International Journal of Computer Theory and Engineering, Vol.3, No.1, February, 2011
1793-8201

Enhanced Facilitation of Biotechnology Education in Developing Nations via Virtual Labs: Analysis, Implementation and Case-studies

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***Abstract*— Methods for educating students in biotechnology require intensive training in laboratory procedures. Laboratory procedures cost Universities in terms of equipment and experienced guidance which often come short in many developing countries. Universities need revitalizing approach and well-adapted curriculum especially in terms of laboratory practice. For enhanced education at the level of University-level laboratory courses such as those in biology or biotechnology, one of the key elements is the need to allow the student to familiarize laboratory techniques in par with regular theory. The Sakshat Amrita virtual biotechnology lab project focusing on virtualizing wet-lab techniques and integrating the learning experience has added a new dimension to the regular teaching courses at the University. Establishing virtual labs requires both domain knowledge and virtualizing skills via programming, animation and device-based feedback. This paper reports a cost-effective process used in virtualizing real biotechnology labs for education at Universities. The major challenge in setting up an effective knowledge dissemination for laboratory courses was not only the scientific approach of biotechnology, but included the virtualization aspects such as usage/design scalability, deliverability efficiency, network connectivity issues, security and speed of adaptability to incorporate and update changes into existing experiments. This paper also discusses an issue-specific case-study of a functional virtual lab in biotechnology and its many issues and challenges.**

***Index Terms*—virtual lab, e-learning, biotechnology virtual labs, virtual neurophysiology, sakshat amrita.**

I. Introduction

Software technologies developed by academic institutions as well as industries worldwide is revolutionizing the educational system. In particular, the use of virtual reality techniques is emerging as a new possibility in imparting training to students. Simulation is the most effective tool in training students in the use of sophisticated as well as complicated instruments that are routinely employed in modern biological and chemical laboratories. This technology circumvents the use of expensive and hazardous biological and chemical agents which toxic to the experimentalists as well as to the environment. Above all, the virtual lab technology is cheap as well as cost effective.

Many universities and research institutes from developed nations have realized the potential of this concept and have already launched their own virtual laboratories on the web, which are accessible to people around the world. It has already been established that the Virtual Lab enables the students to understand the underlying principles and the theory behind laboratory experiments. The procedure for operating an analytical instrument can be simulated by a mathematical and/or empirical model. Using this virtual model, the student is trained in optimization, calibration and method development for the simulated sample. E-learning plays and will play an important role in diverse regions such as India where the traditional lab facilities at Universities are not very well localized to suit requirements of all sub-regions. With multi-campus scenarios as in some Universities including ours, offering cross-disciplinary courses needs to exploit the use of extensive e-learning facilities (unpublished observation but see [3]).

Biotechnology lab courses richly rely upon new up-to-date content and various techniques that require a new synergy of knowledge and experimental implementation. Hence a new kind of experimental science that can be brought as a virtual simulation based laboratory is necessary. The developments of the virtual labs include mathematical techniques in biology to study, to hypothesize and to demonstrate complex biological functions. However virtual labs in heavy engineering topics such as analyzing nanomaterials with high-power microscopes and lab courses in biotechnology or biology will also have to exploit multiple techniques besides simulators alone as many scenarios cannot be reproduced mathematically while retaining the “real” lab-like feel.

In this paper, we focus on the development on the virtualization of biotechnology lab courses through a combination of techniques to try completing the learning experience as that of a regular University laboratory.

Manuscript received December 20, 2009. This work is funded under the Sakshat project of National Mission on Education through ICT, Department of Higher Education, Ministry of Human Resource Department, Government of India.

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