

Delivering Laboratory Based Courses Via Distance Education

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Abstract

Teaching distance education courses offers many challenges that are atypical of the “on-campus” instruction experience. Incorporating laboratory experiments and “hands-on” activities into the distance education courses present unique challenges for the instructor and the students. This paper describes the experiences professors with the New Mexico State University Department of Engineering Technology, Information and Communication Technology program have had with providing the distance education student with the opportunity to fully participate in the classroom/laboratory learning experience. Each professor presents a different technique for solving the laboratory dilemma. The techniques presented include the use of WebCT instruction exclusively, configuring Linux and Oracle Database servers to support the distance education classes, and lastly, custom developed CD laboratory videos coupled with WebCT assessments that provide the students with a virtual laboratory experience.

Introduction

The thought of delivering a laboratory course via distance education is certainly a concern for most colleges and universities. The question is, “Can a quality lab based course be offered to the remote students?” When discussions about offering a lab based course via distance education, most instructors will say that it is not possible or it won’t be effective. It was reported in the *20th Annual Conference on Distance Teaching and Learning*, that distance learning professional journals, conferences, and discussion boards cite numerous studies comparing the effectiveness of distance classes with face-to-face classes. This article reports that a well-designed on-line class is as effective and in many cases more effective than an equivalent face-to-face class. {1}

Today, university and college professors must look at distance education as an opportunity to expand our on-campus walls. Laboratory based courses will and must be part of the university’s distance education course offerings. This means that a solution must be developed that faculty and students readily accept. An article in the *Journal of Asynchronous Learning Networks* stated that offering distance labs for a laboratory science is a challenge but it must be met if undergraduate degree programs for distance learners are to be successful. {2} There are many reports that address the challenge of teaching science and engineering based course via distance education. {1}{3}{4}{5}. All of these articles present a method for solving the distance education dilemma. Their solutions include kitchen experiments for chemistry, using remote facilities for hosting the remote students, and providing self-contained laboratory kits.

The ICT program at New Mexico State University

In the fall of 2004, the department of Engineering Technology began offering a distance education degree completion program called Information and Communication Technology (ICT). The ICT curriculum covers the topics and concepts that are required to design, implement, and manage a variety of computer-based information technology systems. The curriculum includes the study of computer hardware, application and operating systems software, system integration, database design and management, networking, and network security. Many of the courses offered in the ICT program have a laboratory

base. The goal of the ICT program is to offer quality distance education courses for the off-campus student. These courses will include laboratory based computer technology studies.

ICT 362 Software Technology II

ICT 362, a computer programming language course as applied to the IT industry, was one of the first course offerings in distance education by the department. The course was taught using WebCT interface with some voice over lectures available on CDROM. Traditionally this course is taught in a computer lab with the instructor present and assisting students as problems arose. The most common problems were manipulation of code, debugging the code and application errors. Most of the problems were solved with one on one instructor assistance. Once the course was moved to the virtual arena the student's problems still existed, but how to virtually assist them?

To simulate the one on one relationship of a lab setting several techniques were instituted. First was the WebCT chat room. The students could log on during office chat room hours (in this case 3 times nightly per week) and ask the instructor for assistance if problems arose. If the problem was code related then the student would simultaneously send their code via WebCT email and the instructor would be able to discuss the problem "live". If it was an application problem it would be possible to walk the student step by step to a resolution of the problem. Another added benefit to the chat room is that a log is created and can be made viewable to the class as whole, thereby benefiting students with similar problems.

The second technique used was implementing the WebCT discussion module; again here it was used for the purpose of problem solving. If the instructor was unavailable the student could post the problem to the discussion module. The problem then could be discussed between students and by the instructor if need be. The feedback received via other students was able to replace the lab setting where students assist each other and learn in the process.

WebCT email was used extensively as well for students who wanted more private instructor input. The student's questions as well as the code could be emailed back and forth until a resolution of the problem was reached. This was the most time intensive of all the techniques for the instructor. And finally at times some students would require a more immediate private response. In this case students would call during working hours for verbal instructions as well as sending their code via WebCT. This would remove the lag time involved in emailing responses, but was not used often as most students are unable to call during working hours.

