Usability of E-Learning Tools

C. Ardito*, M. De Marsico°, R. Lanzilotti*, S. Levialdi°, T. Roselli*, V. Rossano*, M. Tersigni°

*Dipartimento di Informatica – Università di Bari

°Dipartimento di Informatica – Università di Roma "La Sapienza"

{ardito, lanzilotti, roselli, rossano}@di.uniba.it, {demarsico, levialdi, tersigni}@di.uniroma1.it

ABSTRACT

The new challenge for designers and HCI researchers is to develop software tools for effective e-learning. Learner-Centered Design (LCD) provides guidelines to make new learning domains accessible in an educationally productive manner. A number of new issues have been raised because of the new "vehicle" for education. Effective e-learning systems should include sophisticated and advanced functions, yet their interface should hide their complexity, providing an easy and flexible interaction suited to catch students' interest. In particular, personalization and integration of learning paths and communication media should be provided.

It is first necessary to dwell upon the difference between attributes for platforms (containers) and for educational modules provided by a platform (contents). In both cases, it is hard to go deeply into pedagogical issues of the provided knowledge content. This work is a first step towards identifying specific usability attributes for e-learning systems, capturing the peculiar features of this kind of applications. We report about a preliminary users study involving a group of e-students, observed during their interaction with an e-learning system in a real situation. We then propose to adapt to the e-learning domain the so called SUE (Systematic Usability Evaluation) inspection, providing evaluation patterns able to drive inspectors' activities in the evaluation of an e-learning tool.

Categories and Subject Descriptors

H.5.2 [**User Interfaces**]: User-centered design

K.3.1 [**Computer Uses in Education**]: Collaborative learning - Distance learning

General Terms

Design, Experimentation, Human Factors, Standardization

Keywords

Learner Centered Design, e-learning, usability evaluation.

1. INTRODUCTION

New information and communication technologies allow learning "far away" from the teaching source. One challenge for HCI designers is to develop software tools able to engage and support novice learners. To this aim, in addition to User-Centered Design (UCD) guidelines [2] we need Learner-Centered Design (LCD) methods [11] to make new learning domains accessible in an educationally productive manner. A number of new pedagogical issues raise depending on the new "vehicle" exploited. Contents and teaching strategies must undergo re-purposing, in order to fully exploit the new technologies, adapting to each learner profile. We face a twofold challenge. Effective e-learning systems should include advanced functions, yet their interface should hide their complexity to learners, providing an easy interaction grasping the students' interest. Despite of this, we often find a mere electronic transposition of traditional material, provided through rigid interaction schemes and awkward interfaces. A poorly designed interface becomes a barrier to effective learning [5].

In this scenario, traditional evaluation techniques might not encompass usability attributes specific for e-learning. The present effort is to classify and integrate such attributes in a systematic approach driving both design and evaluation. In this work we adapt to the e-learning domain the SUE (Systematic Usability Evaluation) inspection originally developed for hypermedia evaluation [6]. It uses evaluation patterns, called Abstract Tasks (ATs), for guiding the inspector's activity.

The paper is organized as follows. Section 2 describes the current scenario of usability of e-learning systems. Section 3 outlines the SUE inspection. Section 4 reports the pilot study that highlights problems arising with an e-learning system. Section 5 describes the e-learning usability evaluation and Section 6 provides conclusions.

2. E-LEARNING USABILITY

Ensuring usability is one of the main challenges of e-learning systems developers. Norman [10] asserts that a formative product, to represent a rewarding experience, should:

- be interactive and provide feedback
- have specific goals
- motivate, communicating a continuous sensation of challenge
- provide suitable tools
- avoid any factor of nuisance interrupting the learning stream

Moreover, it should be pedagogically suitable, though attractive and engaging. Using new technologies does not mean to reject traditional and successful teaching strategies, e.g. simulation systems, problem-based learning, and direct manipulation. So, a learning system should allow integrating such strategies.

