THE EVALUATION OF AN E-LEARNING WEB-BASED PLATFORM

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Abstract: In recent years, designing useful learning diagnosis systems has become a hot research topic. In order to help teachers and designers to create useful e-learning environment we tried to find an evaluation method that would evaluate an applications' usefulness and also its pedagogical abilities. Because one evaluator (typically a teacher, designer or planer) can hardly be an expert on all fields of science, a multidisciplinary evaluation framework has been created to help the evaluators to address the critical factors of quality of e-learning. The purpose of this paper is to describe an evaluation system based on usability and pedagogical usability evaluation of e-learning. The evaluation framework and the prototype have been tested at the Department of Informatics at Ionian University, in the courses of Mathematical Modelling.

1 INTRODUCTION

New information and communication technologies allow learning "far away" from the teaching source. One challenge for e-learning educators is to design useful learning diagnosis system (Ssemugabi, De Villiers, 2007). An e-learning system based on the two cores, usability and pedagogical usability. The International Standards Organisation (ISO) defines usability as (*ISO-924, 1998*):

"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context."

There are various evaluation methods such as analytical, expert heuristic evaluation, survey, observation and experimental methods (Hartson, Andre, & Williges, 2003, Quintana, Carra, Krajcik, Elliot, 2001).

Pedagogical usability evaluation should address aspects of pedagogy and learning from education domains as well as human-computer interaction factors (Ravden, Johnson, 1989), such as the effectiveness of interfaces and the quality of usability and interaction (Silius, Tervakari, Pohjolainen, 2003).

The paper is organized as follow:
Section 2 describes the e-learning platform which is used for the evaluation procedure. Section 3 describes the evaluation procedures as well as usability field as at pedagogical. Section 4 reports the early results and Section 5 provides conclusions.

2 THE E-LEARNING PLATFORM

Our e-learning platform (figure 1) consists of a Web Page, with navel point an enhanced Webcast and at the same time it will have other capabilities, like Java applications, connections on the Web in selected applications and services. Looking at the interface (figure 1) we can easily see the format that our e-learning platform have. The system will be user friendly, (Figure 1) it doesn't require any special computer skills from the user. We also suggest that the study of this educational material be linear, exactly like the creator has designed it.
Of course, the system isn't restricted only to the study of the material the Webcast provides, because of the other media that are been utilised, mainly through the Web.

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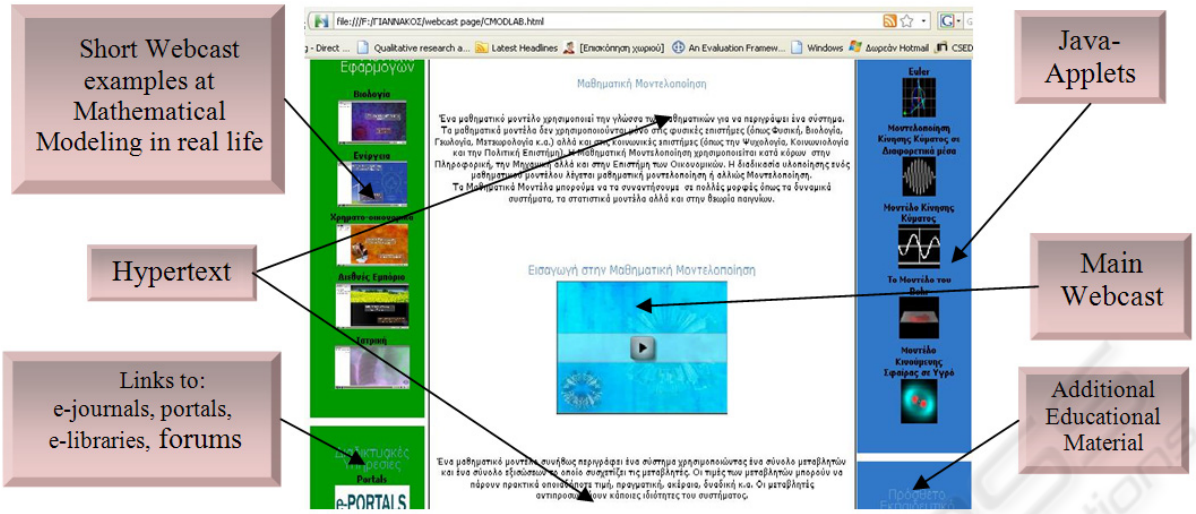

Figure 1: The e-Learning Platform.

