Chapter 5
Designing, Developing, and Evaluating a Cloud-Based Laboratory for Online STEM IT Students

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ABSTRACT

In an IT learning environment, hands-on learning is central to one's learning. Many previous studies found that STEM students who were taught through a hands-on learning method, as opposed to only the textbook and lecture method, showed higher comprehension of the concepts. Hands-on labs and experimenting expand a student's understanding and appreciation of science. For many years, traditional IT program instructors have been able to integrate hands-on approaches into the classroom. Although hands-on laboratory exercises are integral to a successful IT program, e-Learning students in IT do not have the same laboratory experience as onsite students. Consequentially, there is a problem with e-Learning IT students not acquiring all the essential hands-on skills with equipment used in the IT industry. In this chapter, we present a solution which is based on private cloud computing and can be used to build a laboratory and learning environment for a variety of online hands-on IT courses including Wireless System, IP Telephony and Server Application. Students, as cloud clients, can access the server by web access through VPN connection.

1. INTRODUCTION AND BACKGROUND

STEM is an acronym for Science, Technology, Engineering and Math education. The skills and knowledge in each discipline of STEM are deeply intertwined in the real world. It is an interdisciplinary and applied approach that is coupled with hands-on, problem-based learning. Hands-on practice expands a student's understanding and appreciation of science. Experimenting can encourage students to explore new ideas, which

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can lead to increased confidence and competence in the science, engineering, technology, and math (STEM) fields. Nurturing these hands-on skills will help STEM students find satisfying careers and solve issues (Lunt, Ekstrom, Gorka, Hislop, Kamali, Lawson, LeBlanc, & Reichgelt, 2008)

In addition, hands-on learning has been a well-known practice allowing a learner to apply concepts taught in class. Blooms Taxonomy, Kolb's theory of experiential learning, and numerous other studies all support the need for learners to learn in a hands-on environment (Forster & Jazayeri, 2010). Many previous studies found that students who were taught through a hands-on learning method, as opposed to only the textbook and lecture method, showed higher comprehension of the concepts.

Although hands-on laboratory exercises are integral to a successful STEM program, e-Learning students do not have the same laboratory experience as onsite students (Leitner & Cane, 2005). Consequentially, there is a problem with e-Learning STEM IT students not acquiring all the essential hands-on skills with equipment used in the IT industry. In a traditional IT program, a hands-on approach generally requires the students to work on lab equipment, and the equipment is typically identical to devices used in the industry. The lab equipment is almost always isolated from internet denoting it is impossible for an e-Learning student to remotely access the lab. A few workarounds do exist including the use of simulation software, to require students to use their own equipment, or to procure specialized lab equipment that can be remotely accessed, each workaround having its own advantages, problems, and limitations (Leitner & Cane, 2005).

In this chapter, we first investigate several IT technologies that can improve an IT e-Learner's opportunity to experience quality hands-on learning. Then, we present a solution which is based on private cloud computing and can be used to build a laboratory and learning environment for a variety of online hands-on IT courses including Wireless System, IP Telephony and Server Application. Students, as cloud clients, can access the server by web access through VPN connection.

2. IT LABORATORY TECHNOLOGY

There are several laboratory options for IT learners to include onsite laboratories, remote laboratories, and simulation laboratories, each having its own advantages, problems, and limitations.

2.1 Onsite IT Laboratory

To begin with, onsite IT laboratories commonly contain similar or identical equipment that is used in the IT industry (Li, Toderick, Li, Mohammed, & Lunsford, 2008). Routers, switches, servers, and network cabling are all common equipment seen in IT laboratories. A fundamental lab setup for an onsite IT laboratory can be seen in Figure 1.

Figure 1. A typical onsite IT laboratory