Forcing students to spend longer time understanding poorly usable interfaces than understanding learning content disturbs accommodation of new concepts and overall retention of what is being learnt. Interfaces ought to concentrate on learners' needs and goals, providing a clear idea of content organization and system functionalities, simple navigation, advanced personalization of paths and processes. The user should be involved in the learning process without being overwhelmed.

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The key to develop a system conforming to usability criteria is to adopt a Learner-Centred (LC) methodology. Whereas UCD assumes users' common culture and similar experiences, in LCD a variety of learners' categories must be considered, because of personal learning strategies, different experience in the learning domain, different motivations in affording the learning task. Moreover, while for UCD the user's effort only concerns the comprehension of a new tool to perform a well known task, in LCD we also have to consider the *gulf of expertise* between the learner and the learning domain [11]. It is necessary to rely on an educational theory somehow driving the designer. At present, constructivist theory is almost universally adopted. Learning is recognized as an active process, where the learner is stimulated to cognitively manipulate the new learning material and to create cognitive links between it and prior knowledge. For this approach to be effective, a task must be always included in an actual and collaborative context, to make the learner understand the motivation and the final goal of the task itself, also by facing other learners' opinions (socio-constructivist principle) [12].

It turns out that evaluating usability of e-learning systems requires specific criteria. Among existing techniques, inspection methods, e.g. heuristic evaluation, are easier to administer and less costly [9]. Their drawback is that they apply a small set of general guidelines to a wide range of specific systems. This problem is pointed out by various researchers, who defined more specific guidelines for particular system classes [1, 7, 13].

In this paper, we describe our approach to e-learning tools evaluation through a method that systematizes inspectors' work.

3. SUE INSPECTION

Usability inspection refers to a set of methods in which evaluators examine usability-related aspects of an application. One of the most commonly used is heuristic evaluation [8]. However, as highlighted in [3], its major drawback is its high dependence upon skills and experience of evaluators, so that different inspectors might produce non-comparable outcomes. In order to overcome these problems, an inspection technique has been introduced as part of the SUE (Systematic Usability Evaluation) methodology for usability evaluation [6]. In accordance with the suggestion to develop category-specific heuristics [9], the methodology requires to firstly identify a number of analysis dimensions, suited for the class of applications at hand. For each dimension, general usability principles are decomposed into finer-grained criteria. Following users' and experts' experience, a number of specific usability attributes or guidelines are associated to these criteria. In order to guide the inspector's activity, the inspection is based on evaluation patterns, called Abstract Tasks (ATs), addressing the identified guidelines. ATs precisely describe which objects of the application to look for, and which actions the evaluators must perform in order to analyse such objects. They are formulated precisely by means of a *pattern template* including a number of items. *AT Classification Code* and *Title*: univocally identify the AT, and its purpose. *Focus of Action*: lists the application constituents to be evaluated. *Intent*: clarifies the specific goal of the AT. *Activity Description*: describes in detail the activities to be performed during the AT application. *Output*: describes the output of the fragment of the inspection the AT refers to. So, also evaluators lacking of expertise in usability and/or application domain are able to produce more complete and precise results. Following SUE methodology, we have derived a set of usability attributes or guidelines, specialized for e-learning systems. We have not enough space to detail the derived ATs and we prefer to focus on evaluation dimensions.

4. THE PILOT STUDY

In order to discover problems that arise using e-learning systems, we observed a group of e-students, during their interaction with one such system in a real situation.

4.1 Participants and Method

We adopted the thinking aloud technique to observe ten post-graduated students of a Master course at the University of Bari, Italy, interacting with a DL (Distance Learning) system. They had to learn some new topics only using the system via Internet. A number of communication tools allowed to exchange information, to ask help and to suggest solutions. The evaluators took notes of what each user did and described. Then, an interview was carried out for gathering further information. The basic questions concerned the kind of difficulties met, the best way to organize educational material and services, opinions about the communication tools used (forum, chat, mail).

