

**Joel S. Mtebe**

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**Acceptance and Use of eLearning  
Solutions in Higher Education in  
East Africa**

**ACADEMIC DISSERTATION**

To be presented with the permission of the School of Information Sciences of the  
University of Tampere, for public discussion in auditorium Pinni B1096  
on October 31<sup>st</sup>, 2014, at noon.

School of Information Sciences  
University of Tampere

Dissertations in Interactive Technology, Number 18  
Tampere 2014

## ACADEMIC DISSERTATION IN INTERACTIVE TECHNOLOGY

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Acta Electronica Universitatis Tamperensis 1481  
ISBN 978-951-44-9628-8 (pdf)  
ISSN 1456-954X  
<http://tampub.uta.fi>

The originality of this thesis has been checked via the Turnitin OriginalityCheck service in accordance with the quality management system of the University of Tampere.

### Dissertations in Interactive Technology, Number 18

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ISBN 978-951-44-9614-1 (print)  
ISSN 978-951-44-9615-8 (pdf)

Juvenes Print – Suomen Yliopistopaino Oy  
Tampere 2014

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# Abstract

The significance of eLearning solutions to overcome challenges facing the education sector in the East African countries cannot be overstated. Appropriate use of eLearning has potential to reduce costs, to widen access, and to improve the quality of teaching and learning. Although eLearning solutions have been successfully implemented in many developed countries, the degree of acceptance and usage is low in the majority of higher education in East Africa.

The aim of this thesis was to investigate factors that influence acceptance and use of various eLearning solutions in higher education in East Africa. It is a compound thesis comprising five articles that describe four distinct case studies. The first two of the studies adopted and applied the unified theory of acceptance and use of technology (UTAUT) model to investigate students' and instructors' acceptance and use of mobile learning and open educational resources (OER).

The results of the two case studies reveal that all four factors examined – performance expectancy, effort expectancy, social influence, and facilitation conditions – had a statistically significant effect on students' acceptance of using mobile learning, while only effort expectancy had a statistically significant effect on instructors' acceptance of using OER. A follow-up study revealed that lack of access to computers and the Internet, low Internet bandwidth, absence of policies, and lack of skills in creation and/or use of OER were the main barriers to OER use.

The third case study applied the total cost of ownership (TCO) method to compute the cost of hosting eLearning applications and to compare between an on-premises and cloud-hosted approach. The results showed that institutions could save more than \$40,000 in three years by hosting eLearning services in the cloud. The final case study developed and validated an eLearning system success model by extending the updated DeLone and McLean (D&M) model of information systems success with a sample of 201 students who were enrolled in a Moodle-based system at the University of Dar es Salaam, Tanzania.

The results described in the thesis should enable institutions to find strategies that promote greater use and acceptance of eLearning solutions in higher education in East Africa. They also give developers tools to develop eLearning services that are relevant and acceptable to intended users.

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# Acknowledgements

My journey to doctoral studies started when I came to Finland in 2009 in connection with a study tour organized by the Information Processing Association of Tampere Region (PITKY). It was during this visit that I showed an intention to study in the Finnish university system, but my intention became reality only once I met Prof. Roope Raisamo, in 2010. In our conversation of only 30 minutes in his office, I was convinced that the University of Tampere was the best place for my studies.

I would like to express my very great appreciation to Prof. Roope Raisamo, my supervisor, for the valuable advice and support he has given me during the course of my studies. Despite his busy schedule, he has been able to find time to read my work and to provide insightful feedback. His willingness to give his time so generously has been very much appreciated.

I wish to express my sincere gratitude to the University of Tampere for providing me with all of the facilities required for completion of my studies and to the University of Dar es Salaam and the South African Institute of Distance Education for their financial support. Special thanks are extended to the project coordinators, Dr. Hashim M. Twaakyondo (R.I.P.) and Dr. Mussa M. Kissaka, for their support. My thanks also go to Prof. Mwinyiwiwa Bakari, for his mentorship during my studies.

I would also like to thank Kristina Nokso-Koivisto and her family for their encouragement and kindness during my stay in Tampere. She introduced me to so many friends who were helpful during my time in Finland. I also express my thanks to all of the PITKY members - including Jukka Siltanen, Timo Nevalainen, Karoliina Leikomaa, Jussi Hannunen, Heli Jussila, Hanna Teras, and Marko Teras - for their support during my time in Finland.

Finally, my deepest thanks go to my family, especially my loving wife Sophia Rashid, my beautiful daughter Clara, my dearest sons Carlos and Craig, and my uncle Baitoni, for the love, understanding, and support they have shown in the face of my partial absence during my studies. Finally, I am most grateful to my father Nyarubwa Mtebe (R.I.P.), my mother Clarence Mpumba (R.I.P.), and my grandparents John Masimba (R.I.P.) and Bi Moshi.

In Tampere, October 2014

*Joel S. Mtebe*

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# List of Publications

This dissertation consists of a summary and the following original publications, reproduced here by permission.

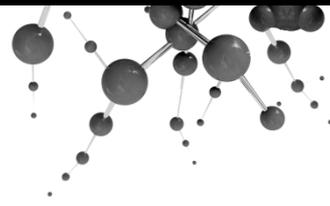
- I. Mtebe, J. S., & Raisamo, R. (2014). Investigating students' behavioral intention to adopt and use mobile learning in higher education in East Africa. *The International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, 10(3), 4–20.
- II. Mtebe, J. S., & Raisamo, R. (2014). Challenges and instructors' intention to adopt and use open educational resources in higher education in Tanzania. *International Review of Research in Open and Distance Learning*, 15(1), 250–271.
- III. Mtebe, J. S., & Raisamo, R. (2014). Investigating perceived barriers to the use of open educational resources in higher education in Tanzania. *International Review of Research in Open and Distance Learning*, 15(2), 43–65.
- IV. Mtebe, J. S., & Raisamo, R. (2014). eLearning cost analysis of on-premise versus cloud-hosted implementation in sub-Saharan countries. *The African Journal of Information Systems*, 6(2), 48–64.
- V. Mtebe, J. S., & Raisamo, R. (2014). A model for assessing learning management system success in higher education in sub-Saharan countries. *The Electronic Journal of Information Systems in Developing Countries*, 61(7), 1–17.

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# The Author's Contribution to the Publications

The publications presented in this thesis are co-authored with my supervisor, Prof. Roope Raisamo. My personal contribution to all of the articles was in planning the studies, conducting the research, reporting the results, and drafting the articles. My supervisor revised the articles and provided comments before they were sent to the journals for publication.





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# 1 Introduction

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## 1.1 OBJECTIVE

The significance of eLearning solutions to enhance of higher education in East Africa cannot be overstated. The eLearning solutions are believed to have the potential to widen access, reduce costs, and to improve the quality of education in Africa (Andersson & Grönlund, 2009) while also helping institutions meet the demands of a growing student population through technology-enhanced distance learning and complementing existing traditional face-to-face delivery (Unwin et al., 2010).

In light of these benefits, it is not surprising that institutions and international agencies have been spending many thousands of dollars to pilot and implement various eLearning solutions in the region (Farrell & Isaacs, 2007). For example, the African Development Bank Group (AfDB) provided a grant of \$15.6 million to African Virtual University (AVU) to build e-learning centers and train content developers at 31 partner institutions in Africa (Adkins, 2013). Seven of these institutions are in East Africa. Similarly, the Partnership of Higher Education Africa (PHEA) has given funding to seven institutions in Africa (three of them in East Africa) to implement various eLearning solutions (Hoosen & Butcher, 2012).

Regardless of these initiatives from both institutions and international agencies, the degree of uptake and usage is low (Lwoga, 2012; Ssekakubo, Suleman, & Marsden, 2011; Unwin et al., 2010). This low use of eLearning solutions implemented in higher education is normally described as technology failure (DeLone & McLean, 2003; Venkatesh et al., 2003). Such failures are likely to be high on account of the limited availability of resources in Africa (Heeks, 2002).

Davis, Bagozzi, and Warshaw (1989, p. 982) have stated as follows:

Computer systems cannot improve organizational performance if they aren't used. Unfortunately, resistance to end-user systems by managers and professionals is a widespread problem. To better predict, explain, and increase user acceptance, we need to better understand why people accept or reject computers.

The thesis project was undertaken to investigate factors that influence users to accept and use various eLearning solutions in higher education in East Africa. The findings from this thesis aims to help institutions to find strategies that promote greater use of eLearning solutions in the their institutions.

The study was influenced by two main motivations. First, much of existing studies have been focusing on contextual and infrastructural challenges that affect the adoption and usage of eLearning solutions (Lwoga, 2012; Ssekakubo et al., 2011; Unwin et al., 2010). However, even institutions in countries such as South Africa and Kenya widely regarded to have reliable ICT infrastructure have been experiencing a low uptake of eLearning solutions.

Second, most previous studies are not based on empirically grounded evidence, and they assume that all African countries face similar challenges. While commonalities do exist among these countries, there are also considerable diversity and a broad range of challenges (Bateman, 2008). The need to investigate challenges affecting the implementation of eLearning solutions specifically in East African institutions is important for enabling institutions to create eLearning services that are relevant and acceptable.

The thesis synthesizes five articles, which cover four case studies. The first two case studies investigated students' and instructors' acceptance and use of mobile learning and open educational resources (OER), respectively. The third case study developed and validated an eLearning system success model through extension of the updated DeLone and McLean (D&M) model, using a sample of 201 students who were enrolled in a Moodle learning management system (LMS) at the University of Dar es Salaam, in Tanzania. The final case study applied the total cost of ownership (TCO) method to compute and compare the cost of hosting eLearning applications with an on-premise and cloud-hosted approach.

