular study, Blackboard, NetMeeting, and Acrobat Connect were chosen because of their voice, video, whiteboard, and application sharing features that are essential to the on-line laboratory exercises, and their availability at the institution. Each of these software packages has been used by the authors, and quantitative data has been collected and analyzed, and is presented in the form of student performance, student feedback, and learning achievement results.

Additionally, further discussion in this paper outlines how collaboration software is used to enable each facet of the course, and the suitability of each software solution (both pros and cons) to implement each facet.

Review of Hands-on Distance Learning

Traditional engineering technology curricula focus on applied engineering and hands-on experience that educates students with real experimental approach projects and lab exercises.² The wide availability of the internet and computers makes the delivery of educational materials beyond the limits of the traditional classroom teaching format easily available to a large pool of non traditional students.

Distance learning is a curriculum delivery technique that has been widely implemented for many years to meet the increasing demands of those students who are not able to attend conventional on-campus classroom or laboratory courses. Most distance learning courses focus on web based static material presentation and "question & answer" format.^{3,4} Other distance learning implementations contain software simulations and virtual laboratories.⁵ However, the current trend is to move toward more face-to-face interaction between students and instructors in distance education courses⁶, a trend that has been driven by TAC of ABET's view that distance learning courses should not differ from their on-campus counterparts.⁷ The obvious goal is to make distance education course pedagogy as similar as possible to that of on-campus classes. Implementing hands-on distance education courses such as microprocessor/microcontroller programming and control exercises, and assisting the students with effective trouble shooting techniques requires various unique methods to bring real time audio and video, white board, and file sharing to the distance learning students.^{8,9} To meet these criteria, the distance learning courses rely heavily on the selection and implementation of appropriate and effective collaboration software.^{10,11}

Course Pedagogy

The particular Old Dominion University courses described in this paper are the EET325 Microprocessor Laboratory, which is a combination hardware/software laboratory based on the Microchip PIC16F84A microcontroller, and EET470 Microprocessor System Design, which is also a hardware/software course based on the Microchip PIC16F84A/PIC16F877A and C++ high level language program design. In these courses, students (both on-campus and distance-learning) are required to construct several microcontroller-based experimental circuits, develop and debug the microcontroller assembly or C++ language codes to communicate to a PIC based system, and demonstrate operation of the circuit. Software is developed and simulated using the Microchip MPLAB suite (downloaded freeware). Students are required to locate and purchase their own components for these courses.

Grading in the course is based upon verification of hardware performance of each experiment and project, submission of properly formatted assembly language source code or C++ code, and periodic quizzes on the material covered in each experiment or project. In the early stages of the course, experiment are assigned weekly, while in the later stages of the course, students are allowed two-to-three weeks per project due to increased complexity of the required software and hardware.

Distance Learning Issues

When offering the microprocessor lab course to an e-learning community, the instructor must overcome four fundamental obstacles that could make the learning experience in the distance learning laboratory unequal to that of the on-campus course. These are obstacles that are unique to the distance education format, and are not normally present when offering the course in an on-campus format. They are 1) the level of interaction between students, 2) the challenge to the instructor to directly assist the student one-on-one to overcome software or hardware problems and software or hardware debugging,¹² 3) the challenge to the instructor to teach programming skills to the class as a group, and 4) the challenge to the instructor to clearly witness the operation or precisely pinpoint the bug(s) in the students' software or hardware and grade the performance.

In the distance learning version of the Microprocessor Laboratory (EET325), collaboration software is used to overcome these obstacles. Among various types of collaboration software available, the authors have employed the most popular (Blackboard) and the most versatile (NetMeeting and Acrobat Connect). For the benefit of readers unfamiliar with any or all of these software programs, a brief description of each and its implementation follow.

Blackboard Virtual Classroom®

Blackboard is the mainstay of most college and university course collaboration software. It provides a web-based portal that is password secured. It allows instructors to post course documents, staff information, assignments, announcements, assessments, grades, and give on-line tests and examinations. Additionally, an email system is provided so that instructors can communicate directly with individual students, groups, or an entire class via email; and assignment submission tools ("digital drop box") are available which allows students to submit assignments electronically. Student-student and student-instructor interaction is available via asynchronous threaded discussion and via a synchronous collaboration portal which allows course lectures and instructor office hours via text chat and whiteboard. Meetings can be recorded, thereby creating archives that are available for viewing at any time. No voice, video, or application sharing is available in Blackboard and the structure of the classroom is preconfigured and inflexible. Students often experience being dropped out of the session and must reconnect. There is no indication they have lost connection until they attempt to post a comment. Also, there are no tools available in the Virtual Classroom to help the student identify or correct connection issues. Figure 1 presents a screen capture of the Blackboard Instructor's Control Panel illustrating the options available to the instructor.