A self-assessment test was scheduled at the end of the study.

4.2 Results and Discussion

In spite of a short training course of 2 hours to get the participants familiarized with the system, both observation and interviews highlighted a number of problems.

A major number of participants experienced disorientation and often reported difficulty to proceed, particularly when following a new learning path or using a service for the first time. Moreover, a number of users complained about the lack of mechanisms to highlight both lesson structure and high priority topics, in particular those scheduled for a particular learning session. Actually, a lot of participants linked to a wrong didactic unit. It comes out that learning material presentation, providing a consistent visual conceptual map for easy navigation, is a relevant aspect for e-learning system usability. It would also be suitable to allow a personalized access to the content.

Participants also reported problems searching the educational material to study: it was included in a list, two or more pages long, but they didn't understand how to access pages following the first one. Search for documents should instead be facilitated, e.g. by a clear specification of key-words for each subject.

A number of participants showed frustration when they had to start from the beginning due to network failures. Moreover, some participants' sight got tired during prolonged interaction with the e-learning system. Therefore, a number of comments stated it should be possible to use the platform offline and the educational material should be printable.

Self-assessment allowed the participants to control their progresses, and this was found very motivating. Finally, participants expressed a positive opinion on the synchronous and asynchronous communication tools, allowing collaborative learning.

We classified the results in three categories of problems with the respective ratio of users reporting that problems: Presentation (80%), Orientation (95%), and Functionalities (60%).

In conclusion, the pilot study confirmed that e-learning usability is a very complex issue. We have to consider presentation aspects, in particular cues helping learning. Moreover, the presence of hypermedia tools requires the possibility to

personalize the reading path and the communication through different channels, still permitting orientation. Finally, user's initiative should be encouraged: the participants preferred self-assessment tests to evaluate their progress. The above aspects are related not only to the e-learning environment, but also to the structure of the educational material.

In the next section we describe the usability attributes identified by means of the pilot study and the literature analysis.

5. USABILITY EVALUATION

An e-learning platform (container) is an environment integrating tools and services. Attributes for a platform generally differ from those of a specific e-learning module (content), since different features must be considered. However, some characteristics of the content provided through a platform are bound to functionalities of the platform itself. In identifying criteria and attributes for evaluating e-learning tools, we must consider nature and goals of e-learning, requiring user-system easy interaction, but even significant knowledge gain. Starting from the evaluation categories identified in the pilot study, and considering recent literature (for sake of space we cannot quote all the interesting material, but see for example ACM E-Learn Magazine, http://www.elearnmag.org/), we identified four dimensions for our analysis: *Presentation, Hypermediality, Application Proactivity, User's Activity*. In section 5.1 e 5.2 we discuss evaluation criteria along this four dimension. As computer scientists, we can only evaluate "syntactic" aspects of tools. In order to go deeply into aspects concerning pedagogical approach and content semantics, experts of science of education and domain experts are to be involved in the evaluation design. This is what we are presently doing in order to refine the analysis.

5.1 Evaluating an e-learning platform

In the following, we detail elements referred by each dimension for evaluating an e-learning platform.

- *Presentation*: all aspects bound to visualization of tools and elements of the e-learning platform. Actually, we ought not to confuse visualization of platform elements, discussed in this dimension, with their structuring and modelling, which pertain, depending on the object at hand, to other dimensions.
- *Hypermediality*: the presence of hypermedia tools appears as a positive feature; as it will be discussed later, this could non be true when evaluating how contents are structured inside educational modules. Hypermediality allows to communicate through different channels (audio, video, textual) but even to organize lessons in a non-sequential way, possibly allowing a student to choose a logical path different from the one suggested. It is important to notice the poor learning value of non-contextual links, saving references to target documents without reference to the point from which the link conceptually starts: in an educational context, information obtains meaning just from its framework.
- *Application Proactivity*: platform tools (e.g. communication tools) not strictly related to reading the content. Ease of use of such tools gains an even greater importance in LCD systems, because the user just makes an effort consisting in learning, which is the primary goal. Moreover, student's errors in using the platform tools should be prevented as much as possible. However, ease of use and error prevention do not apply to tools strictly bound to learning (in particular the learning domain tools) and to students' assessment tests. In these cases, errors must be rather highlighted by the platform, both using mere graphics, providing places for explanations, and automatically suggesting links to scarcely mastered subjects.
- *User's Activity*: user needs that could arise during user interaction.

