

EVALUATION OF THE ADAPTABILITY AND SCALABILITY OF LEARNING  
MANAGEMENT SYSTEMS

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## 1. Introduction

### 1.1 Background and Research Rationale

In contemporary society, many teachers and students use mobile and web-based learning environments because technology offers increased mobility and expands the learning environment beyond one given region. As Brusilovsky, Karagiannidis, and Sampson (2004) noted, schooling institutions increasingly use different forms of computer-based education that is independent of specific hardware platforms. Further, Brusilovsky and Peylo (2003) have asserted that e-learning systems, also called learning management systems (LMSs; Romero, Ventura, & García, 2008), are crucial in supporting the needs of modern students and teachers. Therefore, this need has warranted an increased availability of LMSs in society.

However, despite the increasing popularity of LMSs, Armani (2004) observed that, in most cases, it is only on a few instances that the end-users' needs and the heterogeneous access environments have been taken into account. The term *heterogeneous access environment* refers to the fact that end-users currently access LMSs from various end devices such as desktops, laptops, iPads, smart-phones, or even gaming consoles. These devices are widely used in the market today especially with the ability to connect to LMSs using access technologies such as Ethernet, wireless LAN, mobile broadband, and so on. In order to ensure that the needs of potential users are effectively met, the LMS framework has to be designed to adapt and enable effective learning on these varying devices and varying user-interfaces (Lall & Lumb, 2010; Withall, Hinde, & Stone, 2004). In fact, it is critical that researchers and developers generate an effective framework that meets these demands because the number of students engaged in e-learning has surpassed the numbers involved in traditional classroom learning (Lall & Lumb, 2010).

Despite the importance of user friendly framework, a survey of the currently existing LMSs demonstrates that they are teacher-centric in nature. This implies that these tools are

designed primarily to enable course content management, student administration, monitoring, evaluation, communication, and interaction amongst other functions. However, they are not designed to meet the needs of the students. For example, they are designed to aid the learning and pedagogical requirements from the teacher's perspective alone (Hall, 2007; Kljun, Vivic, Kavsek, & Kavcic, 2007) without considering the end-users' pedagogical needs and the heterogeneous access environment. Hence, there is a need for an LMS framework that is scalable and adaptive to end-users' pedagogical and technological needs.

In discussing LMSs, this research paper explains how developers can create an LMS that retains the focus on the teacher's perspective while ensuring that it meets the students' needs for a mobile learning environment. It also presents information that to ensure that the mobile learning environment is rich in content in order to fit a number of possible platforms in such a way that the arrangement gives room for future advancements and extensions of the system. Since user needs are diverse, I will also focus on proposing the creation of a variably adaptable system that can be customised to meet the needs of different users (Burgos, Tattersall, & Koper, 2007).

## **1.2 Research Questions**

The aims of this research are to:

1. Conduct an evaluation of LMSs based on the criteria of the needs of all possible users within a learning system;
2. Determine the requirements of a flexible, adaptable, and scalable LMS within an academic environment; and
3. Create a system that focuses on presenting the teacher centric environment but also helps students achieve their goals through mobile learning environments.

## **1.3 Research Paradigm**

As noted in the background section, modern education practices and technological advances have increased the demand for mobile systems that support mobile learning for both teachers and students. Although current LMSs are centred on the needs of the teachers, the systems should also be student friendly in order to allow them undertake the mobile learning option. Therefore, the development of a system that allows students and teachers to effectively carry out their duties within their machines is crucial to meeting the needs of various users. In this research, I will employ a positivist paradigm that is based on logic, measurements, truth, absolution, and prediction. Therefore, in order to ensure that accurate results are achieved, I will employ this approach for this research paper.

The positivist paradigm approach adopted for this research paper blends well with the thematic data analysis approach. This is because it involves the collection of verifiable facts that support the theories. In addition, it ensures that data is explained in the most economic way possible. Therefore, this paradigm assists in the process of generating knowledge by the process of quantifying data and this enhances the description of parameters and the exploration of relationships between them.

## 2. Conceptual Framework

### 2.1 Introduction

Figure 1 illustrates the basis for the conceptual framework for this thesis, indicating the relationships between the key ideas and principles involved. The central concepts in this work are those of adaptability and scalability in the context of LMSs, as defined above. I will evaluate LMS and consider the requirements for their design in terms of technological and pedagogical needs throughout this research; therefore, the conceptual framework has to incorporate these key areas.