3 E-LEARNING EVALUATION

The e-learning evaluation was based on earlier research on human-computer interaction (Quintana, Carra, Krajcik, Elliot, 2001), psychology and pedagogy as well as on evaluation research which has its roots in the theory of usefulness of computer system (Silius, Tervakari & Pohjolainen, 2003).
Usefulness of e-learning environments is divided into two main issues: usability and pedagogical usability (Figure 2).

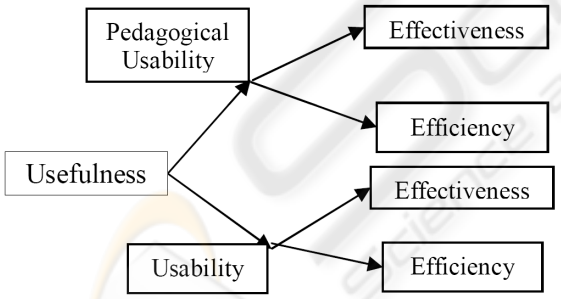

Figure 2: Usefulness of e-learning environment is a combination of its usability and pedagogical usability Based on Nielsen (1993).

3.1 Usability Evaluation

Ensuring usability is one of the main challenges for the e-learning system developers. An appropriate set of 10 criteria (Table 1) based on an undertaken study of the author (Giannakos, 2009) combined with a 5-point rating scale (similar to Nielsen)(Nielsen, 1993) will be a nice solution to assess the problems and assign severities (Table 2).

Table 1: Set of usability criteria.

	General Usability Criteria for e-Learning Context
1	**Avoid unnecessary elements.** Avoid when possible chattiness, complex graphics etc. Extra information distracts the user from its target.
2	**Usage of comprehensive language.** Avoid using computer and system terms. Pursuit to use phrases that the user can easily understand.
3	**Minimization of the users mnemonic load.** Help the user to identify and not to remember
4	**Maintain consistency throughout the interface.**
5	**Provide feedback.** Inform the users about what is happening in the system. If the waiting is >10' then we have a sign of work progress, if it is 1-10' change of the cursor shape.
6	**Give easy and clear ways of escape.** To exit fast from a wrong situation. Give the ability to Cancel, Undo and Redo
7	**Provide shortcuts for quick work access from experienced users.** (e.x. keys, predict typing, repetition of last orders, recent documents, macros.) The shortcuts should be obvious to users
8	**Provide clear messages of errors.** Avoid encoding the error messages. Not aggressive or rude language, precise expression, constructive character, indications, connection with aids.
9	**Design to avoid errors from the user.** For example option of a name record instead of its typing, confirmation before a dangerous act, avoid using the same order with different meaning in a different situation.
10	**Efficient backup- Help and Manuals.** The search in the manuals has to be easy, to be structured according to the user's works; there should be an extensive usage of examples etc

Table 2: Five-point rating scale.

Cosmetic Problem Will not affect the use of the system. Fix it if possible.	1
Minor Problem Users can easily work around the problem. Fixing it should be given a low priority.	2
Medium Problem Users are likely to encounter this problem but will quickly adapt. Fixing it should be a medium priority.	3
Major Problem Users will find this problem difficult but may work around it. Fixing it should have a high priority	4
Catastrophic Problem Users will be unable to do their work because of this problem. Fixing it is mandatory	5
Not Applicable I don't consider this to be a problem	N

Based on a previous research (Ardito, Costabile, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano, 2006) we can divide usability evaluation analysis in 4 same weight dimensions:

- Presentation:

All aspects bound to visualization of services and elements of e-learning platforms.

