Developing Innovative e-Learning Solutions

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Abstract: Nowadays, the interest in applications of e-learning is becoming more and more meaningful in various social and production areas. There are numerous proposals for new learning solutions mediated by technologies that depart from technological innovations. In this paper a method for development innovative solutions in e-learning applications based on the centrality of the studies of human-computer interaction is proposed. In particular, it explores the concept of usability and proposes a design framework. An application to the construction of an e-learning system is also presented.

1 INTRODUCTION

The design of computer systems is based on appropriate paradigms whose goal is the creation of a good system (Haoyu and Haley, 2012). In recent years, particular interest has focused on usability as a significant aspect of the design of computer applications (Jacko and Sears, 2003).

The usability is that form of organization of knowledge in human-machine interaction (HCI) in order to improve the quality of system, i.e. the way in which the objectives are achieved by a user point of view. Evaluate the usability of a system is the first step in order to provide more adequate performance. The usability evaluation of a system is a complex task that requires the development of special mechanisms for analysis and diagnosis, in order to activate strategies (Mehlenbacher et al, 2005).

The field of study of the formation mediated by information technology, although it can be traced back to several years ago is always very timely. This is due to the strategic importance of education and training, which strongly depends the development and future of our society, and by the speed with which new ICT technologies are evolving. Although you can record interesting advances in computer applications in the field of e-learning, little attention has so far been paid to the systematic study of the usability criteria (Squires and Preece, 1996; Oztekin et al, 2010).

A recurrent position in literature in development of e-learning is that the achievement of learning objectives can be improved through the application of the criteria of usability. In particular, in section 2 is discussed the learner-centered design approach, in section 3 is defined the concepts of personalization, in section 4 is discussed the design of an e-learning system usability based, and it is highlighted the importance of usability evaluation. Finally in section 5 is designed a sample application on the proposed framework, defining a Virtual Learning Environment.

2 LEARNER CENTERED DESIGN

The Learner-Centered Design (LCD) is characterized by an analysis centered on the motivations that support or contrast the learning. While in some cases the designer must take into account the reasons that induce a person to learn, in other cases the user may not be interested to learn. So, the problem is to solicit the student's curiosity and generate new learning objectives.

In e-learning applications, the effectiveness of the system will be also the position between student and technology. In fact, in these cases, the effectiveness of learning is mediated by the technological component. Therefore a significant study of student-technology must also be considered already in the design phase in order to develop a good system. It is in fact necessary to identify a technique, or a combination of techniques, in order to define a user interface which can be measured.

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The interface design of a course is one of the crucial choices since it can have a positive or negative impact on the performance of the target audience (Jones, 1994; Tselios et al, 2001).

In this aspect, the usability role is to improve the quality of e-learning using its methods of design and evaluation. In particular, it considers the following characteristics (ISO, 1998):

- *effectiveness*, which measures the accuracy and completeness of the objectives achieved;
- *efficiency*, which measures the accuracy and completeness of goals achieved with available resources;
- *satisfaction*, which measures the comfort and acceptability of the system to its users and other people which refer to its use.

In general, it can be said that usability has to do with aspects of human-computer interaction (Shackel, 1991).

The LCD systems are characterized by a highly interactive form of activity, and therefore their application in the field of e-learning leads to the development of highly interactive computer systems. In this sense, the usability of these systems becomes a significative element of analysis and development.

Knowing the user profile is the best way to design usable systems (Penna and Stara, 2007). The interface should be hold fonts and colors suitable for reading on the screen in order to create consistency, predict lower download times and provide printable versions of the files. The interface should be also interactive and provide feedback, have specific objectives, be constantly updated, providing appropriate tool, to prevent any inconvenience during the use of the course.

These specifications refer to a *user-friendly* design, following the approach LCD. But since that learning follows a series of characteristics based on single student, it is necessary to use a recursive design, which integrates the constant feedback of end users at every stage of the design. The high-level specifications for the development of a design framework LCD based are shown below (Murphy, 2004):

- define the *target*, in order to identify a suitable interface;
- through a *task analysis* understand the objectives of the target and its mental model;
- structuring a *prototype* and evaluate the correspondence of this model compared to the target model;
- *test* the prototype with users through a real method applicable;
- create a *beta version* of the system that unlike the prototype include all functions of the system, test it on a small number of users;
- proceed in the design process until the launch of the *product*.

3 TOWARD PERSONALIZATION

Students have different: characteristics, knowledge, skills, motivations and needs. In order to make the learning process more effective and efficient, and motivate students, it is required the presentation of information in different and appropriate way (Jara-Roa et al, 2010).