ICT462/463 UNIX and Linux Administration

The ICT 462 and ICT 463 UNIX classes use simulated and live UNIX based computer systems. The goal is to provide the students enough exercises, tutorials, and instruction so that when the class is completed, the student can enter a job where they will operate and maintain a UNIX based computer system or network. The course emphasizes making the student comfortable with the UNIX file structure, knowing how to get information in and out of the Unix system, and how to automate various procedures using Python Scripting. The labs are set up to present various real-life problems encountered on shared networks of Linux machines, Apache Web Servers and working with solving hacking problems that are encountered on a regular basis by companies using these servers.

A UNIX server was set-up on campus to accomplish the various lab tasks required for the course. The student can connect to the server using client software such as secure shell (**ssh**). For Windows based computers, a program called **putty** is recommended. For secure copy requirements, a program called **pscp** is used. From the start, students must use a secure shell program on their home or office machine to do almost all the labs the course requires. Most of the course material is accessed remotely using a web

browser. This method of studying and doing the course work becomes part of the lab work itself. The students learn all about the mechanics of logging in to a remote system. These tasks teach the students about UNIX security, one of the focuses of the course. Distance education itself, delivered in this way, is teaching the student about UNIX and Linux. The students are required to design UNIX/Linux software and transfer the application to a live web server.

The result of this real work, all done on the UNIX server housed on campus, is the virtual lab for ICT462/463. The students design web sites using a variety of tool including the python language. The students build directories and data structures on the remote Linux machine that can be viewed by the instructor and other students. Each task performed is a piece of a larger web site they are developing, as they design more complicated UNIX management tools.

ICT377 Computer Networking

The ICT 377 computer Networking class requires the extensive use of “hands-on” laboratory activities for the students to gain a satisfactory understanding and experience with the techniques needed to configure, maintain, and troubleshoot modern computer networks. This class requires that the students configure and assemble networks that incorporate the Windows XP and Linux operating systems, assemble LANs using network hubs, switches, and routers, and WANs incorporating CSU/DSUs, and modems. Meeting the challenge of expanding the laboratory experience for the distance education in computer networking required that multiple tools be developed. These tools included the following:

- I. Custom developed router simulation software.
- II. Custom produced Videos that demonstrate certain networking tasks which included videos of the following:
- III. WebCT laboratory quizzes
- IV. WebCT supplemental lab quiz material that further tests the students understanding of computer networking.
- V. Voice Over PowerPoint Lectures

The materials developed for this class are designed to provide the remote student with the opportunity to experiment with configuring computer networking equipment without requiring that the students have the equipment at the remote location. The Voice over PowerPoint lectures provide the student with pre-lab preparation. The videos (on CDROM) guide the student through the steps required for completing the networking lab. Additionally, the videos give the student a look at the equipment, the required installation and configuration. The router simulation software provides the students with a “real” challenge for configuring the router in multiple networking scenarios. The WebCT quizzes are then used to measure the students understanding of the lab objective. The objective of the WebCT lab quizzes is to make sure students have a satisfactory understanding of key computer networking concepts.

How effective is this method for delivering lab based distance education courses? A comparison was made with the laboratory and homework scores for the on-campus and distance education computer networking scores. Both groups were given the same WebCT lab quizzes and homework assignments. The average class grade for each assignment is provided in Table 1.

Table 1 – Comparison of the grades for the on-campus and distance education (remote) student.

Class	Lab Average	Homework Average	Class Average
ICT377 (remote)	80.5	82.1	81.3
ET377 (on-campus)	75.8	90.1	82.9

Table 1 shows that the class averages for the two groups are comparable indicating that each group has obtained a similar understanding of the objectives presented in the laboratories and lecture material. However, the on-campus students show a higher score for the homework relative to the remote student. The on-campus students have a lower lab average than the remote student. The difference in the average lab score is attributed to the fact that the “virtual labs” developed for the remote students don’t accurately depict the challenge faced by the on-campus students when completing a network exercise using real hardware and software. The lower on-campus scores indicate that actually doing the lab is much more difficult than the virtual exercise experience by the remote student.

Conclusion

Is offering laboratory based courses to the distance education students effective? The answer is, Yes. Are we achieving the course lab objectives by using these methods, Yes. Is quality of the courses being maintained? The answer is, Yes. The laboratory based courses are being successfully delivered with limited or no travel required for the student. Everything we are teaching involves the medium we use for delivering the course material, and therefore they are working with the very thing they are learning. This paper has shown that offering laboratory based courses to the distance education students has been a challenge but also a success for the Information and Communication Technology program at New Mexico State University.

References

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