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Synchronous Delivery of Engineering Technology Courses to a Remote Location – issues and challenges related to Technology and students’ learning

Abstract

Distance delivery of a course is a compromise between a true online classroom and a classroom having live audience. The issues and challenges related to synchronous delivery of lecture and laboratory based engineering technology courses to a remote location are discussed in this paper. In summer (2007), the institution has funded a project to develop the instructional materials for distance delivery of a course in Electrical and Computer Engineering Technology (ECET). The course have been offered to two groups of students, one as live audience on main campus and the other group at an extended campus through audio-video network. The delivery technologies included were Polycom® Audiovisual conferencing system and Virtual Network Computing (VNC).

This paper focuses on the challenges (and dealing with these challenges) as it relates to implementation of technology for synchronous bi-directional delivery and assessment of students’ learning through such delivery. Assessments of students’ learning are discussed in terms of pedagogy, learning environment, and students’ engagement. The benefit of such delivery as it is applied to an urban/commuter campus are also discussed from students and institutional perspective.

Introduction

Purdue University Calumet is a comprehensive University that offers Bachelor’s and Master’s degrees in Science, Technology, Engineering, Management, Education, Nursing and Liberal Arts. It is primarily a commuter campus with 9600 students. Additionally, 1400 students take classes at its Academic Learning Center (ALC) which is 17 miles away from the main campus. Seventy percent of Purdue University Calumet students work more than 30 hours a week and many of these students are enrolled for courses scheduled for evening hours. The institution is striving to accommodate more of its students by delivering course work at an accelerated rate, and through alternative deliveries that includes distance delivery of courses at ALC. This will allow students from surrounding three counties in Indiana to attend and take courses at a location closer to their home.

This paper describes the initiation, development and delivery of a laboratory-based ECET course through the synchronous distance delivery (SDD). The term SDD means that both distance learning and live classroom learning are taking place at the same time.

The objective of this initiative was to identify issues and challenges related to such delivery through actually delivery of one course (as pilot). This would allow identify areas that can be improved for effective delivery of similar courses in future through this delivery method.

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students’ learning through such delivery. Assessments of students learning are discussed in 
terms of pedagogy, learning environment, and students’ engagement. The benefit of such 
delivery as it is applied to an urban/commuter campus are also discussed from students and 
institutional perspective.

Technology and Its Implementation

This section describes the issues and challenges related to technology and its 
implementation. This includes discussion of available technologies and selection of the particular 
technology in terms of appropriateness, need, and justification that includes budget constraints.

Selection of Technology

In Synchronous Distance Delivery (SDD) of a course, a student can hear the instructor, 
ask questions, and see instructor’s computer screen regardless of classroom at which they are 
located. On the other hand, asynchronous distance delivery mode involves video streaming and 
DVD-based delivery. This mode of delivery has been adopted in the delivery of Engineering 
Technology courses at several institutions $^1,^2$. In asynchronous mode student can ask question 
and get answer but not instantly. In asynchronous mode the questioner must articulate the 
questions in words and then place the question.

Available technologies for synchronous delivery of a laboratory-based course are: 1) 
Polycom® Audiovisual Technology System, 2) Virtual Network Computing (VNC) and 3) 24/7 
Server System, Virtual Laboratory facility, 4) Multi-modal Synchronous classroom with two-
way audio/video conferencing capabilities and graphics using VNC technology and 5) Online 
Chat, both text and voice based. Synchronous delivery of courses has been adopted in some 
institutions $^3,^4$ by using only video conferencing technology. The delivery method described in 
this paper is multimodal that uses VNC technology, 24/7 server, in addition to video 
conferencing technology.

Polycom® is a technology used for audio video conferencing. It is like interactive TV. 
One can connect two or more sites and converse audio visually. Polycom® uses video-over-IP 
(TCP/IP based audio video conferencing) that connects over high speed internet connection. 
Thus wherever the internet travels this audio video signal can be received. Polycom® switcher is 
interface between TCP/IP networks. It switches the audio and video signal in and out of the 
network. The technology is usually incorporated into the distance delivery course because 
students and the instructor need to make verbal communication for lecture materials, questions 
and answers, and occasional usage of chalkboard for visual instructions. Polycom® technology 
uses one of network connections available in each of these locations to setup a microphone for 
audio, a camera and a display unit for video interface. Figure 1 shows classroom setup in each of 
these locations. The solid lines in the Figure 1 shows Polycom® network and dotted lines shows 
Ethernet network system. The heavy solid lines indicated wide area network through port among 
computer servers.

Virtual Network Computing (VNC) technology is usually used to capture and transmit 
instructor’s computer screen to the distance classroom. VNC is usually incorporated in the
distance delivery course because students need to see step-by-step instructions on the software tools from the instructor’s computer terminal. The VNC technology displays instructor’s computer screen at the distance classroom quite well. Furthermore, this is a shareware and requires no licensing fee.