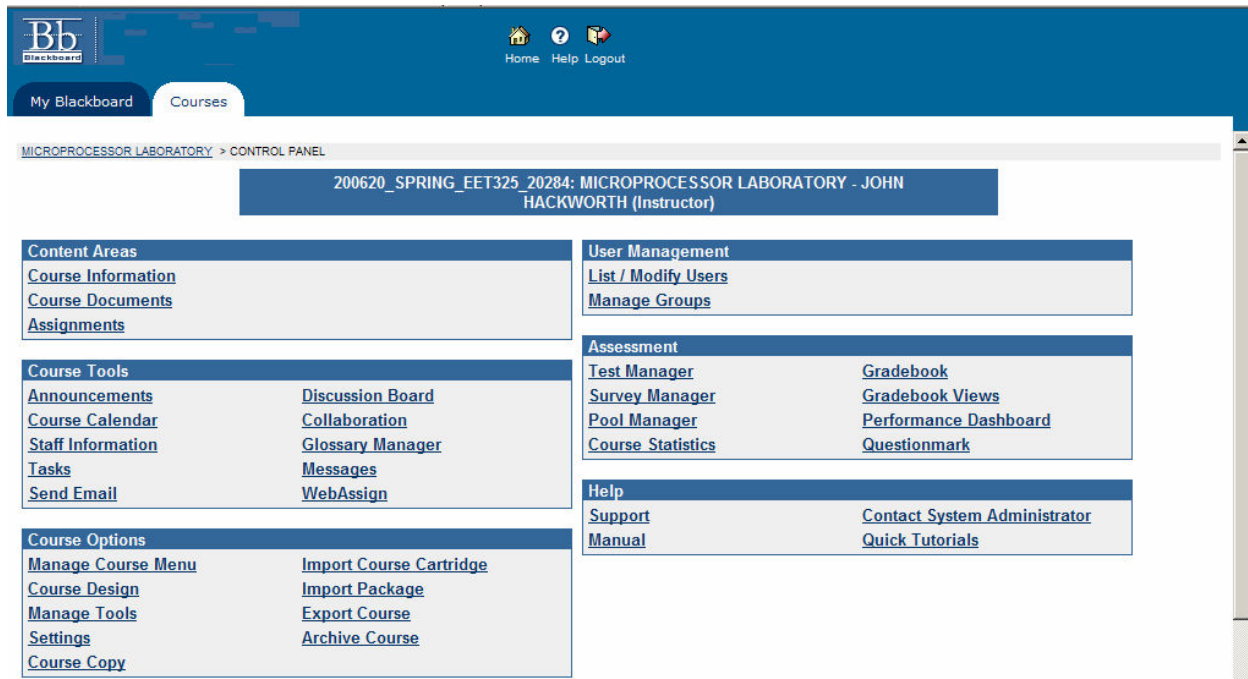


Figure 1 - Blackboard Instructor's Control Panel Screen

Acrobat Connect Professional®

Acrobat Connect is a rather new addition to available collaboration software. It is mainly designed to provide an on-line meeting space for business and academia, and, like Blackboard, it consists of a web-based platform that requires only a web browser for access. Acrobat Connect provides many of the same chat and whiteboard functions of Blackboard; however, it adds voice and video communication. It also has application and desktop sharing, file sharing, and a PowerPoint presentation interface. Meeting rooms can be totally customized by the meeting moderator; that is, meeting panels (called "pods") containing chat, whiteboard, typed notes, and applications can be created, deleted, resized, and positioned as determined by the moderator. Figure 2 is a screen capture of an Acrobat Connect meeting room showing some of the various pods that are available and how they can be used. In this illustration, the instructors have switched off their cameras in order to conserve bandwidth (the video pod in the lower left corner). Notice also that while the instructor is displaying samples of assembly language code in the notes pod (right side), the students are discussing their experiences in debugging the experiment in the chat pod (center). In this example, the instructor is using voice and the students are using text-based chat. After some experimentation it was found that this combination provided the best 2-way communication while conserving bandwidth for possible application sharing.