## 1.2 CONTEXT

In the past few years, higher education institutions in Africa have been adopting various eLearning solutions to enhance education. As of 2006, 54 institutions in 27 African countries had adopted various eLearning solutions, of various types, for their campuses (Gakio, 2006). Similarly, 74% of 447 users, across 41 African countries, were using various

eLearning solutions, 48% of them cell-phone-based, 36% involving shared-resource computing, and 29% desktop virtualization (Isaacs & Hollow, 2012). Additionally, a recent eLearning Africa conference report, from 2013, states that 83% of the 413 respondents, from 42 African countries, were using laptops, 71% cellular phones, and 67% standalone computers for teaching and learning (Isaacs, Hollow, Akoh, & Harper-Merrett, 2013).

The number of eLearning systems implemented in Africa has been increasing too. For instance, five institutions surveyed by Ssekakubo et al. (2011), six by Lwoga (2012), and seven institutions that participated in the PHEA project were found to have installed various eLearning systems, of several types (Hoosen & Butcher, 2012). Eleven of these institutions were based in East Africa. In Tanzania, almost 80% of the relevant institutions had installed various eLearning systems by the end of 2011 (Munguatosha, Muyinda, & Lubega, 2011).

Regardless of the continued adoption of various eLearning solutions in Africa, their actual usage is reported to be low across the continent (Ssekakubo et al., 2011; Unwin et al., 2010). About 49% of the 413 respondents from 42 countries who attended the 2013 eLearning Africa conference indicated that eLearning solutions had been implemented but their usage was low (Isaacs et al., 2013). In some institutions, solutions had been implemented but immediately abandoned.

Among East African institutions, for instance, there were only 60 users of the eLearning system installed at Makerere University, in Uganda (Mayoka & Kyeyune, 2012); fewer than 10 users at Kenya's University of Nairobi (Ssekakubo et al., 2011); and 767 users at the University of Dar es Salaam. Studies have also revealed low usage of systems at the Open University of Tanzania (Bhalalusesa, Lukwaro, & Clemence, 2013) and the one at Maseno University, in Kenya (Unwin et al., 2010). Low usage or non-use of eLearning solutions at institutions in East Africa is becoming a commonplace phenomenon.

The same situation has been observed in the adoption and implementation of OER in Africa. For instance, in 2010, AVU received funds from AfDB and developed 219 learning resources (in English, French, and Portuguese) to be shared and used at no charge by institutions in Africa (Richards, 2013). However, most users who have been accessing these resources are from outside Africa, with more than 250,000 accesses having been from Brazil. Moreover, MIT OER statistics show that only two percent of users since 2004 have accessed MIT OER from Sub-Saharan Africa (MIT, 2014).

In conclusion, although there is a large volume of studies describing how eLearning solutions can overcome challenges facing the education sector in Africa today, the reality on the ground is totally different. People do not actually use the eLearning solutions made available to them. The

examples presented in this subsection give a snapshot of the situation in many institutions in East Africa.

### 1.3 METHOD

For the study described here, data were collected from institutions in Tanzania and Kenya. Institutions from Tanzania include the University of Dar es Salaam (UDSM), the College of Business Education (CBE), Dar es Salaam Institute of Technology (DIT), the Institute of Finance Management (IFM), Mkwawa University College of Education (MUCE), St. John's University of Tanzania (SJUT), and the University of Dodoma (UDOM). Other Tanzanian institutions covered are the State University of Zanzibar (SUZA), Zanzibar University (ZU), the Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha University (AU), the Institute of Accountancy Arusha (IAA), the Open University of Tanzania (OUT), Ardhi University (AU), and Tumaini University Makumira (TUM). Kenyatta University was included also, from Kenya.

The research utilized both quantitative and qualitative methods to gather data from students and instructors at each institution. The unified theory of acceptance and use of technology (UTAUT) model was used as a basis for gathering quantitative data, with the aim being to understand instructors' and students' OER and mobile learning acceptance, while the D&M model was used to develop and validate the model for evaluation of eLearning systems' success. In both cases, data were tested against the proposed research models by means of multiple regression analysis with the Statistical Package for the Social Sciences (SPSS).

The qualitative data were obtained mainly through document review and semi-structured interviews. A qualitative approach was adopted to allow re-assessment of the contextual and infrastructural challenges that affect users' adoption and use of OER. Additionally, the qualitative method were necessary to shed further light on the quantitative data, since many factors were not found by quantitative research methods to be statistically significant.

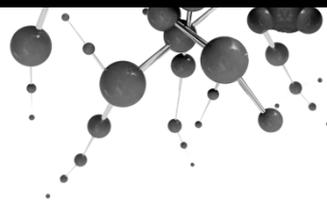
Finally, the TCO method was applied for computing the costs of implementing eLearning and comparing between a cloud-based architecture and an on-premise architecture. This is a widely used method of calculating the capital and operation costs associated with owning and managing ICT infrastructure in a given organization.

### 1.4 STRUCTURE OF THE THESIS

The thesis is composed of a summary and five published articles. Chapter 1 presents the objectives and context of the study, orienting the reader for understanding the motivation, the research problem, and the context

wherein the individual case studies were carried out. This is followed by chapters 2 and 3, which review the literature on technology acceptance models and information systems success models, respectively.

Chapter 4 presents related studies conducted in Africa on acceptance of various technologies and then looks at contexts (outside Africa) wherein information success models have been employed. The core of the work is presented in Chapter 5, which gives a summary of the five articles, along with one further study which complement the main research results. This section is focused on the objectives and the major findings presented in each article. Finally, Chapter 6 offers general discussion, and conclusions are presented in Chapter 7.



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## 2 The Technology Acceptance Models

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One of the biggest challenges facing managers of the 21st century is how to maximize the use of the information systems installed in their organizations. While organizations worldwide have continued to invest in information systems in order to improve service delivery and to attract more customers, it is not uncommon to find users not using the systems made available to them. Consequently, organizations fail to realize the benefits that had been promised by the investments made. The need to predict and to explain users' acceptance and use of a given system becomes important in the pursuit of appropriate corrective measures that will maximize usage (Davis et al., 1989).

There is a body of literature dealing with attempts to propose various models designed to predict and explain why some users might use or reject systems implemented in various contexts. The most popular models are:

- The theory of reasoned action,
- The Technology Acceptance Model,
- The Technology Acceptance Model 2, and
- The unified theory of acceptance and use of technology.

In the next section, these models are discussed in detail.

### 2.1 THE THEORY OF REASONED ACTION

The theory of reasoned action (TRA) is one of the earliest social-psychological / behavioral theories used to predict and explain people's

behavior in various physical and social situations. This theory was proposed by Fishbein and Ajzen (1975), according to whom usage behavior is determined by people’s behavioral intention of use. The behavioral intention itself is determined by the attitude towards the behavior and the relevant subjective norm, as shown in Figure 1.

Fishbein and Ajzen (*ibid.*) define attitude as “an individual's positive or negative feelings (evaluative affect) about performing the target behavior” (p. 216). This attitude is generated from one’s beliefs about a particular behavior and his or her evaluation of those beliefs. In other words, a person who believes a particular behavior to have a positive impact on him or her will have a positive attitude towards that behavior. Such attitudes influence one’s behavior through formation of intentions in several ways.

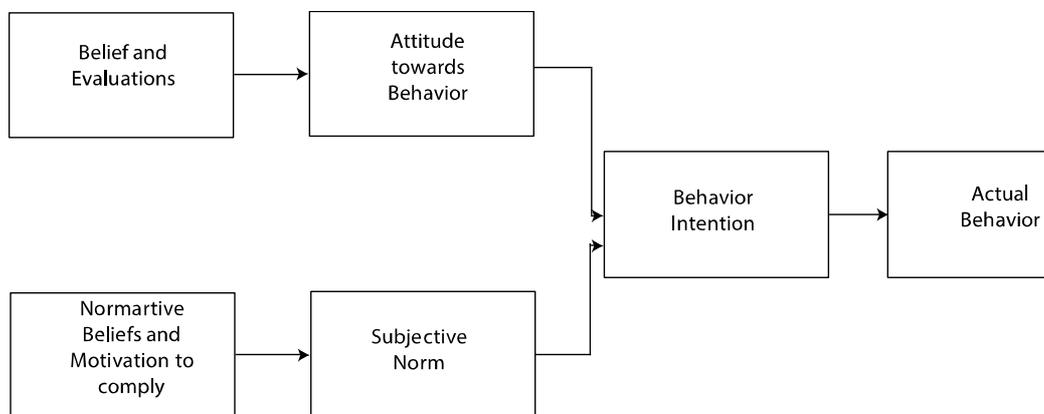


Figure 1. The Theory of Reasoned Action (Fishbein & Ajzen, 1975).

The subjective norm has been described as an important construct in determination of one’s behavioral intention. According to Fishbein and Ajzen (*ibid.*, p. 302), the subjective norm is “the person’s perception that most people who are important to him think he should or should not perform the behavior in question”. It was obtained by weighting one’s attributes to each of their opinions.

Sheppard, Hartwick, and Warshaw (1988) reported that the model performed extremely well in the prediction of situations of both voluntary and mandatory use, contrary to claims made by Fishbein and Ajzen (1975). However, the model was not without its critics. It focuses on individual-level behavior and does not consider environmental and social factors that might influence that behavior. Accordingly, the initial model has been revised and extended by several researchers.

## 2.2 THE TECHNOLOGY ACCEPTANCE MODEL

The Technology Acceptance Model (TAM) is one of the models for technology acceptance that are most commonly referred to in the literature.

As of this writing, it has been cited in more than 11,001 articles (Google Scholar). It is an extension of the TRA, which had been used in attempts to understand the variety of users' behavior in diverse environments, such as voting, exercising, and condom use (Ajzen & Fishbein, 1980). Davis (1989) simplified it to suit the context of information systems.

The model measures users' behavioral intention to adopt and use a given information technology. Since measuring actual system use is difficult, behavioral intention is normally used as a reliable predictor of actual use (Davis et al., 1989). Accordingly, to maximize a system's usage, one needs to elicit strong behavioral intentions to use the system.

In this theory, behavioral intention is influenced by people's attitude towards using the system. In turn, attitudes towards the system are influenced by two beliefs: **perceived ease of use** and **perceived usefulness**. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320), Perceived ease of use, on the other hand, is defined as "the degree to which a person believes that using a particular system would be free of efforts" (*ibid.*).

The two key beliefs are linked by external variables, most of which are system design features. The Technology Acceptance Model is shown in Figure 2.

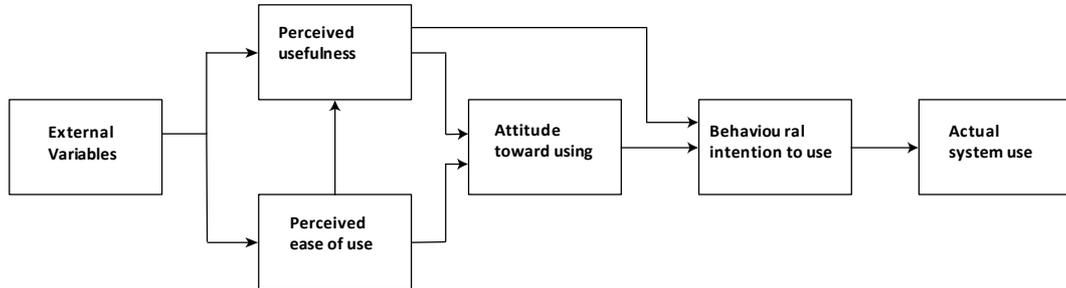


Figure 2. Technology Acceptance Model, version 1 (Davis et al., 1989, p. 985).

Davis et al. (1989) conducted a study with 107 users in which they used the TAM to measure intention to use the system in question. Some important findings emerged. The main outcome was that the factors perceived ease of use and perceived usefulness were found to have direct positive influence on behavioral intention to use the system. Therefore, the attitude construct was dropped from the model. The final version of the TAM is shown in Figure 3.

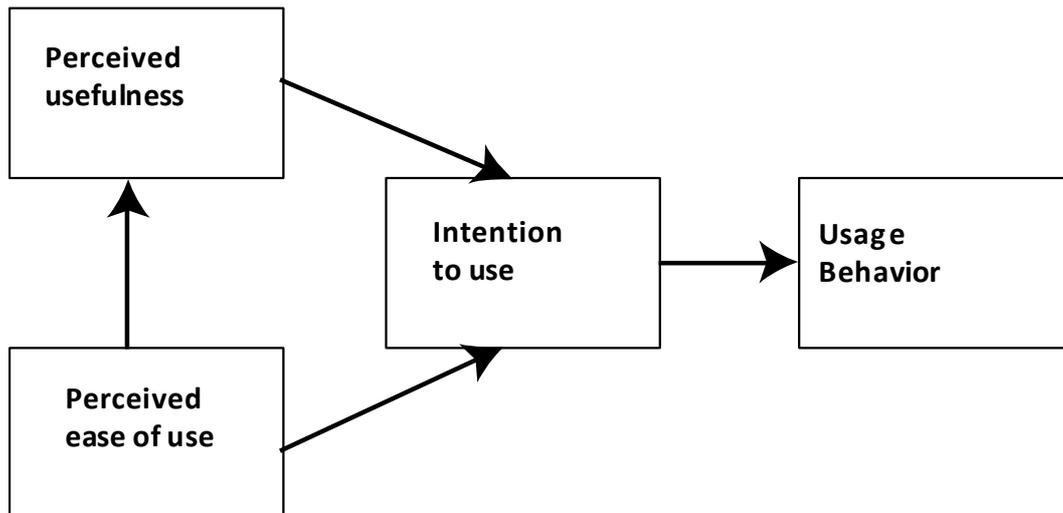


Figure 3. Final Technology Acceptance Model (Venkatesh & Davis, 1996).

While it has demonstrated success, this version too has been extended and modified by several researchers, including its originators. One major limitation is its inability to reveal determinants of the perceived-usefulness and perceived ease-of-use variables (Bagozzi, 2007; Chuttur, 2009). Furthermore, Chuttur points out that the TAM focuses on information systems that have been deployed in voluntary environments, with little consideration for mandatory-use settings.

Several researchers have attempted to extend the TAM to adapt to changes in the environment – for example, a move from single-user to multi-user systems. This has led to chaos and confusion in the theory (Benbasat & Barki, 2007). Benbasat and Barki pointed out that the model’s output focuses on explaining system use as a single behavior, which is narrow and too simple. To respond to these shortcomings and many others, the model has been modified and extended. In the next subsection, a revised form (TAM 2) and proposed modifications are explained.

### 2.3 TECHNOLOGY ACCEPTANCE MODEL 2

Venkatesh and Davis (2000) extended the Technology Acceptance Model by adding variables determining perceived usefulness and perceived ease of use in terms of social and cognitive processes. The social-processes determinants added to the model are the subjective norm, voluntariness, and image. The cognitive-processes determinants are experience, job-relevance, output quality, and the results’ demonstrability. The authors tested the model in both voluntary and mandatory settings through a study of 156 knowledge workers who used four distinct information systems. The model performed well in both voluntary and mandatory settings. It is shown in Figure 4.

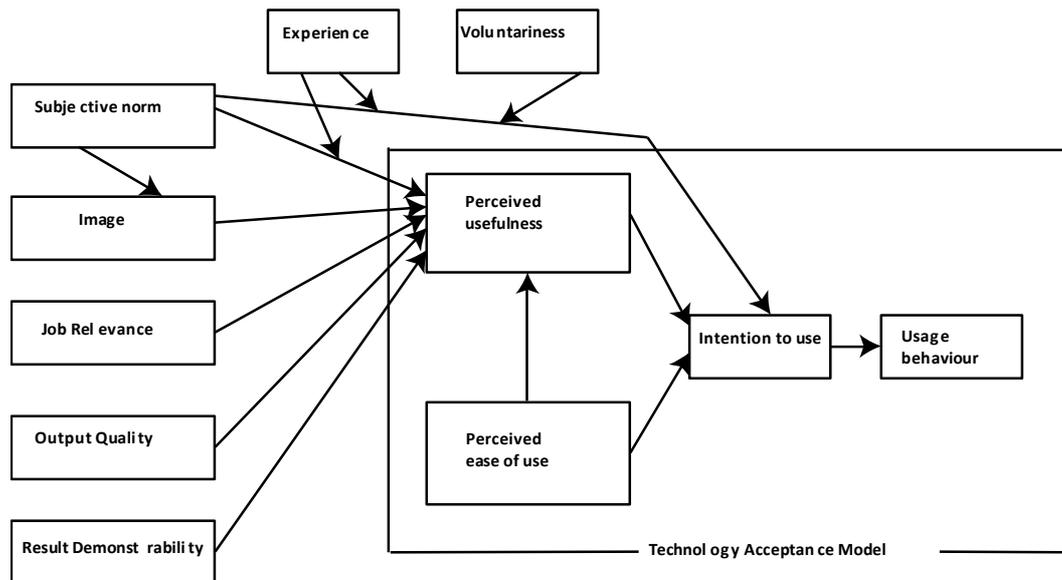


Figure 4. Technology Acceptance Model 2 (Venkatesh & Davis, 2000, p. 188).

## 2.4 THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

As the information technology industry kept growing, several attempts were made to develop and propose various models that could help to predict and explain the acceptance and use of various technologies. Confronted with so many models, researchers were bound to pick and choose constructs across models or to choose a well-regarded model (Venkatesh et al., 2003). As a result, the contributions from the alternative models was ignored. Venkatesh and colleagues felt a need to develop a unified view of individuals' technology acceptance by revising several technology acceptance models and integrating them to form a single model: the unified theory of acceptance and use of technology.

To form the UTAUT model, eight models were integrated, those with the greatest contribution being the theory of reasoned action, the Technology Acceptance Model, the motivational model, and the theory of planned behavior. Other models used are one combining the Technology Acceptance Model and the theory of planned behavior, the Model of PC Utilization, the innovation diffusion theory, and social cognitive theory.

Similar to previous models such as the TRA and TAM, the UTAUT model uses behavioral intentions to predict and explain system usage behavior. In addition, the perceived-usefulness construct famous from TAM work was incorporated into "performance expectancy" and perceived ease of use into "effort expectancy." Likewise, the subjective-norm element was incorporated into the social-influence construct, while facilitating conditions was introduced as a new construct. The model encompasses four key predictor constructs. These are:

- **Performance expectancy** is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” (*ibid.*, p. 447),
- **Effort expectancy** is “the degree of ease associated with the use of the system” (*ibid.*, p. 450),
- **Social influence** is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (*ibid.*, p. 451), and
- **Facilitating conditions** is defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system” (*ibid.*, p. 453).

The four constructs above are direct determinants of usage intention and behavior. The variables gender, age, experience, and voluntariness of use moderate the key relationships in the model. How the various parts of the model fit together is shown graphically in Figure 5, below.

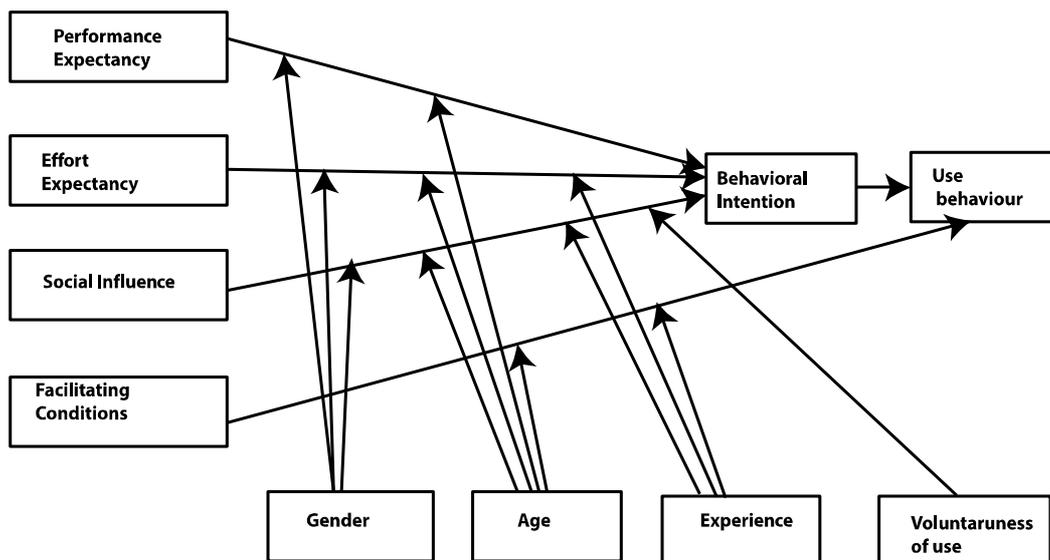
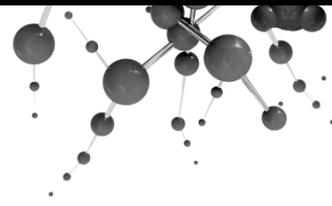


Figure 5. The UTAUT model (Venkatesh et al., 2003, p. 447).

The model was tested in a longitudinal study and found to outperform the eight individual models, explaining 70% of the variance in behavioral intention and about 50% of actual use (*ibid.*). Furthermore, the theory has been cited in more than 9,197 articles to date, an impressive number when one considers the abundance of acceptance theories in the literature.



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## 3 The Information Systems Success Models

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The increased investment and greater expenditure on information systems (IS) in organizations has made IS evaluation one of the most studied topics of recent years. Dozens of models for evaluation of IS success have been proposed, validated, and published. The dominant models are those proposed by DeLone and McLean: the original D&M model (1992) and the updated D&M model (2003). These two models have been used to evaluate thousands of information systems, worldwide, and they have been referred to in more than 4,537 articles.

The original D&M model, developed in 1992, features six interrelated constructs: system quality, information quality, system use, user satisfaction, individual-level impact, and impact on the organization. The IS success is measured through impact on the organization, which is contributed to by the impact of the IS on individuals within the organization. Impact on individuals is determined by system use and through measurement of user satisfaction. Correspondingly, system use and user satisfaction are determined by the system quality and the system's information quality. The model is shown in Figure 6.

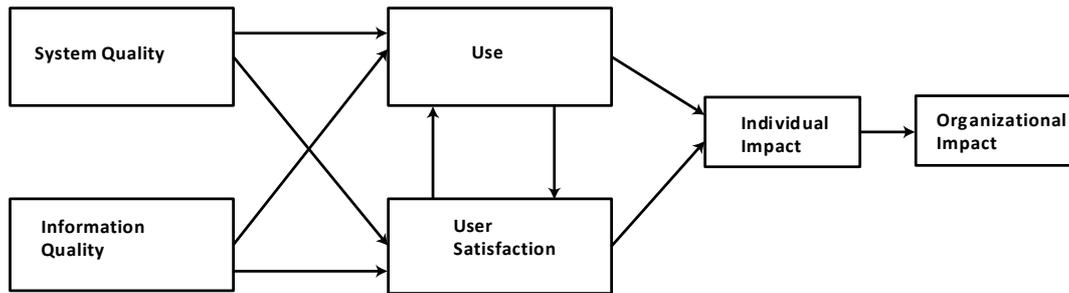
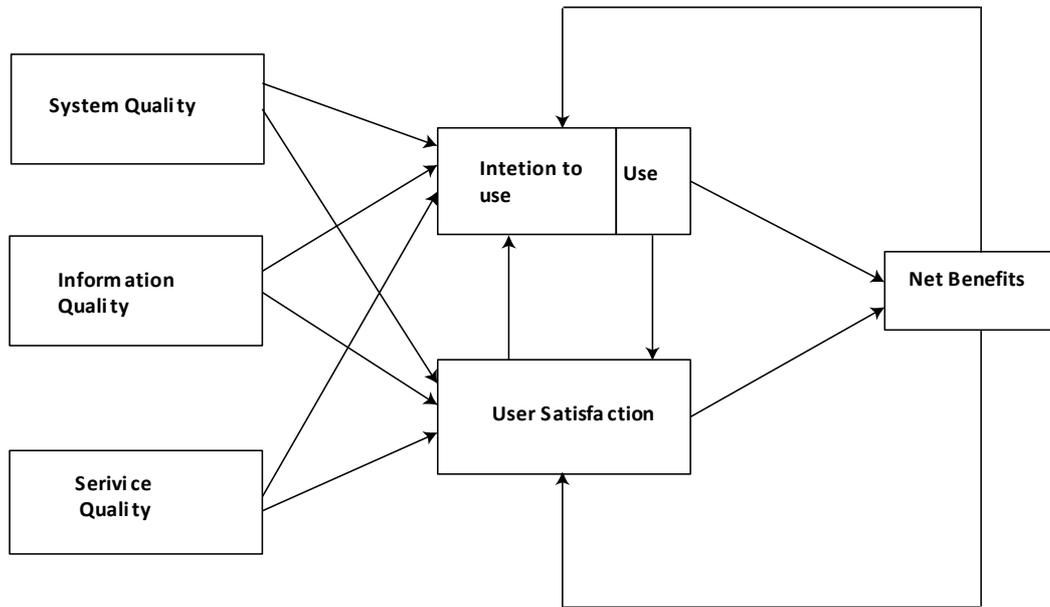


Figure 6. The Original D&M IS Success Model (DeLone & McLean, 1992, p. 87).

Although the original D&M model has been widely used in evaluation of IS effectiveness in various contexts, some researchers have proposed amendments in response to changes in the information technology (IT) environment. Consequently, the updated D&M model was introduced, in 2003. Some of the noteworthy amendments were the splitting of the use variable into use intention and actual use, as proposed by Seddon and Kiew (1995). They describe use as an appropriate metric for IS success in a voluntary environment, while intention to use the system is a more appropriate measurement in mandatory settings.

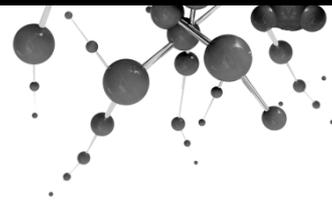
Service quality was added as a new element of the model. According to Pitt, Watson, and Kavan (1995), there was a need to assess the quality of service offered by IT divisions, since most organizations were outsourcing IT services to external companies or a separate unit. Moreover, the constructs for impact on the individual and on the organization were merged, as net benefits. The authors claim that the impact of IS has evolved beyond immediate user to work-group impacts, organizational and industry impacts, consumer impacts, and societal impacts. There was a resultant need to measure overall impact rather than individual-level impact of the information system. The updated D&M model is shown in Figure 7.

The new model encompasses six elements, addressing system quality, information quality, service quality, use intention / use, user satisfaction, and net benefits.



**Figure 7.** The updated D&M model (Delone & Mclean, 2003).

Unlike the model from which it was developed, the updated D&M model can be adapted to measure IS deployed in the Internet world such as eLearning and e-commerce applications (DeLone & McLean, 2003). DeLone and McLean argued that researchers could extend it further to measure IS effectiveness in other contexts.



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## 4 Related Studies

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### 4.1 TECHNOLOGY ACCEPTANCE STUDIES

The literature reveals only a few studies investigating acceptance and use of various eLearning solutions, of whatever sort, in Africa. From 2008 to 2013, most were confined to specific countries, mainly South Africa, Nigeria, Kenya, Ghana, Egypt, Botswana, and Tanzania. Some have investigated the acceptance and use of eLearning solutions in general terms (Abdel-Wahab, 2008; Oye, Noorminshah, & Rahim, 2011; Sarkani, Mazzuchi, & Fletcher, 2012; Totolo, 2011), while others have examined specific technologies used by specific user groups. Studies investigating specific user groups have examined, for example, students' acceptance of mobile technologies (Adedoja, Adelore, Egbokhare, & Oluleye, 2013; Bere & Rambe, 2013; Voigt & Matthee, 2012), students' LMS acceptance (Munguatosha et al., 2011; Venter, van Rensburg, & Davis, 2012), academics' OER acceptance, (Percy & Van Belle, 2012), and students' acceptance of e-mail (Macharia & Nyakwende, 2010).

Most of the studies adopted TAM-related methods in their research model. Two of those reviewed employed the UTAUT model (Oye et al., 2011; Percy & Van Belle, 2012). Studies that applied the TAM added new constructs to suit the context of their studies. These constructs were job-relevance (Venter et al., 2012), self-efficacy (Adedoja et al., 2013; Chinyamurindi & Louw, 2010; Macharia & Nyakwende, 2010; Voigt & Matthee, 2012), perceived enjoyment (Macharia & Nyakwende, 2010; Voigt & Matthee, 2012), attainment value (Voigt & Matthee, 2012), and interest in technology (Adedoja et al., 2013). Other constructs used in the TAM-applying works are resources' availability, pressure to act (Abdel-Wahab, 2008), perceived convenience (Bere & Rambe, 2013), attitude (Abdel-Wahab, 2008; Percy & Van Belle, 2012), and information quality (Percy & Van Belle, 2012).

Overall, the research models in the articles reviewed explained a reasonable percentage (in R<sup>2</sup> values) of variance in acceptance and use of eLearning technologies in the countries studied. The acceptance values ranged from 27% to 68.4%, with the exception of one study applying the UTAUT, with four percent (Oye et al., 2011).

The main conclusion from the literature review is that the constructs **perceived ease of use** and **perceived usefulness** are the most prominent predictors of existing users' acceptance and use of eLearning technologies in Africa. These two constructs have been statistically shown to have a consistently positive effect on acceptance and use of the majority of the technologies studied. These findings suggest that people in Africa believe they will adopt and use these technologies if these will enhance their educational performance and will be effort-free.

Of the constructs added to the TAM family of models, **self-efficacy** was found to have a statistically significant positive influence in most of the studies. So far, however, too little is known of studies that have investigated the acceptance and use of mobile learning and OER in an East African context. Table 1 provides a summary of some research articles that have examined acceptance and use of eLearning solutions in various countries in Africa between 2008 and 2013.

**Table 1.** Selected research papers that have investigated acceptance and use of eLearning solutions in Africa from 2008 to 2013.

Year	Article	Constructs	Type of eLearning technology	Coverage	Participants	R <sup>2</sup>
2013	Learners' acceptance of the use of mobile phones to deliver tutorials in a distance learning context: A case study at the University of Ibadan (Adedoja et al., 2013)	PU, PEOU, interest in technology, self-efficacy	Mobile technologies	Ghana	201	50.3%
2013	Extending technology acceptance model in mobile learning adoption: South	Perceived convenience PU, PEOU	Mobile technologies	South Africa	196	58%

	African University of Technology students' perspectives (Bere & Rambe, 2013)					
2012	Tablets with restricted mobility: Investigating user acceptance in a South African mathematics mobile learning project (Voigt & Matthee, 2012)	Self-efficacy, perceived enjoyment, FC, SI, attainment value	Mobile technology	South Africa	n/a	n/a
2012	Drivers of learning management system use in a South African open and distance learning institution (Venter et al., 2012)	Job-relevance  FC, PU, PEOU	Learning management system	South Africa	218	57%
2012	Exploring the barriers and enablers to the use of open educational resources by university academics in Africa (Percy & Van Belle, 2012)	FC, PE, SI, FC, information quality, attitude	OER	Africa	96	53%
2011	A social networked learning adoption model for higher education institutions in developing countries (Munguatosha et al., 2011)	PU, PEOU, readiness	Networked technologies	Tanzania	1,588	68.4%

2011	Adoption and use of computer technology among school principals in Botswana secondary schools (Totolo, 2011)	PU, PEOU	Computer technology	Botswana	111	27%
2011	Examining the effect of technology acceptance model on ICT usage in Nigerian tertiary institutions (Oye et al., 2011)	PE, EE, SI, FC	ICT usage	Nigeria	100	4%
2010	Gender differences in technology acceptance in selected South African companies: Implications for electronic learning (Chinyamurindi & Louw, 2010)	PU, PEOU, self-efficacy	Electronic coursework	South Africa	191	n/a
2010	The influence of e-mail on students' learning in higher education: An extension to the technology acceptance model (Macharia & Nyakwende, 2010)	PU, PEOU, self-efficacy, perceived enjoyment, perceived resources, relevance to studies, computer anxiety, ICT access	E-mail	Kenya	1,092	n/a
2008	Modeling students' intention to adopt eLearning: A case from Egypt (Abdel-Wahab,	PU, PEOU, attitude, resources availability, pressure to act	General eLearning	Egypt	258	33.1%

2008)						
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**Key**

PE: Performance Expectancy

EE: Effort Expectancy

SI: Social Influence

FC: Facilitation Conditions

PU: Perceived Usefulness

PEOU: Perceived Ease Of Use

**4.2 ELEARNING SYSTEM SUCCESS MODELS**

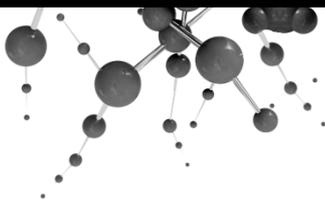
The review of the literature revealed no studies that have proposed eLearning success models for evaluation of eLearning systems' effectiveness in higher education in Africa. The majority of the studies found were designed in consideration of certain unique challenges facing users in higher education in developed countries. However, users in Africa face different challenges, both contextual and infrastructural; hence, they need a model that can take into account these challenges, so as to have a tool that provides measurability.

Most studies that have developed models of this sort have extended the updated D&M model to suit the context of the relevant eLearning environments. These extensions include introducing new constructs and dropping some elements of the original model. For example, Ozkan and Koseler (2009) added four constructs to the D&M model - **content quality**, **learner perspective**, **instructor attitudes**, and **supporting issues** - while retaining **system quality** and **service quality** from the original model. The new model was validated at the UK's Brunel University with students as respondents.

Hassanzadeh, Kanaani, and Elahi (2012) added three new constructs to the D&M model: **loyalty to the system**, **goal-reaching**, and **education-system quality**. They also separated **intention of use** and **actual system use** into two distinct constructs. In total, their new model has 10 constructs. The model was validated with students, staff members, and alumni at five universities in Iran.

Holsapple and Lee-Post (2006) divided the D&M model into three stages: design, delivery, and outcome. Factors in the design stage are **service quality**, **system quality**, and **information quality**, and those in the delivery stage are **system use** and **user satisfaction**. Finally, the **net benefits** construct was integrated into the outcome stage. That model was validated in the US, at the University of Kentucky.

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## 5 Introduction to the Publications

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This thesis addresses the research gap by contributing a summary of four case studies investigating factors that affect acceptance and use of various eLearning solutions in higher education in East Africa. The first two case studies, described in Paper I and in Papers II and III, respectively, looked at students' and instructors' acceptance of mobile learning (the first study) and OER (the second). The first two papers drew from the UTAUT model and quantitative research methods. Paper III was written as a follow-up to the second case study; the more recent work was designed to elicit more information, via qualitative research methods, about the barriers to the use of OER.

The third case study (described in Paper IV) compared the cost of hosting eLearning services between on-premises and cloud-based provision. It employed a TCO-based approach. The final case study (covered in Paper V) developed an eLearning success model. Figure 8, below, shows the connections among various publications, research methods, and eLearning solutions that were investigated. A summary of each article is provided next.

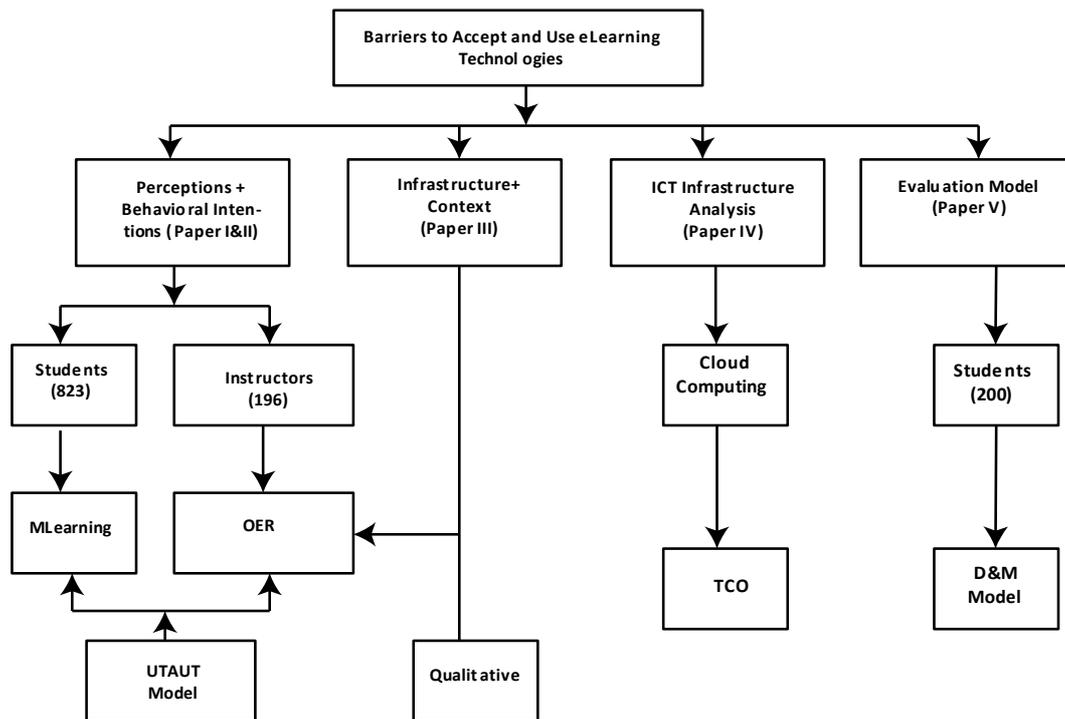


Figure 8. A summary of a research process and publications.

**Key:**

- TCO: Total cost of ownership
- D&M: DeLone and McLean
- ICT: Information and communication technologies
- OER: Open educational resources
- M-learning: Mobile learning
- UTAUT: Unified theory of acceptance and use of technology

## 5.1 INVESTIGATION OF STUDENTS' BEHAVIORAL INTENTION TO ADOPT AND USE MOBILE LEARNING IN HIGHER EDUCATION IN EAST AFRICA

### The Author's Contribution

My personal contribution in relation to the first paper was to plan the work, collect empirical data and analyze the data collected, and draft the article. I also finalized the paper, addressing the comments from my academic supervisor, before submitting the paper to the journal for publication.

### Objectives

Recent penetration of mobile technologies and mobile services in East Africa has provided a new platform via which institutions can expand access to education through mobile learning. Mobile technologies provide learners with flexibility and ubiquity: they can learn at any time and

anywhere via wireless Internet. However, far too little research has been conducted to investigate factors that contribute to students' acceptance and use of mobile learning in East Africa. The main objective of the study was to investigate students' behavioral intention to adopt and use mobile learning in higher education in that region.

We applied the UTAUT model and extended it to suit the context of the study. A sample of 823 students selected randomly from five institutions was collected for testing against the research model by means of regression analysis. The institutions were the University of Dar es Salaam, Tanzania's College of Business Education, Kenyatta University, Dar es Salaam Institute of Technology, and Tanzania's Institute of Finance Management.

