Design and Evaluation of a Technological-enhanced Lab Environment for a Systems and Network Administration Course

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Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

Tareq Alkhaldi
Statement of Authorship

I hereby certify that the work embodied in this thesis contains published papers of which I am a joint author. I have included as part of the thesis a written statement, endorsed by my supervisor, attesting to my contribution to the joint publications.

Tareq M. Alkhaldi

By signing below, I confirm that Tareq Alkhaldi contributed to the following publications:


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List of Acronyms

CA  Constructive Alignment
DBR  Design-Based Research
ELC  Experiential Learning Cycle (Kolb, 1984)
ICT  Information, Communication and Technology
LMS  Learning Management System
PLTs  Pedagogy and Learning Theories and Principles
SAT  Students Satisfaction
TAM  Technology Acceptation Model
TePF  Technology-enhanced Pedagogical Framework
VCL  Virtual Computer Laboratory
VM  Virtual Machine

Further details are presented where appropriate in the relevant chapters.
Abstract

Advances in technology are influencing all fields including education. Recently, we have observed a wide use of emerging technologies to support and facilitate the establishment of virtual laboratories with many benefits that overcome the constraints of traditional physical laboratories. These laboratories provide a number of advantages such as remote 24/7 access, flexibility, freedom to learn at one’s own pace, to reset/retrial experiments without wasting resources in a safe environment and providing new opportunities for learning. Although virtual and remote laboratories provide many new opportunities for learning, they have not necessarily been shown to assist students in achieving higher learning outcomes. How do we design technology-enhanced lab environments for effective learning?

To answer this research question, this thesis conducts a comprehensive literature review on technology-enhanced lab environments. In the literature review, we observe that pedagogical techniques integrated with virtual lab environments provide the best outcomes for student learning. Based on the findings, a hypothesis is proposed that considers a holistic view of designing technology-enhanced lab environments taking into consideration learning context, curriculum, learning activities, assessments, technology artefacts based on pedagogical and learning theories and principles (PLTs).

To validate the hypothesis, a technology-enhanced lab environment is developed and evaluated for a particular learning context: a systems-level course in computing. A literature review on technology-enhanced lab environments in systems level courses in computing reveal that only a few studies consider pedagogy in the design of such lab environments.

In this thesis, we propose, design and evaluate a comprehensive pedagogical framework that incorporates both technological and pedagogical considerations for teaching in a network and system administration course. The framework incorporates learning theories and principles, such as Biggs’s Constructive Alignment, Kolb’s Experiential Learning Cycle (ELC), in its design and innovative technology tools such as virtual labs and feedback tool.

The proposed framework is developed in two iterations and evaluated in real-world classroom environments following a Design-based Research (DBR) methodology. The evaluation consists of student perceptions of the proposed framework using mixed methods and the impact on student learning. In the first iteration, two architectures for virtual labs implementation and a feedback tool are developed and evaluated. A quasi-experiment is conducted to evaluate the impact of the technology intervention. The results provided useful insights that guided the design of the second iteration.

In the second iteration, the proposed framework is implemented and evaluated in its entirety. A quasi-experiment was conducted and students’ assessments scores were compared. The results showed that the students in the experimental group, who were subjected to the proposed framework, scored higher marks which was statistically significant than the students who did not use the proposed framework. Furthermore, the findings indicated that the learning process encouraged a deep approach to learning. These results not only provided evidence of higher learning outcomes by students but also that a deeper learning process was undertaken when using the proposed framework. The lab activities incorporated the PLTs in their design, and the benefit of this approach was validated, supporting the hypothesis. Furthermore, components of the framework were evaluated providing useful insights and suggestions for improvements in future.

Finally, we reflect on the overall process used in the design, implementation, and evaluation of the framework. From this activity, design principles are derived that provide guidelines/principles to designing technology-enhanced lab environments for effective learning in future.
List of Publications

Dissemination: Journal articles:


Conference Paper: