Chapter 22
Developing Remote Labs for Challenged Educational Environments

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ABSTRACT

Most publications on online laboratories assume that all institutions have similar scenarios. Unfortunately, this is far from the truth. Many developing countries and disadvantaged colleges have challenges that hinder successful deployment of remote laboratories, whereas these challenges may not be applicable in more developed environments. In this chapter, we highlight these challenges and propose solutions. In doing this, we will draw from our experiences, garnered while developing labs in selected challenged environments.

INTRODUCTION

Much work has been done on online laboratories. The designs of these laboratories usually assume that there is abundant and adequate bandwidth and that power supply is constant. In addition, adequate funding levels and reliable networks are assumed. This is usually not so in many developing countries and disadvantaged colleges. Most books and articles on remote laboratories assume the above scenarios in all educational institutions. Unfortunately, this is far from the truth. Many developing countries and disadvantaged colleges have challenges that hinder successful deployments of remote laboratories. For such institutions, the Total Cost of Ownership (TCO) of online labs is usually higher than initially apparent because of hidden costs and the effort required to solve

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problems peculiar to their environment. Notwithstanding, the high initial and hidden costs do not diminish the overall benefits, when results like increased infrastructure, improved training and collaborations are considered. In this chapter, we highlight these challenges with two universities in mind, namely Obafemi Awolowo University in Nigeria and Texas Southern University in the USA. In particular, we will look at insufficient funding, lack of requisite equipment and software due to high purchase costs, inadequate infrastructure, lack of desired training and uncoordinated training resulting in low quality faculty members, insufficient bandwidth, power supply challenges, lack of consonance between labs and curriculum, lack of cooperation between colleges and low innovation levels. Drawing from our experiences while developing and using online labs in challenged environments, we will propose some ways to solve these problems or ameliorate their effects.

BACKGROUND

The rapid development of Internet technology and its increasing popularity has had an enormous impact on engineering. This technology provides new tools across the spectrum of engineering disciplines. Meanwhile, it also facilitates the development of additional teaching strategies, including vivid and interactive ways of illustration, simulation, demonstration, experimentation, operation, communication, and so on (Selmer et al., 2007). Broadband access and data compression allow for the delivery of audio and video streaming of lectures via the Internet. Nowadays, computer and Internet-based learning have become important parts of education. The 2009 Sloan Survey of Online Learning revealed that online learning enrollment rose by nearly 17 percent from the previous year. This survey of more than 2,500 colleges and universities nationwide found that approximately 4.6 million students were enrolled in at least one online course in the Fall semester of 2008. (Allen & Seaman, 2010).

A particular challenge for online education in engineering is how to extend the traditional hands-on laboratory experience over the Internet. Since the earliest days of engineering education, hands-on laboratories have been an essential part of undergraduate engineering programs (Feisel & Rosa, 2005); concepts taught through lectures are often complemented with laboratory experiments. Hands-on education allows students to imbibe the core principles of engineering by conducting experiments, observing dynamic phenomena, testing hypotheses, learning from their mistakes, and reaching their own conclusions. With the rapid progress of the microprocessor and communication technologies, more and more instrumentation can be reconfigured and controlled remotely. These new functionalities have been making remote hands-on training via the Internet possible. New developments in the way lab exercises are performed include the simulation of the lab environment, automated data acquisition and the remote control of instruments, all of which can proceed online.

Currently, there are two types of online labs: virtual labs and remote labs. The virtual lab is based on the use of computational, animation or modeling software to simulate the lab environment. Popularly used software in a virtual laboratory implementation includes LabVIEW, Matlab/Simulink, Java and Flash. Virtual labs can be used for experiments that would normally require equipment that is too expensive, unsafe (e.g. nuclear reactor) or unavailable. Virtual labs also allow students to repeat an experiment multiple times, giving them the opportunity to see how changed parameters and settings affect the outcome. One of the very important features of the virtual lab is that it lets the students learn from failures without causing any real damage. Although learning from failure is one of the thirteen objectives for the engineering education laboratory defined by ABET