### Results and Discussion

The study showed that the proposed research model was significantly descriptive at  $F(4,818) = 79.597, p < .0005$  with the SPSS package's "Enter" method (rather than with stepwise regression). The model was able to explain 27.7% of the variance (adjusted  $R^2 = 0.277$ ) in students' acceptance of mobile learning. We also found that all four factors in the UTAUT model had a significant effect. Thus, all hypotheses were supported.

The most interesting finding was that performance expectancy was found to be the strongest predictor of mobile learning's acceptance. This implies that students in higher education in East Africa believe mobile learning is useful and believe it will enable them to accomplish their learning activities faster and more efficiently. Students also think that mobile learning will help them to improve their learning performance and to obtain better grades. To strengthen this belief, educators should pay attention to the quality of the learning resources deployed for mobile devices: these learning resources should be able to facilitate student learning.

The results of this study also suggest that students believe intensive training is not necessary for enabling them to use mobile learning, since they believe the mobile learning applications will be clear, understandable, and easy to use. This is important to consider, since the effort expectancy had a significant positive effect on mobile learning's acceptance. To strengthen and validate this belief among students, developers should create readily usable mobile learning services (Wang, Wu, & Wang, 2009). Many mobile devices have small screens and small keyboards, which might hamper learners' use of them for learning purposes. Greater usability of mobile learning applications should help learners find the applications easy to use and meet their learning objectives.

Finally, the results also indicate that students believe they possess the resources and knowledge necessary for using mobile learning applications. This was demonstrated by the fact that the facilitating conditions construct

had a significant positive effect on students' acceptance of mobile learning. This coincides with the fact that 93% of students indicated that they had access to the Internet via mobile devices.

## **5.2 CHALLENGES AND INSTRUCTORS' INTENTION TO ADOPT AND USE OER IN HIGHER EDUCATION IN TANZANIA**

### **The Author's Contribution**

My personal contribution in relation to the second paper was to plan the work, to collect the empirical data, to analyze the data collected, and to draft the article. I also made the final revisions to the paper on the basis of the comments from my supervisor before submitting the piece to the journal for publication.

### **Objectives**

Higher education in Tanzania, as in many other countries in Sub-Saharan Africa, suffers from insufficient availability of quality teaching and learning resources, on account of lack of tradition, competence, and experience in development of such resources. Nevertheless, there are thousands of OER freely available in the public domain that have potential to improve the quality of existing resources or aid in the development of new courses. Despite the availability of these resources, the majority of instructors working in higher education have not been using them.

The study was conducted to ascertain which factors hinder instructors' adoption and use of these resources at their institutions. To this end, we applied the UTAUT model in the research. A sample of 104 instructors selected randomly from five institutions was tested against the research model by means of regression analysis. Instructors were selected from the University of Dar es Salaam, Ardhi University, Dar es Salaam University College of Education, Dar es Salaam Institute of Technology, and Mkwawa University College of Education.

### **Results and Discussion**

The results indicate that the research model was significant at  $F(4,99) = 4.563654$ ,  $p < .005$  with the "Enter" method. The model was able to explain 12.2% of the variance (adjusted R-squared value = 0.122) in instructors' behavioral intention to adopt and use OER. Although the percentage looks small, it is acceptable in social science research (Gaur & Gaur, 2009).

We also found that effort expectancy had a significant effect on instructors' intention to use OER. This finding is consistent with other studies of OER acceptance conducted in Africa (Percy & Van Belle, 2012) and of acceptance of open access in Tanzanian higher education institutions (Dulle & Minishi-Majanja, 2011). These results showed that many instructors believe they will not need a lot of instructions and

training before being able to use OER. Accordingly, OER developers are advised to improve the usability of OER repositories, in order to strengthen this belief.

The most interesting finding is that three factors – performance expectancy, facilitating conditions, and social influence – did not have a significant effect. In consequence, we conducted a follow-up using qualitative research methods to find more information on the factors that hamper the use of OER. The results of the latter work are discussed in Paper III, described in Subsection 5.3, below.

### **5.3 INVESTIGATION OF PERCEIVED BARRIERS TO THE USE OF OER IN HIGHER EDUCATION IN TANZANIA**

#### **The Author’s Contribution**

My personal contribution to the follow-up work was to plan it, to conduct interviews at 11 institutions, to analyze the dataset, and to write the draft article. Finally, I developed the paper submitted to the journal in response to the comments from my supervisor.

#### **Objectives**

The work was a follow-up to that described in the second article (Paper II), which had revealed that three factors, performance expectancy, facilitating conditions, and social influence, did not have a statistically significant effect on instructors’ acceptance of using OER. The study showed that only effort expectancy had a statistically significant effect. For further exploration of factors that operate counter to instructors’ use of OER, a qualitative research method was used.

In the follow-up, we conducted semi-structured interviews and reviewed important documents from 11 institutions. In total, 92 instructors – from St. John’s University of Tanzania, the University of Dodoma, Zanzibar University, State University of Zanzibar, Dar es Salaam University College of Education, and Tumaini University Makumira – were interviewed. Other institutions were the Nelson Mandela African Institution of Science and Technology, the Open University of Tanzania, the Institute of Accountancy Arusha, the University of Dar es Salaam, and Tanzania’s Institute of Finance Management.

#### **Results and Discussion**

The results revealed that lack of access to computers and to the Internet, low Internet bandwidth, lack of policies, and lack of skills in creation and/or use of OER were the main barriers. We also found that the Internet connection speed at most of the institutions is still low. Speeds ranged from 7 Mbps to 20 Mbps, with the exception of the University of Dar es Salaam and its affiliated colleges, which had a bandwidth of 155 Mbps. These findings corroborate those of similar studies conducted in Tanzania,

which found Internet speed to be a factor inhibiting the use of various eLearning solutions (Lwoga, 2012; Munguatosha et al., 2011; Samzugui & Mwinyimbegu, 2013; Tedre, Ngumbuke, & Kempainen, 2010).

In the previous part of the study (see Paper II), we found that instructors believed that they do not need a great deal of instruction to be able to use OER. In this study, we found that most of them do not, in fact, have the skills necessary for using these resources. Similar findings have been obtained at the Open University of Tanzania, where instructors depended on support from librarians for finding relevant OER for their courses (Samzugui & Mwinyimbegu, 2013). Clearly, there is a need for institutions to create awareness of the OER repositories available and for conducting training in how to use these resources.

We also found that lack of trust in others' resources, lack of interest in creating and/or using OER, and insufficient time to find suitable materials were not barriers. This confirmed our findings in the part of the study described in Paper II, wherein we found that the majority of instructors were willing to share their resources via the Internet. They were also using the Internet to search for course notes and other teaching materials. This implies that instructors do trust resources from the Internet but are not aware of the OER repositories available.

Unexpectedly, instructors were almost equally divided on two factors: lack of quality of OER and difficulties in finding suitable and relevant OER. This may be because most of them are not aware of OER repositories and have instead been seeking teaching notes from unreliable Internet sites.

Finally, instructors indicated that lack of policies at the institutional level was a major barrier to the use of OER. In documentary review, we found that nearly half of the institutions surveyed did not have eLearning or ICT policies in place. The policies that did exist were either outdated or never implemented. For example, the University of Dar es Salaam's ICT policy had been developed in 2006, while that of the Open University of Tanzania was developed in 2009. Institutions are required to develop or update existing policies in order to clarify issues that create barriers to the adoption of OER, such as intellectual property and quality assurance.

## **5.4 eLEARNING COST ANALYSIS FOR ON-PREMISE VERSUS CLOUD-HOSTED IMPLEMENTATION IN SUB-SAHARAN COUNTRIES**

### **The Author's Contribution**

My personal contribution to the next study was to plan it, to conduct a review considering various cloud computing cost-analysis studies, and to draft the article.

## Objectives

The cost of acquiring and managing ICT infrastructure is one of the main factors that inhibit institutions in Africa from adopting and implementing eLearning solutions (Lwoga, 2012; Ssekakubo et al., 2011; Unwin et al., 2010). For example, the cost of deploying an eLearning system at the University of Education, Winneba, in central Ghana, was estimated to be \$2,100,000 for seven years for a minimum of 15,000 students (Unwin et al., 2010).

Studies have described the use of cloud computing services as able to reduce the cost required to implement eLearning solutions in Africa. Using cloud computing can enable institutions to pay for only the actual service usage, in an analogue to the way one typically pays for utility services such as water, electricity, and telephony (Carroll, van der Merwe, & Kotzé, 2011). They can also reduce the costs associated with hardware purchases, software licensing, electrical power, and salaries for IT personnel (*ibid.*).

Regardless of these advantages, relatively few institutions in Africa have embraced cloud computing in education (Kshetri, 2010). Although there are many factors that may drive institutions to adopt cloud services, cost-effectiveness is often key among them. The study computed the cost of hosting eLearning services on-premise and in the cloud and compared between the two, using a TCO-based approach. The comparison assumed that the institutions in question would adopt Open Source LMS and took Tanzania as its case study.

## Results and Discussion

The results showed that institutions could save approximately \$40,000 over the span of three years by hosting eLearning services in the cloud. Our findings were consistent with those of several other studies, conducted elsewhere (Chandra & Borah, 2012). For example, Chandra and Borah found savings of \$942.60 per user per month when five computers were replaced through migration of all their services to the cloud. They also noted that Florida Atlantic University reduced its ICT costs by at least \$600,000 by migrating its Blackboard system and the associated services to the cloud. Similarly, also in the USA, North Carolina's Wake Technical Community College reduced its ICT costs from \$1.04 million to \$570,000 annually (nearly 50%) by hosting its IT services in the cloud.

Our cost analysis assumed that the institutions would host eLearning services with commercial cloud companies. However, it did not consider that several cloud service providers, such as Google, IBM, and Microsoft, provide cloud services at a discount for educational institutions (*ibid.*). Institutions can significantly reduce the cost of hosting eLearning services by subscribing to these educational packages.