- Hypermediality:

Hypermediality allows communicating through different channels and even to organize lessons in a non-sequential way, possibly allowing a student to choose a logical path different from the one suggested.

- Application Proactivity:

E-learning platforms services not strictly related to reading the content. Ease of use of such services gains an even greater importance in Learning Centre Design (LCD) systems, because the user just makes an effort consisting in learning, which is the primary goal.

- User's Priority,

User's needs that could arise during the interaction.

Each dimension according to the general principles (Ardito, Costabile, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano, 2006) is effectiveness and efficiency:

Effectiveness:

How the tools provided by the platform allow learning and preparing lessons in effective way. How the provided services satisfy these needs greatly influence the learning effectiveness.

Efficiency:

How efficiently the activities the user usually performs are structured and visualised.

How the platform adapts to the technology used by the learner to access it.

Making a deeper analysis (Ardito, Costabile, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano, 2006), it result this model of usability evaluation (Figure 3).

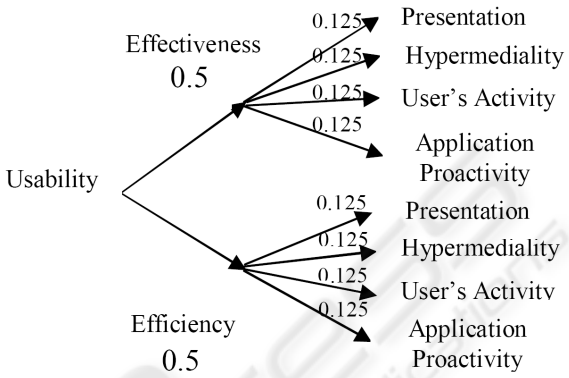

Figure 3: Usability evaluation model.

According to the 10 criteria study we undertook combined with the four directions that has been studied we come to the Table 3. The table with the 5-point rating scale and with the following equation (1) are our guide for the usability evaluation procedure.

$$U = 0.5U_1 + 0.5U_2 = 0.5\left(\frac{P_1 + H_1 + UA_1 + AP_1}{4}\right) + 0.5\left(\frac{P_2 + H_2 + UA_2 + AP_2}{4}\right) \quad (1)$$

Presentation → P, Hypermediality → H, User's Activity → UA, Application Proactivity → AP, Usability → U, Indicator 1 → Usability Effectiveness, Indicator 2 → Usability Efficiency.

3.2 Pedagogical Usability Evaluation

In its different form the e-learning offers a set of considerable priorities over the traditional teaching (Valcheva, Todorova, 2005).

- Individual Instructions
- Reduced Costs
- Opportunity for team work
- Flexibility of the learning material etc.

e-Learning takes the place of face to face learning. As a result all these pedagogical theories (Bruner, 1960, Quintana, Carra, Krajcik, Elliot, 2001) that were applied in face to face learning must be implemented into e-learning. That is the reason why we should make the pedagogical evaluation of e-learning.

Table 3: The outcome of the combination of the table 1 criteria and the 4 dimensions analysis evaluation, compose this questionnaire which is the base of the usability evaluation of the e-learning platforms. Based on (Ardito, Costabile, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano, 2006, Vlamos, 2001 Gillham, 2000).