Some requirements for educational adaptive system solutions are:

- it should adapt to what a learner already knows (prior knowledge) and what it can do already (previous skills);
- it should adapt to the different learning abilities of students;
- it should fit to particular preferences or learning styles of students;
- it should adapt to a suitable level of performance of different learners and to their state of knowledge (i.e. the system should provide adequate and consistent feedback);
- it should adapt to the educational interests of students;
- it should adapt to a student's personal situation (place, time, etc.).
- it should adapt to students' motivation.

Tutoring can be seen as an adaptation to the individual student, expanding the concept of the LCD seen in the previous section, that instead involves a “class” of users. The concept of customizing the presentation of information is closely linked with that of usability of the system, as it introduces the ability to function effectively and efficiently, while providing the personal satisfaction for their users (Notess, 2001).

The supporters, developers and designers of educational environment are needed to obtain effective, accessible, flexible, attractive designed and distributed systems based on learning personalized specification. The main characteristics of e-learning systems are their ability to recognize the students’ needs, educational behavior and also their capabilities. These systems should be able to make the appropriate recommendations to improve the efficiency of the education process (Saberi and Ali Montazer, 2012).

4 DESIGN AN "USABLE" e-LEARNING SYSTEM

4.1 Framework Project

The design of an e-learning system from the methodological and technological perspective must contemplate the collaboration of several key actors: disciplinary experts, educational advisors, technical experts, tutors and, of course, end users, i.e. students. While taking into account the fact that it is a recursive process, we can identify three main phases concerning: the preliminary phase of the design, the design-methodological and the phase related to the technological infrastructure, as shown in Figure 1.

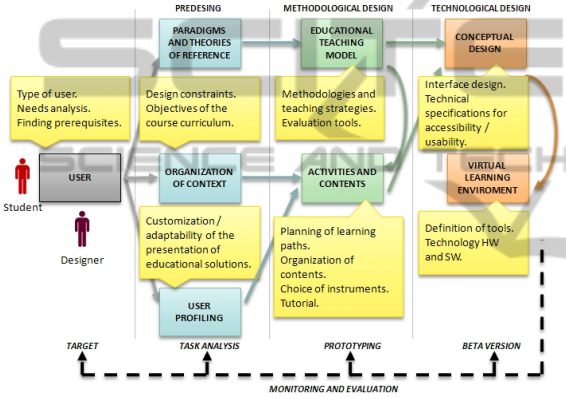

Figure 1: The usability based framework proposed to design an e-learning system.

In this scheme we can place standards and guidelines as follows:

- *user profiling*: classification of the different types of users of the system;
- *pedagogical-didactic model*: methods and instructional strategies to apply, as well as indicators to assess the quality of education;
- *activities and content*: guidelines for the creation of educational content and educational programs to be implemented;
- *conceptual design* and definition of the *virtual learning environment*: parameters for the accessibility and usability of websites and web platforms.

During the *Predesign phase* we can identify the paradigms and theories of reference: in order to arrive at the choice of an appropriate theoretical paradigm we can examine theories and models of e-learning training. The choice of a learning model implies a theoretical choice and, consequently, the choice of a suitable architecture teaching; in learning theories the design models represent the most general level, within which we can delineate teaching strategies, methodologies, technical skills and student activities. If we have clear theoretical foundations that are upstream of the assumptions on learning and knowledge we will be able to design properly the learning environment.

Reasoning from the educational point of view, the effectiveness of an e-learning system must be related to a number of factors, ranging from the type of learning theory to which one intends to inspire and to its teaching strategy to implement it, the type of target, the context in which it must fit the training activity, the objective constraints such as the number of users, to economic resources to design and create the training process, the tractability of electronic content to be provided, and so on (McDonald and Schvaneveldt, 1988).

From the above, it clearly emerges that the definition and the choice of the type of e-learning approach to be taken is of great importance not only from the point of view didactic-pedagogical but also from the more markedly operating. In fact we can consider the efficiency of the system in terms of human resources required to design, execution and operation of the process, the technologies to be used and the organizational structure able to support, manage and communicate between all system components.

This step is followed by profiling of potential users in order to evaluate the parameters related to personal satisfaction: special educational needs are different for groups, types and individuals, and it is therefore necessary to describe these different types to identify their specific needs. To complete the predesign phase we can consider the analysis of learning needs and the identification of prerequisites that must be owned, developed or enhanced.