While cloud computing offers the aforementioned benefits, there is still a need to reduce the cost of Internet bandwidth and to increase Internet

access speeds in East Africa. As we noted in the context of the second case study, many institutions of higher education in East Africa are faced with low Internet speeds. Since cloud computing is an Internet-based service, it is obvious that insufficient bandwidth would render it very difficult to deliver educational services via this route (Laisheng & Zhengxia, 2011). There is also a need to update regulatory compliance policies such as those to do with data compliance, data-protection, confidentiality, and policies related to payments in order to account for the complexity of cloud computing.

## **5.5 A MODEL FOR ASSESSING LEARNING MANAGEMENT SYSTEM SUCCESS IN HIGHER EDUCATION IN SUB-SAHARAN COUNTRIES**

### **The Author's Contribution**

My personal contribution to the final main study was to plan the study, to collect empirical data, to analyze the data collected, and to draft the article. I also finalized the paper, addressing the comments made by my supervisor, before submitting the article to the journal for publication.

### **Objectives**

Higher education institutions in Sub-Saharan Africa have been adopting various LMS in a bid to address challenges facing the region's education sector. However, the majority of these systems tend to fail, partially or totally (Ssekakubo et al., 2011; Unwin et al., 2010), and the institutions do not have ready ways of assessing their effectiveness. The study was conducted to help institutions through provision of tools necessary for evaluation of their existing systems and/or preparation of corrective measures and strategies to avoid future failures.

We adapted and extended the updated D&M model to suit the context of eLearning evaluation. We first renamed the construct for information quality to "course quality," user satisfaction to "learner satisfaction," and net benefits to "perceived net benefits." After this, content for each construct was sought from various studies that measure success of eLearning. The model and the instrument were then validated through a survey of 201 students, enrolled in various courses offered via a Moodle LMS at the University of Dar es Salaam.

### **Results and Discussion**

Through multiple regression analysis, two paths in the research model were shown to be non-significant: the relationship between system quality and learners' satisfaction and the relationship between service quality and learners' satisfaction. In other words, the hypotheses that system quality positively affects learner satisfaction with LMS, and that service quality positively affects learners' satisfaction with LMS were not supported. This implies that learner satisfaction could not be explained by the quality of

the system or by the quality of services offered by the relevant IT unit. Therefore, they were dropped from the model.

All other paths were found to be significant, and factor analysis showed all items within each construct to be highly correlated. Accordingly, no items were deleted. The final research model is shown in Figure 9.

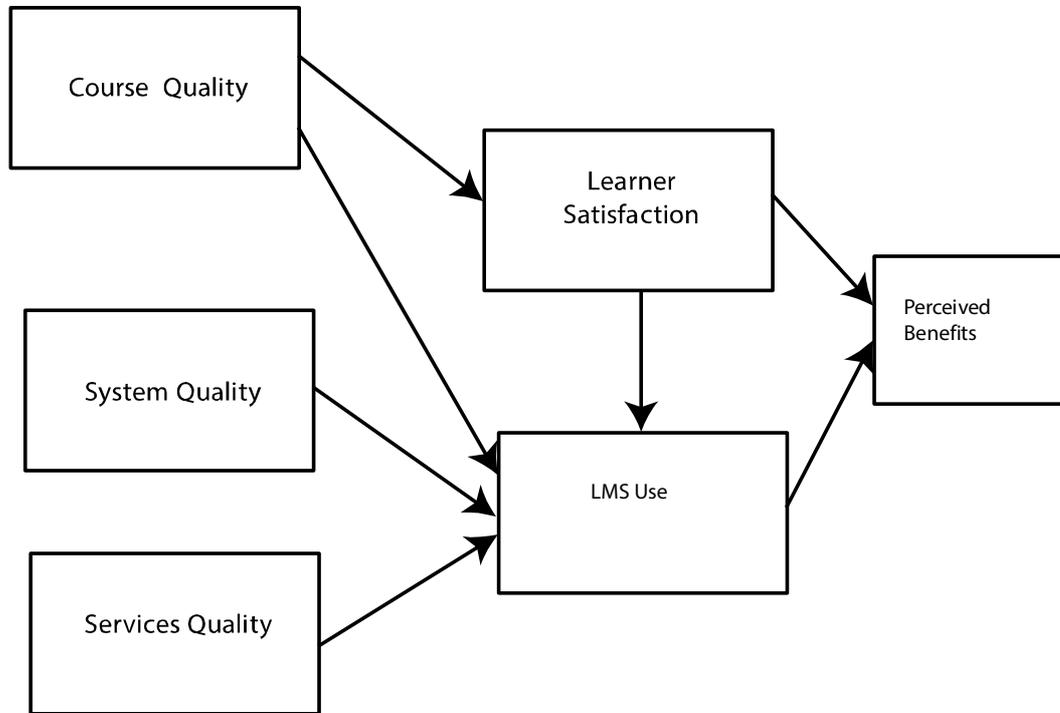


Figure 9. The Final Research Model.

Moreover, course quality had a positive effect on learners' satisfaction with the system and, additionally, had a positive effect on LMS use. These findings corroborate similar results, from studies conducted by Andersson and Grönlund (2009) and Ozkan and Koseler (2009) elsewhere. These results provide further evidence that improving the quality of courses can help students to recognize the benefits of using the LMS. Instructors should develop high-quality course content that matches the intended pedagogical experience, in order to maximize LMS use and to increase learners' satisfaction with the system.

Another important finding from this study was that service quality and system quality had a positive effect on LMS use. This result shows that provision of reliable support services will enable users to use the system more frequently. Institutions should use various support mechanisms, such as training sessions, hotlines, and a help desk, in order to maximize LMS usage.

In conclusion, the perceived benefits of any given LMS are determined by learners' satisfaction with the system and by the extent to which people are using it. In order to reap the benefits of these systems, institutions should find ways to increase learners' satisfaction and to increase use of the systems. These outcomes can be reached through improvements to the

quality of support services, greater system usability, and development of high-quality courses that have the intended pedagogical effectiveness.

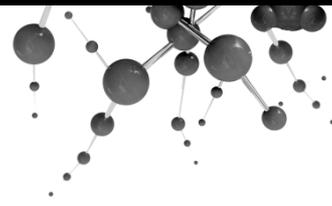
## **5.6 THE COMPLEMENTARY PUBLICATION**

An additional article was written, on studies that were conducted to complement the findings from the four case studies presented in this thesis. That work is referred to in the discussion and findings sections of the thesis. The reader may find it necessary to read the article for more information. The article is:

- Mtebe, J. S., & Raphael, C. (2013). Students' experiences and challenges of blended learning at the University of Dar es Salaam, Tanzania. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, 9(3), 124–136.

### **The Author's Contribution**

My contribution was to plan the study and to write the report on the research results. My co-author collected empirical data from the field and helped to edit the final draft of the article before it was sent to the journal for publication.



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## 6 General Discussion

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As is noted at the start of the thesis, the main objective behind the project was to investigate underlying factors that inhibit adoption and use of various eLearning solutions at the user level in higher education in East Africa. This study has come at the right time, since, although many institutions have been investing considerable resources to procure and maintain various eLearning solutions, of diverse types, for their campuses, many of these solutions have not been fulfilling their potential (Ssekakubo et al., 2011).

Previous studies have described poor ICT infrastructure, low Internet bandwidth, lack of access to computers, and lack of skills as the main barriers to the use of eLearning solutions in Africa (Lwoga, 2012; Ssekakubo et al., 2011; Tedre et al., 2010; Unwin et al., 2010). Nonetheless, contextual and infrastructural challenges have been improving very rapidly in Africa, in tandem with penetration of cellular phones. Some examples of initiatives that have been improving Internet access and speed are the SEACOM (see <http://www.seacom.mu/>) and EASSy (see <http://www.eassy.org/>) marine cables along the eastern and southern African coast.

Regardless of these initiatives and many others, the use of eLearning solutions remains low. Even institutions in countries regarded to have a good ICT infrastructure, such as South Africa, Nigeria, and Kenya, still show low usage of these technologies. This fact prompted us to look at perceptions and acceptance of the use of these solutions. The empirical findings presented in the thesis provide new understanding of the barriers to the use of these solutions beyond contextual and infrastructural challenges.

For the first two articles (Papers I and II), the UTAUT model was adopted in the investigation of students' and instructors' acceptance of the use of mobile learning and OER, respectively. We found that all factors in the UTAUT model had a significant effect on students' acceptance of using mobile learning, whereas only the effort expectancy had an effect on instructors' acceptance of the use of OER.

The findings are consistent with the results of other studies, conducted elsewhere in Africa, that have investigated students' acceptance of using mobile technologies (Adedoja et al., 2013; Voigt & Matthee, 2012). For example, Adedoja and colleagues, using the Technology Acceptance Model, found that perceived usefulness, perceived ease of use, interest in the technology, and self-efficacy had a positive effect on the use of mobile tutorials. Similar findings were obtained in Voigt and Matthee's study of students acceptance of mobile mathematics learning. Together, these findings and our results show that students have a positive attitude towards using eLearning solutions. Our research also found that the majority of students have access to the Internet via mobile devices, a finding consistent with results of studies conducted previously in East Africa (Kihoro, Oyier, Kiula, Wafula, & Ibukah, 2013; Mtebe & Raphael, 2013; Mtega, Bernard, Msungu, & Sanare, 2012).

Our research also revealed that only effort expectancy had a positive effect on instructors' acceptance of the use of OER. These findings show that instructors believed that they do not need intensive training to be able to use OER. This finding corroborates results of a study conducted in Africa with a sample of 96 instructors (Percy & Van Belle, 2012). Our follow-up work (see Paper III) revealed that many instructors are affected by contextual and ICT infrastructural challenges. More specifically, some instructors do not have access to computers and the Internet.

