Computer Supported, Interactive Distance Learning for Engineering and Engineering Technology

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ABSTRACT

Many educators agree that integrating interactive modes of delivery into distance education will significantly enhance the education experience for students and instructors. Most modes of delivering distance education classes today are asynchronous (recorded materials), and one way synchronous communications (cable TV classes, satellite link classes) and thus lack the real time interactions and the resulting collaborative support among students. At NJIT we added a collaborative and interactive distance education delivery system into the distance education program which has been in existence for fifteen years. This paper describes the implementation of that system and the results as perceived by faculty and students.

INTRODUCTION

Current implementations of distance learning come with limitations including: the lack of instructor's presence; the absence of real time collaborative work among students as it relates to class materials; the lack of interaction among students, and between the instructor and students; and difficulties associated with performance feedback. To overcome these limitations, a system has been successfully implemented at NJIT. Recent advances in telecommunications are being employed to extend the traditional classroom beyond the existing settings, specifically from classrooms at the New Jersey Institute of Technology (NJIT) - Newark campus to the Technology and Engineering Center (TEC) at Mount Laurel, a branch campus jointly operated by NJIT and Burlington Community College (BCC). This system provides instructor's presence, real time interactions among students - at both locations. Included in this system are: Integrated Service Digital Network (ISDN) which economically interconnects the two sites, multimedia conferencing equipment that incorporates video and audio communications with collaborative computer visuals simultaneously. Electrical engineering technology courses, engineering courses, computer science and technical writing course are all delivered over this system. In addition, students from three other universities are using the same system for a manufacturing project collaboration with NJIT students.

THE CLASSROOMS

Multimedia conferencing is the back bone of this system and includes video, audio, and a data channel for computer visuals. Equipment at both locations feature the similar capabilities and thus classes can originate from either location. This flexibility maintains the physical face to face interaction, if

geography permits, among the instructor and students at both sites on the network. The local classroom - at the Newark campus - is equipped with the following equipment:

. A PictureTel group video conferencing system

• An AT&T Vistium that provides application sharing capabilities needed for collaborative work among participants

. Document reader for scanning and annotation of materials not suitable for computer visuals. The output of the document reader is shown at both sites simultaneously.

. Multiple video cameras

. Table microphones

Equipment at the remote classroom were limited to the AT&T Desk top multimedia conferencing system which incorporates a low cost video camera, table top microphones and a document reader. The video output and the application sharing data channels were routed to two separate 32" monitors. Each classroom accommodates up to 25 students, so a class of fifty can be taught over this network. The first semester (fall 95) registration in this project is shown in Table A.

TABLE A, NUMBERS OF STUDENTS REGISTERED

Course	Local Site	Remote Site	Total
EET303 - Circuit Measurements	22	10	32
CIS615 - Software Engineering	4	22	26
Eng342 - Technical Writing	21	20	41
total	47	52	99

Class materials are presented in two ways. 1) Computer visuals and application sharing allow real time exchange of information between the local and remote site. Microsoft Windows compatible applications such as POWER POINT, PSPICE, GEOTEST ATEASY, WORD, Hewlett Packard virtual electronic equipment, and multimedia authoring tools are some of the presentation media for real time collaboration among students at the remote and local site and between the instructor and students. 2) A document reader to scan printed text and graphics which are shown at both sites simultaneously via TV monitors and over head projectors. The document reader operation is similar to the overhead projector except that plain paper is used instead of viewgraph transparencies.

LABORATORY BASED COURSES

Teaching laboratory courses in the traditional distance education settings lacked the students' ability to ask questions related to instrument settings, instructors' hands-on illustration to students at the remote site, and the ability of the instructor to keep students interested during the laboratory portion of the class. To investigate the feasibility teaching laboratory courses over this network, one course was selected for an experiment. A circuit measurements course from the Electrical Engineering Technology curriculum was selected. The laboratories at both sites were equipped with the same equipment including computers, instruments, and the General Purpose Interface Bus (GPIB) type equipment.

Software packages needed to be shared were installed at the primary site only. The requirement for sharing these package is that they must be able to run under MS WINDOWS. The delivery was

designed such that each meeting was divided into three sessions: a lecture session, experiment session, then a collaboration session.

The first session is the lecture part including theoretical materials, overview of the experiment to be conducted and an illustration of some instrumentation sessions as well as a prelaboratory exercise to be used as a roadmap for the experiment and to assure student readiness for the laboratory experiment. In the second session students move onto conduct the experiment. A teaching assistant was present at the remote site during this session to assure the correct operation of the instruments and assist students during the experimentation. Students at both sites were encouraged to use video recording equipment to record some of their work to share with others during the collaboration session.

Students then reconvene for the third, and final, collaborative session to discuss the results with the instructor and to share their experience with students at the other site. Students were encouraged to form teams such that each team included student members from both sites. Microsoft Word, Microsoft Excel, SPICE and the document reader were available to students to share results and data in real time. Each team was encouraged to present its finding to the rest through a representative. Representatives changed throughout the semester. Also, to encourage students to use the system, presentations were counted toward part of the grade for the course.