General Principles		Guidelines
Effectiveness	Presentation	For interface graphical matters the same UCD attributes hold
		Errors and points to avoid are marked
		Possibility to personalize interface graphics
	Hypermediality	The lecturer is supported in preparing multimedia material
		Easy navigation between subjects is allowed by highlighting cross-reference through state and course maps
		Through different media channels communication is possible
		You can have a personalized access to learning subjects
	Application Proactivity	Lecturers are able to access scaffolding libraries and propose winning models
		Ability to administer user profile
		The platform automatically updates students' progress tracking
		It is possible to put in learning domain tools
		Possibility to put in assessment test in different forms
	User's Activity	Authoring tools are easy-to-use
		Ability to learn learning domain tools even when it is not on the schedule
		Possibility to eliminate scaffolding or personalize its reduction
		Asynchronous and synchronous tools are available
		Possibility to communicate with lecturers and also with students
		Possibility to make annotation
		Integration of the given material is possible
Efficiency	Presentation	System condition is clearly and continually shown
		Progress tracking is clearly visualized
		Possibilities and commands offered are obvious
		Course form is clearly visualized
		Alteration of the graphical aspect to the context of use is supplied
	Hypermediality	The repository can be accessed by the lecturer and the student also
		Available creation of contextualized bookmarks
		Off-line platform access, without loosing tools or learning content
	Application Proactivity	There are mechanisms in order to prevent usage mistakes
		There are mechanisms in order to teach-through-mistakes
		Easy to use platform tools
		Possibility to automatically and correctly assuage scaffolding
		There are different modes to access the repository by the lecturer and the students
		Possibility to adapt technology into the content of use
		Registration of the date of the last modification so updating is possible
	User's Activity	There are mechanisms for search by key or natural language

Pedagogical Usability Evaluation is divided into learning effectiveness and learning efficiency.

Firstly we will explain the calculation method of learning efficiency. If learning is defined as knowledge or skills acquired by instruction or study, learning efficiency can be defined as the sum of knowledge and skills gained that improves performance divided by the sum of all the information delivered during the learning process(Valcheva, Todorova, 2005).

Perfect learning efficiency where all the information delivered leads to learning that improves performance – is achieved at a rate of 1.0.

$t_j \rightarrow$ test j, $PU_2 \rightarrow$ Platform Efficiency,
$m \rightarrow$ number of students joined the group

$$E = \frac{Gained\_Knowledge\_and\_Skills}{All\_Information\_Delivered}$$

$$PU_2 = \frac{\sum_{m=1}^{m} \frac{t_{(1,m)} + \ldots + t_{(j,m)}}{j}}{m}$$

Figure 4: Efficiency calculation algorithm.

The efficiency score of e-learning course can be counted with special tests. These tests will contain all the delivered knowledge. The average result of

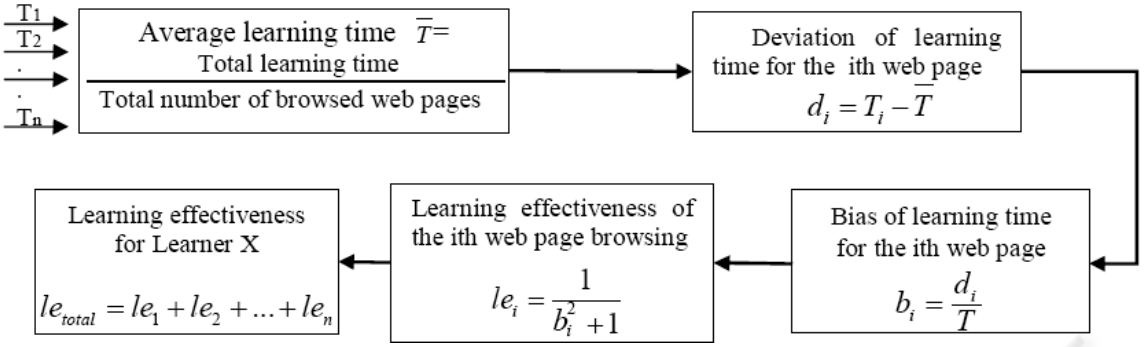

Figure 5: Flow diagram of each learner's e-learning effectiveness calculation (Huang, Chu, Guan, 2007).

these tests of all the members of the group is the efficiency percentage of the platform, PU_2.

In order to calculate the learning effectiveness we have to follow an approved method (Huang, Chu, Guan, 2007). Because our e-learning platform is a web page application, for the e-learning effectiveness we will follow a web page learning effectiveness calculation algorithm.