5.1.1 Usability Criteria for an E-Learning Platform

For each dimension, we considered the general principles of effectiveness and efficiency that contribute to characterize usability [4], dividing them in criteria as follows:

Effectiveness:

- *Supportiveness for Learning/Authoring*: how the tools provided by the platform allow to learn and prepare lessons in an effective way.
- *Supportiveness for communication, personalization and access*: how the provided tools satisfy these needs greatly influence the learning effectiveness.

Efficiency:

- *Structure adequacy*: how efficiently the activities the user usually performs are structured and visualized.
- *Facilities and technology adequacy*: efficiency of scaffolding and supplementary supports provided to the user; how the platform adapts to the technology used by the learner to access it.

From criteria, actual guidelines are derived (Table 1).

5.2 Evaluating an e-learning module

In the following, we specialize each dimension for evaluating an e-learning module.

- *Presentation*: how the lecturer plans visualization of lessons and supports to the students (scaffolding) s/he has prepared.
- *Hypermediality*: hypermedia tools can be surely considered an advantage. Nevertheless, a deeper observation shows the risk, if misused, to burden instead of facilitating the student. This happens if sensory channels are overloaded, also considering that the student is not expert of the learning domain. For example, auditory and textual channels overlap would take to a symbolic memory overload. Moreover, it is good practice not to overuse hypermedial links, as they cause a change in what the student visualizes. Such changes could take to a problem which is common on the web, i.e. to be "lost in hyperspace".
- *Application Proactivity*: value of teaching is found in the ability to propose activities suitable to form effectively and efficiently. One of the principles of socio-constructivist theory is that learning occurs in an environment where tools reflect the actual context of use: the learning domain must be introduced without oversimplifications since the beginning, eventually providing scaffolding; the student will "learn by doing", and making errors.

User's Activity: the student may need to perform unplanned activities. Examples of such needs are customizing media channels, creating personal paths or performing tests.

5.2.1 Usability Criteria for an E-Learning module

In this context, for each dimension we have considered the principles of *effectiveness of learning/authoring* and of *efficiency of supports and teaching modalities*, which do not divide in further criteria (Table 2).

Table 1.