In the *Teaching-Methodological Design phase* we proceed to identify teaching methods and strategies of communication in relation to the pedagogical-didactic model chosen. Each model, in fact, provides the procedural frameworks for the systematic production of training, allowing you to define role and functions of subjects and objects, as well as the ways and means of evaluation of learning.

In many situations the chosen learning model encourages in the definition of educational mediator, i.e. in the process that tends to favor the flow of knowledge by a issuer (the teacher) to a receiving (the student). For example, a behaviorist model has often driven the development of self-instructional materials in the field of training aspects. The cognitive model, often interpreted with problem-

solving strategies or exploration of environments and situations, recalls the need for action combined network of tutors and teaching materials (not necessarily in a self-instruction form). The constructivist model, aimed to the acquisition of complex knowledge through social interaction with peers, implies the organization of groups learning facilitated by an energetic action of tutoring.

In the step of contents production we carry out the planning and scheduling of actions. We also define the organization and preparation of content and teaching resources, which must meet the usability and accessibility criteria, and the choice of instruments communication and interaction in relation to the approach chosen, the definition of tutorial by teachers, tutors, support staff. It is essential to be attention to the quality of the support staff, which must have specific expertise in the management, organizational, technological and educational content.

Finally, in the *Technological Design phase*, we define the construction of the e-learning system starting from the Conceptual Design, which consists in defining the communication architecture and interface design. Here we define the technical specifications for the accessibility and usability of the platform. The design of the Virtual Learning Environment (i.e. the e-learning system) provides, in detail, the design of the tools of communication and interaction to set up and implement the learning environment and the identification of hardware and software support (adaptive technologies and assistive).

4.2 The Importance of Usability Evaluation

In order to evaluate the usability of the system (Granic, 2008), the analysis of user interaction within system interface is based on walktroughs test, guided by predefined steps. Due to the fact that usability, as quality of use in context, is related to the process of use, the usability evaluation is accomplished by testing usability with real users, which are the central focus of the entire system. It is based on criteria expressed in terms of (ISO, 1998; Macleod et al, 1997):

- objective performance measurement of *effectiveness* (the level of correctness and completeness with which users achive specified goals) and *efficiency* (the resources expended in relation to the correctness and completeness of goals achieved) in using the system;
- users' *subjective assessment* in system usage.

These objectives stress the need to quantify usability in terms of user performance and satisfaction. They are measured by the extent to which the intended goals of use are achived, the resources that have to be expended in order to achieve them, and the extent to which the user finds the use of e-learning system acceptable. Such testing is understood to be a combination of behaviour and opinion based measures with some amount of experimental control, usually chosen by an expert. It affords information about how users (teachers or students) use the system (in the creation of learning objects and the interaction with the e-learning system, respectively) and identifies the exact problems with a particular interface (Granic, 2008).

4.3 Methodology and Schedule of the Evaluation

Taking into account that the usability of a particular system depends on the characteristics of the users, the tasks and the purpose of the system, the concept of usability is not simple and meaningful during the design phase. Therefore indicators usability assume empirical values during the design phase and can be evaluated only during the use of the system. Consequently, in order to understand the quality of e-learning system designed we must evaluate the effect of such a system in a specific situation and operational work, for example considering a basic scenario simplified, i.e. detailing a working scenario consists of a sequence of typical tasks and actions that a sample of users to perform. The objectives of usability will be achieved if the potential of the system will actually be used in an effective way (with respect to a given level of performance of users) is efficiently (with respect to a level of subjective evaluation suitably specified). Thus, the usability evaluation based on this scenario includes:

- a preliminary questionnaire (Argentero et al, 2009);
- an evaluation test using the technique of usability walkthrough (Lewis et al, 1990);
- a memo test (Granic et al, 2004);
- a satisfaction questionnaire usability (Harper and Norman, 1993; Lewis, 1995).

Users of evidence that will provide assessment will form a sample as representative as possible of the end users of the e-learning system under consideration and will be tested with real tasks (i.e. based on learning of a knowledge acquired regarding a selected topic), under conditions as close as possible to those of use of the real system (environment class). When we carry out usability evaluation, according to the assertions of Faulkner (Faulkner, 2003) that shows the benefits of increased sample size compared to five users of the

Table 1: Usability attributes specification for evaluation.