The users of an LMS have both technological and pedagogical needs; these are reflected in the design of an LMS and exhibited in the (graphical) user interface. Technological needs are mediated by the access environment, which is in this case a range of platforms through which users interact with the LMS (e.g., desktop, laptop, phone, tablet, etc). In a heterogeneous access environment, these technological needs can be complex and variable. In an LMS, scalability is reflected in the principles of user interface design. The pedagogical needs of the users are mediated by relevant pedagogical theories and, with respect to adaptability, the concept of learning styles. Learning styles can be described as elements of a person's "cognitive style and personality... [which] draw attention to the critical importance of intentionality in academic learning" (Entwistle, 1987) or as "innate preferences of individuals as to how they prefer to go about the process of learning" (Wintergerst, DeCapua, & Itzen, 2001).

As shown in the diagram below, the LMS is composed of various elements. Each of these elements has its own functions and purpose in the LMS. Case in point, the user interface is the element that shall offer the users a platform on which to interact with the system. It shall hide the complexity nature of the system and offer graphs and icons that are

familiar with natural objects and use pointers in order for the user to interact with the system easily (Wintergerst, DeCapua, & Itzen, 2001).

The user interface shall offer scalability, heterogeneous access environment and adaptation for all end user technological and pedagogical needs. This is because we have learners who include students and the teachers and tutors. Further, based on the modern trend and changes experienced in the society, there is need to ensure that the system is adaptable and scalable to allow room for expansion and change to accommodate the dynamics.

