Advances in Engineering Software 40 (2009) 1297–1305

Contents lists available at ScienceDirect

Advances in Engineering Software

journal homepage: www.elsevier.com/locate/advengsoft

eLearniXML: Towards a model-based approach for the development of e-Learning systems considering quality

Habib Fardoun *, Francisco Montero, Víctor López Jaquero

Computing Systems Department, University of Castilla-La Mancha, 02071 Albacete, Spain

ARTICLE INFO

Article history:
Received 22 September 2008
Received in revised form 19 November 2008
Accepted 19 January 2009
Available online 23 April 2009

Keywords:
e-Learning
Model-based design of user interfaces
MB-ISDE

ABSTRACT

With the evolution of technology, and especially of the Internet, a growing interest has appeared for on-line education. The many advantages of e-Learning have made this teaching philosophy an ideal partner for teachers, either as a complement to regular education or as a substitute for traditional education. The development of an e-Learning system poses extra challenges for software developers, since there are other facets, such as contents and user tracking, not usually considered in software development methodologies. In this paper eLearniXML approach to the development of e-Learning systems is presented. This approach enriches the development of e-Learning systems method proposed in ADDIE with the model-based development of user interfaces and software quality consideration. By doing so, we aim at the development of, what we have named, a Model-Based Instructional Development Environment (MB-ISDE), to include e-Learning development in the current trends of model-based software development.

1. Introduction

With the evolution of the Technologies of Information and Communication (ICT) new learning–teaching applications have appeared, being e-Learning one of the main training strategies using the ICT, along with the traditional learning elements. e-Learning provides a powerful tool to either complement regular education or as a substitute for traditional education. On-line education is becoming a must in educational institutions. For instance, almost every university is Spain offers some kind of e-Learning support. Although e-Learning is somehow a mature technology, the methods to design this kind of systems are not mature enough. Different methods for e-Learning development have been proposed [17] so for, but their adoption is not a reality. Furthermore, the methods proposed so far for e-Learning development are not as systematic as they should. In this paper eLearniXML approach to the development of e-Learning systems is presented. This approach enriches the development of e-Learning system method proposed in ADDIE [14] with the model-based development of user interfaces and software quality consideration [4]. By doing so, we aim at the development of, what we have named, a Model-Based Instructional Development Environment (MB-ISDE), to include e-Learning development in the current trends of model-based software development. Next, a description of the ADDIE e-Learning systems method will be discussed. This methodology has been chosen as the starting point for eLearniXML.

2. ADDIE: an example of traditional e-Learning methodologies

The most widely used methodology for developing training programs is called Instructional Systems Design (ISD). It is also known as Instructional Systems Design and Development (ISDD). There are more than 100 different ISD models, but almost all of them are based on the generic ADDIE model [17,14]. This model supports a step-by-step process that helps training specialists in planning and creating their training programs. ADDIE ISD model introduced five components: *Analysis, Design, Development, Implementation, and Evaluation* (see Fig. 1).

The ADDIE analysis phase defines the project's needs and the ways to measure its success. Later, during the design phase, the training specialist plans what the course should look like when it is complete. At the beginning of the instructional design phase, the training specialists should have a pretty good idea of what the learners will already know when they start the course.

During the instructional design phase, the training specialist does not create the course content. The actual course content and training materials will be created during the development phase. A successful development phase draws upon the information collected in the needs analysis phase and the decisions made in the design phase. Since there are many types of training projects, the development phase often adapts to fit the project and the client's needs.

* Corresponding author.
E-mail addresses: habib@dsi.uclm.es (H. Fardoun), fmontero@dsi.uclm.es (F. Montero), victor@dsi.uclm.es (V. López Jaquero).

0965-9978/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.advengsoft.2009.01.019

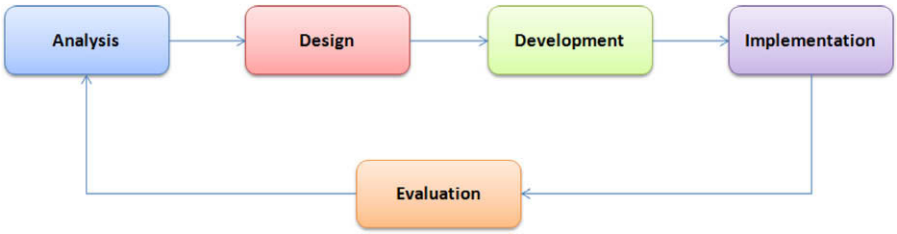

Fig. 1. ADDIE model for educative contents development.