If the instructor requires one-on-one meetings with students, a special meeting room can be created in which the student is given presenter-level permission. This allows the student to activate both a camera and voice which provides a means whereby the instructor can watch the student operate the necessary course software, the instructor can use application sharing to demonstrate to the student how to overcome problems, and allow the student to demonstrate circuit operation by showing the circuit on-camera.

Acrobat Connect also contains several utilities allowing users to tailor the software performance to the bandwidth of their connection ("LAN", "DSL", or "Dialup"). By selecting a slower connection speed, Acrobat Connect reduces the video quality and audio bandwidth in order to maintain a consistent, synchronized flow of audio and video and maintain the two synchronized. A connection speed measurement utility measures the connection speed and suggests the correct setting. Another utility is recording, where meetings can be recorded and archived for later access through a web URL.

Institutions can choose to purchase a software license allowing them to install and run Acrobat Connect on their server system, or, for institutions with limited IT support, Adobe® will rent server space to institutions. Acrobat Connect licenses are priced according to the desired number of users that are allowed to access the server at any given time. Institutions with large classes will naturally pay more for a license than those with many small classes (as long as the classes do not meet simultaneously). Adobe claims that Acrobat Connect is capable of handling up to 2500 simultaneous users in a meeting; however the authors have only used Acrobat Connect with class sizes of 20-25 to date.