EVALUATION

To determine the effectiveness and to enhance this system and the delivery methods, students were asked to complete a survey for each class. This survey was in addition to the traditional class evaluations which are required for all classes taught at N.HT. Students were asked to rate the overall experience, identify opportunities for improvements and make recommendations to improve the system and methods of delivery. The survey dealt with two main issues: students overall satisfaction with this education experience compared to the conventional single classroom, and whether students will continue to register in classes offered in this setting in the future. The survey and results are summarized in Table B.

As can be seen from Table B, the results were positive. Approximately 75% of students at the remote site and 85°/0 of students at the local site rated the educational experience as good as or much better than the conventional single classroom experience. About 90% of the students at the local site and 63% of the students at the remote will register for future classes on the network. Approximately 60% of students at the local site were satisfied with the audio and video quality. It is discernible from Table B that students at the remote site would like to see the conferencing equipment upgraded, especially the audio components of the system. This condition is being remedied with a new group conferencing configuration which employs high level of audio and video quality.

COLLABORATIVE WORK

Students from four universities are engaged in collaborative work experiments in manufacturing engineering. The universities are NJIT, Columbia, Ohio and Penn State. Students use E-mail to exchange project materials and then once a week the students participate in a video conference on our system to discuss and share their work. The document reader is usually the instrument of choice for projecting the shared materials among the conferring students.

TABLE B, SUMMARY OF STUDENT SURVEY RESULTS

Category	Rating	Remote Site	Local Site
Over all educational experience compared to traditional class room setting	Much better Slightly better No significant difference Slightly less Much less	1 1 4 1 1	2 5 10 1 2
Time for collaborative work in future classes	Much more time needed More time needed Current balance is right little less time needed Much less time needed	2 5 1 o o	1 12 7 0 0
Enhance the conferencing quality - audio	Yes, very much so Current quality is adequate	7 1	8 12
Register for future class on on the network	Yes No	5 3	18 2

SCHEDULING

In our model, class scheduling is coordinated between the two campuses such that class times coincide. The instructor can *originate the class from either site* providing not only a virtual instructor presence but also a real one. That is accomplished if the instructor wishes to alternate between origination sites so he/she can see and interact face to face with all students and thus maintain some of the advantages of the conventional single classroom setting. The authors encourage this to allow students at all sites to feel equally part of the course. If fortunate enough to have instructors at both sites, who can give lectures, that will be invaluable addition to the experience. Each instructor may teach every other session.

CURRENT AND FUTURE WORK

The authors are engaged in developing systems to deliver laboratory courses within the distance learning framework while maintaining flexibility for both students and instructors. One of the systems being investigated consists of a centralized laboratory equipped with data acquisition systems, communication access over the Plain Old Telephone Services (POTS), and software for an interactive "computer instructor." Students will be able to remotely dial into the system from any place with a telephone jack and a PC, construct an experiment from real hardware components, record experiment results while interacting with the system during the entire process. Interaction includesprelaboratry exercises, hints and help sessions if measurements do not match that of the expected. The INTERNET will be the access medium for this system. The details of these projects are part of an NSF grant proposal aimed at improving laboratory instruction in undergraduate engineering education.

In our project we are treating the INTERNET as one of the shared computer applications. The NETSCAPE browser will be integrated into the set of computer applications available to students during class and collaboration sessions. We believe this will enormously enhance our interactive distance education setting since it combines the strength of video communications over the public networks with the countless resources of the INTERNET and deliver the two features in one tool to students and instructors. Class materials available on the INTERNET will be accessible to students and instructors at both sites instantaneously during the lab, lecture and collaborative sessions.

CONCLUSION

In general, instructors and students rate this initial introduction of the interactive extension of the classroom as a positive experience and most encouraging is the remote site positive response to the survey. We believe we initiated an enabling project that is advantageous to all involved. It enables offering classes and extending campus sites despite geographical limitations. It also keeps the fundamental advantages of the conventional single classroom via allowing face to face interaction among all participating in the class including instructors an students. Above all is the ability to offer laboratory type courses in a distance learning setting. It enables colleges and universities to reach a wider population of students, increase collaboration among colleges and universities, and easily permits access of educational technology to both instructors and students. In addition this system will eventually allow colleges and universities to share resources to deliver an enhanced education and research activity. This setting will eventually evolve to easily allow a wider variety of laboratory based courses with the use of CD-ROM technology combined with the INTERNET and the multimedia conferencing technologies.

REFERENCES

1. "Narrow Band visual Telephone Systems and Terminal Equipment, " CCITT Recommendation, H.320

2. "Video Code for Audiovisual Services at Px64 kb/s," CCITT Recommendation H.26 1

3. "Frame structure for a 64 kb/s channel in audiovisual services, " CCITT RecommendationH.221

4. David A Berkley and J. Robert Ensor, "Multimedia Research Platforms," ***AT&T Technical Journal,*** September, 1995

5. K.C. Howell, "Introducing Cooperative Learning into a Dynamic Lecture Class", ***Journal of Engineering Education,*** January 1996.

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