There are plenty of issues to address during ADDIE implementation phase. It is important to make sure that the course gets delivered smoothly and effectively to the learners. Of course, these delivery issues will substantially depend on the course's delivery format. Usually, the implementation phase contains a lot of project management and logistic issues.

Finally, the ADDIE evaluation phase can produce pretty graphs and metrics, but that's not its main purpose. The evaluation phase measures the course's efficacy and it searches for opportunities to improve learner's on-the-job performance.

The ADDIE model describes an ideal-world methodology. It assumes that training specialists will have plenty of time to create a great training program. Unfortunately, that's not always the case. With an urgent training project, you have to balance quality and timelines. The great strength of the ADDIE model is implied in it. A model is a template, a structure or an approach to be used. But, it is just exactly like any other generic description of the design process in any other field. The ADDIE model is criticized [2] as not being effective, efficient, or even what instructional designers really do. It means that it does not necessarily lead to the best instructional solutions, nor does it provide solutions in a timely or efficient manner. Moreover, ADDIE model does not guarantee quality, does not work efficiently, is out of date, and does not even reflect the real work of instructional design. In this paper, we introduce additional refinements to overcome these limitations, a set of alternative models are considered and the concept of Model-based ISD Environment (MB-ISDE) is introduced.

3. E-learning system components

Previously, we introduced a representative model for instructional systems design. Next, we identify what components should be considered when an e-Learning system is developed. Over the past decades, large and small organizations have implemented a variety of e-Learning system components, using either proprietary and/or homegrown solutions to serve their individual and diverse learning needs. There are a multitude of isolated and technologically distinct databases containing a wealth of useful information. Learner/Student Information Systems (SISs) are used for admitting learners into programs, course registration, and other administrative functions. More recently, organizations involved in e-Learning have invested in Learning Management Systems (LMSs) to deliver content in learning environments that may include a variety of synchronous and asynchronous communication channels (*e-mail, chat, discussion boards, whiteboards, group-surfing, Voice-Over-IP, etc.*) and instructional support tools (*grade books, student tracking, etc.*). Still more recently, e-Learning content is being developed in Learning Content Management Systems (LCMSs) or in Learning Object Repositories (LORs). These components are represented at Fig. 2.

Our proposal, which we will introduce in the next sections, considers an user interface component (see Fig. 2). A good user interface is important for several reasons. First of all, the more intuitive the user interface is the easier it is to use, and the easier it is to use the less expensive it is to use. The better the user interface the easier it is to train people to use it, reducing your training costs. The better your user interface is the less help people will need to use it, reducing your support costs. The better your user interface is the more your users will like to use it, increasing their satisfaction with the work that you have done.

4. Model-based development of interactive systems

Traditionally, one of the main problems when designing an interactive system is the creation of its user interface. User interfaces are becoming more and more complex, drastically increasing the effort spend in its development. Nevertheless, they are still being created in an ad-hoc manner. Fortunately, there is a growing interest, not just in user interface development, but also in general software development of using MDA [9], to design the systems by specifying some models and how to transform those models to obtain the final product. These model-driven development trends stress the importance of using systematic methods in the development of applications, and the promotion of models from a mere documenting role to a generative role.

Since the beginning of the 90s, there has been an interest within Human-Computer Interaction community to be able to design the user interface of an application out of a set of models. Thus, the user interface designers instead of coding the user interface using a regular programming language, they specify the functionality, look and feel, contents and the rest of user interface features by means of models. This approach to user interface design is known as model-based user interface development environment (MB-UIDE) [13].

Although there is no standard in MB-UIDE for the set of models to be used, most of the models are the same in different approaches with slight differences. In Fig. 3, the set of models most commonly accepted is depicted. This set of models is based on the user interface development framework specified in [6]. Each

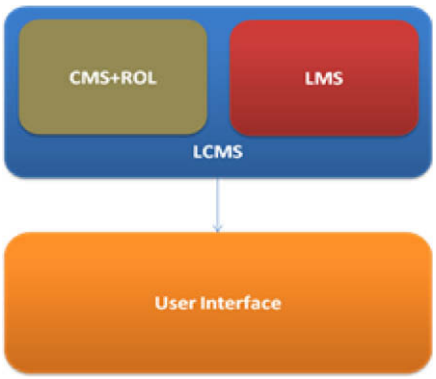

Fig. 2. Structure and components of e-Learning system.