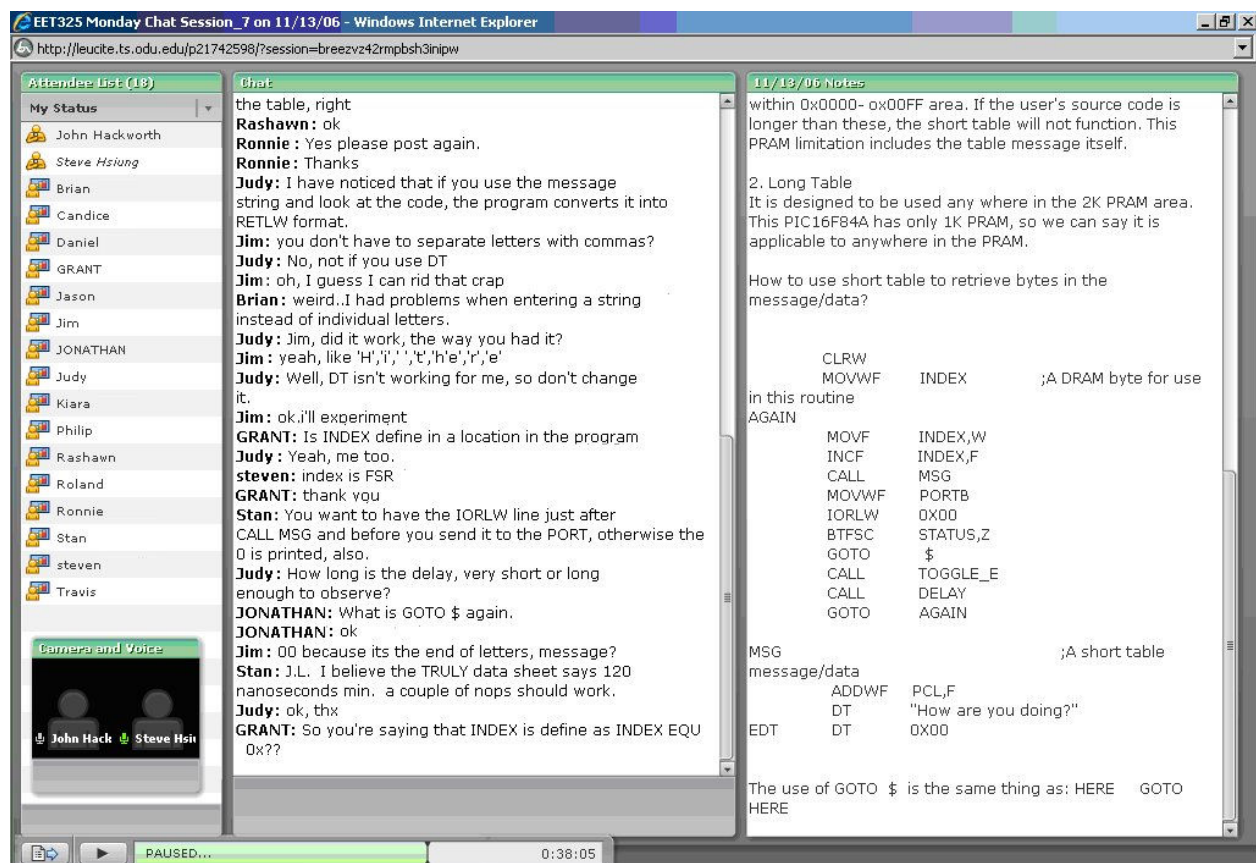


Figure 2 - Acrobat Connect Meeting Screen

Microsoft NetMeeting®

Microsoft's NetMeeting is a collaboration utility included with the Windows operating system. Its features include audio and video communication, whiteboard, chat, and application and file sharing. User-to-user connections with NetMeeting require that the meeting attendees enter the current internet protocol (IP) address of the moderator. This presents several potential connection problems since many computer networks use dynamic IP assignment and many IPs are deliberately hidden behind firewalls. Also, there is a potential security problem with hosts distributing their IP addresses to users. To satisfy user objections to releasing private IP addresses, Microsoft initially provided an internet locator server (ILS) in which meeting moderators could store their email address and IP address. This allows the moderator to "hide" their IP by having the attendees contact the ILS server, give the moderator's email address, and be automatically connected to the desired meeting. However, recently Microsoft turned over ILS server operation to third parties, thereby significantly reducing the security of the system, and in turn relegating NetMeeting to use by clubs and individuals.

For NetMeeting, the maximum user capacity within a given meeting is not specified. However, several extensive analyses have been performed which, as one would expect, determined that as users are added to a meeting, the quality and speed of communication within the meeting decreases.¹³ Experience by the authors has shown that in addition to decreased speed, NetMeeting suffers connection consistency problems; i.e., attendees are routinely dropped from the meeting without warning, thereby requiring that they reinitiate the connection. Figure 3 shows a typical NetMeeting screen.

Collaboration Software Study Results, Student Survey

The EET325 Microprocessor Laboratory course was offered in the summer 2006 session, and EET470 Microprocessor System Design course was offered in the fall 2007 semester. All three collaboration applications (Blackboard, Acrobat Connect, and NetMeeting) were utilized, and data was collected in the form of student and faculty opinions (both written opinions and numerical rating polls). Participation in the student surveys was voluntary. A total of 16 students were asked to participate in the survey and 11 responded, resulting in a response rate of 68.8%.

During the summer 2006 session, the EET325 lab course used NetMeeting and Blackboard. During the fall 2006 semester, the EET325 lab course and the EET470 course used Acrobat Connect and Blackboard (Acrobat Connect was not available until the fall 2006 semester). The students recruited from these classes for the survey were those who had used both combinations of software and who could therefore fairly compare the performances of each. The student survey was divided into two sections which were 1) compare Acrobat Connect and Blackboard and 2) compare Acrobat Connect and NetMeeting. Questions centered on the students' opinions of the relative performance of each of the pairs of software when compared to each other. Students were asked to rate each based on a score of 1 to 5, with 1 being worst and 5 being best. The results of these surveys are shown in Tables 1 and 2.