According to the approved method of e-learning effectiveness calculation (Huang, Chu, Guan, 2007):

The input Ti, shown on the upper-left of Figure 5 represents learner X's browsing time of the ith web page during his/her online learning activities. Notably, the browsing time measured is a single trip to the web page instead of a sum of trips to the page over time.

In this work we first compute learner X's average browsing time of each web page,

$$\overline{T} = \frac{T_1 + T_2 + ... + T_n}{n} = \frac{\sum_{i=1}^{n} T_i}{n}, \quad (2)$$

Where n represents the total number of web pages that learner X browsed.

We then compute the deviation of the effective learning time for browsing the ith web page,

$$d_i = T_i - \overline{T}. \quad (3)$$

The bias of the effective learning time period for browsing the ith web page is defined as,

$$b_i = \frac{d_i}{\overline{T}}. \quad (4)$$

Next we compute the weight value of the ith web page that represents the learning effectiveness when learner X browsed the ith web page,

$$le_i = \frac{1}{b_i^2}. \quad (5)$$

Notably, the integer one is added to the denominator to resolve the infinity problem when the bias is zero.

Accordingly, lei becomes one when the bias bi is zero. This also consists with the definition of the learning effectiveness in this work since the learner spent a regular learning time in browsing the ith web page when the bias bi is zero. Furthermore, all the web pages organized for the learning materials on the e-learning platform are assumed to have similar complexities and difficulty levels in this work. In case different pages have varied inherent complexities and difficulty levels, the instructor should specify a difficulty level for each web page that is proportional to the estimated web page browsing time for each pupil, and then the rectified average browsing time of each web page is given by:

$$\overline{T} = \frac{\frac{T_1}{w_1} + \frac{T_2}{w_2} + ... + \frac{T_n}{w_n}}{n}, \quad (6)$$

Where wi denotes the complexity and difficulty level of ith web page.

The deviation of the effective learning time for browsing the ith web page as given by Eq. (3) should be updated as follows accordingly,

$$d_i = \frac{T_i}{w_i} - \overline{T}. \quad (7)$$

The learning effectiveness that learner X achieved after browsing n web pages can be cumulated as follows (Eq.8)

$$le_{total} = \sum_{n=1}^{n} le_i \Rightarrow$$
$$PU_1 = \frac{\sum_{m=1}^{m} \sum_{n=1}^{n} le_i}{m}. \quad (8)$$

As a result the effectiveness of the e-learning platform (PU_1) can be calculated as the average learning effectiveness of all the members of the experimental group that we examined.

4 CONCLUSIONS

Finally, the goal of this research is a general algorithm, which gives us the usefulness of our e-learning system (eq. 9). Defining: Usefulness → Use, Usability → U, Pedagogical Usability → PU, Effectiveness → Indicator 1, Efficiency →Indicator 2, we conclude into the following general algorithm

$$\begin{aligned} Use &= \frac{U + PU}{2} \Rightarrow \\ Use &= \frac{\frac{U_1 + U_2}{2} + \frac{PU_1 + PU_2}{2}}{2} \Rightarrow \\ Use &= \frac{U_1 + U_2 + PU_1 + PU_2}{4} \end{aligned} \quad (9)$$

Our effort for an early credibility verification of this e-learning evaluation system is composed by the evaluation of the e-learning application with the method mentioned above and with the conduction of a between-groups evaluation case study. In this case study the traditional teaching method is considered to be a useful learning way. More specific, our e-learning platform examined according to the effectiveness efficiency and 5-rating evaluation system criteria mentioned above. After that, a class of 40 students at Ionian University, department of Informatics were divided in two equal groups. The first group took the e-learning courses at the laboratory and the second group took the courses with the traditional way. Following we, with the method mentioned above, defining: E1→E-learning Efficiency, E2→Traditional learning Efficiency

$$E_1 = \frac{Students\_Score}{Use\_platform} = \frac{0.6}{0.7} = 0.86$$

$$E_2 = \frac{Students\_Score}{Use\_traditional} = \frac{0.75}{0.85} = 0.88$$

Thus, we can accept in some point that the evaluation method we suggest is correct.

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