24/7 server, Virtual Laboratory Facility is a high speed expandable computer server equipped to allow enrolled student to login and use commercial grade software tools to perform his/her assignments anytime from a distance location. This server system is for use by the students located in the remote classroom during class and laboratory demonstration. Students sitting in live classroom do not need to use this facility while they are logged on to the local server at the main campus.

Figure 1. Polycom® network and Ethernet network system, and Wide Area Network among Servers
Implementation of Technology

The project was implemented during fall 2007 semester. In SDD mode, syllabus, assignments (home work, laboratory and other assignments), schedule all are kept on a 24/7 computer server for the enrolled students to access though high speed internet access. Thus, a student can retrieve assignment and work on the assignment. When a lecture is being delivered a student must be present at one of the two locations, either in a classroom at main campus or at the ALC classroom. Time and day for each lecture was fixed and the semester schedule was included in the syllabus.

Polycom® audiovisual technology system (a mobile unit) was available at Purdue University Calumet on its main campus at Hammond, IN. Also, an entire classroom setup using this technology was also available at ALC. The setup allowed each student to have a microphone for asking question and a pair of audio speakers to listen to the lectures by the instructor. The two display units were used at each location for bidirectional video transmission. Initially, this technology was also used for displaying the instructor’s computer at the ALC. Transmitting instructor’s computer screen captured by the Polycom® camera was not very successful in terms of clarity due to the problem with glare. A separate camera was used at ALC to capture the classroom image and student activities and transmit to the live classroom at main campus. A projection monitor was used to deliver the instructional activity from the main campus to ALC. A TV monitor in the live classroom on main campus was used to create an interactive environment between the instructor on main campus and the students at ALC. Initially, the camera (in live classroom) was installed on a trolley/TV cart and with a little movement it caused glare on the monitor at the remote location. The VNC technology was implemented to display instructor’s computer terminal, to students at the remote location, and that removed the glare problem. Furthermore, each classroom (both at main campus and at the ALC) was provided with two projectors. One projector at each location was connected to display instructor’s computer screen through VNC technology. The second one was connected with Polycom® network system to display instructor and the chalk board, in the live classroom.

There was a little transmission delay experienced at ALC due to the pace of mouse movement by the instructor. However, this slower pace was insignificant, because, the instructor needed to allow enough time for the student (in both, live classroom and remote classroom) to be able to follow the step-by-step instructions and also for them to take written notes.

The university had purchased limited network licenses for Cadence software tools. As per the term of the contract, the university needed a license server for the tool. Cadence Software tools are extensively used in the Electronic System Fabrication course. The course consists of four parts. Learn the software tools (Cadence), Design PCB layout for nine electronic circuits, Populate PCB with components and perform functional testing and debugging on the circuit. Students in this course are not required to do actual PCB fabrication. Softcopy of students’ design and fabrication files (GerbTool files) are always sent to a commercial fabricator. First part of course was to learn Cadence’s Schematic Design and PCB Layout design tools. The second part of the course was to use these tools by logging onto the 24/7 server to complete nine assignments of progressive level of difficulties throughout the semester. This applies only when a student is logging in from outside ECET network from ALC. The students who were sitting in one of the laboratories in live classroom can directly login to the ECET network and use the
software tools. While working on an assignment a student could save his/her work on a local drive (USB jump drive or external hard drive) or print on a local printer. The latter was also true when a student logged on to the 24/7 server from a remote location. Students could also logged on to 24/7 server from various locations on main campus via several networked (including wireless network) computer laboratories.

The purpose of each student to seat, in front of a computer was to follow instructions from the instructor regarding the software tools to learn, use and complete the assignments. Each student in the distance classroom were also seating in front of a computer as in the live classroom. Figure 2 shows display of instructor’s computer screen in the live classroom. The group of students who were sitting in the distance classroom could see the instructor on one of the two screens, and the instructor’s computer terminal on another screen. Both screens were located in front of the students. In the live classroom, students could see the instructor and the instructor’s computer on one of the two screens in front of them. The other screen in the live classroom was displaying the distance classroom with students.

![Figure 2: Instructor’s Computer Screen in the Live Classroom](image)

As the instructor showed step by step process using the software tools, students at both locations could follow instructions on their own computers. If a student in the live classroom failed to understand, and could not follow a step, or had questions, then he/she could show hand and consequently, the instructor stopped and repeated the steps. On the other hand, students in distance classroom could show their hand and called for the instructor. These types of questions and answers created interruptions for all students at both locations. Therefore, the following protocol was established. The instructor would stop periodically to allow questions from both locations (during the same period) and respond through his/her computer terminal or spoke directly through audio-video link.

**Assessment of Students’ Learning**

The assessment of students’ learning was done under three categories; pedagogy, learning environment, and students’ engagement. The process included subjective and formative assessments. The formative assessments were conducted for students while subjective assessments were through interview and elaborate discussion with the ALC director, and two
technicians who facilitated the delivery at both, the ALC location and on main campus. There was 21 students enrolled in the course of which 18 attended the live classroom session on the main campus and other 3 attended the class at the remote location (ALC) at the same time.