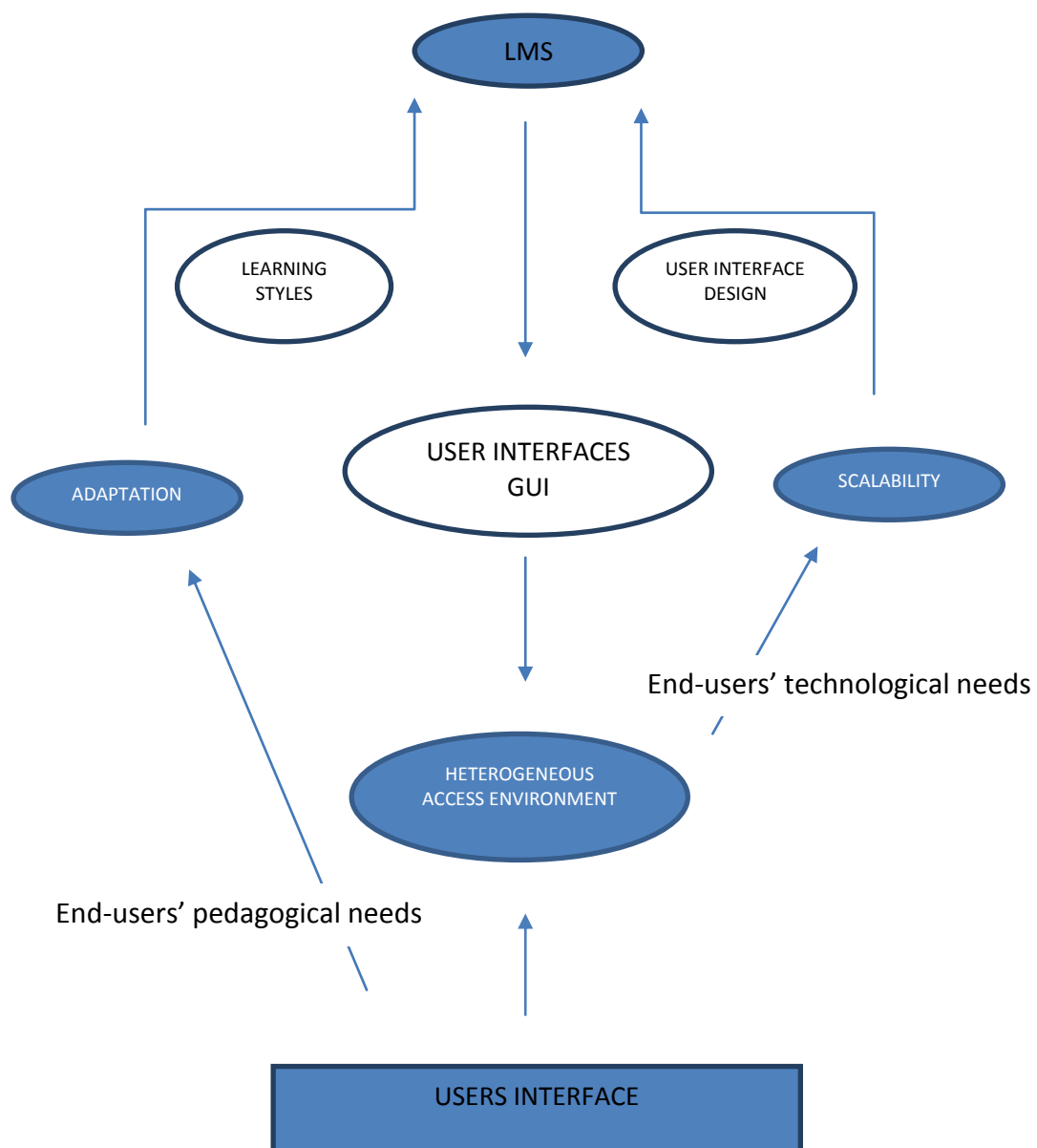


Figure 1. Conceptual framework of this thesis.

The research questions require an evaluation of LMSs with respect to adaptability and scalability. Most of the frameworks for evaluating an LMS are based on frameworks initially designed to evaluate computer software and later adapted to meet LMS needs (Britain & Liber, 2004; Donham, 2004; García & Jorge, 2006).

Dixon and Barreto (2003) provided a framework that describes how virtual learning environments (VLE) can be evaluated. Their framework included the purpose of evaluation, evaluation methods (e.g., summative, formative, integrative), and applied measures; considers types of experiments (e.g., case study or test study); and proposes criteria to measure effectiveness and usefulness. Methods of evaluation can include interpreting results, determining processes, or identifying outcomes, depending on the type of data (e.g., qualitative, quantitative, subjective, objective) and participants (e.g., general users, experts). The framework proposed measurements including usability heuristics, frequency of interactions, and learning outcomes.

In addition, Britain and Liber (2004) presented a framework based on two models. The first is based on the Conversation Framework (Laurillard, 2002) that looks at ways of teaching: adaptive, discursive, interactive, and reflective. The second model, the Viable System Model, looks at collaborative learning with resource negotiation, coordination, monitoring, individualization, self-organization, and adaptation. Britain and Liber (2004) proposed a number of criteria for both models and suggested that different subjective methods (e.g. questionnaires, elaborating comparison grids) can be used to evaluate against them.

Researchers such as García and Jorge (2006) have noted that these and similar frameworks do not perform well when trying to evaluate LMS quality using benchmarks, which give formal measurement reference to allow comparison. One method of performing



benchmarks is the LEARNING PLATFORM EVALUATION MODEL SITE (2005). This model considers three main areas of functionality: content, communications, and management. LMSs were also evaluated by van den Berg (2005) using another method with an open source software (OSS) evaluation model that uses criteria and had been used in other OSS evaluation activities (Chavan, 2005; Dixon & Barreto, 2003). Criteria in this model included community, release activity, longevity, license, support, support options, documentation, security, functionality, integration, goal, and origin. These criteria are general purpose and applicable to commercial products as well.

## **2.2 Methods**

The background section provided a definition of adaptability and scalability, while the above section described different methods by which LMSs have been evaluated in the past. In this research, adaptability can be described as the capability of a system to adapt to different learning styles. Scalability in this research means the ability for systems to operate effectively on different devices

1. To explore the requirements for an adaptive and scalable LMS within an academic environment; and
2. To propose criteria for designing a novel LMS framework that addresses the above shortcomings.

To successfully meet these objectives, I will adopt a qualitative method for conducting research using semi-structured interviews to explore the above issues.

## **2.3 Qualitative Research**

Qualitative research is the range of processes and procedures that takes qualitative data (from sources such as interviews, focus group discussions, etc.) and translates them into explanation, understanding, or interpretation of the people and situations being investigated. The objective is to understand qualitative data by examining the meaningful and symbolic

content through ascertaining the people's points of view and the reasons behind these perspectives. The process of analysis usually involves writing, identifying themes, coding themes, and interpreting them (Silverman, 2005).

The purpose of this thesis, as mentioned above, is to explore the adaptability and scalability of LMSs in relation to learning styles and a heterogeneous environment of access methods. Learning styles are highly individual and have been studied in depth and categorised in many different ways (Silverman, 2005). Individual preferences and affordances to learning styles do not strictly dictate one method over another and are open to interpretation (Abrams, Maloney-Krichmar, & Preece, 2004; Muller & Kuhn, 1993; Sanders, 2002). Ultimately the measure of success in this respect is in measuring a combination of learning outcomes along with individuals' own views and opinions on their learning experience. Similarly, this work also intends to measure the effectiveness of LMSs over different devices, with respect to scalability and suitability for education. Again the measure of this factor will be a combination of learning outcomes and learners' experiences of using the LMS. These factors make qualitative research an appropriate choice, as it is able to provide explanation and interpretation of a diverse range of factors that are otherwise difficult to express in a qualitative fashion.