Furthermore, we found that the ICT infrastructure is not the same in all institutions in Tanzania. For example, many instructors at the University of Dar es Salaam had access to Internet-connected computers (Mtebe & Raphael, 2013) and the same was true at the Open University of Tanzania (Samzugui & Mwinyimbegu, 2013); however, the situation is totally different at, for example, Iringa University College (Tedre et al., 2010) and Muhimbili University Health Sciences (Lwoga, 2012), where there is an acute shortage of computers and low Internet bandwidth.

It should be noted that the majority of the eLearning solutions adopted and implemented in Africa are donor-funded. Therefore, success stories are reported while failures often go unrecorded and undocumented (Tedre et al., 2010). In addition, institutions do not have means to evaluate their success. In our work, we developed an eLearning success model that could be used to evaluate the success of eLearning solutions deployed in higher education in East Africa. The proposed model and the instrument

were validated with students enrolled in various courses at the University of Dar es Salaam, Tanzania.

Previous studies too have described the cost of ICT infrastructure as the main barrier to implementation of eLearning technologies in many African countries (Bhalalusesa et al., 2013; Farrell & Isaacs, 2007; Lwoga, 2012; Tedre et al., 2010). The emergence of cloud computing could be leveraged to deliver cost-effective computing services that support eLearning solutions. However, many institutions have not been adopting these technologies, with the reasons including unawareness of the cost-effectiveness of the technology. In this thesis (see Paper IV), we have analyzed the cost required to implement eLearning technologies and compared costs between on-premises and cloud-hosted solutions, taking a Moodle LMS as the case studied. The findings were encouraging, and they confirmed results obtained previously, in other countries (Chandra & Borah, 2012). In general terms, the study revealed that institutions can reduce the cost of their ICT infrastructure significantly by migrating their computing services to the cloud.

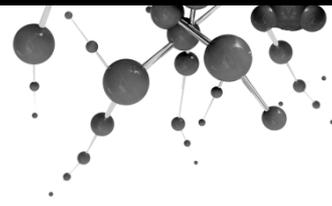
While these findings are of use, our studies are subject to at least three main limitations. First, all but one of the case studies were conducted in Tanzania, on account of time and budgetary constraints. Some conclusions obtained from these studies may not be applicable in all three East African countries. However, we believe that Tanzania is representative in terms of the challenges facing many East African countries. Further research might broaden the scope by including institutions from all three countries in East Africa in empirical verification of these findings.

Second, our case studies relied on students and instructors as respondents. Although these are the key stakeholders in the acceptance and overall success of eLearning solutions, there are other important stakeholders, such as management personnel, alumni, and technical workers, who were not considered. More research is needed if we are to gain better understanding of perceptions of and acceptance by these stakeholders, thereby getting a broader picture of eLearning challenges.

Finally, the UTAUT model used in the work ( see Papers I and II) takes the perspective of users' perceptions. Individuals' perceptions change over time as the users gain experience (Venkatesh et al., 2003). With rapidly changing ICT infrastructure and ever greater penetration of mobile devices, further research into acceptance and perceptions will be worthwhile to address the evolving circumstances.

Regardless of these limitations, the findings from the case studies presented in this thesis, particularly when taken in sum, provide new understanding of the barriers to the use of various eLearning solutions in East Africa. Institutions can use these findings for assistance in finding

strategies that will maximize the use of these solutions in their specific context.



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## 7 Conclusion

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The role of eLearning solutions in overcoming the challenges facing the education sector in Africa cannot be ignored. The eLearning solutions have proven able to reduce costs, to widen access, and to meet the needs of contemporary students in developed countries. The same benefits can be gained in an East African context if institutions can overcome the challenges presented in this thesis. For reaping the benefits of these technologies, the work points to several courses of action:

First, institutions should conduct awareness workshops for instructors that stress the importance of eLearning solutions for augmented teaching and learning. Instructors are the key stakeholders in the learning process, for they constitute the primary foundation of knowledge and education for students. However, most of them are not aware of many eLearning solutions that could improve teaching and learning. They had not used these solutions in their own studies, so they do not have ready prior knowledge of how these could or should be used (Tedre et al., 2010).

Second, institutions should develop and/or update their ICT policies in order to facilitate the smooth adoption and use of eLearning solutions. Deficiency or absence of policies was found to be a barrier to the use of these solutions, in a parallel with findings from studies conducted previously (Lwoga, 2012; Munguatosha et al., 2011). For instance, many policies prohibit free sharing of educational resources in the public domain. This contradicts with openness, which emphasizes the use of, for example, Creative Commons licenses to protect and share learning resources. In this thesis project, we found that instructors are willing to share their resources freely via the Internet but that the copyright policies within their institutions often render this impossible.

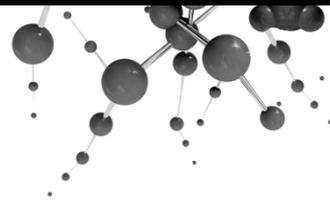
Third, institutions should improve the reliability and speed of their Internet access. While many initiatives are underway to upgrade Internet connection speeds in the region, many institutions still face low Internet bandwidth. In the follow-up work (see Paper III), we found that 9 of the 11 institutions surveyed had an Internet bandwidth between 7 Mbps and 20 Mbps. We believe this situation is largely representative of many institutions in East Africa. Some eLearning solutions, such as cloud services and off-site video-based learning resources, would not benefit many users in the region at present, since they require good Internet speeds.

Fourth, institutions should establish and strengthen their IT units so as to provide reliable and timely support services to both instructors and students. In the research (see Paper III), we found that instructors lack the skills to use various eLearning solutions. Describing a similar impact, in Paper V, we reported that the quality of support services offered by the relevant IT unit had a positive effect on the use of eLearning solutions. In fact, many people in Africa have not been exposed to very many IT solutions, and, therefore, their level of confidence in using these solutions is normally low (Ssekakubo et al., 2011). Without reliable, timely, and effective support services, such people might not be able to use the eLearning solutions more effectively. In fact, instructors' and students' mastery of technology is a key ingredient if they are to continue using it and have a positive attitude towards it. This can be achieved by providing reliable support that addresses how to use the technology.

Additionally, institutions should improve the quality of learning resources, especially those offered through eLearning solutions. We found that the quality of learning resources has a positive effect on both learner satisfaction and the use of eLearning solutions. Institutions should develop locally based learning resources that are accurate, are up-to-date, and present skills relevant for the given discipline. Localizing learning resources to the learners' native language and ensuring relevance to local settings is believed to be a good predictor of students' doing well in courses offered through an eLearning environment (Andersson & Grönlund, 2009).

Finally, institutions should improve the usability of the eLearning solutions implemented in the region. In the project, we found that the quality of the eLearning systems had a positive effect on eLearning system usage. The low level of use of eLearning solutions in East Africa might be due to usability problems. Most of the institutions have been adopting eLearning solutions without conducting usability evaluations, because of lack of expertise and/or the cost of performing such evaluations (Ssekakubo et al., 2011). It is not clear whether users find the eLearning solutions implemented at their institutions easy to use and easy to learn and whether they meet the learning objectives set.

In conclusion, the role that eLearning solutions can have in overcoming the challenges facing the education sector in East Africa cannot be ignored. The findings from the thesis project and the recommendations made could enable institutions and other stakeholders to develop eLearning services that are relevant, usable, and acceptable to the majority of users in the region. The findings may also help institutions to develop eLearning solutions that provide the intended educational value and display pedagogical effectiveness.



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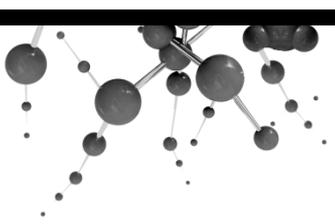
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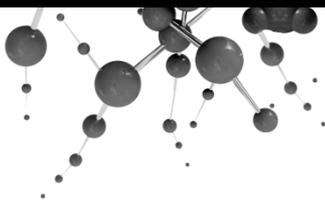
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## Paper II

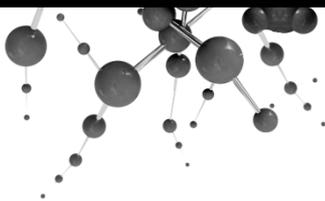
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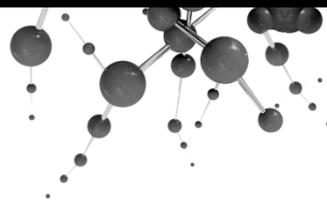
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## Paper IV

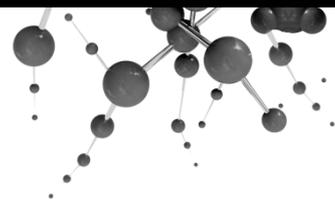
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## Paper V

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Details of the dissertations are available at  
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1. **Timo Partala:** Affective Information in Human-Computer Interaction
2. **Mika Käki:** Enhancing Web Search Result Access with Automatic Categorization
3. **Anne Aula:** Studying User Strategies and Characteristics for Developing Web Search Interfaces
4. **Aulikki Hyrskykari:** Eyes in Attentive Interfaces: Experiences from Creating iDict, a Gaze-Aware Reading Aid
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7. **Harri Siirtola:** Interactive Visualization of Multidimensional Data
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13. **Toni Vanhala:** Towards Computer-Assisted Regulation of Emotions
14. **Tomi Heimonen:** Design and Evaluation of User Interfaces for Mobile Web Search
15. **Mirja Ilves:** Human Responses to Machine-Generated Speech with Emotional Content
16. **Outi Tuisku:** Face Interface
17. **Juha Leino:** User Factors in Recommender Systems: Case Studies in e-Commerce, News Recommending, and e-Learning
18. **Joel Mtebe:** Acceptance and Use of eLearning Solutions in Higher Education in East Africa
19. **Jussi Rantala:** Spatial Touch in Presenting Information with Mobile Devices