

Remote laboratories

- from learning objectives to infrastructural considerations -

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Abstract — Before applying technology in education, some evaluation must be made so it can be accepted by students and teachers. Internet and Personal Computers (PCs) are currently well accepted solutions, and have been contributing to the appearance of several E-learning courses, and more recently to the Remote Experimentation concept that comprehends the use of remote laboratories (or weblabs) in education. This paper analyzes remote laboratories focusing on learning objectives and on infrastructural considerations.

Keywords: Remote experimentation, Remote laboratories, weblabs, learning objectives.

I. INTRODUCTION

Currently, knowledge is crucial in a society with increasingly demands in every domain. If technology is contributing for this trend, imposing more technical skills to everyone, at the same time it also acts as a facilitator, providing easy access to resources/tools for students' learning outcomes. This is especially true with the Internet widespread, since it facilitates disseminating information using several multimedia resources. It is enhancing the traditional school, providing mix learning environments (blended learning/flexible learning/mix learning) with resources/tools for online teachers' instruction and students' learning. However, they must be well analyzed before being adopted in educational scenarios. Two models can be applied for that purpose, namely: the i) Unified Theory of Acceptance and Use of Technology (UTAM) for evaluating their acceptance, and the ii) Innovation, Research, Implementation and Systematization (IRIS) for understanding how to apply them in an educational scenario. The UTAM, defined by Venkatesh et al. [1], describes a theory indicating that technology acceptance depends on: i) the degree on which people believe that using it will help them to acquire performance in specific tasks (performance expectancy), ii) how easy it is using it (effort expectancy), iii) the influence that others may have on its adoption (social influence) and, on the believes that organizational and technical infrastructures provide good technical support for those technologies (facilitating conditions). The IRIS model, developed by Siemens et al. [2], defines innovation as the first step to evaluate what is possible to do with new technological resources/tools followed by a research on how to apply and implement them in real educational scenarios. Implementation and research is described as a cycle that may lead to a systematization process that enables duplicating innovative solutions in education.

Thus, applying technologies in education can enhance learning, as described by the term Technology Enhanced Learning (TEL). However, they must be previously evaluated, focusing on the added value that they bring to improve students' learning outcomes. In current era, PCs and Internet are cases of well accepted technologies, proved by the number of online courses available supported on several resources/tools. Traditionally, those courses are associated with the E-learning concept. It defines a process of learning that applies to the use of technology (e.g. PCs and Internet), and comprehends several other definitions usually available in literature, as briefly presented in table 1.

TABLE 1: COMMON DEFINITIONS USED WITH THE E-LEARNING CONCEPT.

Computer-Based Assessment (CBA) or Computer-Based Testing (CBT)
Refers to the use of computers or an equivalent electronic device for assessment purposes.
Computer-based learning (CBL), Computer-Based Trainings (CBTs) or Web-based training (WBT)
Refers to the use of computers as a key component for education.
Virtual Learning Environment (VLE)
Is a software system designed to support online teaching and learning. Other definitions are also available, some with the same meaning and other focusing on a specific part of the learning environment (e.g. MLE, LMS, LCMS, etc.).
Managed Learning Environment (MLE)
Focus on VLE management systems.
Learning management system (LMS)
Is a software application for the administration, documentation, tracking, and reporting of training programs, classroom and online events, e-learning programs, and training content.
Learning content management system (LCMS) or Content Management System (CMS)
Is a related technology to the LMS focused on the development, management and publishing the content that will typically be delivered via an LMS.
Open Course Ware (OCW)
Term applied to course materials in a VLE created by universities and shared freely with the world via the Internet.
Computer Supported Cooperative Work (CSCW)
Is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques.
Computer-supported collaborative learning (CSCL)
Refers to the adoption of innovative solutions to improve teaching and learning with the help of modern information and communication technology such as PCs and Internet. Most recent developments in CSCL have been called E-Learning 2.0.

More recently, E-learning has being extended to other contexts, namely the ones that use mobile devices (M-learning) and to others that enable remotely conducting laboratory experiments required by Sciences and Engineering (S&E) courses (Remote Experimentation). This is achieved by the so-