Chapter 69
Remote Access to Scientific Laboratory Equipment and Competency-Based Approach to Science and Technology Education

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ABSTRACT

This article describes the competency-based approach to e-learning education that utilizes remote access to the laboratory equipment. The main focus of the paper is the structure and design of the e-learning system used in the Southern Federal University (Russia). The article discusses the related pedagogical strategies and presents system's features in the context of the education for skilled workers. This approach uses access to the scientific and technology laboratory equipment either for provisioning of the individualized educational programs or to enable the students who are unable to attend a conventional laboratory for a variety of reasons, such as disability, and part-time study to conduct the experimental work. It will be shown that the experimental work involving the modern scientific equipment is an important aspect of the learning process in the areas of material science and nanotechnology. The learning strategy is the reverse of that used in the traditional approach. The authors suggest to start with the introduction to the practical applications of science and technology relevant to the current job market, and study the general laws and theoretical principles afterwards, to deepen understanding and achieve the educational goals.

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INTRODUCTION

Technical education involves the purposeful application of mathematical and natural sciences, technology and techniques. It must efficiently use available resources, protect health and safety, be cost-efficient and environmentally sound, and generally manage risks throughout the entire lifecycle of the learning process.

In an era of high technology, many problems of the scientific and technological progress can often be solved only with the help of the very complex, often unique technological equipment and scientific instruments. Therefore, such expensive and rare devices are necessary for the effective educational process in the area of science and technology. To ensure the efficiency of the learning process, the technical education qualifications have been developed based on the outcomes-based criteria and professional competencies while taking advantage of the new pedagogical strategies and education technologies.

Laboratory work is recognized as a key element of many educational disciplines, particularly in the nanotechnology and the applied sciences (Ahmed, 2012). The ubiquity of network access and the increasingly complex delivery and study patterns of students have led to a steady increase in the development of remote laboratories over the last decade. When utilized to support the appropriate educational objectives these laboratories have a number of major benefits including significantly enhanced flexibility and convenience for students, improved reliability, reduced maintenance costs and the opportunity for sharing laboratories across multiple universities.

REVIEW OF LITERATURE

During the past 20 years of Web and information technology development, e-learning systems have been widely used in higher education (Kim & Bonk, 2006). As the use of e-learning has increased, so has research into those factors affecting learners' attitudes toward e-learning (Fuller, 2012; Lee, Tseng, Liu, & Liu, 2007).

E-learning is one of the most promising applications of network and information technologies, and characterizes the most recent evolution of distance learning representing a situation in which instructors and learners are separated by distance, time, or both. Essentially, e-learning is the use of the telecommunication technology to deliver information or knowledge available to learners regardless of time restrictions or geographic proximity, and the learning environment is emerging as the new paradigm in education (Shee & Wang, 2008). This approach to learning expands the scope of interaction, between learners and instructors (through the software), and among learners, removing limitations of time and space through the use of asynchronous and synchronous learning tools; thus satisfying the educational requirements and expanding the demand for higher education (Sun, Tsai, Finger, Chen, & Yeh, 2008; Fengfeng, 2013).

As e-learning environments have grown, so grew the interest of researchers and educators in the students' self-regulation in e-learning. Self-regulated learning is an active process of development in which learners set goals for their learning based on past experiences and the contextual features of the current education. Recent years has seen a growing adoption of the electronic portfolio (ePortfolio) practice in higher education and professional training. ePortfolios are commonly characterized as a constructive learning tool by which students can become involved in a self directed process to keep track of learning progress for course assessment (Cang &Chau, 2013).

The concept of using the remote control (remote access to equipment) in science and technical education is not new. Scientists often use the advantages of the remote access when they cannot perform an experiment in a laboratory physically or in the case of danger. Recently, number universities have made many advances in implementing