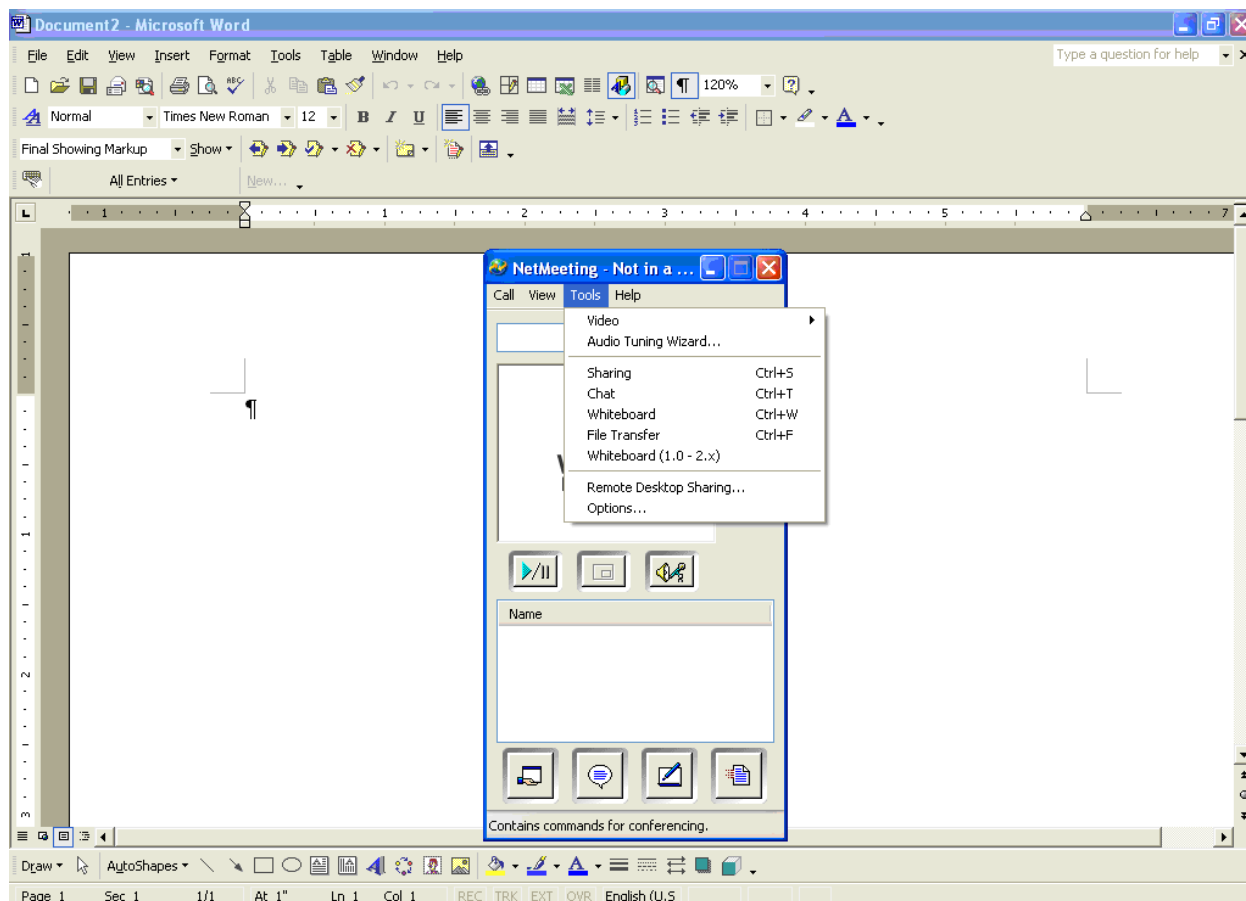


Figure 3 - NetMeeting Screen

Table 1 - Acrobat Connect-Blackboard Survey Results

#	Question	Acrobat Connect	Blackboard
1	Rate the flexibility in use of Blackboard and Acrobat Connect.	4.36	2.70
2	Rate the reliability of internet connection in Blackboard and Acrobat Connect.	4.36	2.10
3	Rate the note pad function of Blackboard and Acrobat Connect.	4.00	2.56
4	Rate the drawing sharing function of Blackboard and Acrobat Connect.	4.27	2.00
5	Rate the file sharing function of Blackboard and Acrobat Connect.	4.55	2.20
6	Rate the application sharing function of Blackboard and Acrobat Connect.	4.50	2.20
7	Rate the capability of handling communications of more than 2 individuals in Blackboard and Acrobat Connect.	4.73	2.80

Table 2 - Acrobat Connect-NetMeeting Survey Results

#	Question	Acrob Connect	NetMeeting
1	Rate the general communication quality of NetMeeting and Acrobat Connect.	4.55	2.70
2	Rate the Audio quality and delay of NetMeeting and Acrobat Connect.	4.09	3.10
3	Rate the Audio flexibility (volume, tuning, and recovery) in control of NetMeeting and Acrobat Connect.	3.82	3.10
4	Rate the Video quality and delay of NetMeeting and Acrobat Connect.	4.18	2.60
5	Rate the Video flexibility (sizing, resolution, on/off control, and recovery) of NetMeeting and Acrobat Connect.	3.45	3.00
6	Rate the quality of application sharing in NetMeeting and Acrobat Connect.	4.20	3.30
7	Rate the desktop and application sharing capabilities of NetMeeting and Acrobat Connect.	4.20	3.56
8	Rate the capability of handling communications of more than 2 individuals in NetMeeting and Acrobat Connect.	4.82	1.88
9	Rate the flexibility and capabilities in NetMeeting and Acrobat Connect.	4.36	2.60
10	Rate the recording features of the meeting in NetMeeting and Acrobat Connect.	4.45	2.30