The choice of method is also influenced by the final objective of this work, which is to provide criteria by which a novel LMS evaluation framework can be designed. The outputs of qualitative research therefore will provide a rich source of opinions and an interpretation of the emergent themes. This form of data is ideal to stimulate the design of a novel LMS framework and is widely used in design exercises such as user-centred and participatory design (Abrams, Maloney-Krichmar, & Preece, 2004; Muller & Kuhn, 1993; Sanders, 2002).

#### **2.4 Semi-Structured Interviews**

For years, researchers and scholars have used the semi-structured interviews in conducting their studies. This is because semi-structured interviews are loosely structured interviews consisting of open-ended questions that allow viewpoints to emerge freely (Silverman, 2005). A semi-structured interview is a verbal interchange between two people, the researcher and the informant, where the researcher aims to gain information by asking questions. Although there is a pre-determined question list, the interview is conducted in a manner of a conversation whereby the informant can express issues they feel important (Longhurst, 2003). In this study, I will prepare interview schedules in advance with a number of predetermined themes to frame the discussion. Following the creation of these schedules, I will conduct interviews either in person or over the phone on potential and existing users of the LMS.

Semi-structured interviews have been widely used to evaluate measures of learning styles and experiences of learning (e.g., DeCapua & Wintergerst, 2005; Jie & Xiaoqing, 2006; Kember & Gow, 1990). They are also widely used within user interface design evaluation to explore users' perceptions and opinions of a particular design (Jie & Xiaoqing, 2006; Johnson & Wiles, 2003; Stiemerling, Kahler, & Wulf, 1997). Similarly, semi-structured interviews are used as a source of design inspiration (Luck, 2003; Miller, Friedman, & Jancke, 2007). Semi-structured interviews therefore provide a synergistic method that will cater to the three principle aims of this thesis.

### **3. Data Analysis**

#### ***Thematic Data Analysis***

In this research, I will analyse data thematically. Themes are patterns that emerge across the entire data set; in this case, themes will emerge in the data acquired through the semi-structured interviews. These themes are important to describe the phenomena associated with the research questions mentioned above. These themes or codes will become the categories of analysis to find meaningful patterns across the data. To successfully identify themes, the researcher must read and re-read the data to become familiar with it, generate initial codes by highlighting phrases or concepts, search for common themes across these codes, review the themes, define and name the themes, interpret the themes, and produce the final report (Silverman, 2005).

A thematic approach constructs a flexible framework based upon pre-determined and emergent themes. It is suited to this research because the intention of the semi-structured interviews and the purpose of the data analysis are to inform each of the main research questions. A thematic approach allows me to gather evidence across the whole dataset and to draw interpretations relating to all relevant factors, focusing on the intentions, meanings, and opinions expressed (Braun & Clarke, 2006). Therefore, the thematic approach is particularly relevant as the third research objective is to stimulate the design of a novel LMS accounting for problems as-yet unknown and to be determined through the evaluation itself. Allowing themes to emerge through the iterative thematic analysis makes this possible, as it does not require specific questions to be determined up front (Richard, 2008).

#### ***Use of Other Forms of Data Analysis***

The quantitative method of data analysis could also be used in this research. However, it was rejected following a number of disadvantages associated with its application. Case in point, unlike the thematic method of data analysis, the quantitative technique is not flexible

enough to allow researchers apply numerous theories while dealing with large data sets. Further it does not allow categories to be drawn from the data in question. Nevertheless, it is more accommodative than thematic data analysis as it offers unlimited interpretation power in cases whereby theoretical framework is included. Moreover, it is more reliable whereby numerous researchers have conducted the research (Daly & Gliksman, 2007). This research required limitation and did not incorporate the knowledge of many researchers. Therefore, the advantages associated with quantitative data analysis technique are not critical for this research study.

#### **4. Conclusion**

This document has introduced the background to this research, detailing the need for learning management systems to account for both adaptability to learning styles and scalability across an increasingly diverse ecosystem of platforms and devices. The conceptual model of the thesis has been introduced by defining the concepts of adaptability and scalability while introducing learning management systems. A relationship diagram was used to illustrate the relationships of adaptability and scalability with user requirements and the design of learning management systems. The final section of this document has outlined the research approach and specific methods to be used, relating them to the research questions and indicating their applicability to a study of adaptability and scalability within an evaluation of both educational tools and user interface design.

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