	Effectiveness measurements	Efficiency measurements	Satisfaction measurements
Suitability	% goals achived during the walthrough test	Time to complete the test	Questionnaire rating scale
Learn-ability	% goals achived completing a task from the walthrough test	Time to complete a task	Questionnaire rating scale
Error rate	Errors / perfomed actions completing a task from the walthrough test	# of errors completing a task from the walkthrough test	Questionnaire rating scale
Memor-ability	% functions memorized successfully	Time to complete the memo test	Questionnaire rating scale
Subjective satisfaction			Questionnaire rating scale
Overall subjective satisfaction			Questionnaire rating scale

usability testing, the evaluation process must therefore be conducted on a group of users of at least 10 students. The evaluator will meet with the group and explain the purpose of the evaluation, presenting an overview of usability evaluation. At the end of this, the session will proceed with the analysis of the results obtained that will begin to give a measured "weight" to the usability of the designed system.

The evaluation session allow the acquisition of the principal measures of usability system. Because we consider tests made by the users, like all empirical studies show, their evaluation requires a theoretical framework for definitions and measures, therefore quantifiable attributes are defined, as shown in Table 1.

5 AN APPLICATION OF THE e-LEARNING FRAMEWORK

In this section, as a sample application on the proposed framework, we present the definition of a Virtual Learning Environment in which the previous conceptual analysis has highlighted the importance of an element can provide the customization of presentation of educational solutions. This component aims to show skills training and operating the different educational situations, trying to provide an environment for each individual student, in order to develop a direct interaction and dedicated to the professional educator, and presenting the necessary resources at the appropriate time, which are adapted to different individuals. The choice of learning strategy must reflect the specific model of e-learning system which is expected to put in place, as well as being functional learning style model that seeks to promote. Given these premises, we can model, in the first instance, our e-learning system based on proposed Framework, as shown in Figure 2 (Castellano et al, 2007).

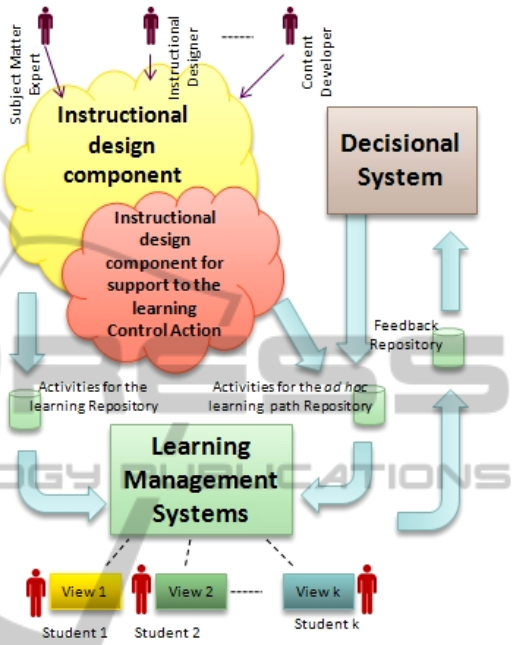

Figure 2: Architecture of Virtual Learning Environment based on proposed Framework.

The proposed approach is to design a Virtual Learning Environment with the components for:

- *didactic planning and production of the contents*: it favours the development of the process enriching it with in progress evalutation;
- *distribution of the contents by Learning Management System* (LMS): it expose mechanisms to measure, in progress, the abilities that the student has acquired;
- *monitoring*: it acquire and storage evaluation data and trigger the control component if a knowledge learning degree is in debt;
- *intelligent control*: it can be waked up by the monitoring component. Its task is to effect the correct action of control in an intelligent way. This module is able to processing of cases never seen before.

The advantage of such solution is that we can provide different integrated environments, where coexist functionality for the production and management of content, activities for interpersonal communication, for the evaluation and tracking of

paths that fulfill the users in the use of the material, and so on. This, as well as offering the possibility to standardize the various components of the learning environment (definite advantage to the user), it must also meet the need of interoperability between the different platforms, provided of course that each feature is according to the international standard.

The use of adaptive and intelligent technologies that add functionality to a targeted and precise educational system, allows a specific design approach, able to consider both communicational and cognitive aspects and represents the functional relationship that links these two concepts, able to increase the benefits that these aspects can bring in terms of learning and education, thanks to the way they constantly check the level of knowledge of the student, increasing transparency and personalization of the learning environment.

6 CONCLUSIONS

The new ICT technologies in recent years have allowed the systems of learning and education to evolve into new forms of distance learning. In this work we proposed a method for innovative e-learning system based on the centrality of the studies of human-computer interaction. In particular, we explored the concept of usability, and we proposed a design framework. Finally, it was presented a sample application of e-learning system. Future work will further deepening of the proposed framework with the intention of developing new mechanisms and functions related to the analysis of usability in e-learning.

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