Table 1 clearly shows that the students considered Acrobat Connect to be preferable to Blackboard. In Table 2, the students considered Acrobat Connect to be far superior to NetMeeting in several categories including questions 1, 4, 8, 9, & 10. Of particular interest is question 7 in Table 1 and question 8 in Table 2, in which the students were asked to compare the communication quality when more than 2 attendees are involved. In both cases the students considered Acrobat Connect to be far superior.

Collaboration Software Study Results, Faculty Comments

Faculty comments comparing the programs tend to agree with the results of the student survey.

"Acrobat Connect is paid software and NetMeeting is free. If the cost is not a factor, I would definitely use Acrobat Connect for my distance learning classes because:

- Acrobat Connect can handle multiple students and NetMeeting cannot.
- Acrobat Connect can record and archive sessions and NetMeeting cannot
- Acrobat Connect has better file sharing and desktop control than NetMeeting
- Acrobat Connect has better communication quality than NetMeeting
- Acrobat Connect has easier audio and video setup than NetMeeting
- Acrobat Connect is flexible in wireless communication and does not require an IP address as NetMeeting does. This makes Acrobat Connect flexible in different internet configurations.

- Acrobat Connect is running on a private/customized server and NetMeeting is running on a public server, so Acrobat Connect has better security control than NetMeeting.
- NetMeeting requires a fixed IP address for communication which poses a high risk in internet security.
- Acrobat Connect can accommodate an online lecture session but NetMeeting cannot, other than just for one on one sessions.
- Not being able to resize the video window is a drawback in Acrobat Connect.
- A separate control of audio and video (on/off, sizing) will be a needed improvement on Acrobat Connect."

"Acrobat Connect can not replace Blackboard. Each one has its unique features that are needed for various distance learning activities. The reasons are:

- Acrobat Connect can do multiple student communications in real time. Blackboard cannot.
- Acrobat Connect has real time audio and video features. Blackboard does not.
- Acrobat Connect can record/archive audio and video but not Blackboard.
- Acrobat Connect can assist hardware circuit trouble shooting and software debugging via video and audio. Blackboard cannot.
- Acrobat Connect supports online lectures in real time. Blackboard does not.
- Acrobat Connect supports file real time file and screen sharing. Blackboard does not.
- Blackboard supports documentations/notes/grade posting. Acrobat Connect does not.
- Blackboard supports topic discussions. Acrobat Connect does not.
- Blackboard supports online testing and grading. Acrobat Connect does not
- Blackboard supports class e-mailing and specified group e-mailing. Acrobat Connect does not
- Blackboard provides various options to instructors to manage the course online. Acrobat Connect does not.
- Drawing and note pad functions are about the same between Acrobat Connect and Blackboard.
- Recording and archive functions are about the same between Acrobat Connect and Blackboard.
- Security issues are about the same between Acrobat Connect and Blackboard.
- Communications setup is about the same between Acrobat Connect and Blackboard.
- Multiple students' communications are about the same between Acrobat Connect and Blackboard."

"Both Blackboard and NetMeeting suffer connection consistency problems which resulted in students being dropped from the meeting room at random. In Blackboard, this problem seemed to be amplified when the class sizes exceeded 15-20." (Note: It is possible that this is a problem caused by the institution's IT equipment, and not the software.)

Conclusions

The survey results from both the students and faculty show that the most desirable software for collaboration is Acrobat Connect. If we consider that reliability, ease of use, elegance of interface, and extended functionality of the technology approach¹¹ contribute to generating the identical or nearly identical experience of the on campus classroom for the distance learning laboratory student in an e-learning community, then we can suggest that Acrobat Connect in conjunction with an adequate learning management system such as Blackboard provides a parallel experience. The learning management system provides the needed platform for the distribution of course materials and grades, email, and threaded discussion, while Acrobat Connect provides the necessary live on-line collaboration that is needed between the instructor and students.

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