Dimensions	General principles	Criteria	Guidelines
Presentation	Effectiveness	Supportiveness for Learning/Authoring	For interface graphical aspects, the same UCD attributes hold
			Errors and cues to avoidance are highlighted
		Supportiveness for communication, personalization and access	It is possible to personalize interface graphics
	Efficiency	Structure adequacy	System state is clearly and constantly indicated
			Progress tracking is clearly visualized
			Possibilities and commands available are clearly visualized
			Course structure is clearly visualized
		Facilities and technology adequacy	Adaptation of the graphical aspect to the context of use is provided
Hypermediality	Effectiveness	Supportiveness for Learning/Authoring	The lecturer is supported in preparing multimedia material
			Easy movement among subjects is allowed by highlighting cross-references through state and course maps
		Supportiveness for communication, personalization and access	Communication is possible through different media channels
			A personalized access to learning contents is possible
	Efficiency	Structure adequacy	Both lecturer and student can access the repository
		Facilities and technology adequacy	It is possible to create contextualized bookmarks
			The platform can be used off-line, maintaining tools and learning context
Application Proactivity	Effectiveness	Supportiveness for Learning/Authoring	Lecturers can access a scaffolding library to suggest winning models
			It is possible to insert assessment tests in various forms
			The platform automatically updates students' progress tracking
			The platform allows to insert learning domain tools
		Supportiveness for communication, personalization and access	Users profiles are managed
	Efficiency	Structure adequacy	Mechanisms exist to prevent usage errors
			Mechanisms exist for teaching-through-errors
			Lecturers and students access the repository in different modes
			Platform tools are easy to use
		Facilities and technology adequacy	It is possible to automatically and correctly attenuate scaffolding
			Adaptation of technology to the context of use is provided
			The date of last modification of documents is registered in order to facilitate updating
User's Activity	Effectiveness	Supportiveness for Learning/Authoring	Easy-to-use authoring tools are provided
			Assessment tests to check one's progress at any time are provided
			Reports are managed about attendance and usage of a course
			It is possible to use learning domain tools even when not scheduled
		Supportiveness for communication, personalization and access	It is possible to eliminate scaffolding or to personalize its attenuation
			Both synchronous and asynchronous communication tools are provided
			It is possible to communicate with both students and lecturers
			It is possible to make annotations
			It is possible to integrate the provided material
	Efficiency	Structure adequacy	Mechanisms are provided for search by key or natural language
		Facilities and technology adequacy	Authoring tools allow to create standard-compliant documents and tests (AICC, IMS, SCORM)
			Authoring tools facilitate documents update and assessment tests editing

6. Conclusions

We have discussed several issues related to the evaluation of e-learning systems. We have defined a set of usability criteria that capture "syntactic" features of such applications. We have also proposed to adapt to the e-learning domain the SUE inspection technique, which uses evaluation patterns (Abstract Tasks), to drive the inspectors activities. Though platform-container and educational module-content are to be evaluated separately, a number of implications exist among aspects pertaining to the two spheres. The quality of an educational module, when provided through a platform, suffers of the quality of the tools provided by the platform itself:

• only if the platform provides insertion or automatic detection of the course map, the lecturer will be able to exploit it;
• learning domain tools can be used if they can be inserted;
• if both synchronous and asynchronous communication tools are provided, "blended learning" is possible;
• assessment can suffer of the lack of assessment authoring tools and lack of error-handling mechanisms;
• authoring mechanisms influence lessons quality; specifically, update consistency, equilibrium in scaffolding presence and standard-compliance could be affected;
• the eventual platform has to allow the student to attenuate scaffolding, so that it results more useful;
• mechanisms to search by-keyword or through natural language, facilitates both lecturers and students.

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Table2.

Dimensions	Criteria	Guidelines
Presentation	Effectiveness of teaching/authoring	Content update is consistent
		High priority subjects are highlighted
		Graphic layout does not distract the learner but helps him/her in learning
		Hierarchical structure of course subjects is highlighted
	Efficiency of supports and teaching modalities	Scaffolding are assigned a non-invasive space to not distract the learner
Hypermediality	Effectiveness of teaching/authoring	Used tools are able to plunge the learner in the learning domain context
		Specific communication media are used for each subject and learning goal
	Efficiency of supports and teaching modalities	Communication channels are used in an optimal way
		Hypertextual and hypermedial links are carefully used
		Learning material can be reused and integrated
Application Proactivity	Effectiveness of teaching/authoring	Specific learning domain tools are provided
		The help and number of scaffolding are carefully chosen
		Testing tools are reliable
	Efficiency of supports and teaching modalities	Scaffolding is correctly attenuated (if attenuation is driver by the lecturer)
		The document formats used do not require specific plug-ins
User's Activity	Effectiveness of teaching/authoring	It is possible to limit or choose the media channels
		Blended-learning simulations are provided
	Efficiency of supports and teaching modalities	Search for documents is facilitated by a correct and clear specification of key-words

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