Pedagogical assessment

The pedagogical assessment was done in terms of learning outcomes of the course (Electronic System Fabrication) delivered under this project. The objective of the course was for the student to learn the subject matter and apply the knowledge to perform course assignments. For this particular course, the objective was to learn the designing process of electrical and electronic circuit schematics and printed circuit board layout using Cadence software tools. Students were required to complete three homework, three laboratory assignments and three projects. Homework and laboratory assignments were provided by the instructor along with submission deadline for each assignment. Students needed to identify three projects having progressive level of difficulty based on given sets of criteria. First two projects dealt with the design of circuit board and the third project required fabrication of printed circuit board that was populated with components. Each student was then required to test and demonstrate functionality of the fabricated circuits. Deadline was firm for the third project because fabrication ready files (GerbTool files) were sent to an outside fabrication facility. Figure 3 shows students PCBs on an 18” X 24” panel (after fabrication) by a commercial PCB manufacturer. Figure 4 and 5 shows completed students’ project being demonstrated.

Figure 3:
Students’ PCBs on an 18” X 24” Panel after Fabrication by a PCB Manufacturer.
Students’ response to questions related to clarity on course objectives, accomplishment of course goals, instructor inspired interest in course materials, timely feedback by instructor, and clarity of instructor provided feedback, varied from "somewhat agree" to "strongly agree". Homework and laboratory assignments were evaluated for the assessment of, learning the software tools, and two design projects were evaluated for assessment of students’ gaining the knowledge on course topics. Finally, evaluation of the third project provided assessment of each student’s ability to produce fabrication ready files for actual fabrication of the printed circuit board. Therefore, the course grade of a student had direct correlation with his/her overall learning of the course material.

Average course grade for all 21 students was ‘B+’ and two out of three students who took the course at ALC received a grade of ‘B’ and one received an A in this course. An average grade of third project (fabrication, tests, and functionality) for all 21 students was ‘B+’, and two out of three students at ALC received a grade of ‘B’ and one student received an ‘A’. Therefore, it can be inferred that the students at the remote location (taught under Synchronous Distance Delivery) learned the course topics similar to students in the live classroom and were able to apply the gained knowledge to design and fabricate functional printed circuit board. It is also worth noting that the two of the students who attended at ALC and received an average grade of “B” were absent during two entire class periods. This in turn delayed their assignment submission and which resulted in lower grade average. Since this course was criterion and goal based, the time management by a student in any classroom (live or distance) could be a factor in their overall grade. Absenteeism and poor time management for assignments were prime reasons for lower grades in the course.
Learning environment

Out of three students, one had on-line course, one had SDD course and the third student did not have any experience with distance education course. Students have indicated that they had signed for SDD course for convenience, smaller class size, and as the last resort. Their concern indicated lack of trained individual to help them with software, and lack of readiness of computer, printer, and server at the first few days of the class. They have also indicated that it would help if someone would provide hands-on help. However, the students mentioned that the learning environment improved through the implementation of the VNC technology with which they had clear view of the instructor’s computer. Students did feel that there was too much to learn in the first month and sometimes it was difficult to resolve a question. Two students had indicated that they would take SDD course again and found the SDD environment better than the on-line distance delivery environment, however, one student responded “No” to this question. All students agreed that the 24/7 availability of software and the technical assistance (as pertain to assignments) were useful.

Students’ engagement

Students’ level of participation in the live classroom compared to that of distance classroom was not of much different. During the classroom presentation students from either classroom could raise their hand and ask questions to the instructor. For the students in the live classroom, instructor could go to the student’s computer and show his/her mistake, help identify the problem, and/or answer the question instantly. However, for a student at the remote location answer could not be provided instantly. Instructor first needed to determine where the student was having the problem and then show the answer on the instructor’s computer that could be viewed by the student in the remote location. This has caused some frustration among students in
remote location due to lack of hands-on help at the location. Similar problem was faced by the students in receiving feedback on their assignments. Students of the remote location can submit their assignment online but providing feedback on their assignment on-line was time consuming and some time it was impossible to provide. To alleviate such frustration, a courier service that would allow sending assignments to home campus for immediate feedback by the instructor could be a viable option.

Summary and conclusions

Performance of the students who attended the course concurrently in a remote classroom and in the live classroom showed very little differences in their earned grades in homework, laboratory assignments, and projects. One student of the distance classroom received a better grade than the overall class average. This showed that students were able to learn the course materials and successfully completed their assignments from (through a SDD course) a remote location. Two other students who attended the course from remote location had received grade that was same as the class average. Also, all 21 students (both at home campus and remote location) strongly agreed (3.56 on a scale of 4) that, the stated learning objectives were met for the course.

References

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